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SURGICAL EMERGENCIES

AND

ACCIDENTS.

BY J. G. GILCHRIST, M. D.,

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TO MY FRIEND

R. C. OLIN, M. D.,

AS A TOKEN OF ADMIRATION AND ESTEEM,

FOUNDED UPON NEARLY TWENTY

YEARS OF CLOSE AND INTIMATE

FRIENDSHIP.

THE AUTHOR.

PREFACE

The systematic study of accidents of all kinds, the indications for treatment, both instrumental and medicinal, with particular referance to prognosis as affected by Homœepathic therapeutics will form the subjects for our present enquiry. Some attempt has been made to treat the subjects presented in an exhaustive manner, in fact on a plan somewhat different from that of any work, in our school at least, with which the writer is acquainted. In this the third volume in the series, the student is introduced to what should constitute the studies for the third year of his pupilage; he is now required to apply the principles inculcated in the preceding years. The plan grew out of the following:

Students have frequently asked, why is it that extreme heat and extreme cold, affect living tissues similarly? or, how is intestinal hæmorrhage produced by cuticular burning? These are examples of questions, in the nature of conundrums, that have been so frequently asked, probably, of all teachers. The ordinary text-books ignore them entirely, as a rule, hence the present work was conceived, with a design to fill what really seemed a "long-felt want," inasmuch as an attempt has been made to meet these perplexing questions.

Whilst this has been the aim and object of the writer, carrying the student through a systematic course of study, yet there is a demand for just such a work for professional readers. None will

question that the higher walks of surgical practice are not to be lightly entered upon; that they demand a degree and kind of preparation beyond the reach and without the legitimate sphere of the physician. Still, there is very much of a strictly surgical nature, that *all* practitioners should be familiar with, particularly if their field of labor is remote from cities, or large towns, where competent surgical skill can not be obtained. Frequently demands are made that admit of no delay in applying means of relief, and a knowledge of the resources of surgical art may not only save mutillation, or even life to the sufferer, but reputation to the practitioner. Very much that is found in the following pages is contained in the larger works on surgery, but it is evident that no single work contains it all; a glance at the table of authorities quoted will amply sustain this assertion. Many of our best authors dismiss with a few lines that which is here deemed worthy of extended notice. Most of these topics are touched upon in college lectures, it is true, but our authors, as a rule, seem to consider them too trivial to claim attention. It is these "little things," often of inestimable value to the student and general practitioner, that I have attempted to put into a more enduring and systematic form.

No extended instruction has been given on principles of dressing, or ordinary pathological processes, as the work is supplementary to its predecessors. Major operations, and the principles of operative surgery, have also been briefly alluded to, as a later volume is designed to cover this field as thoroughly as the author's ability will permit. Nevertheless it is hoped that both for students and practitioners, the work will commend itself as eminently practical, and be found useful in the class-room, and the varied emergencies of professional life.

The present volume has been greatly enhanced in value by the addition of a chapter on *Injuries of the Eye*, and one on *Injuries of the Ear*, by D. J. McGuire, M. D., of Detroit, whose acknowledged skill as a practitioner, and accurate information as a student render unnecessary any commendation at my hands.

It is a subject of profound regret that in spite of the greatest care in proof-reading many misprints occur in the body of this work. The most glaring, which if left uncorrected would often entirely change or destroy the meaning of a sentence, have been noted in the subjoined list of *errata;* the reader will do well to make these corrections before undertaking to read the work. Minor errors, chiefly of orthography, have not been included in this list, as the correct meaning or spelling will be at once apparent.

J. G. GILCHRIST.

DETROIT, Mich., 1884.

CONTENTS.

DEDICATION, - - - - - - - - - - - - 5
PREFACE, - - - - - - - - - - - - - 7
LIST OF ILLUSTRATIONS, - - - - - - - - - 14
INTRODUCTORY, - - - - - - - - - - 17

I. SHOCK AND TRAUMATISM: - - - - - - 21
Primary and Secondary Shock.

II. ANÆSTHESIA: - - - - - - - - - - 28
Nitrous oxide gas; Sulphuric Ether; Chloroform; Methylene; Local anæsthesia.

III. CONTUSIONS: - - - - - - - - - - 38
Symptoms; Degrees; Prognosis; Consequences.

IV. WOUNDS; GENERAL CONSIDERATIONS: - - - 43
Definitions; Indications for Treatment; Processes of Repair.

V. CLASSIFICATION OF WOUNDS: - - - - - - 58
Incised; Lacerated; Contused; Punctured.

VI. GUN-SHOT INJURIES: - - - - - - - - 77
Nature; Causes of Death.

VII. POISONED WOUNDS: - - - - - - - - - 88
Poisons of Chemical Nature; Envenomed Wounds; Altered Normal Secretions; Dissecting Wounds.

VIII. EFFECTS OF HEAT AND COLD: - - - - - 107
Burns and Scalds; Frostbite; Chillblains.

IX. ASPHYXIA (APNŒA): - - - - - - - 121
Causes; Symptoms, Ante and Post mortem; Effects of Lightning.

X. INJURIES OF THE BLOOD-VESSELS: - - - - 131
Hæmorrhage, Primary and Secondary; Arterial, Venous, and Capilary; Callateral Circulation.

XI. INJURIES OF THE NERVES: - - - - - - 149
Immediate Consequences; Remote Consequences.

XII. INJURIES OF MUSCLES AND TENDONS: - . 159
Rupture of Muscles; Rupture of Tendons; Slipping of Muscles; Strains.

XIII. INJURIES OF THE JOINTS: - - - - - - 167
Wounds; Contusions; Sprains; Dislocations of Cartilages; Dislocations in General.

XIV. INJURIES OF THE BONES: - - - - - - 189
Contusions; Fractures in General.

XV. INJURIES OF THE HEAD AND SCALP: - - - 208
Contusion and Wounds of the Scalp; Contusion of the Skull; Fractures of the Skull; Compression, Concussion, Inflammation, Irritation, and Suppuration of the Brain; Hernia Cerebri; Injuries to the Cranial Nerves.

XVI. INJURIES OF THE EYE: - - - - - - 236
Wounds and Injuries to the Lids; Wounds and Injuries to the Ball.

XVII. INJURIES OF THE EAR: - - - - - - - 262
Foreign Bodies in the Ear; Injuries to the External, Middle and Internal Ear.

XVIII. INJURIES OF THE FACE: - - - - - - 266
Wounds of the Face; Wounds of the Nose; Wounds of the Lips; Injuries in the Parotid region; Salivary Fistula; Burns and Scalds of the Face; Wounds of Arteries in the Face; Wounds of Nerves in the Face; Fractures of Facial Bones; Dislocations of Facial Bones.

XIX. INJURIES OF THE MOUTH: - - - - - - 290
Wounds of Mouth and Tongue; Bee-stings in the Fauces; Injuries of the Arteries in the Mouth; Burns and Scalds in the Mouth and Pharynx.

and Concussions of the Larynx; Fracture and Dislocation of the Hyoid; Wounds of the Œsophagus.

XXI. INJURIES OF THE SPINE: - - - - - - 331
Sprains, Fractures, Dislocation of the Spine; Injuries to blood-vessels; Compression, Concussion, Puncture, and Division of the Cord.

XX. INJURIES OF THE THROAT AND NECK: - - 296
Foreign Bodies in the Throat; Wounds of the Neck; Injuries of Blood-vessels; Injuries of Nerves; Wounds, Fracture, Rupture, and Hernia of the Trachea; Burns, Wounds, Fracture,

XXII. INJURIES OF THE UPPER EXTREMITIES: - - 364
Wounds of Soft-parts; Injuries of the Blood-vessels; Wounds of Nerves; Fractures; Dislocations.

XXIII. INJURIES OF THE CHEST: - - - - - - 419
Contusions; Wounds of Chest; Injuries of Viscera; Fractures; Dislocations.

XXIV. INJURIES OF THE ABDOMEN: - - - - - 448
Contusions; Rupture of Muscles; Injuries of Viscera; Wounds of Abdomen; Injuries of Blood-vessel; Foreign-bodies in Abdomen.

XXV. INJURIES OF THE PELVIS: - - - - - - 478
Injuries of the Viscera; Fractures; Dislocations.

XXVI. INJURIES OF THE LOWER EXTREMITIES: - - 494
Fractures; Dislocations; Injuries of Blood-vessels, and Nerves.

XXVII. INJURIES OF THE MALE GENITALS: - - - 548
Injuries of the Scrotum, Testes, Urethra, Penis.

XXVIII. INJURIES OF THE FEMALE GENITALS: - - 563
Contusions and Wounds: Foreign-bodies in the Vagina.

AUTHORITIES AND REFERANCES: - - - - - - - 566
INDEX, - - - - - - - - - - - - - - - 570

LIST OF ILLUSTRATIONS.

FIG.		PAGE.
1.	Diagram of Gun-shot wound,	80
2.	Head and fang of Rattlesnake,	89
3.	Formation of Clot in an Artery,	138
4.	Petit's Tourniquet,	139
5.	Spanish Windlass (Garrote),	140
6.	Maws' Compressor,	140
7.	Esmarch's Tourniquet,	141
8.	Seizing Artery with Tenaculum,	142
9.	Tying Artery, in continuity,	144
10.	Torsion of Arteries	146
11.	Accupressure, 1st method,	146
12.	" 2nd "	146
13.	" 3rd "	147
14.	" 4th "	147
15.	Dressing for ruptured Heel-tendon,	163
16.	Suture of Muscles, subcutaneous,	163
17.	Clove-hitch,	185
18.	"Spanish Windlass," for extension,	185
19.	Pulleys for dislocations,	186
20.	Transverse fracture (*en rave*),	193
21.	Oblique fracture (*bec de flute*),	194
22.	Longitudinal fracture,	194
23.	Partial (willow-twig) fracture,	195
24.	Buck's extension dressing,	203
25.	" " "	203
26.	"Tailing" of wounds,	268
27.	Subcutaneous wound, from a bone,	268
28.	Splint for the nose,	279

29. " " lower jaw, ... 286
30. Œsophageal forceps, ... 299
31. Double catheter, ... 337
32. Heyfelders' Splint, for wrist, ... 367
33. Line of fracture of clavicle, ... 380
34. Displacement of fractured clavicle, ... 381
35. Splint for the shoulder, ... 384
36. " " " elbow, ... 392
37. " " " olecronon, ... 396
38. " " " Colles fracture, ... 400
39. " " " the fingers, ... 403
40. "Indian puzzle," for dislocation, ... 417
41. Levis' Adjuster " " 417
42. (*a.*) Aspirator, ... 433
42. (*b.*) Ligature of the omentum, ... 468
43. Ligature of intestine, ... 470
44. " " 471
45. Suture for intestine, ... 471
46. Lembert's Suture for intestine, ... 472
47. Distribution of pelvic arteries, ... 491
48. Diagram of the head of the femur, ... 498
49. Long splint for fracture of femur, ... 501
50. Diagram of line of fracture of neck of femur, ... 502
51. Splint for fracture of patella, ... 511
52. " " " " fibula, ... 514
53. Ileo-femoral ligament, ... 519
54. Extension for hip dislocation, ... 524
55. Obturator Internus, ... 528
56. " " in hip dislocations, ... 528
57. Arching of spine, in ischiatic dislocations, ... 529

CORRIGENDA.

Page	48,	line	26,	read,	or lead wire	for,	wire, or lead.
"	80,	"	37,	"	present	"	permit.
"	90,	"	4,	"	preceeding	"	opposite.
"	108,	"	last,	"	convalescence	"	convulsions.
"	112,	"	9,	"	burning	"	boiling.
"	113,	"	5,	"	head	"	heart.
"	132,	"	32,	"	prevent	"	present.
"	183,	"	33,	"	tied	"	tried.
"	148,	"	9,	"	seton	"	suture.
"	172,	"	22,	"	excite	"	exert.
"	212,	"	29,	"	digastric	"	digestive.
"	215,	"	30,	"	there	"	these.
"	223,	"	37,	"	in	"	on.
"	228,	"	8,	"	description	"	descript.
"	346,	"	46,	"	aerated	"	arrested.
"	372,	"	7,	"	musculo-spiral	"	musculo-spinal.
"	372,	"	16,	"	the	"	then.
"	381,	"	21,	"	corocoid	"	corcoid.
"	388,	"	5-6,	"	prefered	"	prefer.
"	389,	"	37,	"	longer	"	larger.
"	393,	"	2,	"	to the condyles	"	of the and etc.
"	398,	"	10,	"	function	"	fracture.
"	400,	"	27,	"	Hays,	"	Hoynes.
"	407,	"	26,	"	their	"	there.
"	408,	"	18,	"	imminent	"	eminent.
"	411,	"	11,	"	machinery	"	marching.
"	414,	"	5,	"	preternatural	"	putrenatural.
"	417,	Fig.	41,	"	Levis'	"	Levi's.
"	417,	line,	19,	"	clove-hitch	"	close-hitch.
"	421,	"	9,	"	even	"	over.
"	422,	"	last,	"	lung	"	wound.
"	428,	"	24,	"	of	"	by.
"	428,	"	4,	"	argue	"	agree.
"	428,	"	27,	"	not to be interfered	"	interfered.
"	432,	"	40,	"	spaces	"	spans.
"	478,	"	18,	"	interested	"	intrusted.
"	519,	"	22,	"	ligamentum teres	"	capsualar, etc.
"	519,	Fig,	53,	is	upside down.		
"	520,	line,	33,	read	ischiatic	for	ischiatei.
"	524,	"	3,	"	constriction	"	construction.
"	526,	(table)	1st line	"	adduction	"	abduction 1st column.
"	526,	"	3d line	"	adduction	"	abduction 2d column.
"	527,	line,	31,	"			
"	529,	"	19,	"	adduct	"	abduct.
"	531,	"	5,				
"	534,	"	42-43,	"	they	"	it.
"	557,	"	15,	"	present	"	permit.
"	560,	"	11,	"	exertion	"	examination.

SURGICAL EMERGENCIES.

INTRODUCTION.

THE NECESSARY REQUIREMENTS.

The first desideratum, in all arts, is the possession of proper "tools of the trade," by the possession of which only can facility in their use, and knowledge of their purposes be acquired. This is so true in surgical matters that we are justified in doubting the abilities or experience of those who do not possess proper instruments. For the practice of surgery in its entirety, many instruments are required, but for purposes contemplated in the following pages the number is small, and of exceedingly simple construction. Every medical man should possess a compact pocket case of instruments, the selection of the different articles being made with reference to the amount of surgical practice the possessor expects to have. To those who practice surgery largely or exclusively, a pocket case need contain only such articles as are of service in dressing wounds and injuries; these do not require particularization, as surgeons are supposed to know their own needs. The general practitioner, who only proposes to give surgical attention to the commoner accidents and injuries, will require a larger case with instruments for a variety of purposes. After much experiment in the past fifteen years, I have decided that the following list will embrace all his wants: Scalpel; straight bistoury; curved sharp-pointed bistoury; curved probe-pointed bistoury; tenotome; tenaculum; aneurism needle; oxploring needle (or trocar); jointed catheter, about No. 6; two or three probes; dissecting forceps; spring-catch forceps, for needle or artery; scissors; with a dozen assorted needles, pins, wire, silk, etc. For the sake of compactness, two blades in one handle will be found desirable, which should be supplied with either a sliding or spring catch, the former much the better. The handles should be firm, and the blades of a rather larger size than would be needed in a surgeon's dressing case. The greatest care should be paid to the instruments, keeping them clean, dry and sharp. They should never, under any circumstances, be used for anything but their legitimate purpose. A rusty spring in the artery forceps, might possibly place a patient's life in jeopardy, and dirty knives or needles are not incapable of producing septic poisoning.

In addition to his pocket case of instruments, the physician should

have what I call "an accident case." This is a small satchel, which is kept constantly supplied with the following articles: A role of adhesive plaster; two or three clean sponges; two or three roller bandages of different widths; a roll of lint; a small quantity of raw cotton, or the modern absorbing cotton; with half ounce vials of the following tinctures: Arnica, Hamamelis, Hypericum, Ledum, Staphisagria, Calendula, Conium, Symphytum, Ruta graveolens, Carbolic acid, with a vial of Amyl nitrite, and one of Aqua ammonia. A vial of Chloroform may be added, and a box of simple cerate or cosmoline. This must be kept always supplied, and on being summoned in haste to a case of accident, with the pocket case, the physician will be prepared to meet almost any emergency that may arise, without losing precious time in looking up articles that may be useful.

WHAT TO OBSERVE.

Upon reaching the scene of an accident, there are several matters that demand attention, which may be treated under two heads, viz.: our duty to society, and our duty to the patient.

1. *To Society* we owe a duty which nothing must be permitted to interfere with. Many cases of accidents are due to assaults, others to criminal negligence, and some to causes of various characters, all of which may become the subject of legal inquiry, particularly if death should ensue. It should be a constant practice, therefore, to take accurate note of the surroundings, and the time of day when you first appear upon the scene, marks of struggle, disordered or torn clothing, blood-stained weapons; the position of the sufferer, the demeanor of the by-standers, particularly with reference to sobriety, must all be noted, and committed to writing. The nature, number and direction of the wounds, if any, must be noted, and, in short, every detail carefully observed, committed to writing, the notes carefully dated, and all particulars that might be required to fix guilt or establish innocence. There are so many instances on record in which inability to establish a material item of evidence has freed the guilty, or caused conviction of the innocent, simply from carelessness on the part of the medical attendant, that too much importance cannot well be given to *our duty to society*. Murders have been attributed to homicidal assault, which have subsequently been proved impossible of infliction with a weapon, or in the manner alleged; suicide has not seldom been mistaken for murder.

2. *Our duty to the patient* implies a preservation of life by arresting hæmorrhage, etc., a promotion of healing without deformity, and the prevention of loss of function. We must, therefore, consider the best way to promote union of wounds with the minimum of scarring, and the consolidation of fractured bones with the preservation of symmetry and a continuance of function; the restoration of failing strength, and the subduing or preventing febrile excitement, must all claim our attention. The position and expression of the patient must first

be noted, as in desperate cases valuable time will be saved by knowing where to direct our energies. A prone position, with coldness of the extremities, pale face, feeble respiration, and much thirst and uneasiness, will indicate dangerous bleeding. Similar conditions, with stertorous respiration and coma, indicate lesions of the brain. A tight closed mouth, with breathing through the nostrils, shows thoracic injury. With the body curved backwards or to one side we will look for spinal trouble. The trunk curved forward, with the knees drawn up, shows abdominal injury; while moderate anterior flexion, with nasal respiration, will often point to pelvic complications. In case of fractures or dislocations, or any other injury to the extremities or locomotor apparatus, the signs are numerous and valuable, and will be fully given when we reach the appropriate chapters.

Having decided in this way the location of the injury, our attention is at once paid to that point, and when two or more wounds exist, the largest and most important is, of course, first attended to. When hæmorrhage has been arrested, and the more urgent symptoms have had attention, carefully examine the body for other and concealed injuries. A neglect to do this may cost your patient his life, and somewhat dim your reputation. I knew of a case where the medical attendant set and bandaged a fractured arm, and then found his patient almost moribund from a penetrating wound of the abdomen with hæmorrhage from the internal epigastric artery. The patient's name, age, nativity, residence and occupation must be committed to writing, with a full and accurate description of his injuries, with *actual* measurements taken when any are needed.

Attention to these apparently trivial matters is of the utmost importance, and I have added note-book and pencil to my own "accident case" for this purpose. It will only be necessary to mention, that a large proportion of these cases of accident are the result of affrays, to emphasize the need for care in all the particulars referred to. A cursory examination of the description of shock, in our text-books, will bear abundant testimony to the frequency of death from trivial injury; a reference to any work on medical jurisprudence will furnish ample proof of the evils resulting from insufficient or careless medical attention. From a consideration of these two classes of facts, it is evident that we cannot demand too much care and method in medical examinations, and it would seem, from this view of the case, that the claims of society might outweigh those of our patient. Still, as a matter of fact, the interests of both are of equal value, and one should not preponderate over another.

SHOCK AND TRAUMATISM.

NATURE AND BEST MANAGEMENT.

While there is a pressing necessity, in all cases, to differentiate between *shock* and conditions similar as to semieology, there is much practical difficulty in doing so. As a matter of fact, it is often impossible, in many instances, and the most accomplished surgeon will find himself at fault, except so far as plausible probabilities are concerned. For instance the symptoms of shock are those of syncope from hæmorrhage or injury to nerve centres; they resemble somewhat the coma of compression of the brain; and also the insensibility of inebriation. If the injury has been one that could not possibly produce a severe hæmorrhage, syncope is at once ruled out of the problem; if injury to the head is equally impossible, and there is no appearance of intoxication, as alcoholic odor to the breath, etc. the condition can only be either shock or lesion of the nerve centres. In the majority of cases the history and nature of the injury will at once settle the question. In exceptional instances confusion will exist, and, in the present state of surgical knowledge, is inevitable. We are forced, very unwillingly, to accept this situation, and are consequently compelled to treat the case expectantly. This is the more to be deplored as much depends upon the recognition of the true condition; each practitioner must depend upon his own power of discrimination, aided by the summary of the knowlede of the day given below.

After the reception of an injury, there is found a state of nervous depression and physical prostration, known as *shock*. There is an objection, in some quarters, to the use of this word with the above significance. DR. CARNOCHAN (J. M.), seems to be among the most earnest and emphatic advocates of reform. He says (*Contributions to Operative Surgery*, Pt. III p. 88): "The term shock is used frequently as synonymous with collapse, probably from the fact that in some cases the effect follows the concussion so instantaneously that they appear to be identical. Shock may be regarded as the source of the nervous symptoms that take place after the occurrence of an accident, concussion being the first link of the chain of the consequent morbid phenomena; while the word collapse should properly be used to express the extreme prostration of strength and the agitation and perturbation of the nervous system which follow upon all severe injuries." The term shock, if retained in use at all, our author thinks, should be restricted to mean death resulting immediately, as from a blow upon the epigastrium.

None will be willing to dispute the accuracy of the term collapse, probably, as used by DR. CARNOCHAN, but that any positive benefit would accrue from such a radical change, I for one, very much doubt. There are many instances where even a radically defective word, yes even totally wrong from a consideration of its etymology, has been retained from the fact that long usage had given it sanction. So in this instance, *shock*, to a medical man, means just what is proposed to call collapse; and the word *collapse* to most of us, signifies extreme prostration from material causes, such as excessive hæmorrhage, and not a purely nervous prostration. I do not propose an attempt to force our writers to accept my definitions, yet it is necessary that the statement should be made that I use the words *shock* and *collapse* in the sense that long custom has sanctioned.

The symptoms vary greatly in intensity and duration, depending upon the extent of the injury, the vital resistance and mental strength of the individual, or the organs or tissues injured. The face is pale, hands and feet cold, with cold clammy perspiration (often confined to the head, face, or chest) and in extreme cases, much mental disorder and relaxation of the sphincters. The pulse is small, or weak and fluttering, and the whole condition may not inaptly be termed collapse. Cases have been observed in which comparatively trivial injury, or even simple mental impression — has been followed by severe shock, even death; while in other cases the most serious accident may be sustained, with slight shock, or none at all. Indeed shock alone is often sufficient to cause death, and it has been noted, by competent observers, that in death on the gallows almost two-fifths die from this cause, dying even before feeling the constriction of the rope. In the worst cases the appearance of the patient is very like the collapse stage in cholera, or in fatal hæmorrhage. The temperature is much lowered, and is a highly important symptom, as a means of prognosis at least. A fall of a degree or more is dangerous, and WAGSTAFF found that where the thermometer indicated a fall of 3.7° death inevitably followed.

Occasionally the patient will rally well, after an injury or operation, and after a time, days, weeks, or even months — sudden sinking will occur with all the worst symptoms of shock, the lips becoming white, face pale, extremities cold, and great disturbance of the heart's action. Persons of strong and robust constitution and vigorous mind, may disguise shock by a simple exertion of the will, as long as their bodily strength is unimpaired; but when they become weakened by loss of blood or long confinement, there may be a sudden giving way of the vital powers. This is known as *remote* or *secondary* shock, and death is a very frequent result. We should make it a rule, therefore, to watch closely our patient who has had no primary shock, and by prompt treatment, even anticipating treatment — may ward off this most serious complication.

The question of operation immediately after an injury or during the existence of shock, is one of much moment, and has long occupied

the attention of surgical students. The subject has been discussed elsewhere, to some extent, in the present volume, and it may serve the purpose, at this place, to give the results as far as they are attainable, without attempting to summarize the valuable reports from which the deductions are drawn.

Operations have always been grouped into three divisions or classes, when for traumatic conditions, and with sole reference to the time elapsing between the injury and the operation. Various writers have attempted different classifications; some including in the *primary* group all operations performed during the existence of shock; and others all performed at any time between the time of the accident and the commencement of inflammatory conditions. The lamented GEO. A. OTIS, UNITED STATES ARMY, in *Circular No. 2, Surgeon General's* Office, p. 6, uses the following language: "I describe the operations in three categories; primary, intermediate, and secondary. This classification, adopted by this office in discussing all the major amputations and excisions, has been criticised by students of the closet and by surgeons of civil life, but by no military surgeons of practical experience. If the study of the histories of over twenty thousand major amputations, and of more than four thousand excisions of the larger joints, performed during the late war, may permit me to speak authoritatively on this point, I would say that no doctrine in military surgery is supported by more ample evidence than that which teaches that in operations for traumatic causes there is a wide difference in the results of those performed immediately after the reception of the injury, those performed during the existence of inflammatory action, and those done after the symptomatic fever and inflammatory symptoms have abated." Without quoting additional paragraphs this will suffice to indicate the classification quite generally adopted to-day, and while it is unquestioned that the "primary stage" may be continued for twenty-four hours, and the operation not necessarily performed during the stage of shock, which usually continues for only a few hours, and then the earliest in this period, yet it is also unquestioned that most primary operations were *immediate*, and thus performed during the shock.

We find (*Ibid*, p 112) that the result in one hundred and eighty-three cases of resection of the hip was as follows:

	Cases.	*Died.*	*Recovered.*	*Doubtful.*	*Ratio.*
Primary,	79	75	1	3	98.68
Intermediate,	76	70	6	....	92.10
Secondary,	20	13	7	....	65.
Re-amputations,	8	4	4	....	50.

Of excision of the shaft of the humerus (*Medical and Surgical History of the War: Surgical Volume, Part II.* 696), the following summary is given:

	Cases.	*Deaths.*	*Recovery.*	*Unknown.*	*Ratio.*
Primary,	487	145	326	16	30.7
Intermediate,	93	29	64	....	31.1
Secondary,	41	5	36	. ..	12.1
Unknown,	75	12	51	12	19.0
	696	191	477	28	28.5

Of amputations of the arm (*l. c.* p. 697), the following summary is given :

Operation.		*Cases.*	*Recovered.*	*Died.*	*Unknown.*	*Ratio.*
Primary.	Upper third,	1,338	1,155	183	....	13.6
	Middle third,	1,162	1,019	143	....	12.3
	Lower third,	512	406	106	....	20.7
	Not stated,	247	77	170	....	68.8
		3,259	2,657	602	....	28.9
Intermediate.	Upper third,	347	239	108	....	31.1
	Middle third,	348	255	93	....	26.7
	Lower third,	161	94	67	....	41.6
	Not stated,	46	12	34	....	73.9
		902	600	302		43.5
Secondary.	Upper third,	173	127	46	....	26.6
	Middle third,	162	127	35	....	21.6
	Lower third,	51	37	24	....	39.3
	Not stated,	15	6	9	....	60.0
		401	297	114		36.6
Unknown.	Upper third,	94	61	21	12	25.6
	Middle third,	67	45	13	9	22.4
	Lower third,	44	42	....	2	0.0
	Not stated,	699	345	194	160	35.9
		884	493	228	183	20.5
Totals.		5,456	4,027	1,246	183	23.6

A study of these tables will mislead, unless an important fact is constantly borne in mind. A very large proportion of the primary cases were so severely injured that no attempt was made to continue the case to a later period; they had lost much blood, sustained other injuries, and were cases of emergency; in spite of the unfavorable surroundings a large percentage recovered. In the intermediate cases we find a uniformly large percentage of deaths. The secondary cases represent only the small number who survived the "expectant" plan of treatment; probably many, perhaps a majority, of the cases of injury succumbed without having undergone an operation, and that might have been saved had a primary operation been performed. I think I reflect the opinion of most surgeons of experience, when I state that primary operations are to be prefered. And in this connection it may be noted that LISTER (*Vide* HOLMES *Syst. of Surgery*), has shown most clearly, that Chloroform is a stimulant, and its use

will alone cause reaction. Further he has shown, and my experience has fully verified it—that in cases of organic cardiac disease, Chloroform, so far from being contra-indicated, is the patient's greatest means of safety. Deaths on the operating table, but more particularly in the dental chair, have *all occured after insufficient anœsthesia*, as not only must we have unconsciousness, but even suspension of reflex action; hence death is due to shock. This is fully argued in the next chapter.

One of the most interesting facts connected with this subject, is that autopsy reveals no lesion sufficient to account for the fatal result; in an immense majority of cases we find no pathological conditions that would be thought diagnostic, everything appearing perfectly normal. Undoubtedly it is one of those cases in which the mind is alone at fault, and death follows from suspension of nervous stimulus whatever that may be. The examples of fatal issue from slight injury are too numerous and well known to need any space here; indeed the cases are not few in which death has followed simple mental emotion, as extreme joy, grief, fear, etc. In this connection I wish to give a theory of the cause of death that was worked out by my assistant in the University, Dr. H. M. Corey, a graduate of our college therein. I shall use his language substantially: "The only change that autopsy reveals, is that the heart and large venous trunks leading to it, are engorged with blood; but the integrity of the structures is, to all appearances, unimpaired. The blood coagulates rather imperfectly, the clots being loose and dark, and sometimes it is entirely fluid."

"Where shall we look for an explanation? It is plain that the all-important organ is the heart, whose functions are seriously interfered with; we find it engorged with blood, as the venous trunks, and how could this occur, unless the heart's action were suddenly suspended? The action of the heart is automatic; it is not directly dependent upon the nervous system, but simply regulated by it. The heart will continue to act after the removal of the whole of the great nerve centers, provided the operation be gently and gradually performed." (We see evidence of this in death while under Chloroform the heart will beat for from one to four minutes after respiration has ceased). "Still further proof of this is, that even the mammalian heart will continue to beat for some time after being removed from the creatures breast. The heart of a cat, after being divided into the one hundred and twenty-eighth part of its original size, will respond to a slight pinch of the forceps, or a prick with a pin, as I have myself demonstrated. This goes to show that its power of action resides in itself, and only requires the presence of blood to stimulate it, and the nervous system to regulate, to carry on all its functions. The chief nerve supply of the heart is from the cardiac plexus, which is, in turn, made up of branches from the pneumo-gastric and sympathetic system. The only branches that are not derived from this plexus are the left cardiac, which is a branch from the cervical ganglia; and the

left inferior cardiac from the pneumo-gastric; the heart is therefore supplied entirely from the vagi and ganglionic system. When we study the influence of these different sets of fibres on the heart's action, we shall see that they are very unlike indeed; for when we irritate the pneumo-grastric, the heart's action is diminished; while sympathetic irritation accelerates it. Now when the nervous system receives a severe shock, from any cause, it produces excessive nervous irritation; the primary effects being great stimulation, which disturbs the equilibrium of the entire system; and allowing this stimulation to be equally distributed to the heart, by the vagi and ganglionic systems, it would seem, at first sight, that its actions ought not to be affected in the least. But when we remember that the irritation is general, and that the irritation of the vaso-moter nerves reduces the calibre of the blood-vessels, and in so doing accelerates the flow of blood to the heart without compensatory heart's action, the cause of death in shock is, I think, satisfactorily made out."

TREATMENT.—Mild cases of shock may often be successfully treated by what has been called *moral* methods; kind and reassuring words, in some cases, and harsher expressions in others. One thing is certain, in the case of hysterical or "nervous" women it is better to let them "have their cry out," as any attempt at suppression will only be followed by more trouble later, secondary shock. The surgeon must exercise his judgment, in deciding how to treat such cases, as harsh treatment might seriously aggravate one case, while very essential in another. In grave cases, one in which the condition approaches syncope, and quite prolonged, or with only slow, interrupted, or imperfect reaction, the prone position (dorsal) had better be assumed; brisk rubbing with the hand instituted, and the use of pungent stimulating applications. *Amyl nitrite*, by olfaction, is a potent remedy, and when accessible will always produce speedy reaction. In any case, however, no matter what the attending circumstances may be, I would avoid the use of alcoholic stimulation, for the succeeding depression will be quite dangerous, more so, in fact, than the primary shock. In cases of *profound* shock, with syncope and prolonged unconsciousness, bleeding has certainly had surprising effects; certainly the flow of blood, as Dr. Corey has shown, will have some influence in overcoming the cardiac and venous congestion, and is an additional argument in favor of primary operations. The temperature of the body must be kept as near the standard as is possible, and all harsh treatment forbidden. Some of the methods used in asphyxia, particularly MARSHAL HALL'S, may be employed. When the patient is partially restored to consciousness, or has not entirely lost it, remedies will materially aid, or alone produce reaction. Some of our authors give a long list for this purpose, but my experience, which has not been at all inconsiderable, suggests a small number. The indications will be given shortly.

A return to consciousness, or the establishment of reaction, is foretold by the temperature rising, the color returning, the pulse becoming

more regular and stronger, the mind clearer, and the dorsal decubitus exchanged for some other position. Vomiting is quite a constant symptom of approaching reaction. Frequently the opposite condition may succeed, and we will have a febrile action of more or less intensity set up.

Arnica mon.—Wants the head low; diarrhœa with *involuntary stools;* involuntary urination; dizzy, with nausea.

Camphor.—Great coldness, *with hot breath;* hands and feet tremble on raising them; tongue trembles so he cannot speak.

Veratrum alb.—Cold as ice; *breath cold; tongue cold;* great weakness; distorted face; expression of terror.

II. ANÆSTHETICS AND ANÆSTHESIA.

THE BEST, ACCIDENTS AND EMERGENCIES.

In all ages the want of some means to induce insensibility to pain during surgical operations has been felt, and many attempts have been made to accomplish such a desideratum. Up to within a comparatively recent period, however, all efforts were accompanied by failure, many inducing greater danger from the anæsthetic than relief from suffering. The term *anæsthesia*, liberally translated, means *without feeling*, and is used to indicate a condition of insensibility to pain, with suspension of sensory and motor phenomena. Inasmuch as the various anæsthetic agents are in frequent demand in cases of accident, it is proper that a chapter should be devoted to the subject in a work of this character, but a complete dissertation is neither required nor desirable. I shall present the more practical phases of the question, and refer the curious reader to the work of SNOW on *Anæsthesia;* MORTON in his *Statement*, and the pamphlet of SIR JAS. Y. SIMPSON, together with the articles in the more complete works on Surgery, as HOLMES, GROSS, etc.

Considered solely with reference to priority of discovery, that is as an anæsthetic agent solely — and with no reference to its value as such an agent, NITROUS OXIDE GAS must take the first place in our historical account. It was the first agent that deserves the name of anæsthetic, and was discovered by SIR HUMPHREY DAVY, in 1800. A full account of its earlier use is found in the *Chemical Researches*, by this author, on page 556. Originally this gas was known as the protoxide of nitrogen, and may be prepared by "the action of equal parts of Nitric and Sulphuric acid, diluted with ten parts of water, upon metallic Zinc." It should be collected over warm water, and will appear as a colorless transparent gas, of a specific gravity of 1.527, of a faint sweetish taste and smell. Dr. HORACE WELLS, a dentist, employed it in his practice as early as 1844, which according to MORTON, (*Statement*, p. 42), is the earliest record of its use, for anæsthetic purposes, in this country at least. The gas is collected in a rubber receiver, and is inhaled through an appropriate mouth piece until the effect is produced. It should be fresh made, or at least not above a day or two old, and for this reason is of little value in ordinary practice, or even in special surgical practice; in hospitals, or large public institutions it may be suitable in a large number of instances, but I am not aware that it possesses any advantages over other agents. The effects are exceedingly evanescent, and the time required to produce its full effect is fully equal to that of Ether or Chloroform, if

not greater in many instances. Then, again, the muscular excitement is far greater than in the case of Chloroform, and from any point of view I fail to see any reason why it should be retained among surgical anæsthetics, unless it be preferable in those occasional instances where the patient has an unconquerable objection to the use of more legitimate agents.

Next on the list, in point of time, comes SULPHURIC ETHER. While it is only of late years that this substance has been used for purposes of anæsthesia, it has been known, it is supposed, as a pharmaceutical preparation since the thirteenth century, when RAYMOND LULLY had knowledge of it. Formerly it was produced as Nitric or Sulphuric ether, as either acid was employed in its preparation, but as the same result may be produced by the action of other substances upon alcohol than either of these acids, it is now commonly known as ether, but the prefix *sulphuric* is still retained from habit and long usage. The process is varied by different manufacturers, the result being about the same, or differing slightly in absolute purity, and is essentially the boiling a mixture of Sulphuric acid, and alcohol, of at least a specific gravity of 0.834, the distillation of which produces the Ether. The various methods are too long and complicated to receive attention at this time, but we may note that the process of BRANDE seems to give the best results, both as to economy and purity of the article. When finally prepared it is a highly volatile, and inflammable substance, combining readily with alcohol, of a specific gravity varying from 0.713 to 0.752; it boils at 96.5°, and when anhydrous has not been frozen at a temperature of 166° below zero. The chemical formula may be expressed as $C_4 H_{10} O$.

Perhaps the "priority of discovery" of no medicinal agent has been the subject for a more animated controversy than that of Ether.

In DR. MORTON'S *Statement* (p. 45), it is claimed to have first been administered by him for surgical purposes, in October, 1846, at a clinic of Dr. Warren's in the Massachusetts General Hospital. As far as its use by our Allopathic friends is concerned, this is probably correct. But we are in a position, I think, to claim this honor for Homœopathy, as PROF. C. B. MATHEWS, formerly a member of the Faculty of the Homœopathic Medical College of Pennsylvania, advises its employment in a pamphlet published in 1827. The article was published in the *Medical Recorder* for 1827, as an "*Essay on the Exhilirating and Medicinal Effects of Etherial Inhalations.*" HELMUTH, (*Surgery*, p. 73), devotes a paragraph to this matter, and there can be no doubt that the facts are as stated; although he simply gives the results of an experimental inhalation, I am informed that Dr. Mathews employed the agent, or secured its employment, in an operation in 1828. As an anæsthetic agent, without reference to surgical practice proper, DR. SAML. WOOLSTEN, (*Med. and Surg. Reporter*, May 27, 1870) refers to an advertisement still extant, in the *National Intelligencer* for June, 1836, of a dentist who used it in his practice, combined with Morphia. This is also noticed by HELMUTH, (*loc cit* p. 72.)

Thus it appears, that leaving Dr. Matthews out of the question, some unknown dentist in 1836 employed daily an agent claimed to have been discovered by MORTON in 1842. Still there can be no question that the common use of anæsthesia in surgical practice, dated from Dr. Warren's operation in 1846, and thus far Dr. Morton's claim may be conceded valid.

Ether has always, at least until quite recently, been more extensively used in the United States, and Chloroform abroad, but it is now falling somewhat into disrepute, chiefly on account of the time required to put a patient under its influence, and the very unpleasant sequelæ. Its supposed absolute safety will always make it a favorite anæsthetic with timid or inexperienced surgeons, but there are some instances of fatal results, I am told, from its use, which, however, I am not able to find well authenticated. However, it is desirable of course, to secure a pure article, if not for safety at least to ensure the most speedy effect. For this purpose it should be anhydrous, free from oils, and alcohol. The specific gravity must not be lower 0.713, and the reaction should be neutral. Should oil be present, dropping a small quantity on the palm of the hand, and rubbing it with the finger, will impart a greasy sensation; after evaporation this greasy feeling will continue. Placing a drop or two on a piece of white paper, will reveal oil, also, by the stain left on evaporation, as when pure the papers will be unsoiled. Should alcohol be present, the evaporation will be slow, and the paper will not become completely dry for a long time.

Having satisfied yourself of the purity of the article, proceed to make preparations and administer it as follows: Remove all constriction from the throat and waist of the patient, having previously ordered an omission of the last meal to avoid nausea and vomiting. The position may be anything most suitable for the purpose, all things being equal, prefer the recumbent, with the head quite low. Pour about one ounce of Ether upon a sponge wrapped in a towel, or enclosed in a paper cone. Have this large enough to cover the nose and mouth. There are many "inhalers" made by our instrument makers, but I much prefer the sponge and paper cone to all other apparatus. For a moment or two, hold the sponge at some little distance from the mouth, to avoid unnecessary irritation, and direct the patient to breathe *into* it strongly. When the irritation has passed away, produced by the first few inhalations, the sponge may be applied close to the face. The phenomena of anæsthesia are developed in three well marked stages, which it is important to recognize:

(*a.*) The *first stage* may he called the local irritative, in which the fumes of the Ether cause redness and irritation of the mucous surfaces exposed to its influence, shown by the injected conjunctivæ, hacking cough, and sensation of suffocation. This soon passes away, and the patient becomes quiet, with regular breathing, and the novice may think anæsthesia is complete; but on speaking to him he will be

aroused, and on opening the eye there will be a spasmodic closure of the lids.

(*b.*) The *second stage*, is one of muscular and mental excitement, varying greatly in form and degree in different cases. In some there will be simple loquacity, singing, praying, swearing or inordinate laughter; in others, furious rage, or frightened, and endeavors to escape. In some cases, it seems impossible to get beyond this stage; in one case I used a pound of Ether, and several ounces of Chloroform without inducing the third stage. The face is red and bloated, the eyes injected and staring, and the mouth filled with tough saliva.

(*c.*) The *third stage* is one of complete relaxation, and is that to be selected for the operation. The eyes are closed, and on opening them the finger may rest upon the cornea without resistance; the respiration is stertorous; the muscles are completely relaxed, and there is a complete suspension of sensibility, the integument enduring pinching and pricking without reaction. During this stage avoid pressing on the abdomen, as respiration is chiefly, if not entirely, diaphragmatic and abdominal, and warn the assistant having control of the anæsthesia to watch the patient and attend strictly to his own affairs.

The time required to induce anæsthesia by means of Ether, varies from five, as a minimum, to twenty minutes, and full reaction from the effects will require four or five times as long. In many cases, particularly when etherization has been prolonged, several hours may elapse before perfect restoration of the mental faculties. There is likely to be much headache and drowsiness, which calls for *Nux vom.*, and an encouragement of sleep. At other times there will be much nausea, with vomiting, which is best met by *Ipec.*, although a spoonful of brandy administered half an hour before commencing the anæsthesia will often avert all unpleasant sequelæ. The rule is, however, that nausea, headache, and much discomfort continues for hours, or even days, after the use of Ether, and this alone has led many surgeons to abandon it.

CHLOROFORM, after being in use for a short time as Chloric Ether was first used, I believe, by SIR JAS. Y. SIMPSON, at the suggestion of MR. WALDIE, of Apothecaries' Hall, Liverpool, England, in 1847. It succeeded the Chloric Ether, introduced by MR. LAWRENCE, at St. Bartholomew's Hospital, in the same year, on account of the diminished irritation to the mucous surfaces. Its safety, in experienced hands; rapidity of action; the freedom from unpleasant sequelæ; and the small quantity necessary to anæsthesia, have gradually led to its adoption in all countries, and it is now fast displacing Ether. As in the case of Ether, however, there has been some controversy as to priority of discovery, but all are agreed that its introduction into surgical practice is as given above. True, MR. GUTHRIE of this country, LIEBIG in Germany, and SOUBEIRAN in France, each announced its discovery in 1831, and DR. IVES, of Yale College, used it to relieve some difficulty in breathing in a hospital patient; but it was not employed as an anæsthetic, for surgical purposes, until 1847. DUNOS

in 1835, first determined its formula, and gave it its present name; previous to this it had been known as "formic anhydride, in which the whole of the oxygen is displaced by its equivalent amount of Chlorine." * * * "It is now looked upon as methylic Ether, in which two atoms of hydrogen are displaced by two atoms of Chlorine, and its formula is C. H. Cl3." (*American Cyclopædia.*) Chloroform is made by many processes, the result being about the same—chiefly (*American Cyclopædia*) "by the action of hypochlorite of lime upon numerous organic substances, such as wine, alcohol, wood alcohol, acetone, salts of the acetates, volatile oil, acetic acid, tartaric acid, formic acid, oxalic acid, and other bodies; but the only practicable method on a large scale consists in the distillation of alcohol from chloride of lime. Six parts of chloride of lime, twenty-four parts of water, and one part of alcohol are mixed in a capacious still, and the temperature raised as rapidly as possible till it reaches 180° F. The distillation is then continued until about one part and a half has passed over; the products, consisting chiefly of Chloroform, accompanied by water collect in two layers in the receiver; the Chloroform constituting the lower layer. It is decanted from the aqueous portion and agitated, with oil of vitriol in order to destroy traces of volatile oils which accompany it; by another rectification it is obtained in a state of purity." When produced, from either method, it appears as a colorless, slightly greasy feeling, pungent smelling fluid, of a specific gravity of about 1,480, and of neutral reaction. It becomes decomposed by exposure to light, particularly sunlight—giving hydrochloric acid as an essential element. Prior to using it, tests should be made of its purity. The impurities are usually oils, alcohol, or ether, or hydrochloric acid from exposure to light.

For oils, add a drop or two of strong Sulphuric acid to a small quantity of Chloroform; if any oil is present, it will be changed to a brown color. Placing a small quantity in the palm of the hand, or dropping it on white paper, as in the case of Ether, may also be employed as a rough test.

For alcohol, drop a single drop into a glass of water; if pure the Chloroform will appear as a clear glistening globule at or near the bottom of the glass. If alcohol is present, in any quantities, the globule will be milky.

For Ether, apply the test of fire. Pure Chloroform is non-inflammable, or burns with difficulty, and then with a greenish smoky flame. When Ether is present it will ignite readily, and burn with the characteristic flame.

Hydrochloric acid is to be suspected when the Chloroform has been kept in an unprotected bottle, or in any way exposed to the light for a length of time, acquires a greenish tinge, and particularly when there is a greenish scum on the surface. The litmus paper, also, is faintly reddened, but it soon disappears. The ordinary chemical test, or at least that which is the most easily performed, and giving positive results, is as follows: To some of the suspected Chloroform, in

a test tube, add a few drops of a strong solution of Nitrate of Silver; Chlorate of Silver is thrown down, as a white precipitate, and the test is confirmed by finding it soluble in Ammonia, and insoluble in Nitric acid.

The *preparation* of the patient is the same as in the case of Ether, with, perhaps, much more attention to posture. Certainly there is less danger when the position is recumbent, and much more care must be taken to avoid pressure on the stomach and diaphragm. A number of inhalers have been produced from time to time, but I think most surgeons are agreed that no method is to be preferred to the old one, viz., a folded towel. About a drachm is poured on a handkerchief or towel, and held at a little distance from the nose and mouth. LISTER, and others, estimate that there should be an admixture of at least five per cent. of atmospheric air to constitute perfect safety. Of course this can only be approximately estimated, but the careful and conscientious practitioner will at all times prefer safety to rapidity and a large percentage of air will not be objected to.

The phenomena attendant upon anæsthesia with Chloroform, are similar to those of Ether, but are more rapidly produced. The three stages are usually well marked, the second of less distinctness than in the case of Ether, and the last is a more profound insensibility, and perhaps more prolonged. It must be borne in mind, however, that there are many cases in which anæsthesia seems impossible, even when the agent is used in a dangerous amount; and this is equally true of Ether and Chloroform. At other times the three stages undergo many modifications, either the first and second absent, the third coming on at once; or while sensation is suspended, the mental vigor is unimpaired, there being perfect cognizance of all external surroundings. These cases are of course exceptional, but they do occur, and I must be understood as giving the symptoms of each stage as they usually appear. The effects being, therefore, so varying in different individuals, no attempt should be made to measure the quantity to be used in a given case; we should be guided entirely by the effects on the patient.

The effect of Chloroform on the body is variously described by different authors and observers, but we have not space to give even a summary of the views — some attribute it to a retardation of oxygenation, either by a direct action of the vapor on the blood corpuscles, or the feebler respiration and diminished amount of atmospheric air admitted to the lungs. While either or both of these theories may be true, the influence of the agent is certainly expended on the nerve centers, and in a certain order. First the brain, then the cerebro-spinal axis, and when pushed to extremities, the sympathetic. We thus mark the distinction between full anæsthesia and narcosis; the former being a suspension of sensory phenomena, with a consequent loss of irritability of the voluntary functions; whilst the latter indicates an extension to the involuntary sphere, or, in other words, an over dose. We thus have a condition analogous to sleep, the respir-

atory and circulatory processes going on uninterruptedly. According to LISTER, (HOLMES, *Syst. of Surg.*, v., 482), and as fully borne out by other testimony, death may ensue from Chloroform, as in *all* cases perhaps — through the brain, lungs or heart.

Coma, in the first instance, indicating paralysis of the brain from too rapid administration.

Syncope, from paralysis of the heart, due to an over dose, in which the anæsthesia extends to the ganglionic centres.

Apnœa, due to an absence of atmospheric air.

These are the conditions that induce death directly from the Chloroform, but in careful hands such accidents should be of, at least, very rare occurrence, if not absolutely impossible. Very many deaths have occurred of patients under the influence of Chloroform, that were only indirectly due to the anæsthetic, and the question is of sufficient importance to claim some consideration at this time.

Statistics have been published intending to show that the death rate in surgical practice had increased since the introduction of Chloroform. The figures are still disputed, and from the conflicting statements it is impossible to attach much importance to either showing. We may admit the increased mortality, but can reasonably deny the direct agency of Chloroform. It must be remembered that within the period of time embraced since the introduction of anæsthesia generally, travel and mechanic arts has been revolutionized; the railway, steam navigation, labor saving machinery and the multitude of occupations now carried on by the agency of steam, has largely increased the liability to accident. The improvement in weapons of war has enormously increased and greatly modified execution on the battle field; wounds are more severe than when made by the comparatively slowly moving, and spherical balls of our ancestors. These facts would indicate a larger number of cases of accident to treat within the last thirty or forty years, and accidents of a more serious character than obtained formerly. Joined to this, the absence of pain insured by anæsthesia, has emboldened surgeons to attempt operations to-day that would not have been dreamed of a half century ago. A brief citation of such facts should be a complete answer to the charge that Chloroform itself has increased the death rate, and doubtless the truth will be found that it has much diminished it. Indeed the most bitter opponent to this beneficial agent cannot show a doubling of the death rate, while the frequency and magnitude of surgical operations has increased three fold. The mortality should be in proportion to the increase of surgical operations, whilst it really falls below. Thus we may safely assert, that the increase is only apparent, and that Chloroform has diminished the percentage of deaths.

One of the objections made to the employment of Chloroform has been its supposed sedative properties, and it was once proposed to employ Ether, from its likewise supposed stimulating effects, as a suitable antidote in cases of narcosis. Facts recently developed go to

show that this is a great error, so much so that LISTER, (*loc cit*, p. 482), strenuously claims stimulating effects, and that primary operations, even where there is great shock, may not only be safely performed, but that the promise of success is greater than when other anæsthetic agents are employed. Our author says: "It seems now clearly established that the cessation of the contractions of the heart in the shock of injury depends upon an action of the brain and cord upon the cardiac ganglia, through the medium of the vagus and sympathetic nerves; Chloroform rendering this action impossible, protects the heart from the indirect effect of external violence. In this way it has greatly diminished the risk of death upon the operating table. * * * Indeed, an amputation under Chloroform has often the effect of improving instead of lowering the pulse."

What, it may be enquired, is the cause of death from Chloroform? The answer is easy, and is largely drawn from the excellent paper by LISTER above quoted. We have already learned that coma, syncope, or apnœa, are the peculiar and pressing dangers, but will find, I think, that apnœa is the more frequent. One of the greatest dangers is undoubtedly from a timid use of the article and insufficient anæsthesia. The former requires so much more Chloroform to produce the desired result, the patient being partially roused so frequently, that syncope may be induced, and the sequelæ are much more annoying and persistent than would otherwise obtain. When the anæsthesia is insufficient, on the other hand, there is imminent danger of shock, and the fact that most of the fatal cases occur in the practice of dentistry, or other trivial operations, would go to show that the incomplete paralysis of cerebro-spinal action exposes the patient to very great danger. The old idea, that subjects of cardiac disease were placed in especial danger by the administration of Chloroform, is thus shown to be fallacious; the cause of death being *shock*, the more profound the anæsthesia, the greater the safety. Shock has been quite fully treated of in a preceding chapter, and need not detain us here, but it will be a profitable study in this connection.

These being the commoner causes of death under Chloroform, and apnœa being perhaps the most frequent, it is evident that the breathing must be very closely watched during the administration of this agent. Many practitioners to-day, will be observed watching the pulse with great sapiency, while the more important respiratory function is entirely unnoticed. LISTER, (*loc cit*) gives many instances of imminent danger from this habit, and I have concluded that the action of the heart, except in a few exceptional cases, is valueless as a guide. It is well known that the heart will continue to beat for some minutes after respiration has ceased, and when it stops examination will show that the patient has been dead for some time. Watch the breathing closely, therefore, and when it becomes embarrassed, or suspended, instantly resort to the measures given below. We may conclude, therefore, that if there are any cases that forbid the employment of Chloroform, it would be in the very aged, or those

who have been much debilitated by previous illness. Uræmic cases are quite generally considered unfavorable, and HARLEY uses a mixture of one part alcohol, two of Chloroform, and three of Ether, which, it is claimed, is absolutely safe. The formula has been written, for ready reference, A-C-E, 1, 2, 3.

When death threatens, immediately suspend the administration, lower the head, and admit fresh air. Tickling the fauces, olfaction of ammonia, or Amyl nitrite, and other diffusive stimulants, have been strenuously enjoined. Of course if heart and lung action is suspended, some of the means noted under *asphyxia* must be employed. But when respiration ceases, or becomes embarrassed, while cardiac action continues, seizing the tongue and drawing it *forcibly* forwards, is the most convenient and efficacious practice. This is not to open the glottis, merely, as was once supposed to be the sole effect —but establishes respiration on other principles, as given by LISTER, (*loc cit.* 491). He found, by a series of experiments on himself, that there are two kinds of stertorous respiration, the *palatine*, and the *laryngeal*. The former is the commoner form, and is induced by vibrations of the velum, of a nasal or buccal sound, or character, as the breathing is through the mouth or nose. The latter, or *laryngeal*, is due to reflex nervous action, and is produced by a closure of the larynx, by the engorged aryteno-epiglottidean folds being carried forwards against the base of the epiglottis. On making traction on the tongue the base of the tongue was little, if any affected, nor was the epiglottis moved in the slightest degree. The traction, therefore, is not to overcome a "falling back" of the tongue, but either by inducing muscular, or reflex nervous action, causing a retirement of the folds of mucous membrane. The tongue may be seized with a towel, or a pair of toothed forceps, and under all circumstances provision should be made for such emergency. I feel warranted, from my own experience and the experience of MR. LISTER, in placing this simple method at the head of the list of procedures, in such accidents. We may summarize the cause of death, therefore, as follows:

Coma; syncope; asphyxia; insufficient anæsthesia, and closure of the larynx as above.

The *sequelæ* are about the same as in the case of Ether, with perhaps less urgency and severity in general. *Amyl nitrite* or *Ammonia* are exceedingly useful agents in hastening the restoration to consciousness when delayed, but ordinarily it will be sufficiently rapid without aid of this kind. Perhaps it is better to take more pains to secure sleep after Chloroform anæsthesia than when Ether has been used; at least the tendency to sleep is greater, and after sleep headache and nausea are not so severe. The treatment for these conditions, however, is precisely the same as in the case of Ether.

METHYLENE (BI-CHLORIDE), was first suggested and used as an anæsthetic by DR. B. W. RICHARDSON, and whilst rapid in its effects, and inducing profound and prolonged insensibility, its reputation, perhaps somewhat exaggerated, of danger to life has never made it a

commonly used agent. SPENCER WELLS uses it, I believe, largely in ovariotomy, but in this country it is little known. It is a substance of a specific gravity of 1.344, boiling at 38°, and its formula is expressed as $C_2 H_2 Cl_2$. It is a colorless liquid, resembling Chloroform in odor, and is produced by exposing, in a glass globe chlorine and gaseous chloride of methyl. The chloride is made by heating together one part of wood spirit, two parts of common salt, and three of Sulphuric acid, collecting the gas over water. It is said to induce anæsthesia without passing through the two preliminary stages, and to be much more agreeable in its effects than other agents. Muscular irritability remains for a very long time after apparent death, in this respect presenting a marked contrast to Chloroform and Ether.

What has been said may be considered a summary of *general anæsthesia*, and whilst other agents have been recommended, few employ them in this country, perhaps none.*

LOCAL ANÆSTHESIA, was first proposed, it is believed, by DR. JAMES ARNOTT of London, who employed ice and salt to freeze the part. It was found useful in diminishing the pain of the actual incision, in abscess and the like, but the pain of freezing, in the case of felon particularly, was as severe and of far longer duration than the operation would have been. There was apt to be, also, some difficulty in restoring sensibility without loss of tissue, and gradually it fell into disuse. AMBROSE PARE, and others after him, had attempted it by prolonged pressure, and many methods were tried subsequently, with only partial success. The spray of Ether, or some other rapidly evaporating substance, has also been used, more particularly *Rhigolene*, a product of petroleum. This seems to give the best results, as to rapidity of the freezing process, and was first announced by DR. BIGELOW, of Boston, about 1864. Of late good results have been had from Carbolic acid, and as it does not induce any noteworthy tissue lesions, and seems to be quite effectual, it has been largely used. A saturated solution is to be employed, which is painted on the part to be incised, with a small brush; when almost dry the incision may be made with little if any pain. In the case of nervous or debilitated persons, such anæsthesia may be useful, but in ordinary practice I have not been in the habit of employing any such methods unless my attention is called to it at the time. If any of the volatile fluids are used, an ordinary spraying instrument, such as is used in the toilet, will answer every purpose.

* *Bromide of Ethyl*, recently introduced by DRS. LEVIS and TURNBULL of Philadelphia, is still far from having established its claim to a place among the recognized anæsthetics, there being much opposition to its use. I prefer to leave the subject under advisements, for the present.

III. CONTUSIONS.

DEGREES.

A *contusion*, commonly known as a *bruise*, is an injury inflicted by a blunt instrument, in which the parts are more or less lacerated without rupture of the integument. Physically, it is the result of a squeeze, between the body inflicting the injury on one side, and some resisting body on the other, as a bone. This class of injuries is perhaps the most common of accidents, and is infinitely more serious, apart from the hæmorrhage, than wounds of almost any description. The first symptom, depending somewhat upon the extent of the injury, is a numbness and tingling of the part, to which is soon added *pain*, *swelling* and *discoloration*.

Pain, is rarely acute, oftener aching in character, and not persistent or long lasting unless some of the more important nerves are injured. It is due partly to the direct violence inflicted on the peripheral nerves; and partly to the stretching of these nerves by the subsequent swelling. Different cases, however, furnish many modifications of pain, both as to quality and intensity, for the most part dependant upon the extent to which deep parts are implicated. Thus in contusions of the abdomen, as will be shown later—when one of the viscera is contused the sensation is of weight: of the chest, dyspnœa; of the head, either cephalalgia, confusion of the mind without pain, or coma. Pain, as a symptom, however, is of little therapeutic or diagnostic value, except as intimated above; when unusually severe an injury to some important nerve trunk may be suspected.

Swelling is perhaps the most characteristic feature of contusions, and is always present to some extent. It is greater, as a matter of course, when the texture of the part is loose, and less in proportion to the density. It is due to several causes, or rather several degrees of intensity in the same condition, viz., injury to the blood vessels. The effusion of *serum*, is due to a momentary vaso-motor paresis, inducing dilatation of the vessels, and congestion or stasis, which produces transudation, as in the case of inflammation. Such a swelling is firm, or boggy, but quite colorless, or it may be of a marbled appearance. The tumefaction is not of long duration, and there is little, if any, tendency to suppuration.

The *hæmorrhagic* effusion, may be capillary, arterial, or venous; when the former, coagulation occurs early, the swelling is firm, and the color dark. The same is true of arterial hæmorrhage, but when

the tissue into which the blood is forced is of loose texture, the hæmorrhage may be great, even fatal, and the symptoms will be quite pathognomonic. Venous hæmorrhage, will furnish, as a rule, a soft fluctuating swelling, in which the blood coagulates slowly or imperfectly, and in some cases remains fluid. Such swellings are usually pendulous, resembling a bladder, and are quite frequent in contusions of the lower lid, scrotum or labia.

Discoloration is due to hæmorrhagic effusion, and technically known as *ecchymosis*. It is the last symptom to appear, and is of uncertain duration. Usually it appears early, sometimes cotemporaneously with the appearance of swelling, and increases in depth of color until the maximum swelling has been reached. It then remains stationary, (under proper treatment), for from one to four days, depending upon the extent of the injury—and then commences to disappear. During the process of resorption the swelling undergoes many changes of color, the fibrinous exudation imparting a yellowish tinge to the parts for some time longer. Should suppuration ensue, which is quite a common termination—the discoloration will gradually fade, but the swelling will remain, and symptoms of pyo-genesis will appear.

In contusions of cavities, in which the force is largely expended on the contained viscera, the external symptoms, as given above, are either wanting, or much modified, and functional disturbances will direct attention to the injured part. This, however, will demand attention elsewhere, and need not detain us here. In all cases of contusion, great or small, *shock* is a prominent feature, and while usually in proportion to the injury, cannot at all times be considered of little moment in slight cases. Instances are noted, in a former chapter, of death following trivial violence, and no shock accompanying very severe accidents. We find, however, that when the injuries are superficial, not involving deeper parts or important organs, the shock is trivial, and need give no concern. When the abdominal organs are contused, on the other hand, the collapse is often fatal, and at all times is a symptom of the greatest urgency, and gravest significance.

Contusions may be considered as of three degrees, a classification that is of much practical value from a therapeutic stand-point. Each degree represents varying extent of subcutaneous lesion, and as a matter of course involves different considerations in treatment.

First degree.—This represents the most benign form, in which the violence has been slight, and the effusion is either entirely serous, or hæmorrhagic from ruptured capillaries. The subcutaneous tissue is little injured, and the ordinary bruise is the typical form.

Second degree.—The distinguishing feature in this instance, is the rupture of blood vessels, large or small, with consequent hæmorrhagic effusion. The degree of muscular lesion, as well as other tissues, is considerable, but with the division of fibres, there is no disorganization of the parts.

Third degree.—In this form we have the maximum of the injury, the subcutaneous parts are crushed, or pulpified, vessels severed, nerves equally injured, and even the bones broken into fragments. Such injuries are of the greatest severity, and from the accompanying shock, the many foci furnished for inflammation by the particles of devitalized tissue, and the arrest of the circulation in parts below the point of injury, the loss of life or limb is imminent, indeed must be a natural consequence. Such extensive disorganization, can only be produced by extreme violence, but to constitute a contusion, and not a contused wound, there must be no laceration of the integument. To students, I have observed, this distinction seems frivolous, until explained, and there may be some of my readers who entertain the same opinion. It will only be necessary to observe, that the admission of air, in deep wounds, as would be the case if the skin gave way in contusions of the second or third degree — introduces an additional element of danger, by favoring suppuration, and other undesirable processes, which would make the indications different, and materially complicate the case. In the large majority of instances, traumatic effusions of all kinds, so long as they are not exposed to the action of the air, will be resorbed in a quiet normal manner, without inflammation, and with no departures from the standard of health. In tenotomy, and myotomy, subcutaneous section is preferred to others, chiefly on these grounds; so that it can be at once conceded, that the distinction between a contusion and a contused wound, is important and actual.

The *result* of contusions, as already intimated, is usually in resolution, with resorption of effusion, after a period of rest, or preparation, of varying duration. Occasionally, however, other conditions obtain, and a brief *resume* is demanded.

Secondary hæmorrhage, is not an infrequent accident, in cases of the second degree, and is ordinarily due to a portion of an artery becoming devitalized, by the contusion, and subsequently sloughing. Such an accident can scarcely be provided for, and will demand prompt treatment, and a cool head, in the surgeon. The records of our late war, compiled in that magnificent addition to our surgical knowledge, *The Medical and Surgical History of the War*—shows indisputably, that temporizing measures, or expectant treatment will always lead to disastrous results, frequently to death. My own experience, necessarily limited, fully bears out this statement, and there can be no question that the only rational practice is to expose the bleeding vessel and ligate it. Of course this converts our contusion into a wound, but the danger of fatal hæmorrhage must outweigh all other considerations.

Suppuration, while not a necessary occurrence, does occur occasionally, and must be an indication of bad treatment, or a depraved condition of the patient physically. In cases of the third degree, where the injury is confined to a small space, and does not include a limb, spiculæ of bone, or devitalized tissue, will be exceedingly prone

to induce suppuration, and in this event may be considered an element essential to a cure.

Ulceration, sometimes occurs when the integument has been devitalized by pressure, or heat, but more particularly when the individual is of feeble recuperative powers, or the victim of cachexia or specific disease. A *purely* traumatic ulcer, due to the violence of the injury, is a matter of little consequence, and while usually healing readily, must always engage our watchfulness for a secondary hæmorrhage, which the extreme violence inflicted renders a probable sequelæ. When the ulcer is due to constitutional causes, the indications for treatment are different, and the mere injury simply occupies the position of an exciting cause, and sinks into comparative insignificance.

Paralysis, as a matter of course, indicates lesions of the nerves, and is of interest solely as modifying nutrition, possibly, yet in some instances may threaten life from the interruption of function. When we reach *Injuries of the Nerves*, it will be seen that it is only in very exceptional cases that the paralysis is permanent, and even then is only partial, or much alleviated after union has taken place.

Sloughing comes under the same conditions, for the most part, as ulceration. It argues either a serious devitalization, arrest of the local circulation, or a depraved condition of the vital powers. The consideration involves the same points of prognosis, etc., as in the case of ulceration, and the loss of tissue may be sufficient to produce very unsightly cicatrization.

Neoplasmata, in rare instances, have succeeded contusions, but never, I believe, when of the second or third degree. I consider such an event to be one of hypernutrition, or hyperplasia, and the product, in otherwise healthy subjects, always of a benign or homologous character. Should there be other conditions, as noted in another volume, (*Surg. Therap.*, article *Tumors*), either local or constitutional, that would induce heteroplasia, of course the product will be of a malignant nature. I think, however, that a contusion, pronounced enough to merit that term, cannot take on any such morbid action very readily, while the minor degrees, those that are not accompanied by any lesion perceptible to the surgeon, are the most frequent exciting cause for all forms of tumors. It is foreign to our purpose to enter into this discussion at any length, and I think the majority of my readers will be able to see a distinction as above. It may be summarized, that structural lesion only causes normal reparative action, except in dyscrasia or cachectic individuals; slight functional perturbations, are more likely to arouse dormant hyperplastic, but particularly hetroplastic tendencies. Notwithstanding the grave complications that accompany contusions, it is a noteworthy fact, that the percentage of mortality is very small, when all degrees of the injury are considered together. Thus in the war of the rebellion, (*Med. and Surg. Hist. of the War*, surgical volume, Part I, p. XXV), it is recorded that from May 1, 1861, to June 30, 1865, there were 46,972 cases of contusion, of all degrees, in our armies. Of this number only 172 died, and nearly

all of them of injuries of the third degree. In civil practice we have, as yet, no reliable data, at least I know of none — but it would seem natural to suppose that the percentage must be much less.

TREATMENT.—Contusions present different indications for treatment under different circumstances. When of the first or second degree, the question is entirely a matter of choice of remedies; when of the third degree, amputation has to be considered. Under all circumstances, incisions, for the purpose of removing a clot, or allowing the exit of fluid blood, must never be entertained; such a procedure will be sure to be followed by suppuration, and an unsightly cicatrix. On the other hand, when suppuration is set up, the indications are imperative for early incision. The condition and character of the effusion determines the remedy to be used, which will act equally well if given internally in attenuation, as externally in tincture; in fact I think the action is more prompt in the first instance. As the laity demand local treatment in such cases, it does no harm to yield to it, but a little observation will convince any candid practitioner that nothing is gained by it.

Arnica.—This remedy is indicated when the effusion is chiefly hæmorrhagic, the swelling firm, and coagulation rapid. It is chiefly useful as favoring resorption of the blood, and this, I believe is its sole office in cases of trauma. We shall find that in all injuries there is a period of rest before repair commences, and this is occupied by nature in removing clots of blood, and all impediments to healing. This function is admirably performed by *Arnica*, and beyond this it exercises little, if any influence on the union of divided tissues.

Conium mac.—When the swelling is largely serous, pale in color, hard, and with a heavy stone-like feeling, this remedy is to be preferred to *Arnica*. It materially assists in the disposition of the serum, and has been thought to exercise a powerful influence in preventing the organization of lymph.

Hamamelis virg.—This is to be preferred to the preceding remedies, when the effusion is entirely hæmorrhagic, which remains fluid. The part is fluctuating, red in color, and there is no disposition to coagulation. It not only induces prompt resorption, but prevents, to a considerable extent, the degeneration into pus.

Hypericum perf.—When the peripheral nerves have been injured, and there is great soreness, or even violent pain. A truly invaluable remedy to allay pain from nerve lesions.

Ledum pal.—Under similar circumstances, particularly when the parts are cold and numb.

Stramonium.—Also in nerve lesions, when there is a tendency to spasms, of various kinds.

In contusions of the third degree, when one of the extremities are injured, amputation is the only resort. The sole question to be considered, under these circumstances, is the strength of the sufferer and

the extent of the shock. Still the use of Chloroform will aid materially in inducing reaction, and by using Esmarch's bandage, to prevent a loss of blood, many lives will be preserved that in former years would have certainly been lost. When the trunk is so injured death is the rule, but no case should be abandoned until a faithful effort has been made. In such cases *Arnica* occupies the first rank, and has been the means of saving many lives.

III. WOUNDS IN GENERAL.

GENERAL CHARACTERS.

A *wound* is an injury produced by cutting, tearing, piercing or bruising instruments, by which the tissues are divided, more or less smoothly. The special phenomena attending such accidents are: gaping of the edges, pain, hæmorrhage, and succeeded by various processes of repair.

Gaping, or separation of the edges, whilst always present to some extent, varies greatly with the tissue injured. Muscular or extensable tissue will separate more widely than that of an inelastic or more rigid character, but is greatly modified by the direction of the wound with reference to the direction of the muscular fibres. Thus a wound made parallel to the fibres will gape much less than one made more or less transversely. The occurrence is one of much practical interest, as the rapidity of healing, degree of impairment of function and extent of cicatrization, is in direct relation to the separation of the cut surfaces.

Pain varies greatly with the nature of the wound, its extent, and the anatomical character of the parts. As a rule, I think the pain is usually much less than the appearance of the injury would lead one to expect, as extensive wounds are apt to be accompanied by considerable *local* shock, at least, and the sensibility is partially suppressed. Other things being equal, the smoother and clean-cut the injury the less the pain; and when the parts are torn by extreme violence, whilst the primary pain is insignificant, or even absolutely wanting—the secondary sufferings may be intense. The pain of most wounds is usually an aching or burning, rarely acute, but may be severe when the nerves of the part are extensively injured.

Hæmorrhage is by far the most important consideration in wounds of all characters. It is unnecessary to enter at length into the means for arresting it at this place, as the subject will receive full attention when we reach injuries to the blood-vessels; but it may be laid down as a cardinal principle that arterial bleeding, no matter how small the vessel, always demands ligation or some other equally efficacious treatment. Many a life has been lost from inattention to the matter, as external coagulæ are very feeble barriers to bleeding, and under all circumstances greatly retard the cure. Small vessels may be allowed to retract, or styptics may be employed, but no chances should be taken with wounded arteries under any circumstances. Unquestionably hæmorrhage is the most frequent cause of death, from wounds of all kinds, notwithstanding serious nerve lesions are equally fatal.

For this reason I place hæmorrhage as the first consideration, and none should undertake to treat large wounds, involving blood-vessels, without accurate knowledge of hæmostasis.

The indications to be fulfilled in the treatment of wounds in general, are as follows: Arrest of hæmorrhage, cleansing the wound, coaptation of the cut surfaces, hasten repair, and to prevent, or modify, unhealthy or unsightly cicatrization. Each of these must receive general notice at this time, special notice being referred to the appropriate chapters.

CONTROLING HÆMORRHAGE.

ARREST OF HÆMORRHAGE should more properly come under the head of *wounds of blood-vessels*, but a general account of the various methods may properly be considered here. It is of importance in the outset, to determine whether the blood is arterial or venous. For this purpose, the size of the stream of blood, its color, force of its expulsion, and the time which has elapsed since the accident must all be taken into the account. When the stream is large, it is evident that a large vessel is injured, and much can be told from the appearance of the blood under the circumstances. When venous hæmorrhage has continued for some time, from large vessels, the blood soon becomes somewhat arterial in color, from the rapid emptying of the veins; therefore when the flow is still dark and without arterial impulse, the accident must be *very* recent; when, on the contrary it is red in color, but still without the spirting characteristic of arterial hæmorrhage, the case is probably one of venous injury, and the examination must be very careful and thorough. While the exhaustion will be great in either case, the experienced surgeon will recognize at once the greater collapse from arterial injury when the flow is steady and continuous.

As to *color*, as a rule, arterial blood is bright red, and thrown in jets, with greater or less violence, depending upon the size of the vessel. Such blood is, also, hot, and coagulates rapidly. When a large vein has been wounded, however, and the flow of blood has been consequently rapid and profuse, the red color, and other characters of arterial blood will be present, but the absence of the forcible ejaculation, and the slightly lessened prostration will serve to differentiate. Attention should also be paid to the direction from which the blood comes; *i, e*, whether from the distal or proximal side of the cut or injury, the former indicating venous, the latter arterial lesion. In cases in which the blood comes, or seems to come from both sides of the wound, the presumption is that the vessel has been completely divided; when only from one side, that the division is partial.

In cases of doubt, which are actually more frequent than many suppose—and as a sure test in any event, pressure on the vessels supplying the part, and observing the effects on the bleeding, will be conclusive. Thus should proximal compression lessen or arrest the

hæmorrhage, the lesion is arterial; when distal pressure has the same effect, the injury is venous.

Having determined the nature of the injury, the next question is, what shall be done to remedy it. We have four methods, either separately useful in appropriate cases, or indicated in any emergency: *Exposure to the air*, *styptics*, *compression*, *occlusion*.

Exposure to the air, when small vessels are wounded, will frequently arrest hæmorrhage by hastening coagulation. This is particularly the case when the part injured is temporarily hyperæmic, as occurs when the sufferer has been wounded during exercise, as on a long march, or other causes that would determine an increased amount of blood in the part. Here we find many vessels that are usually only a degree removed from capillaries bleeding freely, but which will soon return to their usual condition on being emptied of blood. This is particularly the case with the veins. When small arteries have been wounded that would not yield much hæmorrhage under ordinary circumstances, the flow soon assume a passives or venous character, the jets ceasing to some extent; when this diminished flow is unaccompanied by exhaustion or syncope, the presumption is that the vessel will become contracted and hæmorrhage cease—should there, on the contrary, be an evident lowering of the vital forces, no matter how small the vessel may be, it should receive ligation or some equally efficacious treatment. The experienced surgeon can tell at a glance, usually, the importance of hæmorrhage, but the general practitioner, or the young surgeon, would do well to err on the side of safety, and close a bleeding vessel at once; particularly is this true of the present age, when so many appliances are at hand which remove the objections well-entertained to the ligature of silk. Closing the wound, by putting the parts somewhat on the stretch, and by the compression of the straps and dressings—will frequently control such hæmorrhage as do not seem to need ligation, but the selection of such cases can only be made by the experienced. The bleeding being usually trifling, no ill-results will follow waiting for it to cease. Here is a question of the gravest character, one that words alone can scarcely delineate. What amount of bleeding is dangerous? It has been remarked by a distinguished author, GROSS — that the dread of hæmorrhage deters many from the practice of surgery. It might be added, that it is not the hæmorrhage itself that causes so much alarm, but the uncertainty experienced by the novice as to how *much* of it is dangerous. What would be of trifling moment in one case, would be fatal in another; and a mere trickling, if continued for a length of time, would insidiously sap the life. Nothing but actual experience can teach this discrimination, and it will be a safe rule to adopt that *all* bleeding is dangerous, and none are secure while it continues. Therefore, see to it that the most apparently trivial hæmorrhage is *completely* arrested before leaving the patient.

Styptics, whether cauterizing or not — are to be very sparingly used. It is well known that the primary contraction, from non-cauterizing

styptics, is followed by a corresponding degree of dilatation, or relaxation. Should the coagula thus produced not have time to become very firm, which is almost constantly the case — bleeding will return with the relaxation. When a cautery is used, the results are still more unsatisfactory, as an eschar, of greater or less magnitude, must necessarily form, which will induce secondary hæmorrhage on the detachment of the slough in a majority of cases. It is therefore evident, that in addition to this hæmostatic agent being unreliable and untrustworthy, there is an additional objection on the score of its unscientific character. The only instance where such methods are admissible, is where wounds are inflicted in cavities, from which the hæmorrhage is chiefly capillary, and which can only be controlled, apart from styptics, by ligating the main feeding artery, which formidable procedure would not be justifiable in many instances.

Compression, which is a very satisfactory method in many cases, may be induced in a variety of ways; the various forms of tourniquet come first on the list, but their action as a permanent hæmostatic would be very disastrous to the tissues involved. In all cases in which large vessels have been severed or wounded, a tourniquet of some form, should be at once applied for the purpose of controlling the bleeding while the vessel is being found and secured. Esmarch's bandage, or the ordinary tourniquet are of course to be preferred when they are at hand; but as few practitioners will be at all times prepared with such appliances, other improvised agencies must be sought. The best of these is what is known as the "Spanish windlass" to seamen, but while perfectly satisfactory as a temporary expedient, will not be borne for any length of time. In wounds of the extremities, below the knee or elbow, forced flexion will be useful; but even this method will produce much suffering if too long continued. Compression of the artery between a neighboring bone and the fingers of an assistant, or by means of mechanical pressure — will also fully control the hæmorrhage. In *all* of these methods of compression, be it remembered, it is only purposed to hold bleeding in check until the vessel can be permanently secured, and no attempt should be made to secure obliteration by such means. We would not only have much unnecessary suffering produced, but would leave our patient in constant danger of secondary hæmorrhage.

Occlusion comes last on our list, but in importance takes first rank. By this is meant a permanent closure of the vessel, at the wounded point, and the establishment of collateral circulation as described in its appropriate place. We may select, either according to the circumstances of the case, or our individual preferences — ligature with silk or catgut; accupressure; or torsion. In either event the rule should be inflexibly observed, I think, to secure *both ends of a vessel completely divided;* while the proximal side of an artery or the distal, of a vein, will only require attention in *partial* division. As a rule veins will not require ligation, or any very close attention, as light pressure, with a compress and bandage, will ordinarily amply suffice. In some

cases, where the vein is a large and important one, some more effectual measure must be taken, and I infinitely prefer accupressure, or catgut ligatures to any other. These are the methods, in common use, which are employed to arrest hæmorrhage, but a full consideration of the details and explanation of the *modus operandi* must be deferred until we reach wounds of the blood vessels.

IMMEDIATE MANAGEMENT OF WOUNDS.

CLEANSING THE WOUND, while much neglected by many writers and teachers, is a matter of the first importance, next to the arrest of hæmorrhage. Not only is the *act* of cleansing of vital necessity, but the *method* is likewise to be carefully considered. The process includes the removal of all foreign material, dirt, splinters, spiculæ of bone, shreds of clothing, blood clots, and everything that can be detached or detected. It will be seen that two things are of the first importance in the healing of wounds: viz, absolutely clean surfaces, and the absence of inflammation. The first of these indications is to be fulfilled as above, and the latter may be aided by the manner the cleansing is secured. This will forbid all rough or harsh treatment, rubbing with sponges, cloths or the like — and care to prevent the addition of new irritating substances, as sand from new sponges, or strong soap. With forceps, therefore, remove all foreign material, of whatever nature, that can be reached, avoiding force in detaching partially dried blood clots, or substances imbedded in the parts. When all has been removed in this manner that can be, allow warm water to trickle over the wound, from a sponge, *absolutely clean*, but do not apply the sponge to the raw surfaces. When the water has loosened the attached coagulæ, etc., remove them with forceps, as above, and continue this alternating process until the wound is perfectly clean. If the parts injured are covered with hair, it must be removed with a razor for some distance around the edges of the wound; not only will the hair itself act as an irritant if allowed to remain, but by retaining some portion of the secretions, no matter how much care is taken to prevent it — a constant source of irritation and often danger is kept up. The subsequent dressings of the wound should be conducted with as much caution, and in this way inflammation will be averted or very much modified.

COAPTATION, or approximation of the cut surfaces, should next demand attention, and care should be taken to make this as exact as possible. As a rule ragged portions of the integument should be retained, and carefully brought into place, but if they seem devitalized they may be removed. Coaptation should not be attempted until all oozing of blood has ceased; the reason is obvious, as the blood retained in the wound will coagulate, and not only induce suppuration, in many instances, but materially delay repair. When the parts are once placed in position they should be carefully retained there, and not disturbed, if possible, during the progress of the case. This

is effected in one of two ways, which may, however, be employed conjointly in large wounds. In small wounds, with little gaping of the edges, narrow strips of some adhesive plaster may be employed, not placed so closely together as to interfere with the discharge of the secretions. (See *Minor Surgery*.) In larger and deeper wounds, with much gaping, sutures or stitches must be employed. These are of two general kinds, the wet and the dry, each of which is more particularly useful in particular cases. The *dry suture** is of especial advantage in wounds of the face, or other parts of the body where scaring is particularly objectionable, but it is not as efficacious as the wet variety. It is made by attaching a piece of adhesive plaster to the integument, one on each side of the wound, reaching quite up to the margin, and extending throughout its whole length. Through the adjoining margins of these strips the sutures are passed, and the edges of the wound are thus closely approximated. The *wet sutures* are stitches taken through the tissues, and are of various kinds, according to circumstances, but all having the same object, to hold the parts firmly in place. The material of which sutures are made, varies with the case, somewhat, but is largely a matter of individual preference. Many surgeons declare that after three or four days sutures cease to be of especial advantage, and are even an element of mischief. This I cannot concede. I am firmly of the opinion, that provided the suture does not induce irritation, or the parts are not too much on the stretch, they are a positive advantage to the healing process, even if retained to its close. With this conception of their value, I prefer metallic sutures, either silver, iron, wire, or lead, inasmuch as they do not induce any irritation, and, if the cut ends are not permitted to excoriate the integument, they may be retained for almost any length of time. The hare-lip pin is a very admirable substitute for the metallic suture, but cannot be retained as long as the suture, from the irritation produced by the silk or other material wound around them. With all the temporary expedients, such as complicated or ingenous systems of bandaging, I have no patience, and strongly urge the importance of *securely* approximating all wounds, and, indeed, discountenance all half way or temporizing procedures in surgical practice generally. It must not be forgotten, however, that when important muscles have been divided, or should muscular action have a tendency to cause separation of the edges of wounds, great attention should be paid to position, in order to relax such muscles so that the cut extremities may be approximated, or muscular action counteracted.

DRESSING of wounds has two considerations that are prominent, perhaps we might say that all the indications are to be met by attention to these two points. They are protection of the immediate dressings, *i. e*, straps and sutures — and protection of the wound from atmospheric influences. Within a few hours after finally closing a well cleansed wound, the margins become slightly agglutinated by a

* For greater particularization *vide Minor Surgery*.

feeble lymphatic effusion, not organized, simply inspissated. This is ample protection from ordinary atmospheric influences, but is readily cracked or broken, indicating a necessity for additional protection. This being met by additional dressings, or bandages, care must be taken to avoid applying any that have a tendency to injure this first product of repair, whilst still filling the necessary requirements. There is good argument here against all wet, greasy, or irritating dressings, such as oakum, etc., and can explain why the "dry treatment" of wounds furnishes better results than the wet. I make it a rule, and the reasons will suggest themselves as we get farther along in our subject—to keep all wounds *dry*, as long as they are not discharging; when suppuration is set up, the indications are changed, and a compliance with this rule becomes impossible. For minute particulars I refer to the special treatment of wounds, and to the volume of this series on *Minor Surgery*, but it can be summed up here, very briefly, in the injunction to use light, dry, unirritating dressings. The contact of air, *as* air, is not objectionable; it is the danger of germ implantation, or other atmospheric particles. Therefore light dressings are equally efficacious to the more complicated and burdensome. As will be more fully shown shortly, many remedies have a direct influence on the healing process of different wounds, and wounds of different tissues, and whilst perhaps as much benefit can be derived from their internal administration, it will do no harm, and *may* do good, to use them externally as well. As their continued application would be contrary to our principles of treatment, I make it a rule to wash the wound with a solution of the indicated remedy, after cleansing it, and repeat the process at every change of dressings. Usually *Acon.*, is given for twenty-four hours, followed by the proper remedy, a dose three or four times a day, until the healing is complete. In the case of contused, punctured, and poisoned wounds, however, the proper remedy is to be given from the beginning.

Much has been said and written, of late years, about the benefits to be derived from "hermetically sealing" wounds of certain characters, with collodion, etc.; after due trial I am constrained to pronounce such treatment vicious. The penning up of the discharges has always induced unhealthy suppuration, much loss of tissue, and considerable constitutional disturbance, and I now never resort to it. Notwithstanding there *may* be cases, such as burns, or other injuries involving some superficial loss of tissue—in which an artificial scab may promote speedy repair and lessen cicatricial contraction, my experience has not been happy, even in these cases, and I have no hesitancy in advising against such practice. It was claimed, during the war, that gun shot wounds treated in this way did remarkably well, but the authority of the *Medical and Surgical History of the War*, is strongly opposed to any such claims.

REPAIR OF WOUNDS.

To conclude this portion of our subject, we have to consider the PROCESS OF REPAIR, with the action of remedies as aids thereto.

Wounds heal in various ways, the processes really being simple modifications of some recognized standard, but various writers have given us varying classifications. Thus PAGET (HOLMES' *Syst. of Surg.*, I., p. 633) gives five methods, while others, and more recent writers, give but four. Under any circumstance, however, the method is one that is similar, if not identical to the original formation of the tissue injured, and can only be well understood in proportion as our knowledge of histology is accurate. In the case of open wounds the breach is healed by the deposition and organization of nucleated cells; in subcutaneous wounds, by the interposition of nucleated blastema, but in every instance, with a solitary and rare exception, by the formation of new tissue, more or less normal in character according to circumstances. There is nothing in the domain of surgery that offers such an interesting and profitable field for study as this, and none, I think, which is, as yet, in such an unsatisfactory stage of development. From the fact that the subject is purely histological, as well as our want of accurate and definite knowledge, it must answer our purpose, at this time, to treat the question in a very general manner.

It may be noted in the outset, as set forth in a previous volume (*Surg. Therap.*), that while a determination of blood to the injured part is an essential feature of the process of repair, inflammation, in the true sense of the term, will not only retard the reparative process, but even prevent it. The preliminary condition, therefore, is one of hyperæmia, in which there is no change in the *character* of blood, unless it be a slightly increased plasticity — but a simple increased supply. It is from this vital fluid that our plastic material is derived.

In all methods of healing, save one only — the progression of phenomena is about as follows: It is stated in nearly all of our text-books, that there is a period of rest before active repair commences. This, I have concluded, is an error. The fact seems to be determined only after extended observation, that repair commences immediately on the reception of injury. It is true there is no effusion of lymph, nor any apparent attempt to heal the breach, but it is evident from an observation of the hyperæmia, and other symptoms, that nature is not idle. This period is occupied with efforts tending to expel all foreign material, such as clots of blood, and small particles overlooked in our preliminary dressings. During this effort, in many cases, active inflammation is set up, and not infrequently results in suppuration; this inflammation, however, must cease, at least to a considerable extent before active repair is inaugurated, although the pus may continue to the close of the process. Organic obstruction to healing, such as clots of blood, are put out of the way in many ways;

oftener expelled by the swelling of the parts; sometimes resorbed, after undergoing a sort of metamorphosis; again they are carried out by the pus or other discharges. We see a practical illustration of the increased rapidity of healing in wounds perfectly *clean*, in the common custom in amputation of large parts, when the cut surfaces are not approximated until all bleeding has ceased and they are dry and shining. This inaugurates more rapid healing by saving the time required to clear the wound of foreign material. Under all circumstances, therefore, healing commences *actively*, as soon as the parts are in a favorable condition, but *actually* immediately upon the reception of injury. It is in this stage, the eliminating, that *Arnica*, has such a beneficial effect, as its action is to hasten the resorption of the blood.

Upon the completion of this process, the accompanying inflammation subsides, in a healthy condition, and lymph is poured out to close the gap. This lymph becomes organized into connective tissue, in all methods of repair but one—which in a majority of cases becomes gradually converted into the tissue of the part. Under other, and unfavorable circumstances, this organization, which we denominate cicatrization, or scarring—is either deficient or vicious, resulting in great deformity, imperfection, or positive danger from a pseudo-malignant action. This topic, however, must be left until later, when we have considered the various methods of repair.

From a careful and systematic consideration of the subject, I have adopted the following division of the methods of healing as the most rational and commendable.

1. *Immediate union.*—In this form, which is quite exceptional, there is an immediate union of the cut surfaces, without the interposition of new tissue or plastic exudation. It has been properly called a "process of negations," as it can only be described as produced without hyperæmia, without lymph, without pain, and actually without symptoms of either normal or morbid action. As indispensable to success, there must be an absolute cessation of hæmorrhage, cleanliness of the wound, and accurate approximation of the wounded surfaces. The parts being placed in exact apposition, they seem to adhere without any adhesive material being thrown out. Thus we have absence of scarring, normal pliability and function of the part, and nothing remaining to indicate that any lesion had ever existed. Of course a division of muscular tissue, with much retraction, must forbid such a desirable union, yet cases are not unknown in which the most unfavorable conditions have been followed by immediate repair. I have said that such union was very exceptional; but while this is true, as far as complete healing of wounds is concerned, yet it is quite frequent to a certain extent, or as applied to a portion of a large wound. Thus it is quite commonly found that a portion of wonnds, particularly where large surfaces are involved, has united by primary union, particularly in flap amputations, or ablation of the breast. Cases are recorded where the superficial portions of deep wounds have become

united in this manner, and so firmly that pus which had formed late finds no outlet, and an abscess, to all intents and purposes, is formed. Whilst it is certainly the most desirable form of union, yet the difficulties are so many, and the conditions so rarely attained, that we must consider it a consummation rarely to be expected or hoped for.

2. *First Intention.*—In this method of union the appearnces of healing are not visible until some time has elapsed for the purpose of preparing the wound for this next step. This time varies, in proportion to the size of the wound, from a few hours to a day or more. It is inaugurated by the appearance of lymph on the edges of the wound and the cut surfaces, but not infiltrated into the tissues. To the eye this lymph appears as a ruddy, translucent, viscid, unirritating substance; when examined with the microscope it appears as a confused mass of leucocytes. Capillary loops gradually extend into this mass from each side, and ultimately unite in the centre, resulting in a complete circulation in the new tissue. In time the lymph becomes organized into a dense, more or less inelastic tissue, of a lower grade of vitality than the older tissue, but in process of time, occupying years for its full completion, it becomes fully organized, nerve supply is perfect, deep attachments become loosened, and in all essentials it becomes like the tissue of the part. The time required to perfect this union varies with the depth and extent of the injury, the nature of the tissue, and the bodily condition of the patient. Large wounds usually require more time than small to become completely united; but when no large vessels are wounded, which would necessitate the retention of a ligature in the wound, from four days to a fortnight gives ample time for complete repair. Cutaneous wounds heal the most readily, muscular tissue next, after which comes cartilage, tendon, nerve, and bone, in about the order named. The vascularity of the part, and its nearness to the centres of circulation, will also play an important part in the rapidity of healing. Thus wounds of the head and face, will heal, other thing being equal, with greater rapidity than wounds of the extremities. Inflammation will arrest this process, as will anything that may have a tendency to interfere with the organization of the lymph. For this reason precautions must be taken to avoid all local irritation, and any applications that would induce deterioration of lymph. Hence heating and complicated dressings, wet or greasy applications, or continued use of the part must all be forbidden. Notwithstanding nearly all surgical writers assert that healing under a scab is the most natural method, and that which should be attempted and desired, they all equally recognize the fact that, as PAGET says, "it is difficult to excite or study in man." I, therefore, feel satisfied that as first intention is secured with greater readiness, and occurs so frequently as to be considered the "*human method*," it should receive our first attention. Of course immediate union is more desirable than even that under a scab, and the attempt to secure this, if we fail, will leave us in the

best condition to secure that by first intention; whereas, if we fail in attempting to induce scabbing with the requisite character, our patient must undergo a less desirable method, and one which can never give as good results as either of the remaining three. First intention, therefore, to repeat, is the form of union to be secured.

3. *Second Intention.*—This is otherwise known as *granulation.* This form of union is that accomplished in wounds that have been left open, or that are deep with small external opening. The process is accompanied by more or less pus, which, in this instance at least, is a veritable luxuriation, or the excess of reparative material. The perfectness of the healing may be foretold by the character of the pus; while the pus is laudable the process is normal, and any defect will be detected by a deterioration of this fluid. The first notable change in the parts will be a grayish film covering the raw surfaces, which soon becomes filled with minute elevations, gradually growing in size and increasing in firmness, attaining a size varying from a mustard seed, to a large pea in some cases. These elevations are known as *granulations*, and it is by the union or aggregation of these that the new tissue is formed. On examining the minute anatomy of a granulation, it will be found composed of lymphoid corpuscles, irregularly heaped together, with little, if any intra-cellular substance. Blood-vessels will be found extending into them, terminating in loops on the apex. As the granulations increase in size they approach each other, interchange their vessels, and ultimately, the whole gap being filled with them, they gradually acquire an epithelial covering and assume an enduring form. When the process is perfectly normal, the integumentary covering is thin and delicate, and the scar is white and partakes of the characters familiar to all medical men. Abnormalities of cicatrization will receive attention shortly. The granulations themselves are liable to accidents of various kinds, and many abnormalities in development. The invasion of inflammation may destroy them; they may be too exuberant; they may be weak; they may be irregularly developed, here large, there small; in short the perfection of development is often difficult of attainment. Most of these conditions are readily improved by remedies, to be given shortly — but when of a chronic character, the wound becomes practically an ulcer, and must be treated as such. (*Vide, Surg. Therap.*) When healthy, they are florid in color, firm in consistency, and bathed in laudable pus; they often bleed slightly on handling, but should not do so violently; the sensitiveness should not be great, but any anæsthesia is indicative of imperfect formation. PAGET adds a fifth form of union, which he calls "Union of two granulating surfaces," but it seems to me that it can only be considered a union by second intention, the granulations uniting by their apex, rather than their sides.

4. *Under a Scab.*—In animals this is the universal method of healing, and failing in immediate union is very desirable in man, from the fact that there is no granulation and consequently no cicatricial contraction. It only occurs in open wounds, those with much gaping,

and is not well understood. The difficulties in the way of observing this process are insurmountable, as any destruction of the scab will interrupt it; also, in the case of man, the tendency to suppuration will equally lessen the probability of the crust remaining unchanged until healing is completed. It is only known that the blood, lymph, and probably dust and hairs, unite in forming a crust, and under this healing goes on without granulation. The cicatrix is always softer in these cases, and the connective tissue of which it is formed soon takes on characters like that of the part. It has been attempted to imitate this method by sealing up wounds with collodion and lint; and it was thought, as said above, that gunshot wounds were best treated in this manner. The records of our late war will not substantiate this claim, and my own experience in a few cases has not encouraged me to attempt it in the future. In all of my cases the pain was excessive, about the fourth or fifth day, and on opening the wound much pus has always been found, and usually of an unhealthy character. I must repeat, therefore, that as this form of repair is difficult to secure; while fully recognizing its desirability, attempts should be made to secure immediate union, or by first intention in cases at all suitable

REMEDIES that materially aid the repair of injuries, may be selected with reference to the following indications:

Aconite, which has a marked influence in modifying vascular excitement, will be found valuable in smooth cut wounds, as favoring immediate union; failing in this, in the absence of any dyscrasia, the parts will be placed in the best condition for union by first intention. I always give this remedy, for a few hours, immediately after dressing in all kinds of wounds.

Hypericum perf.—This remedy has a remarkable action in allaying irritation of peripheral nerves. This irritation, which has a direct tendency to cause conditions favoring inflammation, *viz.*, dilatation and stasis in the vessels of the part — in all cases in which the pain is excessive, or there is unusual soreness, it should be given as a succeeding remedy to *Aconite*.

Arnica mon.—In all wounds, particularly of the contused variety, in which there is retention of blood in the parts this remedy will have a very powerfuleffect to hasten resorption or elimination of the coagulæ.

Staphysagria.—In wounds involving division of nerves, particularly should there be much hyperæsthesia that neither *Acon.* or *Hyperic.*, will allay, this remedy has a very beneficial effect. It is more or less indicated in all clean-cut, incised wounds, and may be advantageously used as a substitute for *Aconite*.

Calendula.—In all wounds with much loss of substance, or with much gaping, which necessitates healing by granulation, this remedy is of the first importance. Many surgeons employ it in all varieties of wounds, and for many years I did so myself; of late, however, it has appeared to be demonstrated that its function is to correct unhealthy suppuration, and to hasten granulation. In promoting union by second intention it must, therefore, take the first rank.

Sempervivum tect.—In unhealthy granulations, particularly when large, flabby, pale, and jelly-like, this remedy has come to be my main reliance. I have never, however, used it internally, probably from habit, but concede, of course, that it should be as efficacious, given in attenuation, as in tincture applied topically.

When we reach *classification* more will be said as to special indications of these, and other remedies, in different kinds of wounds.

SCARRING OR CICATRIZATION.

SCARRING is an inevitable result of wounding, unless immediate union is secured, and we must at all times endeavor to control this, as much as possible, to prevent deformity, or even loss of function. Cicatricial tissue is of an inelastic character, and when cavities are wounded, hernia is always to be feared in the future, from the loss of resistance to visceral protrusion. Thus a muscle having been divided the union never restores the last contractibility; the organ is forever lost. The contractions are in each direction from the cicatrix, and the constant traction to which the nodular tissue is subjected gradually induces attenuation, or the muscle itself atrophies and disappears. In either event the resistance to viceral protrusion is diminished, and hernia is a constant possibility. Muscles of locomotion are liable to the same loss of function, and whether the new tissue interposed between the retracted ends is much or little the result is pretty much the same. When a muscle is completely divided, it is *possible*, in some instances, by attention to positions that will completely release the parts, and the introduction of *deep* sutures, to excite immediate union, in which case function will not be lost. Such a happy result, however, is extremely rare, and the cases in which it could be reasonably expected are necessarily very few.

In a normal condition of the body, and when the injury is sustained before middle life, scars ultimately either disappear completely, or become very much modified in course of time; deep attachments becoming loosened, and the tissue becoming similar, at least, to that of the part. *Silicea*, in the absence of any special indications, will usually have a good effect in hastening the metamorphosis.

The *modifications* of cicatrization are many and important. We will briefly consider some of them.

(*a.*) There may be an utter *failure of the healing process*, due to excessive hæmorrhage, habitual anæmia, the introduction of irritating substances, the invasion of inflammation, or some dyscrasia or cachexia. The condition is then one of ulceration, practically, and must be treated as such. Local stimulus can have little benefit, certainly can produce no lasting improvement—and our attention must be directed to the constitutional condition. The treatment, as a matter of course, must have especial reference to the cause, and cannot be given here at length. Irritating substances must be removed; anæmia, if acute, corrected by diet and remedies; inflammation subdued

by appropriate remedies, as *Acon.*, *Bell.*, *Rhus*, etc.; special dyscrasia or cachexiæa, treated as if no wound existed; in short the exercise of sound common sense is what is particularly needed.

(*b.*) There may be an imperfection in the scar, due to some interruption of the process, or some feebleness of the same, so that it is too *thin*, and the new integument thereby easily broken and irritated. Such conditions I have seen much benefitted by *Natr. mur.*, or *Caust.*

(*c.*) The scar may be *depressed*, due nearly always to some dyscrasia, oftener of a specific nature — and which is practically irremediable. Should such a condition occur without such dyscrasia, simply from some accidental disturbance of the reparative action, it would be justifiable, if much deformity is due thereto, to dissect it out, and begin *de novo*, or treat by PARSONS method. (*Vide* paragraph *e.*)

(*d.*) The scar may be *thick and elevated*, due to either morbid action, or excessive reparative action under unusual stimulus. In either case *Silicea* will often induce improvement. In case of deformity, and the failure of our remedies, when well selected, dissection may be practiced.

(*e.*) Scars may *form deep attachments*, and seriously impair function. Deep attachments form in most cicatrices, but should become loosened in time. Should *Sil.*, fail, when the natural changes do not occur, an operation suggested by PROF. S. B. PARSONS, (*Am. Hom. Observer*, XIV, p. 297) has yielded excellent results, in my practice in two instances. He says, "My manner of proceeding is to make a subcutaneous puncture with a tenotome, and divide thoroughly, close down to the bone, or whatever tissue the cicatrix is adhered to, and insert into this space or cavity as much cat-gut as it will hold. This I let remain until it is entirely absorbed, which may be in four days, and may be two weeks. * * * * * From subsequent experiments and observations, I find that the power of absorption of cicatrices is very much less than healthy skin, in the ratio of one to ten, although this is subject to modifications by circumstances relating to the age of the person, constitutional condition, etc. I have never been required to operate the second time, nor failed to elevate the depressed surface, nor have I ever witnessed any bad results or inconvenience from the cat-gut remaining under the skin. Previous to using, it should be oiled and washed by the hands to be made soft, but not allowed to soak in any liquid substance." This same process has done good service in countracting-scars, as from burns, which will receive attention under that head.

(*f.*) *Morbid action* in cicatrices, is common, but as it is purely due to constitutional influences, does not demand attention at this place. Thus we may have carcinoma, syphilis, keloid, etc., induce characteristic phenomena, which has received due attention elsewhere. (*Vide Surg. Therap.*)

Finally we will note, that all wounds are productive of, or followed by, fever, which is a sequelæ to shock, and succeeded by some exhaustion. As a matter of course either of these states will be mainly

dependent upon the extent of the injury, the violence with which it has been inflicted, and the bodily condition of the patient. It needs nothing at this time in the way of suggestions of treatment, as it is conducted on general principles, and is familiar to every practitioner.

V. CLASSIFICATION OF WOUNDS.

Having now considered wounds in general, and the principles of repair from such injuries, common to them all, it becomes necessary to take the subject up in detail, and treat of the varieties into which the subject is commonly divided, with the treatment that experience has proved to be the best of any of which we have knowledge in the present state of therapeutic art. It has been shown in the last chapter, that while nature is amply competent to heal injuries without the interposition of art, yet there are not only numberless cases in which some local or general vice, accidental or constant — materially cripples the natural powers, but, even when all things are in the best possible condition for a restoration of the part, our remedies have a powerful influence in hastening the process, and warding off many dangers that could not otherwise be met. For this reason we find an unquestioned field for therapeutic considerations, from a Homœopathic standpoint, notwithstanding accident and disease are not synonymous terms, nor have they any actual relation to each other. Those who are unfamiliar with the resources of Homœopathic art can have no conception of the extent of our means to mitigate suffering, lessen deformity, and hasten repair; it requires actual experience, and careful individualization, to as great an extent, perhaps, as in the case of disease.

The most reasonable and natural division of wounds is into six classes or varieties, the first four of which will be considered at this time: 1. Incised. 2. Lacerated. 3. Contused. 4. Punctured. 5. Poisoned. 6. Gun shot. To this list some add a seventh, sub-cutaneous, which it occurs to me is unnecessary, as such wounds may partake of the character of either of the others, differing solely in the mode of repair. The first four of these groups represent conditions of simple division of tissues, without the introduction of any additional element of danger; whilst the fifth, has in addition to the wound, which may be of either of the above varieties, a toxical consideration, which makes it something more than a simple wound. Of gun shot injuries, the peculiar injury inflicted on the tissues, the complicated processes following and accompanying them, and the modified and different considerations and indications in the treatment, all combine to make the subject of especial interest, and demand consideration apart from that of wounds in general.

I. INCISED WOUNDS.

An incised wound is one made by a sharp-cutting instrument, by which the tissues are smoothly divided, and not torn or contused. The best type of this variety is the incision made by the surgeon,

and this will be taken as the standard in giving the treatment. Sword wounds are often included in this class, but, in modern times at least, they are actually contused. The chief points demanding attention are as follows: Gaping, bleeding, pain, and consequences. Each of these will demand some attention in addition to that given previously under wounds in general.

(*a.*) *Gaping*, or dispartition as it is sometimes called — is a natural consequence of dividing soft tissues, and is greater or less with the reference to the nature of the tissue. The text-books generally adopt the table of NELATON, (*Elements of Surg. Path.*, Vol. I, p. 106), in which the tendency to gaping is in the order named, beginning with the maximum: Skin, elastic tissue, cellular tissue, arteries, muscles, fibrous tissue, nerves, cartillage. Circumstances, however, frequently cause some derangement of this order, and it may be a matter of practical import to determine which tissue is greater retracted in a given case, particularly with reference to possibilities in impairment of function. The position and condition of the part affected will exercise much influence on the extent of separation, whether in a state of tension, flexion or extension. A transverse wound of the thigh, will gape more widely when the leg is flexed than when extended. Transverse division of strong muscles, will gape more widely than of those which are not in constant operation. The integument itself, being more muscular in some places than others, will cause much variation in the degree of separation. Under most circumstances, however, I am inclined to think that the condition of subcutaneous parts, their elasticity, compactness, and volume, will exercise a very important influence on the integument. Thus when there is any unusual augmentation of volume of subjacent parts, as in the case of tumors, incision of the integument will be followed by greater dispartition than under other conditions. It is quite common to have fat, cellular tissue, or other parts, pushed out and firmly held in integumentary wounds.

I have alluded to the fact that a muscle which has been completely divided, in the majority of instances, loses its function permanently; the loss may be partially avoided by securing as close coaptation of the cut surfaces as possible. In surgical practice, therefore, the lines of incision are carefully planned with reference to the direction of the muscular fibres, and every precaution taken to avoid dividing them transversely; particularly is this true in the case of muscles of locomotion. In cases of accident, however, such matters are of secondary importance, as nothing can control the direction of the wound, and our efforts must be directed to placing the parts in the best condition possible for speedy union.

The degree of gaping will be often to such an extent that the inexperienced surgeon will be led to believe that a piece has been cut out. In wounds of the forearm, involving the long supinator particularly — I have seen the retraction so great that the direction of the

wound seemed to be changed; that is a transverse wound appeared longitudinal. This must always be the case when powerful muscles are divided, particularly when they are such as are used constantly. I have seen, in two instances, such a wide retraction in subcutaneous wounds of the temporal muscles, that it gave the impression of a deep depression, and was mistaken, in one instance, for a depressed fracture of the skull.

(*b.*) *Bleeding*, as said elsewhere, is the most important symptom demanding attention. The amount of hæmorrhage, and the danger, depends upon the size and number of the blood vessels, the state of the part, and the state of the patient. As a rule small vessels close almost immediately upon division, unless there is some condition of the part that would prevent their retraction, such as hypertrophy, or intense inflammation. At other times any disease, particularly if local in its manifestation, will have a tendency to greatly increase bleeding. There are so many conditions that modify bleeding, that it is hopeless to attempt a consideration of them all, but they may be generally placed in two classes, those permanent or habitual, and those temporary and transitory. In the first class will be included all chronic morbid action, tumors, etc., that necessarily induce increased blood supply. In the second, recent exertion, as walking, local inflammations and the like. It was found during the late war, that men wounded during or shortly after a long march, particularly if injured in the lower extremities, bled more profusely than under other circumstances. Operations performed, under similar conditions, presented more vessels for ligation. It is true that this increased vascularity is purely physiological, and would soon pass away; but the smaller vessels are so much enlarged that the hæmorrhage might have a fatal termination while waiting for the contraction of these small branches.

After the ligation of the larger vessels, the bleeding from the smaller soon becomes more passive; they cease to discharge blood one by one, and the blood itself becomes paler and thinner, until finally it is a mere reddish serum, which soon becomes colorless and takes on all the appearances of lymph. On examination it will be found largely composed of lymphoid corpuscles, and is the material nature provides to heal the injury. The contraction of these small vessels may be much hastened by the application of *hot* water, as hot as can be borne; it is the custom to laud the virtues of cold applications in such cases, but none who have witnessed the speedy cessation of bleeding after the employment of this truly Homœopathic remedy, and the permanent character of the contractions, will ever willingly return to ice and cold water.

(*c.*) *Pain* is a symptom difficult to describe, no words can give an adequate idea, and as PAGET says, "it is like describing colors to a blind man." While all incised wounds cause pain, yet there is much variation in degree and character, dependent upon the part injured, the condition, and the sensitiveness of the individual. Certainly

wounds inflicted unexpectedly, are far less painful than when they are foreseen; and persons of a highly excitable or nervous temperament suffer acutely, or at least *express* more suffering than those of a different constitution and habit. The integument is unquestionably the seat of greatest pain, but is not equally sensitive in all parts of the body. That of the inner surface of the arms and legs, the back, and the genitals, is generally more sensitive than other parts; but circumstances may greatly modify this. Inflammatory conditions, particularly when plastic exudation is considerable, will greatly increase the sensitiveness to pain, and it is said the division of the constriction in operations for hernia, excedes in painfulness that of any other tissue divided in this operation. Lancing felons is known to be exquisitely painful, and so with all tissues unusually gorged with blood, particularly when dense and indistensible. In cases of destructive morbid action, however, the pain is greater in the healthy tissues immediately adjoining the disorganized parts. Thus Nussbaum, in his scraping operation for myeloid and encephaloid growths, found that the process was painless until the healthy tissues were reached, or at least comparatively so. The pain, however, in all incised wounds, may be described as at first cutting, with a feeling of heat; next becoming smarting and burning; finally a simple painful stiffness. The pain itself is not to be despised as a hæmostatic, inducing, as it does, a spasmodic muscular action which greatly favors contraction and compression of the smaller vessels.

(*d.*) The *consequences* of incised wounds, leaving out of consideration repair, are shock, reaction, and hyperæmia.

Shock, to a greater or less extent, is a feature in all wounds, but is usually slight in the incised form, even when the wound is extensive and produced with much violence. It is unquestionably more severe when the impending danger is foreseen, and an attempt is made to avoid it. In sword wounds of the head it is the custom to consider shock as commonly of a grave degree, but it would seem that concussion of the brain would be the actual lesion, observers mistaking it for shock. The symptoms, however, are the same as under other circumstances, and demand practically the same treatment and consideration. *Arnica*, *Opi.*, and *Camph.*, are the chief remedies, perhaps the last being the most serviceable in slight cases. Stimulation must be avoided, as the secondary effect will either be increased prostration, or if used too freely, surgical fever will be high.

Reaction, following the shock, will be proportionate to the degree of collapse; it is usually a mild, evanescent febrile condition, readily controlled by *Acon.*, and often so slight as to be unnoticed. In many cases it assumes a hysterical form, but without great loss of blood need never occasion alarm. The chief point of interest attaches to the fact, that if the fever is high, and is not readily controlled, inflammation is imminent, and repair will be much embarrassed. After the first symptoms of shock have passed off, usually by the time the

dressing is completed, I make it a rule to give a few doses of *Aconite*, until all danger of inflammation has passed.

Hyperæmia, in large wounds accompanied by erythema—sometimes accompanies reaction, at all events appears immediately after its full establishment. It must not be confounded with inflammation, which would be a highly undesireable condition, although hyperæmia would represent the first step in that process. There is redness, it is true, and some heat, swelling, and pain, but the remaining essentials of inflammation are wanting, and none more noticeably than the different results, viz., in the one active repair, and in the other equally active destruction. It will, in exceptional cases, require some skill to accurately differentiate, and it will be manifestly necessary to do so. In general the appearance of the wound will be conclusive proof. Thus when the edges show a tendency to fall apart or there is a failure to produce granulations, inflammation may be pronounced; when opposite conditions exist, even with extreme sensitiveness, hyperæmia, or what was formerly called "adhesive inflammation" is the condition. Pus, of any character, must, at first, indicate active inflammation, whether it is laudable or not; it may, and does, continue, however, after the subsidence of inflammation, and while laudable and normal, healing advances; any deterioration in quality indicates a defect in healing, and usually denotes, also, a return of the inflammatory condition. In fact the pus is the best guide we have, often, in determining the progress of our case.

TREATMENT.—The treatment of incised wounds is to be conducted on the principles laid down in the chapter on *Wounds in General*. The nature of the injury favors immediate union, and in all cases our efforts should be directed to that end. The cleansing of the wound having been completed, a weak solution of *Staph.*, should be allowed to trickle over it, and it then should be closed. In wounds of the face, when not very deep or with little retraction, no sutures should be used, if it is possible to secure coaptation and retention without it. Should this be impossible, fine wire suture, or harelip pins may be used. I have found that a single turn of a roller bandage, or any thin light covering, is all that is needed; and, indeed, the wound will do better just in proportion as the dressings are uncomplicated and light. As inflammation is the one thing to be dreaded, the first dressing should be final, not needing re-adjustment, as thus all motion of the cut surfaces on each other is avoided, as well as undue handling. When it has been necessary to ligate bleeding vessels, the ligatures should be brought out at the most dependent angle of the wound, and while their presence will prevent immediate union at that point, the remainder may well heal as desired. I have seen cases in which a number of ligatures, six or eight, did not induce notable suppuration, the whole wound healing up so tightly that when the threads finally became detached it required some exertion of force to withdraw the

knots through the small openings. Usually, in case of wounds of the face particularly — accupressure pins had better be used in arresting hæmorrhage. Finally, the part is to be placed in such a position that the muscles injured, or that would have a tendency to draw apart the edges of the wound — may be fully relaxed.

If all does well, on the second day substitute *Staph.*, for the *Acon.*, which had been previously given, and, giving a dose once in four hours, continue it until the close of the case. The dressings should not be disturbed until they become offensive from the discharges, or are displaced, and then immediately replaced. At each dressing the parts may be bathed in the *Staph.* lotion, and it matters little whether the tincture or thirtieth be used. Should suppuration supervene, and the wound look swollen and tense, the sutures must be loosened to allow exit to the pus, and need not always be reapplied. When there is no inflammation, no suppuration, the patient is in good health, and no accident occurs, such wounds should heal, depending upon depth and extent — in from four days to a fortnight. When nerves have been wounded there will be more or less paralysis, but if no nerve tissue has been lost, it will soon disappear. When suppuration sets in, of course all hopes of immediate union must be abandoned, and the next best thing, or first intention, sought for. To secure the highest benefits from this mode, it is essential to limit the extent of cicatricial tissue as much as possible, and to keep the parts in close apposition. It is well, therefore, as soon as the inflammation subsides, to close the wound up again, even to the extent of reapplying the sutures if the end cannot be reached without it; in this case, however, care must be had to leave an outlet for the discharges.

In small incised wounds, if moderate pressure be made and *persisted* in, to keep it closed, applied *immediately* upon the receipt of the injury, union may take place, throughout a considerable extent, at least, at once. Should any blood exude before the pressure is applied, however, there will be no hope of this.

In examining the wound, at the second and subsequent dressings, great care should be had not to disturb the relation of the parts, nor to injure the inspissated lymph that covers the margins; the quieter the parts are kept the better the chances for speedy union. In an operation for the removal of a tumor from the face of a young woman, not long since, by paying close attention to these principles of treatment recovery took place with a scarcely perceptible scar. In time even this faint mark promises to become completely effaced. In surgical incisions, that is those made designedly by the surgeon, I have long made it a practice, wherever practicable, to make them sloping with reference to the surface. The results have been most happy, in lessening scarring, and I notice in a recent number of the *Hahnemannian Monthly* (Vol. I., [N. S.], p. 121), that DR. PACKARD makes the same recommendation.

II. LACERATED WOUNDS.— A lacerated wound is one in which the

tissues are torn asunder; not smoothly cut, as in the case of incised wounds, nor crushed, as in the contused variety. Such injuries are usually produced by the agency of machinery, cannon shot wounds, or by the fangs of animals. They vary in degree from a slight laceration of the integument, to the tearing out of whole limbs; cases are on record of the whole arm, with the scapula and clavicle being torn or twisted out; or the leg completely disarticulated at the hip. The symptoms vary with the extent of the injury, the nature of the injury, and the construction of the part; but in certain essentials the same phenomena are observed, *viz*, shock, little if any primary pain, scanty primary hæmorrhage, with various secondary symptoms, as hæmorrhage, pain, tetanus, erysipelas, sloughing, and pyæmia.

(*a.*) *Shock* is usually proportionate to the extent or degree of the injury, yet when such are expected the shock will always be greater. Inasmuch as the majority of lacerated wounds are produced by machinery, or on the battle field, primary shock is the exception; at least my experience would lead me to infer that remote or secondary collapse is to be much feared. In the graver forms of this injury no amount of will, or strength of mind, can protect the sufferer from shock, and, as said elsewhere, treatment for this condition should be instituted from the beginning.

(*b.*) *Pain* is usually insignificant, particularly as a primary symptom, and many terrific lacerations have occurred without the sufferer being conscious of it, for some time at least. Later, however, when reaction is established, the pain is severe, at times almost beyond endurance. In some cases it has seemed almost an imperative necessity to resort to anæsthetics to subdue this, and cases may possibly occur in which an anodyne might be called for. This last has never occured in my practice, nor, indeed, has the necessity for anæsthesia; such remedies as *Hyperic.*, or *Stram.*, answering every purpose. The character of the pain, whether primary or secondary, varies with each case; in the majority of instances the primary pain is a dull aching, with a feeling of stiffness or numbness, and the secondary intense burning, throbbing, or lancinating. This is always succeeded by a return of the aching, usually occurring when suppuration is established, but occasionally being deferred until the healing process is well advanced.

(*c.*) *Hæmorrhage* is usually insignificant. This is owing to the nature of the injury, by which the vessels are violently stretched, and torn asunder. The stretching induces a vaso-motor paralysis, which greatly retards the current of blood; the method of division is that most favorable for retraction, and the shreds of tissue acting as nuclei for coagulation, a clot soon forms. The collapse will also aid both in diminishing the force and rapidity of the blood current, and in connection with the other conditions materially assist in coagulation. Instances are very numerous in which a limb has been torn or twisted off, and not a drop of blood lost. I have seen two instances,

accidents from machinery — in which the vessels, were seen hanging out an inch or more, pulsating vigorously, and not discharging a drop of blood. Very frequently the veins are torn off high above the line of separation of the other tissues, and as reaction comes on blood will be found coming out of the distal opening; this, of course, only occurs when the separation of the part is not complete. If primary hæmorrhage is of rare occurrence, as much, unfortunately, cannot be said of secondary. Next to shock, as far as my personal experience goes, this is the greatest element of danger. The violence with which the separation of the vessels has been effected greatly favors gangrene, and the application of a ligature can promise little safety, as it is impossible to determine to what extent this devitalization has been carried. The bleeding coming on secondarily, is not due to a washing out of the coagulæ and the re-establishment of the patency of the artery, but to a sloughing of the devitalized extremity. For instance, in one case, the radial and ulnar arteries were severed about the lower third of the arm; when secondary hæmorrhage occurred it was as high up as the flexure of elbow. In many cases, however, the dangers resulting from secondary bleeding are materially lessened, from the fact that all the tissues of the part are equally devitalized, and a line of demarkation will form sufficiently early to denote the limit of arterial degeneration. In many instances, also, the extremity of the torn vessel will become firmly closed before the extrusion of the dead portion. Nevertheless the experienced surgeon will always consider the possible occurrence of secondary hæmorrhage as among the most serious complications of wounds of this character.

In some rare instances the most serious and extensive mischief may be produced, the parts extensively torn and disorganized subcutaneously, with a very insignificant cutaneous wound. In this respect, as will be shown later, they resemble contused wounds, and had better, for the avoidance of confusion, be so considered. After serious injuries, therefore, a slight wound must always excite suspicion, and demand a careful and systematic examination of the part. Muscles, nerves, and blood vessels may be extensively torn, and unless attention be paid to function and sensation below the point of injury, never be suspected until gangrene has set in. It is true that the local shock of a severe contusion, with no structural lesion, will destroy sensibility and impair motion; but if the shock is not general there will be no cessation in arterial pulsations below the point of injury. Rapid swelling, therefore, with loss of sensibility, cessation of arterial pulsation, and lowered temperature, must always indicate extensive mischief, and call for the exercise of sound judgement in determining treatment.

The TREATMENT of this class of injuries demands the consideration of many items In small lacerated wounds the indicationsare the same as in the incised wounds. When the injury is severe, when limbs are

wholly or partially torn off, or cavities opened, the case assumes a totally different character. We may divide the indications under two heads: *Local* and *general*.

Under the first head, the first question to be decided is amputation, *pro* or *con*. Amputation is generally to be performed when a large joint is opened, with muscles pulled out, and nerves and vessels severed. The majority of observers have decided, I think, that primary operations are to be preferred. The sole objection to this practice, considered as a constant rule, would be the difficulty in determining, in all cases, the extent to which the disorganization has been carried. The results of tactile examination, arterial pulsation, and sensibility, will usually decide this, but it is safer, in this instance if no other — to amputate a little higher than ordinary. When a part has been twisted off completely, the state of the parts must be taken into account in determining the question of amputation of the stump. If the shoulder or thigh is disarticulated, the patient can hardly survive, and the proximity to the trunk prevents any instrumental interference. In such cases the most that can be done is to place the parts in the best position for healing, and aid the process somewhat by removing tissue that is manifestly dead. When a stump is left, however, it has been debated whether it is better to perform re-amputation primarily, or allow the devitalized tissue to slough. It would seem that there can be no question that the former is the better practice, both from considerations of humanity, and as hastening the process of repair, which, as has been said, cannot become fully established until all impediments have been removed. The point of election, therefore, must be with reference to the probable line of separation should gangrene supervene, and the stump removed an inch or two above this.

Should it be deemed advisable to attempt a preservation of the part, all dead tissue, or that which must certainly perish, should be removed. The wound may be closed with sutures, and dressed as usual. As swelling is great, in such cases, attention must be paid to the sutures, and should the strain become too great they must be instantly loosened. Under no circumstances, I think, should they be permitted to remain longer than three or four days; in fact, the stitches should never be drawn tightly, room being left for subsequent swelling. In most instances, it would be preferable to discard sutures, and rely upon judicious bandaging and the employment of adhesive strips. Many surgeons of eminence strongly object to stitches, whether loose or tight, and in view of the fact that immediate, or even primary union cannot be anticipated, and the parts will not endure a long retention of sutures, it might be laid down as a rule, that they should not be used.

Suppuration is inevitable, and care must be taken to give pus free exit. The character of the discharge must be frequently examined, and any deterioration in quality, or diminution in quantity must

receive prompt attention. The suppression of such a discharge will indicate either the invasion of erysipelas or pyæmia. While it is a rule, therefore, to allow the dressings of incised wounds to remain as long as they continue to fulfill their office, in this case they must be removed frequently; perhaps every day, or even twice a day, in severe cases — would not be too often; but as soon as healing has fairly commenced they may be permitted to remain.

Sloughing is almost a necessity of the case, the only consideration being to limit it as much as possible, and to hasten the detachment of the sloughs. This is usually a rapid process, the extreme injury done the tissues, and the interruption of circulation and innervation, kill the parts at once; it is not a gradual loss of vitality, but the vitality is destroyed at the moment of the injury. Unless the shock is severe, and the patient is in poor bodily condition, the sphacelation will not extend far, if at all beyond the limits of injury. The arteries will frequently become occluded above or at the limits of disorganization, and when proper attention is paid to keeping up the warmth of the part, collateral circulation is readily established.

The proper treatment for the *local* condition would be as follows: First cleanse the wound perfectly, even with more care than in the case of incised injuries; every little particle of foreign material, or scrap of devitalized tissue, will only prolong the sloughing stage. Should it be decided to attempt to save the limb, remove, *with a scalpel* (scissors bruising the parts and adding to the sloughing), all shreds and masses that are hopelessly devitalized. Close the wound with straps and light bandages, after washing it with a dilution of *Hyperic.* or *Calendula*. In most cases the former remedy is preferable, but in small wounds where not much pain is to be anticipated, *Calend.*, will ensure speedy union, and much modify the suppuration. *Hypericum* is of the first importance in subduing the pain that comes on with full reaction, and my preference is most decidedly in favor of the first dilution. It may be further diluted with water, in the proportion of one to twenty, and cloths wet with it may be kept constantly applied. It will answer a better purpose, however, to avoid wet dressings, as is the case with all wounds — and wash the wound with the prepared remedy at each dressing. The same remedy may be given internally, in a higher attenuation. When sloughing has ceased, and healing has become established, the dressings may be tightened, still leaving an outlet for the discharges — and the case treated as an ordinary incised wound left to heal by second intention.

The *general treatment* has been laid down elsewhere, (*Surg. Therap.*), and has especial relation to shock, erysipelas, pyæmia, and tetanus.

Shock will call for *Arnica*, when there is relaxation of the sphincters. *Opi.* when coma is present; *Verat.* when there is much prostration, with coldness; and *Camphor*, in the milder forms, when there is trembling, cold sweat, cold extremities, and hot breath. Stimulants must be used very sparingly, indeed they had better be avoided

entirely. My invariable rule has been, to administer *Arnica* in all cases where there is no primary shock, for at least twenty-four hours, and watch the case carefully for collapse later.

Erysipelas is treated on general principles, with a more frequent indication for *Bell.* or *Rhus.* A few doses of *Arsenic* will often ward off or abort this, when administered as soon as the discharges are observed to lessen, the edges of the wound fall apart, and the patient shows signs of disquietude without being enabled to refer to any special feeling of discomfort.

Pyæmia is likewise to be treated as laid down elsewhere. *Arsenic* and *Lach.*, take the first rank, and as the initiatory symptoms are almost identical with erysipelas, a resort to *Arsen.*, at the first symptom of danger will either abort the process entirely, or very materially modify the severity.

Tetanus (*Vide Surg. Therap.*), may be cured, if combatted at the first symptom by *Stram.* *Ledum pal.* must take first rank if there is positive objective coldness, and should the attack come on suddenly. In one case the patient was suddenly seized with pain in the head, and soon the wound became so painful, that he was almost frantic. The eyes were injected, the face red and bloated, and the pulse full and tense. *Bellad.*, promptly changed things for the better, and the impending tetanus passed off. In another case, the pain commenced under the sternum, and was of a most agonizing description; *Cupr. ac.*, here did good service, and the spasms were not fully established. In the majority of instances, however, the remedies more frequently called for are given above. *Plantago maj.* has been strongly urged as an invaluable agent for tetanus, but its recommendation is largely based upon purely theoretical and speculative grounds.

Among the more remote and less constant dangers of lacerations of some extent, we must not forget to mention neuroma. The condition under which the nerves are divided would readily induce such morbid action, and yet it is so rare a concomitant that it is scarcely mentioned in our text-books.

III. CONTUSED WOUNDS.

In the contused variety of wounds, we meet different conditions than are noticed in either of the preceding, yet there will be found many points of resemblance to the lacerated. Here we have a division of the tissues by crushing, or squeezing; the minor degrees are represented in wounds from clubs or sticks; the major, in loss of limbs by railroad accidents. Whether the injury is great or small, however, the conditions are the same, and the indications for treatment not materially different.

The most notable features in contused wounds, are shock, absence of hæmorrhage, absence of gaping, and sloughing. From every point of view the condition is not as grave as in laceration, but still sufficiently more so than incised injuries to merit close attention.

There seems to be an unnecessary confusion, existing in the minds of most students, as to the differences between a contusion and a contused wound. While a contused wound has a disorganization of the tissues, by the crushing force, precisely as is the case in contusions of the third degree, it has this additional feature, viz., a communication with the external air by a cutaneous wound. Any experienced practitioner can at once see that this circumstance is of sufficient importance to warrant a separate classification. It not only indicates a more extensive injury to the tissues, but at once places the parts in a less favorable condition for healing, and very materially adds to the danger, both to life and functional integrity.

Shock, as in the case of lacerated wounds, is a very prominent feature in contused wounds, and is, likewise, oftener of the remote or secondary kind. This statement, however, must be taken with the same qualifications mentioned earlier, viz., the time and degree of the shock must be dependent upon the nature of the injury, *i. e.*, whether expected or not. In fact this rule, I apprehend, will be found to extend throughout the whole domain of surgery, that injuries foreseen induce primary shock, those which are unexpected remote. A contused wound of some extent, such as would involve the loss of a limb, must always induce shock, and I have thought that in wounds of this character the severity of the shock must be proportionate to the extent of the injury, or the degree of force with which it is inflicted. This, it will be remembered, does not hold good in all kinds of injuries, as severe shock often follows slight accidents, and little, if any — is often noticed in severe ones. But in contused wounds, or even contusions — it would seem that shock must be in proportion to the extent of the lesion. When we recall the peculiar character of the force employed; the crushing of nerves, blood vessels, bones, and other tissues that is a natural consequence; the sudden and complete suspension of vital activity of the part, there can be no wonder that shock is such a constant condition.

Hæmorrhage is always small in proportion to the extent of the wound, and in many cases no blood whatever will be lost. The same conditions obtain to prevent this as in the case of laceration, the nature of the arterial division favoring speedy coagulation. But from the fact that the injury to the soft parts is less extensive, that is it does not extend to such a distance from the margins of the wound — there is much greater danger of secondary bleeding. We have learned that in severe lacerations the muscles, tendons, nerves, and blood vessels are pulled out, often separating far up from the limits of the cutaneous wound, and that before the dead tissues are all expelled the torn vessels have ample time to become firmly closed. When a limb is severed from the body by a car wheel, the tissues are only injured at the point of contact, or but little beyond, and the crushed extremities of the arteries will soon separate, and not always afford time for perfect occlusion. Thus I make it an invariable rule, to pre-

pare for an almost certain secondary hæmorrhage. When apart has been completely severed from the body by crushing accidents, however, the best practice is, should there be sufficient room for such a procedure — to reamputate, and thus place the parts in a better position for union, and avoid the delay of waiting for the separation of the dead tissue.

Gaping is usually absent in severe contused wounds. The separation of the edges of such a wound, is rarely more than the width (or size) of the agent producing it, plus the inversion of the edges. In almost all cases, if not absolutely all — the edges of the wound will be found turned in; when the part has been completely separated, however, the inversion only occurs on the side first injured, the opposite side being either everted, ragged, or perfectly flat or smooth.

Sloughing is an inevitable consequence in contused wounds of any extent, and the nature of the case does not call for any extended notice at this time. Like burnt tissue, it may be said that the parts immediately injured never recover their vitality; they must be cast off, or else remain a constant menace of greater evil, *e. g.*, pyæmia, septicæmia, or erysipelas. The amount of sloughing, however, is always less than in lacerations of a corresponding extent, frequently being little more than the edges of the wound, from a line to five or six lines in extent; in wounds which are inflicted by swiftly moving bodies, as a sabre, or cannon ball — the sloughing is less in extent than where it is slow, as from slowly moving machinery.

TREATMENT.— The preliminary treatment of contused wounds is similar to that laid down under lacerated wounds. This includes a thorough cleansing of the wound of all foreign material, and the removal of hopelessly dead tissue. In small wounds, the contused edges may be permitted to separate themselves from the living tissues, provided the part injured is not an exposed one, as the face; in this case cicatrization, such as would follow such a sloughing, would remain a blemish which measures should be taken to avert. When the wound is narrow, under such circumstances, it might be closed at once, and when the dead tissue had been separated, the stitches or straps might be tightened. When, however, the injury is extensive, the results in these cases seems to warrant the recommendation that the edges be pared, as in operations for fistula, and the wound treated as an incised one. In each of the cases in which this has been practiced, the resulting scar has been very faint, and deformity unquestionably much lessened. In other regions than the face, where scar ing is less objectionable, sutures should be used, of silk in most cases — and tied loosely; when the bruised edges are thrown off, they may be tightened. *Arnica* is the remedy in this class of injuries, to be used as *Staph.* and *Hyperic.*, in other cases as above.

All of the foregoing applies particularly to the smaller kinds of wounds; those not involving the whole or greater part of the circumference of a limb, nor extending deeply into the tissues. In the

graver forms, while the general principles of treatment are the same, a question of amputation will frequently be presented, and must only be decided after thorough investigation and study. In general, a contused wound involving more than half the diameter of a limb, with comminution of the bones, and division of the main artery, will call for amputation. So, also, when a limb has been entirely removed, or hanging by the integument, even such small members as the finger or toe, experience has shown me that any attempt to restore the parts will result in failure. In incised wounds of this character the results have been good in attempting conservation; but the conditions are not at all similar to severe contusions. In all such cases, therefore, amputation must be performed, and the point of election must be entirely dependent upon the state of the parts. The operation should be made in healthy tissues, above any injury to the bones. It cannot be denied that the percentage of deaths from such operations is large; the nature of the injury, and the severe shock add much to the probabilities of death, but I have yet to learn that amputation can have any more disastrous results than if the case was left to nature, with sloughing and secondary hæmorrhage to increase the danger. The experiments of LISTER (*Vide* article *Anæsthetics*), as well as the observations of any experienced surgeon, prove that with the aid of Chloroform there need be no fears of increased shock, and hence the rule may be safely stated, to amputate primarily in all cases of contused wounds that demand such treatment. After amputation the treatment must be as if no contusion had entered into the case; the wound is incised, and should be treated accordingly.

Should an effort be made to save the limb, the first indication should be to guard against secondary hæmorrhage; the second to favor the detachment of the sloughs. The first indication may be met by placing a ligature about the larger arterial trunks that have been injured, or passing an accupressure needle; the latter is probably the better plan. From the impossibility of at all times determining the amount of tissues devitalized, and the possibility that a large vessel may be so injured, even without being opened — that the coats may ultimately give way, such vessels, when in close proximity to recognized dead tissue had better be treated as others that have been divided, if the life of the part is not imperiled by cutting off the blood supply.

The second indication can be fulfilled by applying poultices, and, watching for the line of demarcation, removing the sphacelus as soon as it can be bounded definitely.

IV. PUNCTURED WOUNDS.

A punctured wound is one made by a narrow, pointed instrument, in which the depth far exceeds the superficial extent. The typical form is one made by a sharp pointed implement with blunt edges, such as an awl, a bayonet, or a small sword; in practice, however,

stabs, of all kinds, whether made with cutting or pointed weapons, come under this head. Many writers, I think mostly among the older practitioners, consider these wounds the most formidable of any which we are now considering; whilst not admitting this, to a full extent, as compared with contused and lacerated injuries, the frequency of viceral complications, the characteristic concealed nature of the hæmorrhage, and the tendency to tetanus, must nevertheless constitute these accidents a very grave affair.

As already intimated this form of wound will include injuries ranging in severity from a puncture with a carpet tack, nail, or awl, to deep and serious sword and bayonet wounds. We will also find, that the injuries are more or less incised, lacerated, or contused, as they are produced by sharp cutting, blunt, or dull weapons. Thus a stab with a knife is a simple deep, narrow, incised wound; one with a blunt nail, would be a compound punctured-lacerated; whilst one with a bayonet, lance, arrow, or the ordinary dueling sword, would be a mixed contused-punctured. It is partly this compound character that gives such interest to punctured injuries, as the indications for treatment must be likewise more or less complex. The features that will demand special attention at this time, others coming more properly under other divisions of our work — are, hæmorrhage, visceral lesions, nervous lesions, and consequences.

Hæmorrhage is usually primary, but, from the form of the wound, will rarely be external when cavities are opened. Even when the instrument does not enter a cavity, the bulk of the effused blood will be lodged in the cellular tissue, unless an artery of some size be opened. This last accident rarely occurs, however, as the vessels frequently glide aside, and escape all injury; the *contusion* they receive, however, may induce gangrene, and secondary hæmorrhage occur on the separation of the slough. Internal hæmorrhage will be more accurately spoken of elsewhere, but at this time it is important to allude to some of the prominent features in the semiology, the symptoms so closely resemble collapse, that it will often require an enlightened judgement to accurately differentiate the conditions. There will be various symptoms peculiar to the region, such as dyspnœa, in the chest, coma, in the head, etc.. but in *all* cases, I think, the patient will express a conviction of bleeding from symptoms difficult to transcribe. There will be increasing weakness, coldness of the extremities, gradually encroaching upon the trunk and face; cold breath, with intense burning thirst; there will be ringing in the ears, loss of sight, with more or less nausea; on raising the head there will be an aggravation of these last symptoms, with faintness, and often syncope. The pulse will get weaker and weaker, at first markedly slow, then quick, thread-like, and compressible. Such symptoms, gradually increasing in intensity, should call attention at once to the true state of the case, particularly as shock is quite infrequent in such injuries, and unless some of the the viscera are injured, may be said

to be always insignificant. Should the wound be comparatively shallow, and no cavity is opened, some of the temporary expedients, to be noted under *Injuries to Blood Vessels*, may be employed; but in accordance with a well proved practice, the only safe, scientific, and proper treatment, is to expose and tie the wounded vessel, if it can be reached, or the main vessel, if circumstances warrant it. Of course in wounds of the ramifications of the pulmonary artery, temporary expedients must be resorted to, as none would attempt to tie that vessel. In other regions, however, analogous vessels have been tied, that is ramifications, from a large central trunk—and a very important and interesting case is found in *Circular No.* 3, (*Surg. Genl. Office U. S. Army*), case 334, page 100, in which the stomach was incised by a knife wound, and the hæmorrhage controlled by tying a branch of the gastro epiploica dextra. Another case (*ibid*) number 319, (page 96), a branch of the mesenteric artery was tied, whether upper or lower is not stated. In each of these cases, however, as well as numerous others in the same collection, there was intestinal protrusion, and the external wound was enlarged to give room for replacement. An interesting case, of another character, is given in Baron Steinmetz' *History of Dueling*, in which a French duelist was wounded by his adversary's sword entering in the supra-clavicular fossa on the right side, making its exit over the left hip. In its course, as was subsequently ascertained, nearly every organ in the body was more or less injured; the lungs, heart, stomach, pancreas, large and small intestines, and the left kidney—and numerous vessels cut. He was supposed to be in a dying condition, and placed in as comfortable a position as possible, but after weeks of confinement fully recovered. No vessels were tied, and nothing appears to have been done to arrest hæmorrhage beyond the recumbent posture and absolute quiescence. Not learning wisdom by his experience, he soon fought another duel, and died on the field. An autopsy revealed the extensive injury received in his former encounter, and it is difficult to account for his recovery. The case is too well authenticated to admit of a doubt as to its nature.

Visceral lesions, as the case just related proves—while of vast importance, renders a prognosis an exceedingly difficult matter. Wounds of the various organs will be taken up in their appropriate chapter, but we will note here, that they are of consequence first as to resulting hæmorrhage, and second as to the destruction of function. Hæmorrhage depends upon the construction of the organ, whether vascular, muscular, glandular, or otherwise; when non-muscular, but highly vascular organs are punctured, hæmorrhage is a very important matter, and little can be done, beyond the employment of styptics to arrest it. In muscular organs, the direction of the wound will have much influence. Thus when it is transverse to the fibres, a condition that favors gaping, bleeding must be profuse; when in an opposite direction, *i. e.*, parallel, it will be less. In the first instance,

styptics and quiescence will be the main reliance; the latter usually ceases spontaneously.

The second consideration, *loss of function*, would follow such injuries as would divide the excretory duct of such organs as the liver, pancreas, kidney, etc; or extensive disorganization of tissue, as of the spleen and the like. Also openings in the bladder, stomach, intestines, etc., would lead to extravasation into the peritoneal or other cavities, or an escape of their contents, with consequent inflammation and probably suppuration.

The most extensive visceral lesions have occurred without destroying life, or visibly impairing function. For instance, a case is recorded in a journal, the reference has, unfortunately, been lost — in which a woman, in sliding from a haymow, fell upon the handle of a pitch fork, which entering the vagina made its way to the first rib, on the right side, against which it broke, fracturing, likewise, the rib. The woman recovered her usual health, *and lived twenty-two years!* At the autopsy the viscera seemed to be in a normal condition, except the right lung and kidney — but misplaced; the right side of the body was completely filled with a dense mass of cicatricial tissue, particularly the thorax. The right ovary, was also not found.

Nervous lesions, apart from the consideration of tetanus, are trivial and not of very frequent occurrence. When punctured wounds are thus complicated, the accident is very severe. The severity is owing to this fact; ordinary nerve fibres usually escape injury, as do the arteries, by rolling under the point of the weapon, unless it be very sharp; nerves near the roots, particularly a large plexus, like the sacral, being flat, are much more readily pierced. Therefore when a nerve is punctured, it is either because the weapon was exceedingly sharp, and thus has probably penetrated deeply, or important nerve trunks or plexuses have been injured. Should the weapon be a blunt one, as a nail, a nerve may be torn, or bruised, and such a wound, as said elsewhere (*Surg. Therap.*), is peculiarly favorable for the invasion of tetanus. Such weapons as an ordinary sword, bayonet, or lance, can rarely produce serious nerve lesions.

The immediate effect of wounding the nerves depends upon the extent and nature of the injury. If they are contused, a few fibres lacerated, or smoothly punctured, there may be some peripheral paresis, but almost certainly severe pain. When the division is complete, paralysis of the parts supplied is a necessary consequence; but when incised, or smoothly divided, the pain will be insignificant. Should the division be accomplished by laceration or contusion, the pain is usually excessive.

The *consequences* of punctured wounds are various, but the most constant are tetanus, and modifications of function from adhesions.

Tetanus has already been fully treated of in a former volume, (*Surg. Therap.*), but a few facts relating to the traumatic form, may be touched upon here. It was for a long time supposed that this dis-

tressing complication was peculiar to wounds of the punctured variety. Recent observations do not sustain this. In *Guy's Hospital Reports*, during a period of seven years, there were twenty-three cases of tetanus occurring in connection with surgical affections.

Major and minor operations,.....	1,364;	tetanus in... 1
Wounds, of all kinds,.....	594;	tetanus in... 9
Injuries and contusions,.....	856	tetanus in... 1
Burns and scalds,.....	456;	tetanus in... 3
Compound fractures,.....	398;	tetanus in... 9
	3,668	23

Wounds and fractures, it is seen from this table, produce the greater number of cases of tetanus, and we are justified in presuming the conditions are similar, *i. e.*, nervous irritation from incomplete division of fibres, or contusions and lacerations of the same. However this may be, injuries of the extremities, particularly the elbow, knee, thumb and great toe seem to furnish the most cases, probably, however, as MR. POLAND says, (HOLMES I, p. 318), because "the extremities are much more exposed and liable to injury." The state of the wound, favoring tetanus, has been differently given by different authors. Thus LARRY states it as occurring when the discharges are suppressed; TRAVERS, at the commencement of cicatrization; and HUNTER, when "the inflammatory stage" commences, or "when good suppuration was come on." I think that the weight of authority agrees with TRAVERS; at least my limited experience would agree with his statement, and others, of more extended practice, have come to the same conclusion.

The time after the reception of injury to the invasion of tetanus varies greatly; from a few hours to many days. It has been observed that the more it is delayed the greater the probabilities of recovery. MR. POLAND (*loc cit* p. 319), gives the following resume of 277 cases:

Before the tenth day.....	130 cases,	101 deaths.
From the tenth to the twenty-second day,	126 cases,	65 deaths.
Above twenty-two days,.....	21 cases,	8 deaths.
	or 277 cases	174 deaths.

The first symptoms in traumatic cases, are either pain or coldness. The latter is usually felt at the point of injury, and is intense; both objective and subjective. The remedy in such instances, is *Ledum pal.* For two typical cases see one by DR. BALLARD, *Med. Invest.* Vol. XI, p. 184; and one by myself, in the same journal. The *pain* is usually of sudden onset, and very severe; it may commence at the wound, calling for *Hyperic.;* in the head, calling for *Bellad.;* or under the sternum, indicating *Cupr. acet.* Sometimes there will be neither pain nor coldness, a sudden spasmodic jerking of the muscles being the first symptom; here we will find *Stram.* promptly curative. Other remedies may be indicated, but rarely in the traumatic forms.

The *cicatricial* consequences need but mere mention to indicate

their importance. Thus pleural, peritoneal, or meningeal adhesions can be at once understood as serious impairment of function, if not a constant source of danger from inflammatory action.

TREATMENT.—As in all kinds of wounds, the first thing to be done is to thoroughly cleanse it. The form and nature of punctured wounds forbids any attempt to secure primary or immediate union; even should we obtain a closure of the cutaneous wound, the inevitable suppuration would demand a reopening, if it did not induce pyæmia. After cleansing the parts, and assuring ourselves that no foreign material is retained, a tent of lint, perhaps smeared with cosmoline, must be introduced to the bottom of the wound, to ensure a healing from the bottom. The tent must be renewed daily, and should never be pushed in with force, to avoid tearing up the recent adhesions. The arrest of hæmorrhage has already been referred to, and does not need repetition here. For the pain, which is at all times severe, much more so than in other kinds of wounds, I know of nothing that will give such relief as *Hyperic.*, I have used it in all attenuations, from the 1x to the 200th, and find the action almost equally rapid in either potency. Deep adhesions may be broken up, as laid down in the preceding chapter.

VI. GUN SHOT WOUNDS.

A *gun shot injury*, literally, is one made by any explosive force; as the bursting of steam boilers, blasting explosions, and the like Practically, however, the term is restricted to wounds inflicted by missiles from fire arms, whether cannon or small arms. The careful tabulation of surgeons reports, during our late war, as found in the various publications of the War Department, has added so much to our fund of knowledge as to the nature and results of these injuries, that the literature of the last half century must be put aside as worthless for all practical purposes. We will find that the teaching of this period of time will lead us astray, if it is carried out into practice, the revolution in matters of treatment being largely due to the radical changes made in firearms, as well as the different tactics now so generally in use; in brief, the art of war has changed. We find not only a different type of injury as regards the nature and extent of the lesions of the part—but the results and remote sequelæ are greatly at variance with the teachings of many of our text-books.

In attempting a systematic treatise on this great subject, the magnitude almost forbids successful condensation; yet by considering the topics under their appropriate heads, we may be enabled to give the *essential*, referring the student who desires a more extended and minute knowledge, to the special works of HAMILTON, GROSS, LONGMORE, etc., on *Military Surgery*, as well as the *Medical and Surgical History of the War*; and the *Surgeon Generals' Circulars*, particularly Nos. 3 and 6. We will divide our subject, therefore, into the following topics: 1. Nature of injury, as modified by (*a*), form and nature of the missile, (*b*), degree of velocity. 2. Symptoms. 3. Causes of death; (*a*), immediate, (*b*), remote. 4. Treatment.

I. NATURE OF THE INJURY.

A gun shot wound partakes of the three-fold character of a punctured, contused, and lacerated wound; one or the other of these characters predominates, as the velocity of the missile is greater or less; it is round, conical, or irregular; and the amount and kind of resistance it meets with in passing through or into the part. Another consideration that must not be lost sight of, will be whether the injury is *direct*, that is produced by a missile coming directly from a gun, without passing through intervening objects; or *indirect*, produced by splinters of wood or stone. To consider the latter first, it will be observed that fragments of the bulwarks of a ship, or stone from the parapets of a fort, when producing fracture, usually

induces one of the simple form, either comminuted or single. This one fact is of the first practical importance, as indicating wounds of less severity, making less exhausting drafts on the powers of recuperation, and partaking more of the characters of a contusion than a wound. A *direct* injury, when it induces fractures at all, always produces one of the compound form, with more or less splintering of the bones, thus adding to the peculiarly severe character of the wound in the soft parts, the worst form of fracture. There are not a few cases, however, in which indirect gun shot injuries produce compound fracture, and from the character of the missile the injury to the soft parts is often extensive, the contused character rendering them particularly severe. It is thus of the first importance to consider the form and nature of the missle, as the term "gun shot wound" does not at all times refer to the same species of injury.

In former times when spherical balls were used entirely, bones were comminuted, or fragments broken off, but severe injuries, of such a character as are now inflicted, were almost unknown. We will note in order, as the most convenient method of comparison, the nature of the injury from each form of projectile.

Conical balls, such as are now used almost entirely, particularly when thrown from a rifle — acting on the principle of a wedge, split the bones, and pierce the part with little tendency to lodge. They are rarely deflected from their course, unless partially spent, and apart from the destruction of the bones, do not do so much damage to the soft parts as round balls. There is more danger, of primary hæmorrhage than when spherical missiles are used, and yet the number of cases presenting divisions of arteries, during the war, were very few. The frequency of such occurrences, from accidental discharge of firearms at posts, since the war, has led military surgeons to search for a reason, which has been found, it is thought, (*Circular* No. 3, S. G. O., p. 87), "that the proportionately large number of such cases contained in the reports of garrisons is explained by the fact that the wounds observed are generally inflicted at short range, and by small projectiles, and that a musket or pistol ball, moving with great velocity, will cut or divide an artery, which, at a greater distance, would only be contused, or, by its resiliency, might escape injury altogether." The appearance of the wounds of entrance and exit will depend largely upon the velocity of the missile, but with conical balls, under either condition, there is little difference between the two, unless fragments of bone, particles of clothing, or some foreign body is carried before the ball; under these circumstances the wound of exit would appear large and ragged. This will receive attention, however, later.

Round balls, even when propelled at high speed, are readily deflected during their passage through a part, and are more prone to become lodged. They do not, as a rule, split bones, but crack and break them into more or less cuboidal fragments. They are frequently split by

impinging on the sharp edge of a bone, as the spine of the tibia, and unless this fact is borne in mind embarrassment may be caused in determining the nature of the injury, *e. g.*, whether made by one missile or several. In matters of a legal character, it is of the first importance to be able to decide such questions, and care must be had to make thorough examinations. One case is mentioned in which a single ball inflicted two wounds of entrance and three of exit. The ball was split on the spine of the left tibia, one fragment passed out on the outside of the leg; one passed through into the other leg, and come out on the outside of the calf. We have numberless instances of a tendon changing the course of a ball, or some other equally trivial cause directing it into a course that could not be foreseen. Thus a shot has entered the abdomen and passed around, under the integument to the spine; or the forehead, and almost circled the head.

Large balls, as cannon balls or grape shot, usually produce extensive injury, the parts struck being either carried away completely, or crushed beyond all hope of repair. There are some cases, however, in which large shot have been embedded in the muscles, and their presence only detected accidentally. One mentioned by TORREY (HELMUTH 2d Ed., p. 367), in which a five pound ball was found on performing amputation, which neither the surgeon or patient had knowledge of being in the part. With smaller missiles this is of frequent occurrence. There are many instances scattered through works on military surgery, of cannon shot injuries in which the skin is unbroken with complete pulpification of the soft parts, and extensive comminution of the bones. This is due either to direct injury from spent balls, or a "grazing" shot. As a rule cannon shot wounds are not painful, but the shock is very severe.

Pistol balls produce injuries as in the case of larger fire arms, but the smaller charge of powder, and the short range, very materially lessen the extent of the mischief.

Bird shot, unless they enter the eye, or are projected from short range, are not very serious injuries. When at short range, not allowing the shot to scatter, such accidents may cause death, or very extensive laceration. As a rule, however, these injuries are comparatively trivial.

Miscellaneous missiles, as wadding, particles of percussion caps, or even the explosion of powder without a missile, have produced death, and are certainly not to be lightly considered. The majority of serious injuries from percussion caps are naturally inflicted in the eye, and will receive attention at the proper place. Wads, however, even simple paper, a finger of a glove, and the like — have, when fired at short range, entered the great cavities and caused death. Any surgeon, of even limited experience, must be familiar with the effect of powder explosions, and need not be reminded of the extensive mischief they are capable of inflicting. The degree of injury varies from a simple scorching of the integuments, to the most severe lacerated wounds, even to tearing off large limbs.

The *velocity* with which a shot is propelled very materially modifies the nature of the injury. All forms of balls, conical, spherical, large or small, have greater penetrating power in proportion as their velocity is greater. There is less probability of their becoming lodged; the destruction of tissue is somewhat lessened, it is true, but the danger of primary hæmorrhage is much increased. At a high rate of speed, conical balls may pierce even the shaft of the larger long bones without splintering, and should no foreign material be carried before the ball, the wound may heal speedily without going through the usual tedious process.

When the rate of speed is low, without reference to the form of the missile, the destruction of tissue is always great, provided force enough is exerted to penetrate the skin. There is greater destruction of bones also, and much greater probability of lodgement. We will also notice, as a peculiar feature under these circumstances, that the destruction of tissue is more wide-spread; it is not only in the immediate neighborhood of the perforation, but the bones will be either comminuted or split to the extremity, and the soft parts will be more or less devitalized for a long distance.

II. SYMPTOMS.

The symptoms of gun shot injuries will depend largely upon the circumstances under which the wound is received, the bodily condition of the sufferer, and the nature and velocity of the missile. They may be arranged in two groups, *primary* and *secondary*.

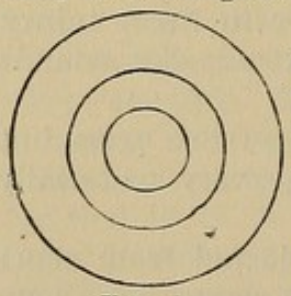


FIG. 1.

The *primary* symptoms include the condition of the parts immediately after the receipt of the wound, before any attempt at repair is made. These would be the character of the wound itself; shock; pain; bleeding; lodgement.

(*a*). The *wound* has been diagramatically described by GROSS, by depicting three circles, one within the other, thus:

The inner circle represents the point of entrance; the second the point of contusion or devitalization; the third, a circle of inflammation, with a normal condition outside of that. When the perforation is made by a ball at a high rate of speed, the point of entrance will permit an opening less in size than the ball; when the rate of speed is lower, it is often somewhat larger, or at least of the size of the missile. The edges are somewhat inverted, may be white and parchment-like, or blue; the former from rapid penetration. At times the integument will be found torn in two or more triangular flaps, particularly when the velocity is not excessive. When the muzzle of the weapon has been near the body, the skin will be more or less blackened, and if held almost in contact, the wound may be large and ragged.

If perforation has occurred, the wound of exit assumes many characters according to circumstances. When no bone has been touched,

and the projectile passes through at a high rate of speed, the wound will not be larger than that of entrance, but may present the edges a little everted, or the protrusion of small particles of fat, or shreds of tissue. When the speed is low, a bone has been pierced or fractured, or particles of the clothing are carried before it, the wound will be large and ragged, and the torn tissues will be seen hanging out in considerable quantities.

In cannon shot injuries, the wound does not differ from lacerated wounds from other causes, and need not detain us further than to state, that the rapidity with which the separation of the part is effected, does not induce such extended injury, tearing out muscles and tendons.

(*b*). *Shock* is greater or less, according to conditions noted elsewhere. Remote shock is the rule in military surgery, but as the injury is somewhat expected in the majority of civil cases, or at least not inflicted under the same state of excitement as occurs in the heat of battle, immediate shock is the common form. Even the loss of a limb, from a cannon shot, is often unconnected with shock, while injury to the viscera, particularly of the abdomen, seems to induce shock speedily, even when trivial, and under almost any circumstances of excitement or repose.

(*c*). *Pain*, at the moment of infliction, is slight; it is often absent, or likened to a slight blow. It is proportionate to the velocity of the missile, however, being less the higher the speed. In the majority of cases there will be little or no pain until after or during reaction, but in cases in which a nerve has been contused, the missile lodges against a nerve, or a bone is splintered and the sharp fragments are driven into the tissues, pain may be immediate and very severe. The structure of the part injured will also much modify the pain. In highly sensitive tissues, pain must be a prominent and early symptom. So also when bones are broken, the pain is usually greater than when a mere flesh wound is inflicted. As a rule, it may be said, the pain in these injuries is not at all proportionate to the extent of the injury, being in nearly every case comparatively trifling. The point of the greatest pain is often of much diagnostic value. Thus in a gun-shot wound of the hand, at my University clinic, the ball could not be found with the probe. Great pain was experienced at the base of the first phalanx of the fourth finger, due to lodgement, it was supposed, on the superficial branch of the ulnar nerve. From the fact that both sides of the finger were equally sensitive to pressure, it was decided that the missle would be found resting upon this branch at or near its point of division, a little below the head of the metacarpal. Notwithstanding nothing could be felt through the integument, and the ball had entered the other side of the hand in such a direction, according to the history—that it should not have lodged in that position, an incision was made, and the ball at once cut down upon and removed.

(*d*). *Hæmorrhage* depends, of course, upon the amount of arterial injury sustained, which also depends upon the velocity of the missile. As said earlier large arterial trunks were very rarely cut or wounded in battle, but frequently in cases of accidental discharges of guns, etc. In civil practice, therefore, we should expect to find serious hæmorrhage the rule, but such is not the case, as far as my experience goes. This is possibly due to the fact that the majority of gun-shot wounds in civil life are produced by pistol shots, of small calibre, and propelled by a small charge of powder. Still at close range, and most of these are thus produced — there should be velocity and force enough to cut an artery. Beyond, perhaps, all other kinds of injury, gun-shot wounds are liable to secondary hæmorrhage. This is due to the character of the injury, contusion. A blood vessel may be grazed by the ball, and a spot devitalized, which soon sloughs out, giving rise to bleeding. In consulting reports of army surgeons we at once note the small number of cases reported with large vessels wounded. This is accounted for on the ground that most of such cases terminate fatally before being brought to the notice of the surgeon.

(*e*). *Sloughing*, from the crushed and contused nature of the wound, is a constant sequence to gun-shot injuries, and is greater or less in inverse ratio to the velocity of the missile. This usually occurs, that is the separation of the dead tissue — about the tenth or fifteenth day, when secondary hæmorrhage is more likely to occur. An artery may be completely denuded, and no hæmorrhage occur at the time, as was shown when speaking of contused and lacerated wounds — but when the torn extremity of the vessel separates, we may confidently expect bleeding.

(*f*). *Lodgement* of the ball, as already said, depends upon many circumstances, as shape of the missile, velocity, and construction of the part injured. There are cases in which there is but a wound of entrance, and none of exit, and yet no ball can be found. This may be accounted for in various ways. In some instances, when the speed is low, a shred of clothing is carried before the ball, which on being withdrawn drags the ball with it. There are other cases, in which the ball rebounds, and is thrown out. Others again in which the circuit is made of the part, under the skin, and the ball is discharged from the wound of entrance. Such instances are not common but we read of bullets entering the neck, deflected by the cartilages of the larynx, and appearing at the wound of entrance; encircling the abdomen in the same way. When a ball enters one of the cavities, particularly the thorax or abdomen, it can readily drop below the line of entrance and escape detection. In the hand and foot, nothing is more common than to find the ball concealed among the tendons, between the long bones, or buried in the numerous short bones, and entirely elude our search. This will be referred to again, however, when speaking of the treatment.

III. CAUSES OF DEATH.

The causes of death from gun-shot injury may be arranged under two heads, viz., immediate and remote.

(*a*). *Immediate death*, occurring directly from the injury, is due to the division or opening of large blood vessels; division or wounding of large and important nerves, or nerve centres; invading important organs, or a combination of all these. We may add to these, particularly when the injury is by cannon shot, shock.

(*b*). *Remote causes* of death are various; pyæmia, erysipelas, hectic, tetanus, etc., each claiming many victims.

The duration of life, when grave gun-shot injuries are received, is sometimes remarkable. A case is mentioned in the *Report of the Dublin Hospital* for 1875, of a man who had been wounded in the battle of Salamanca during the Peninsular war, and lived with the bullet in the right ventricle of the heart nearly forty years! The case of Caruth, reported by my friend PROF. J. C. MORGAN, (*Hahn. Month.* XI, p. 192), in which the patient lived months with a large pistol ball in the brain, (tentorium), and one (*Amer. Hom. Obs.*, VIII, p. 313), of a somewhat similar character, are quite instructive reading. The celebrated tamping-iron case, and others, will be noted in the chapter on the Head, but can be alluded to in passing, at this time, to illustrate the exceeding difficulty in forming an accurate prognosis. Other cases, involving wounds of other regions, will be given in the appropriate chapters, but at this time it is necessary to notice that the consequences of such injuries are very various. In some cases the ball will become encysted, and never give any annoyance; in others, when retained, there will be frequently recurring abscess, closing up and breaking open again, until the patient succumbs to the drain. In others the ball will be expelled during the process of suppuration; and in still others the missile will enter some viscus, by a process of ulceration, after lying in contact with it some time. One such case, of much practical value, is reported in the *Medical and Surgical History of the War*, (Part II, Surg. Vol., p. 36): "Private Thos. B. B——, was wounded at Petersburgh, March 25, 1865, by a ball which lodged over the transverse colon. He suffered from traumatic peritonitis of moderate intensity; but there was no indication of penetration of the bowel, until April 29, when after an attack of tormina with tenesmus, the ball passed during defecation. In this case it is quite probable there was no primary lesion of the gut, and that the missile made its way into the intestinal canal by ulcerative absorption. The printed history closed with the patient's recovery, and discharge from the service on September 22, 1865."

Another consequence of lodgement of missiles, with preservation of life, is persistent neuralgia or neuritis, either from the irritation from the foreign material, or cicatricial tissue involving the nerve. Such a condition, however, it would seem, would call attention to the exact point of lodgement, and allow the surgeon to extract.

TREATMENT.—In an ordinary case of injury of this character, the first consideration is to find the missile, if it has lodged; extract it if it can be reached; and to ascertain the condition of the parts injured. This supposes a case with slight hæmorrhage, and no large vessel wounded; under other circumstances, the bleeding must be first controlled, and perhaps the shock attended to; this last particularly, if severe. The next step is to properly dress the wound; and the last to promote healing. These will be taken up in order.

(*a*). *Hæmorrhage*, as said above, is usually secondary, but may be primary. It is treated as hæmorrhage under other circumstances, but a repetition of a former caution cannot be amiss. Never trust to pressure, styptics, or temporary expedients, but securely tie the vessel, both at the proximal and distal extremities. During the examination of the wound the proximity of important arterial trunks can be estimated, and proper precaution taken to avert or control subsequent bleeding. Thus if a vessel is found in the track of the wound, the presumption is that it has been contused, and it would be good practice to throw a ligature around it, by enlarging the wound upwards, or in the cardiac direction. Should the vessel not project into the track of the ball, there is less danger of bleeding, but caution and prudence demands that the case should be closely watched, and a tourniquet kept at hand. A reference to the reports in the various publications from the Surgeon General's office will satisfy the most superficial reader that many valuable lives are lost by temporizing practice, and that my injunction to tie all bleeding vessels is not to be disregarded.

(*b*). The next step is to *find the missile*, if it has lodged, or, if it has passed through the part, explore the wound to determine the extent of injury, and the probabilities of life. In wounds of not too great depth nothing can equal the efficacy of the finger as a probe. Of course in deep wounds, or those made with balls of small calibre, the finger cannot be used; under other circumstances it will not only detect the ball much more readily than any other form of probe, but the same examination will give an accurate conception of the condition of the parts, particularly as to fracture, and the proximity of blood-vessels. In cases in which the finger is not available, Nelaton's probe should be used. This is made like the ordinary bullet probe, of silver, about six or nine inches in length, but terminates in a button of porcelain which is readily marked by the leaden missile when brought into contact with it. None who have not experienced the difficulty in detecting balls situated deeply can appreciate the value of this apparently simple instrument; it seems to answer its purpose fully in experienced hands, and those who cannot use it would fail with anything. Much harm is done by amateurs, occasionally, in searching for balls with small probes. One case now occurs to me, in which a rural practitioner, with more patience than discretion, spent an hour in searching for a pistol ball in the hand with an ordin-

ary probe as found in the pocket case. The result was, that when brought to me finally, it was utterly impossible to follow the course of the ball, and it was not discovered. It is true that it is a very common occurrence to fail in extracting small balls from the hand, but this case was most unnecessarily complicated by the injury done to the tissues with the small probe. The result of the probing should give definite conceptions of the extent of the lesion, and determine the question of amputation, resection, or conservatism. To avoid unpleasant or dangerous sequelæ, this examination must be so thorough that no second manipulation will be called for; the less the parts are handled, the better condition they will be in for healing.

(*c*). The ball having lodged, and its position determined, the question of *extraction* must be considered. The rule, is, I take it, that when a ball has become embedded in a solid part, as an arm or leg, or can be *readily detected* in one of the cavities, it should be removed. When on the other hand, one of the great cavities are pierced, and the ball is not found at once, no prolonged attempt should be made to find it, as more injury may be done to the viscera by the probe than the retention of the missile. Two methods of extraction are practiced, neither of which can be exclusively used, viz., by counter puncture, and through the wound of entrance. The former is to be employed where the ball has passed entirely through a part, and is found near the surface, on the opposite side to which it entered, or when circling a part as in the instances given earlier. In some cases it is important to carefully plan the line of incision to avoid wounding blood vessels, but in most cases, the missile necessarily lying quite superficially, no such caution is necessary. When the ball can be reached readily through the wound of entrance, it can be removed by almost any one of a number of instruments. The most generally useful are the forceps of THOMASIN, such as are found in nearly every American operating case. When the ball is embedded in bone, or in anyway is firmly held, the screw, scoop, lever, or other special instrument must be employed. It is perfectly proper to enlarge the wound of entrance, for the extraction of projectiles, *but for this purpose only;* not, as some have imagined, for the purpose of improving the character of the wound for prompt healing.

It must not be forgotten that if unusual difficulty is experienced in extracting a ball, it may be allowed to remain, provided it is not in a position to cause suffering or danger to blood vessels. Instances are numerous of recovery and long continuance of life with balls embeded in important organs; a few such have already been given, but the instances are so numerous that time and space need not be consumed in relating them.

(*d*). *Shock* does not demand any consideration in addition to that found in another place. It is only necessary to mention that even when no shock is perceptible, and the injury is grave, *Arnica* must be given to modify or avert secondary collapse. In cases in which shock

is extreme, attention must be paid to it at once, even to the neglect of bleeding; the existence of profound shock having a tendency to lessen hæmorrhage, it will be sufficient to apply a tourniquet, or some temporary appliance, and turn the undivided attention to the shock.

(*e*). *Dressing the wound* comes next in order, and is usually a simple affair. When limbs are carried away, or extremely crushed, there can only be an amputation performed, which had better be made primarily. When the bones are extensively fractured, large blood vessels and nerves injured, and the soft parts extensively torn or crushed, amputation is again the only resource. I am aware that the opinion is expressed by many excellent writers that even under such unfavorable circumstances, resection or the expectant plan had better be preferred. My experience, and a study of the more extended experience of others, had convinced me that valuable time is often lost by such practices, and amputation finally became imperative only when the patient is reduced to almost the last extremity. This is so uniformly the case that I feel warranted in prescribing amputation when such extensive injuries exist. Resection, partial or complete, is to be performed when the bones are comminuted with little, if any, damage done to the blood vessels or nerves. In removing fragments of bone I deem it an imperative indication to remove all splinters, even when firmly attached at one extremity. Such fragments of bone are sure to become necrosed, and greatly prolong the treatment. The sole question therefore, entering into the case of a severe gun-shot injury, as to amputation or resection, is the amount of blood supply and uninterrupted nerve action; the more perfect in these two particulars, the stronger the indications for resection.

When an attempt is made to save the limb, and there is no fracture, the part (*and the patient*) must be placed in the most comfortable position; if there be but a wound of entrance, as much as possible it should be kept in a dependent position, or at least in such a position that free, uninterrupted drainage may be secured. When there are *two* wounds, the wound of exit must act as the drain. The parts should be lightly covered, sufficient to prevent the admission of foreign material, either atmospheric or otherwise,—and, as in the case of *all* wounds, kept dry. All foreign material should be carefully removed, and no sutures, tents, or even adhesive strips employed. When a fracture co-exists, it should be treated as an ordinary compound fracture, not forgetting the probability of sloughing peculiar to these injuries.

Some of the journals, and some of our surgical authors, unfortunately, have quoted the "method" of DR. HOWARD, U. S. A., known as "*hermetically sealing*" penetrating wounds of the thorax and abdomen. The doctor had the fullest opportunities to test the value of his theories in the hospitals of the late war, and we are told (*Med. and Surg. Hist. of the War*, Pt. I, Surgical Vol., p. 497). "It will not be a work of supererogation, or an unnecessary occupation of space, to

show conclusively that what has been bruited abroad as the *American Plan* of treating gun shot penetrating wounds of the chest, was fairly tested during the war, and its indiscriminate application found to be pernicious." It appears from the records of cases (*loc cit*), that fourteen recovered partially or completely; but, per contra, there were forty-two deaths. In my own experience I have attempted to treat three cases by this method, and in each of them failure was the result. In two cases in which it was attempted for wounds of the hand, the dressings were removed, on account of severe pain, on the fourth day, and immense quantities of pus were discharged, with much subsequent delay in healing. One case, however, did very well indeed, and recovered sooner than any case I have seen.

Arnica is the chief remedy in gun-shot injury, but the symptoms that may arise are so various, being febrile, tetanic, erysipelatous, or pyæmic, that no complete therapeusis can be given without repeating much that has already been written.

VII. POISONED WOUNDS.

A *poisoned wound* is one in which poison of some kind has been introduced into the body, with no reference to the form of the wound. Such wounds are usually punctured, but may be partly incised. The most natural division of the subject would seem to be into: 1. Introduction of poison of a chemical nature. 2. Venom or virus from poisonous reptiles or insects. 3. Altered secretions, from animals, inoccuous under normal conditions. 4. Introduction of septic material.

I. With very few exceptions our text-books, and even much larger works, do not allude to poisoned wounds other than those from poisonous or rabid animals. DRUITT (p. 152), speaks of the effects of various kinds of poison applied to the tissue, but his limits will not admit of extended notice. To constitute a *wound*, however, there must be more than a mere contact with some chemical agent; we must have an introduction of the irritant into the blood or absorbents, through a wound. DRUITT considers these agents under two heads, viz., "Those which produce inflammation of the animal tissues through their tendency to *decompose* them *chemically*. *Secondly*, those which operate by producing *violent irritation*, but which have no power of causing chemical decomposition." In the first class he includes the strong mineral and vegetable acids, pure alkalies and their carbonates, and such salts as corrosive sublimate, nitrate of silver, and others. In the second class he places acrid plants, and arsenic.

The effects of the introduction of these substances varies greatly; in all, I think, the immediate effects on the tissues is to devitalize them to a greater or less extent; but in many absorption occurs, and the same symptoms are developed as if the poison were taken into the stomach. The amount of hæmorrhage will very materially influence the degree of poisoning; in incised wounds, with free bleeding, the poison will either be carried out entirely, or its effects will be very feeble. But in punctured wounds, particularly when made with small implements, and little bleeding occurs, the pathognomonic symptoms will be correspondingly intense. It is unnecessary to give at length the symptoms produced by these various agents, as the subject is more properly a toxicological one; it is sufficient to note that the same antidotes are to be employed as in cases of poisoning from the same substances when taken into the stomach. Nevertheless the fact must not be lost sight of that the condition of the patient, at the time of the reception of the injury, may greatly modify the results. Thus great in-

flammatory action will induce more or less gangrene or ulceration, and a poorly nourished, cachectic or debilitated subject may be unable to oppose sufficient resistance to the morbid action to confine it within its original limits. The part injured must also have much prognostic interest, as what would be harmless in one region of the body, would be quite the reverse in another. The mucous surfaces of the pharynx, for instance, when attacked by intense inflammation, will often place life in danger from the purely mechanical impediment to respiration, as well as the serious constitutional disturbance accompanying such injuries. Similar accidents to the eye or ear, while manifestly exposing the patient to permanent loss of the organ or function, may also induce fatal results, partly on account of the extremely sensitive nature of the tissues invaded, and partly from their proximity to, and connection with the brain and its meninges. Apart from considerations such as these, "chemical poisoning" has little surgical signifi-

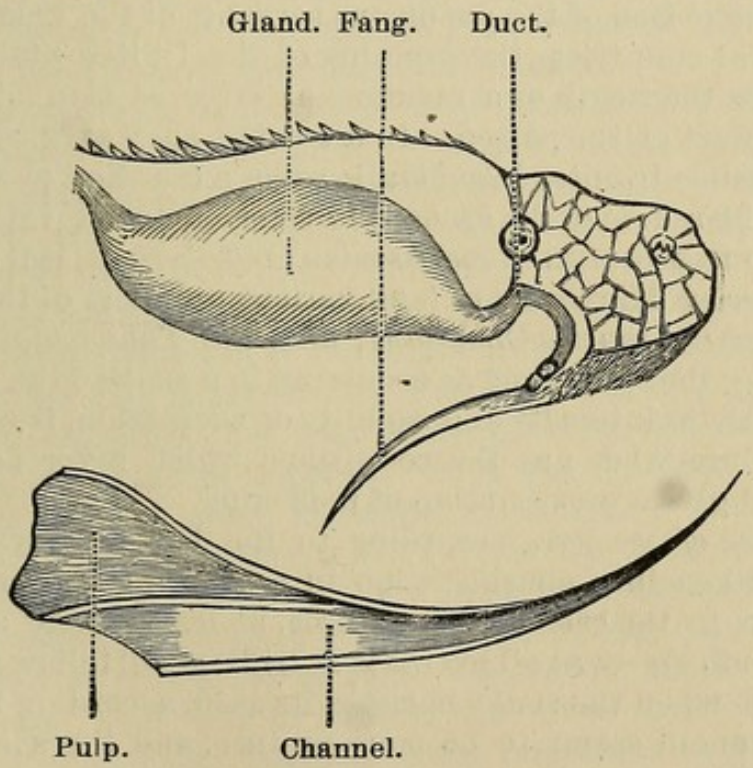


FIG. 2. Head and fangs of Rattlesnake.

cance, and must always be an occurrence of extreme rarity. The application of strong Sulphuric or Nitric acid to the integument may produce a very severe injury, but in no surgical sense could it be considered a wound, or, at all events, one of a poisoned character. Repeating, therefore, what was said above, that the treatment of such injuries must be by the use of the ordinary chemical antidote, or as would be indicated in burns and scalds, this portion of our topic can be dismissed from further consideration.

II. ENVENOMED WOUNDS, the typical poisoned wounds, are those made by the fang or tooth of poisonous reptiles or insects. In most instances the weapon is a channelled tooth, or its analogue, the canal

of which communicates with the gland secreting the venom, which is expelled either by muscular action, or the compression exerted by the pressure of the fang.

The cut on opposite page will give a fair view of the anatomy of the poison apparatus, and serve to show the ground for the doctrines as to probabilities of inocculation to be given later.

The fact that in such cases, providing the poison gland or sac contains venom at the time—the poison is deposited at the bottom of the wound, and that the passage of the tooth through the clothing can have no effect in removing the poison, is the one distinguishing feature in this form of wound. That is, that poison being secreted, inoculation certainly follows upon the wound, with what effect remains to be discussed.

(*a*). It is maintained by many good authorities, notably as contained in *Circular No.* 3. (p. 166) of the War Department—that whatever may be said of the poison of the venomous serpents of the East Indies and other tropical countries, the crotalus of the United States rarely, if ever, induces the death of a mammal as large as man, at least from the direct effect of the poison. In a treatise such as this, it is manifestly impossible to enter into details when a question of such magnitude is considered, and the student is referred to the various articles by DR. S. WEIR MITCHELL, *Smithsonian Contributions*, 1861; *N. A. Med. and Chir. Review*, March, 1861; (and various numbers of the *Am. Jour. Med. Sciences*); HIGGINS *Ophidians;* and the *Thanophidia* of India. Before giving the symptoms as occurring in a snake-bite, which seem to vary mostly in intensity and rapidity of succession, it will be neces sary to enquire what are the conditions which favor poisoning, or which would give a presumption of poisoning.

1. *The time of the year* according to the best authorities, should always be taken into consideration in estimating the probability of poisoning, as in the case of the crotalus, at least—there are times in which no ill-effects, or at all events very trifling will follow snake-bites. In the season when the snake changes its skin, according to HIGGINS, whilst the venom seems to be more profuse, and the snake is easily irritated so that it strikes at every noise or motion in its vicinity, experiment has shown that the poison is much less potent; as a matter of therapeutic interest, shortly to be considered, the gall is found at the same time to have become sweetish. Hence the injection of poison at such times must induce less danger to life than at others. When the rutting season comes on, probably in August or September —the snake, particularly the male, is more vicious, and the venomous nature of the poison greatly increased.

2. It has been observed by all observers, I think, that when a snake has struck an object more than once, each succeeding stroke exhibits a diminished quantity of venom, and finally an entire exhaustion. It is manifest, therefore, that should a serpent bite an individual after having made many strokes at other objects, as a stick, or a dog, etc.,

the probabilities of serious injection of venom are much diminished, and the prognosis correspondingly hopeful.

3. It has been shown that the *part bitten* must receive due attention in estimating the probabilities as to poisoning, or at least the severity and gravity of the accident. It would be manifestly more serious when the wound is inflicted on a highly sensitive part (as the eye), than other parts not so highly organized. In cases of dog bites, as will be seen elsewhere, the passage of the tooth through the clothing frequently wipes off the poison; in the case of snake-bites this cannot occur, as the venom passes into the bottom of the wound through the channelled fang, and is not on the exterior of the weapon at all. The sole significance, therefore, as to the part bitten, depends upon its organization. Wounds of the extremities will be generally less fatal than those of the trunk, and those of the face more so than either. Even should the cause of death be found other than the specific nature of the virus, the proximity to the centers of life, brain, lungs. heart, etc., must greatly complicate the matter.

4. The *distance of the spring*, has been thought by some to exercise much influence on the injection of poison. Thus when the fang is perfectly erect, the axis of the channel is continuous with that of the poison duct, and its impingment on the object struck simply forces out the poison in a direct line. This complete erection is supposed to be calculated for a distance equal to one-half the length of the snake. When an object struck is at a greater distance, the fang is thrown forwards, and the axis consequently is at a greater or less angle to that of the duct, and the duct is itself compressed by the blow, so that the passage of the virus is impeded. At a less distance, it is said, the fang is but partially erect, and either no wound is made by the convex *border* of the fang striking the part, or the same condition exists as when thrown too much forward, and no poison is ejected. Hence, if these statements are true, a snake six feet long can only *positively* inject venom at a distance of three feet, or but little over or under that distance. I am free to confess that these latter conditions are strenuously denied any value by many familiar with serpents, and I can offer no corroboration myself; there is a strong possibility of there being true, however, as those being familiar with serpents in India vouch for its correctness. At all events, until disproved by competent testimony, I shall continue to consider it a question in forming a prognosis.

5. Finally, the *condition of the patient* must receive due attention. As far as my knowledge extends, in every fatal case of bite from the rattlesnake, or other varieties of snakes in this country, the sufferer was either notably debilitated, from some cause, or addicted to a habit of intemperance. Unquestionably there may be instances in which peculiar and accidental departures from the standard of health may render an individual susceptible to such influences at one time, when the same accident at other times would not produce any notable

discomfort. However, this may be, it seems that the rule is, that there should be some constant and habitual adynamia, and that resulting from alcoholism seems to more especially expose the victim to danger of a fatal result.

From a consideration of the foregoing paragraphs, it is evident that much caution must be exercised in determining whether a victim of snake-bite is poisoned or not, without reference to the degree of infection. Unless these conditions are all fulfilled, *i. e.*, bitten in the rutting season, on a sensitive part, without previous exhaustion of venom in the serpent, the distance of the spring of the serpent not over one-half its length, and a somewhat debilitated condition of the sufferer—we are warranted, I think, in considering the fact of inoculation extremely doubtful.

Let us next consider the *nature of the poison*. The venom is essentially analagous to, if not identical with the parotid secretion; but there is a noteworthy variation from the composition of that fiuid in mammals and warm-blooded animals generally. In the latter, the reaction is usually, if not always, alkaline; while the venom of the viper family is neutral, that of almost all others is markedly acid. Careful analysis made by competent students, does not show, to our perfect satisfaction, any constant difference between the ordinary parotid secretion and snake venom; an albuminoid, in the case of the rattlesnake known as *crotaline*,—has been rather suspected than demonstrated, and DR. MITCHELL refers to it as an "organic molecule." According to HIGGINS, our latest authority, the composition of crotalus venom is about as follows: "It is insoluble in sulphuric and hydrochloric acids, which only reduce it to a liquid paste. In nitric acid it acquires a yellowish tinge, otherwise it appears to be affected identically with that of the two former. Vegetable acids, alkalies and oils, do not dissolve it; when heated it does not melt, but swells up and becomes thick; placed in contact with flame it does not ignite." (*Ophidians*, p. 119). Quoting from the analysis of MITCHELL, he gives the following as the qualitative analysis:

"1. An albuminoid body, called *Crotaline*, not coagulable by heat at 212° Fahr.

"2. An albuminoid compound, coagulable at 212°.

"3. A coloring matter, and an undetermined substance; both soluble in alcohol.

"4. A trace of fatty matters.

"5. Salts, chlorides, and phosphates.

The color of the venom varied from *pale emerald green*, to *orange*, and *straw* color." The venomous properties were retained for an indefinite time, when dried but kept excluded from the air, and after weeks, or even months, little loss, if any, in this respect, was observed upon inocculating animals.

The *effects of the poison*, when properly introduced, are shown in two groups of symptoms, local and constitutional, varying in intensity,

duration, result, and various sequelæ with varying circumstances. It is supposed that the actual nature of the venom does not differ materially in the different species of snake, but the very fatal nature of snake wounds in tropical countries is attributed to the size of the snake, and the climactic influences on both serpents and men. In all cases the most marked result will be, fluidity of the blood, and gradually weakening cardiac action. Whether the action of the poison is first expended on the blood, which thus loses its proper stimulating effects on the nerve centres, and thence communicated to the blood, are questions still unanswered, and apparently unanswerable. It is a matter of some moment to settle the question, as the question of therapeutics is directly related thereto, as many who accept the former, demonstrate the condition to be one of septicæmia, with little reference to any specific nature of the poison itself. If I correctly read, MR. POLAND, (*Holmes' Surg.*, I, 680), inclines to this opinion, and it can be seen at a glance that the conditions to be fulfilled, in this case, are widely different than if the opposite conditions are recognized. That a change is effected in the blood, we must admit, none can deny; but whether it is primary, from contact with the poison, or secondary, from nervous influences, cannot yet be told. The change in the red blood corpuscles have been denied by observers of a few years ago, but more recently it is stoutly affirmed that the margins of the discs are found serrated, and indicate the specific nature of the poison. DR. HAYNES, (*Med. Advance*, VI, 481) made a large number of experiments, on over two hundred animals, and thus describes the appearance of the blood: "Most of the red corpuscles of the blood were changed in their shape and character, and the serum crystalized in a very peculiar form; the white corpuscles normal." In a letter to me, he states the serrated character was quite distinct. At all events, the blood is fluid, and dark, and the hæmorrhage from the wound is continuous. HAYNES, (*l. c.*), states that in all cases the wound in his animals was very minute, could not be recognized from the outside, but other reporters did not so observe. In all of the former experiments, the doctor speaks of one of the earlier symptoms being a dragging of the hind legs, and in his own case, (from accidental poisoning), he found difficulty in locomotion, as in locomotor ataxia. Perhaps no mere recitation of symptoms can be as useful as the transcription of actual clinical reports; I am further impelled to do this from observing the great disparity between the symptoms as given by MR. POLAND, (*l. c.*), and those found in cases occurring in actual practice. Before doing so, attention must be called to the fact, that there are three schools, in reference to the nature of snake poison; one claims a specific toxical effect; another the establishment of septicæmia; and a third, the establishment of tetanus. The probabilities seem to be; as stated by SURG. OTIS, (*Circular* No. 3, p. 166), that while there is unquestionably a specific toxical property, the amount can scarcely be dangerous to the life of large mammals in

this country, and that the other conditions, one or both, must be added to place the sufferer in danger of death.

In *Circular* No. 3, of the War Department, (p. 164, Case No. 388), will be found the following: "Private Theodore E. Turner, Troop D, Fourth Cavalry, aged twenty-nine years, was bitten by a rattlesnake at Fort Concho, Texas, June 27, 1866. The bite opening the phalangeal joint of the left thumb, caused violent inflammation. Chronic inflammation ensued, which resulted in the destruction of the joint. On January 23, 1869, the patient was admitted to the post hospital at Austin, Texas, at which time the joint was swollen and exquisitely painful on the slightest motion, the anterior and left lateral ligament being destroyed by ulceration. The patient was feverish, unable to sleep from pain, and desirous of having the thumb amputated. On the date of admission the medical officer in charge administered Ether, and amputated the thumb above the phalangeal articulation by the circular method. There was very little hæmorrhage, and that little was suppressed by torsion of the arteries. The dressing was made with adhesive straps, Carbolic acid and oil. The pain ceased, the appetite improved, and the patient slept well. The wound healed by January 30, 1869, and the man was soon afterwards returned to duty."

Here was a case in which all the conditions were fulfilled requisite to set up fatal symptoms; yet, from some cause, the recovery was good, and the manifestations were purely local. Let us now consider another case, non-fatal, in which the poison seems to have fully developed its action.

Higgins, (*Ophidians*, p. 112), relates the following case, which I have condensed from the original: Man wounded in the finger of one hand, by a large crotalus (cascabella) in Brazil. Swelling of the hand, with bleeding from the wound, came on at once, with pain in hand extending up into the wrist. One hour later, hand greatly swollen, with feeling of coldness; coldness of the lower extremities; pulse from 110 to 140, accelerating at intervals. Fullness in jugulars, in throat, and nape of neck; blurred vision; crawling sensation on face. Half an hour later, pain in hand and arm to elbow, with œdema; full feeling in the whole body; tremors and shaking in whole body; difficult to move the lips; drowsiness; feeling of constriction in the throat; the whole arm very painful, and greatly swollen. Feels cold, wants to be covered; pain in œsophagus, extending to stomach and abdomen. Difficult to speak; swallows with difficulty; anxiety; copious sweat on the chest; epistaxis; groans and moaning; great anxiety. Face flushed; blood from a pustule in the arm pit; unbearable pains in the thorax, and great prostration. Great pain in the whole body, salivation, and slight delirium. Profuse urination; tenacious, dark colored saliva. After nine hours, sleep and recovery.

In fatal cases, or those of greater severity, the same symptoms are noted, but in a more aggravated form, particularly the hæmorrhages,

which occur from every outlet of the body (sometimes seems to be through the unbroken integument), and the swelling. This latter commences soon after the bite, in the near neighborhood of the wound, is hard, dark, becoming mottled later, and proceeds *parri passu* with the increase in the intensity of the symptoms.

The cases just alluded to, go to show that the sequelæ are not always due to the toxical properties of the venom. Thus in the first case a period of two years and six months elapsed before the condition of the injured part called for active treatment. The presumption in this case is, that some dyscrasia favored the destructive process, which followed upon the injury done the tissues of the part rather than any poisonous action. The second case, on the other hand, seems to give a purely toxical picture, and no mention is made of sequelæ. Still the nature of the wound would sufficiently account for the merely local symptoms, which do not materially differ from those following punctured wounds.

A fatal case is given on page 165 (*Circular* No. 3), in which thirty-four days elapsed, after the bite, before death closed the scene, and with few if any of the traditional phenomena. In fact a careful reading of a number of cases, fatal and non-fatal, has shown such an utter lack in uniformity, in this particular, that it ceases to be a matter of wonder that doubt should exist as to the specific character of the snake venom.

The TREATMENT of snake wounds is nearly as much a matter of controversy, as the nature of the injury. Everything to the time of HIGGINS, has failed, and some so-called antidotes seem to have had the effect to place the patients in greater danger than they would have been without it. While I do not believe that death is a frequent consequence upon snake bites, yet there can be no question that there are notable poisonous effects, and a remedy is called for to prevent or modify suffering at least. Of all the measures known to science, it would seem that our choice must lie between two, each of which has been amply verified, and rarely fail when used as laid down by the authorities. These are the serpent gall, introduced by HIGGINS; and *Iodine*, successfully employed by DR. HAYNES, of Indianapolis.

Gall.—As some of my readers may not have access to Higgins' work, I transcribe from pages 209–10, (*Ophidians*), the mode of preparation and administration: "Proportion, *one* drop of pure gall to *ten drops* of as pure alcohol, or high wines, or spirits of wine, as can be procured. The mixture must be thoroughly shaken, and allowed to stand a couple of days, when a lead colored sediment will have deposited itself; the supernatent liquid can be poured off carefully into a perfectly clean, new vial, using a bit of sponge in the neck of a small funnel to filter it, when it is ready for use. Never mix galls of different species. * * * * For all ordinary cases of bites, five or ten drops of prepared gall (selecting, if possible, that of *the kind* causing the bite), in half a tumbler full of water, well mixed, to adminis-

ter a tablespoonful of the mixture every five, ten, fifteen, or twenty minutes, according to the violence of the symptoms, and varying the dose, according to the age, sex, condition, and susceptibility of the patient, will afford entire relief. * * * * I invariably make a deep cruciform incision in the wound with a lancet, and bathe the limb in water as hot as can be borne, into which I pour a few drops of prepared gall. When the blood flows a bright red (and not before) a small pellet of cotton or sponge, saturated with the gall (prepared), applied to the wound and secured with a bandage, will stop the flow of blood, unless a large vein or artery is punctured with the fang; in this case cauterization is necessary." The doctor has treated fifty cases with success in this manner.

It was said earlier, that during the changing of the skin the poison became less virulent and the gall less bitter. When the colors on the new skin come out clearly, the gall becomes bitter again, and poison active. Hence we can learn two lessons, one, that there is *some* relation between the two secretions, and that gall prepared when the change is in progress will not possess antidotal properties.

Iodine.—DR. HAYNES writes me that his first knowledge of this drug, as an antidote to snake poison, came to him from a forgotten source, but in the *Medical Advance*, (Vol. VI, p. 485), he gives the result in two cases in which the curative effect was prompt and permanent. The first was a cat who had eaten some of the flesh of a rat dying from snake poison, and had progressed so far towards death that the breathing was abdominal, and the hind legs were paralyzed; five drops of strong tincture were injected subcutaneously, and improvement commenced in an hour. Fifty-two hours had elapsed since the poisoning before *Iodine* was given. The second case was himself. Poisoned blood, from a subject of the experiment, was absorbed through a wound. The finger was enormously swollen, wrist and forearm as well, breathing oppressed, and legs heavy. Six drops of *Iodine* tincture in one third of a glass of water, relieved entirely in two hours. A rat and kitten were poisoned, treated in the same manner, and fully recovered.

(*a*). INSECTS are quite generally capable of inducing poisoned wounds, but the extent of the morbid action, the virulence, and even the injection of actual poison, is much exaggerated. Tarantulas, centipedes, scorpions, wasps, hornets, and bees, do unquestionably secrete poison, but in the large majority of instances the effects are exceedingly evanescent, and even in the commencement induce very trivial symptoms. Slight swelling, redness, and severe pain is the common local manifestation, and unless a number of insects make an attack simultaneously, the effects soon cease, and no sequelæ remain. The only exception to this is when the sting is inflicted on an exceedingly sensitive part, as the eye, or fauces, when death has occasionly ensued. There is reason to suppose that the virus secreted by insects, if it may be called such—is a simple irritant.

Ammonia, heat, or cold water is all that need be used in most instances; when a person is stung by a number of bees or wasps, much relief has been experienced from plastering the parts with fresh mud. *Apis*, *Rhus*, or *Pulsatilla*, may be used, when the indications correspond. When in South America and the West Indies, a number of years ago, I observed that the stings of the scorpion, centipede, tarantula, and the minute chiga, were uniformly treated by applications of tobacco, moistened by saliva or water. In some instances, at least as far as bees are concerned, the insect leaves the sting in the wound, and this should be removed as a matter of course. In short, as a matter of fact—such injuries, while sufficiently annoying, are too trifling to call for surgical attention, unless they are extensive or inflicted on sensitive parts. When the fauces are stung the great danger is from swelling and occlusion of the glottis. If *Apis* does not give relief, no hesitancy should be practiced in relieving it by incision.

III. FROM ALTERED SECRETIONS.

Whilst several morbid secretions, or normal secretions which become so by some diseased action—are capable of inoculating the human subject, and inducing specific effects, many of them, such as glanders, and syphilis—do not properly fall under the head of poisoned wounds, and some of them are not purely surgical affections. The only morbid condition, induced by a wound, that would naturally claim attention at this place, is hydrophobia, and to that I shall confine my remarks.

Hydrophobia, is a term meaning "fear of water," and is applied to a morbid condition in man, induced by inoculation with virus from a dog suffering from rabies. As the dread of water is not a constant symptom, objection has been urged to the retention of this word, and many offered as a substitute; still the cases in which this prominent symptom is wanting are so few, and it has been so long in use, there seems as good warrant for its continued use as many other nosological terms that are employed without question. It has been thought best to follow, to some extent, the arrangement of the subject as presented by MR. POLAND, (HOLMES' *Syst. of Surg.*, I, p. 684), it being by far the most systematic article of any not found in a special treatise, although the works of YOUATT, TROLLIET, and the article in COPLAND'S *Medical Dictionary* are more elaborate.

(*a*). The first question demanding consideration is, *was the dog mad?* It would seem easy to answer the question, but a reference to the statements of YOUATT, GANT, VIRCHOW, and others will at once dispel this illusion. YOUATT (*Canine Madness*) says as follows: "The disease manifests itself under two forms. The *furious* form, characterized by augmented activity of the sensorial and locomotive systems, a disposition to bite, and a continued peculiar bark. The animal becomes altered in habits and disposition, has a disposition to lick or

carry inedible substances, is restless and snaps in the air, but is still obedient and attached. Soon there is loss of appetite and the presence of thirst, the mouth and tongue swollen; the eyes red, dull, and half closed; the skin of the forehead wrinkled; the coat rough and staring; the gait unsteady and staggering; there is a periodic disposition to bite, the animal in approaching is often quiet and friendly, and then snaps; latterly there is paralysis of the extremities; the breathing and deglutition becomes affected by spasms; the external surface irritable, and the sensorial functions increased in activity and perverted; convulsions may occur. These symptoms are paroxysmal, they remit and intermit, and are often excited by sight, hearing, and touch."

"The *sullen form* is characterized by shyness and depression, in which there is no disposition to bite, and no fear of fluids. The dog appears to be unusually quiet, is melancholy, and has depression of spirits; although he has no fear of water he does not drink; he makes no attempt to bite, and seems haggard and suspicious, avoiding society and refusing food. The breathing is labored, and the bark is harsh, rough, and altered in tone; the mouth is open from the dropping of the jaw; the tongue protrudes, and the saliva is constantly flowing. The breathing soon becomes more difficult and laborious; there are tremors and vomiting, and convulsions."

VIRCHOW (*Text Book on Pathology*, I, p. 344), does not follow this arrangement, although the symptoms are quite similar. He considers that in each case of hydrophobia there are three well marked stages, viz., melancholic, irritable and paralytic; and that the account of YOUATT, given above, represents three stages rather than two forms of the disease. This, I believe, is now quite generally admitted. GANT, (*Practice of Surgery*, p. 226), who has given the subject much attention, adheres to the doctrine of VIRCHOW, and speaks as follows: "Rarely is the rabid state any approach to the popular notion of a 'mad' dog. No wild excitement appears, no savage tendency to bite, and certainly no dread of water, so remarkable in the human subject. Rather will suspicion be aroused on ascertaining that the animal evinces only some strange departure from its usual habits and manner." The symptoms are then given, following quite closely the doctrine of VIRCHOW. It will remain for works on veterinary practice to give details of the malady in dogs, it will be sufficient for our purpose to simply give the conditions to be fulfilled to set the question of rabies at rest.

(*b*). The *predisposing causes* of hydrophobia, are not, as formerly supposed, climactic and degree of temperature, which might induce rabies in the dog, but the "dog supply." All times of year, all degrees of heat, and all parts of the world seem to present the same history, and wherever dogs are found, there are the inhabitants exposed to hydrophobia, and in some direct proportion to the number of these animals. The same is true of animals of the feline race, more partic-

ularly in the wild state; the wolf, polecat, and others, are quite frequently found affected with rabies, but the want of intimate relations with man prevents hydrophobia being of common occurrence. With this exception neither age, sex, race, bodily condition, or social position offers any exemption. The *exciting cause*, however, is accurately defined, and is the introduction of the virus into the body of man. A wound is not essential to induce inoculation, the contact of the virus with a surface capable of absorption is all that is required.

(*c*). Of the *nature of the poison* but little is known. That it is "more volatile and less active" than many other morbid secretions, is well established by many instances. A number of persons have been bitten by the same animal, as is related by HUNTER, and only one or two subsequently had hydrophobia; in one instance twenty were bitten, and all escaped save one. As a rule, based upon a large number of cases, about one-fourth of all the persons bitten develop the disease. A distinguishing feature is, and one that seems to be so well established that I fail to find a solitary exception to the rule—that while the disease is readily communicated from animals to man, or from man to animals, in some instances—it is not communicable from man to man. The popular fear, therefore, of injury from attendance on those suffering from hydrophobia, is groundless, and the extension of this knowledge would be beneficial, as it would have a tendency to secure better care of the sufferers in ignorant communities, where, it is said, the poor victim is sometimes locked up in his room, and shunned by all.

Examination of the secretions of rabies and hydrophobia, has hitherto failed to detect any specific recognizable element, and it is undoubtedly a chemical change in the salivary secretion. Some have claimed that the saliva was itself inocuous, the frothy substance driven out of the bronchi being the infecting agent. Whatever it may be, certain it is that the poison is contained in the salivary secretion, as extended experiments by Trolliet, Majendi and others, has conclusively shown that none of the other secretions have infecting powers.

(*d*). Perhaps there is no morbid condition in the whole catalogue of diseases, that has excited more animated controversy as to the *pathology* than hydrophobia. The fact that the latency of the poison proves that there is not capillary absorption; the absence of all glandular irritations, shows that the lymphatics are not at fault; and so, unlike all other morbid action from poison, whether animal or vegetable, there are no local lesions discoverable before death, and for that matter very few afterwards. That the medulla is primarily and chiefly the originator of the phenomena, none can doubt; from thence the neighboring nerves are affected, until a condition of general hyperæsthesia is established. Until more is known of the nature of the poison itself, speculation seems vain as to the exact pathology. According to POLAND (*Holmes*,' I, 693), it has been variously consid-

ered a form of continued fever; an inflammatory affection; blood changes; purely symptomatic, *e. g.*, of urinary irritations, carbuncle, etc.; others as tetanus pure and simple; whilst a few, have utterly denied its existence, "and attribute the symptoms and effects to imagination." HERING, (*Domestic Pract.*) speaks of a vesicle under the tongue as indicative of exhaustion of the morbid action, but it appears that it was observed as early as 1820, and again in 1821, and occurred in all cases of hydrophobia. There are two kinds described, the crystaline, and the opaque; the latter occurred in all cases, at an advanced stage of the disease, whilst the former were oftener seen in the latent stage and not constant. HERING in speaking of the cure of hydrophobia by "radiated heat," alludes to this latter form as *following his treatment*, and lays great stress on their being opened, as a necessary step in the prophylactic measures. It is certain, however, that we yet know little of the real meaning of the vesicles, but are justified in supposing they represent different stages in the same process, and an essential feature of the disease.

(*e*). Let us now consider the course of, and symptoms of, the disease as it occurs in man. One of the most remarkable features in this most distressing disease, is the prolonged stage of incubation. As said above, this one fact serves to throw apparently impenetrable obscurity about the exact pathology. The length of this latency, also, by throwing the sufferer off his guard, and perhaps deceiving the surgeon, not only renders prophylaxis uncertain, that it throws doubts about the efficacy of measures taken, but discourages attempts from the apparent want of adequate demand for it. This is rendered more particularly forcible, when we recall the fact that but about one in four of those bitten develop hydrophobia at all. The duration of the period of latency varies greatly; the ordinary period is from six to seven weeks, but the observations of THAMHAYN, (*Holmes*,' I. 695), in a total of 220 cases, gives the large number (47) as occurring prior to four weeks, 80 from four to seven weeks, and others varying from 2 in three days, to 6 in five months, and even one each after four and five years and six months respectively! Poland speaks of rare instances, (*ibid*) where 12 years has elapsed, but it would seem that there must be doubt attaching to such a record. At all events, during this stage the wound heals entirely, and no untoward symptoms arise, having the tendency to dismiss all fear from the mind of the patient, until the premonitory symptoms are felt.

After this interval of uncertain duration, the patient will complain of uneasiness, a feeling of being unwell with no pronounced symptoms. He will become restless, complains of loss of appetite; as the case progresses, chills and flushes of heat, sore throat, and stiffness of the neck as in the case of tetanus. General excitement then comes on, with high fever, headache, and nausea. Some observers attach much importance to the conditions of the scar, in this stage, but in ninety-five cases (*ibid* 688) it was normal, and unchanged in sixty-six.

Even when painful, sensitive, or altered in color, in all but four instances, the surrounding parts were perfectly normal. There may be pain, which will be severe and shooting up towards the chest, but the prevailing character of the symptoms will be melancholy and anxiety, with a gradually increasing general hyperæsthesia. Sleep is disturbed, the patient starting frequently in affright, and the disturbance seems to be more mental than physical. In 119 cases (*ibid*) the duration of this stage was from two hours to several weeks; the larger number continued between twelve to twenty-four hours, (or 81 cases), but ten continued three days.

These premonitory symptoms gradually merge into the second, or convulsive stage, which is chiefly characterized by an increase in the severity of the symptoms, with dread of water, and utter inability to swallow it; accummulation of tough saliva; excessive hyperæsthesia of the surface, even currents of air, a fly, or a ray of light being sufficient to bring on renewal of the spasms. The chest feels painfully constricted, the throat painful, dry, and constricted, and the extreme mental agitation and excitement combine to "make the sick room a chamber of horrors." Soon hallucinations and violent delirium set in, the spasms increase in severity, and death usually closes the scene. GROSS, (*Surg.*, I, p. 409), says: "The countenance has a haggard and distressed appearance, horror and anxiety being depicted on every feature. The pupils are dilated, and the eyes have a wild, glaring expression, the tongue is dry and parched; the voice is harsh and shrill, almost like that of a dog; the respiration is short and panting; more or less delirium is present, often amounting to complete mania; the strength is much impaired; and the pulse, small and feeble, beats from one hundred and thirty to one hundred and sixty a minute." Death usually takes place either from suffocation, or exhaustion. The larger number of cases terminate, when fatal, in from twenty-four to thirty-six hours; some have run through all the stages in twelve hours, and some have continued in the second stage seven days.

It is said that hydrophobia can hardly be confounded with any other disease, but in some respects the poisoning of strychnia, and tetanus bear a very close resemblance, and it will often need close and careful scrutiny, and a rigid examination into the supposed anamnesis, to determine the matter. As to the poisoning of strychnia, it has long seemed to be next to impossible for a medical man to accurately differentiate from tetanus, in the absence of any information as to the cause of the paroxysm; the resemblance to tetanus is so exact, that our nearest similimum for tetanic convulsions is strychnia. For our present purpose, therefore, we will simply draw a comparison between tetanus and hydrophobia, using, for that end, the excellent table by MR. POLAND, (*Holmes' Syst. of Surg.*, I. p. 323).

HYDROPHOBIA.	TETANUS.
Spasm of muscles of brief duration; if not voluntary at least temporary, and will cease to exist during intervals of rest and quietude, the jaw being relaxed, and opening and shutting readily. The spasms are clonic.	Spasms of muscles more continued; less remitting and never intermitting. Constant rigidity of the muscles of the jaw, becoming gradually fixed and closed; tonic spasms.
Cause, the bite of a rabid animal, and it rarely appears before the 30th day.	Cause, exposure to cold, or wound, rarely from the bite of an animal, and it generally occurs soon after the injury.
The bite of hydrophobic animals must have communicated the disease, when it exists.	The bite of a tetanic animal does not produce tetanus.
Countenance hydrophobic; an expression of excitement, fearful distress, and peculiar restlessness never to be forgotten; occasionally frightfully convulsed; eyes bright and glistening, but at times suffused.	Countenance tetanic; drawing up of the nose; wrinkling of the forehead; angles of the mouth drawn toward the cheek bone, presenting a frightful *risus sardonicus*. There is an expression of pain, but the eyes are natural.
Thirst and aversion to fluids characteristic; even the sight or noise of fluids induces paroxysms; with frequent and viscid discharges of saliva; efforts to disengage it inducing barking and vomiting.	No great thirst, and in general no great aversion to fluids, administered in small quantities; rarely any discharge of saliva.
Vomiting and gastric pains general.	Vomiting and gastric pain rare.
Mind subject to rabid impulse and numberless deviations, passing to delirium.	Mind generally clear to the last.
No authentic case of recovery.	Recovery in idiopathic forms.
Intolerant sensibility of surface and organs of sense.	

Of course the paragraph referring to curability is purely a quotation, viewed from our standpoint, however true it may be otherwise; with this exception the comparison will serve two purposes, to show at once the *dis*similarity, and the remarkable similarity of the two diseases.

(*f*). As to *post mortem appearances*, I can simply repeat what has been said by every writer on the subject, viz, that they are indefinite, often no morbid condition can be detected. GROSS, and others, give numerous instances in which careful and painstaking dissection has been made, every tissue minutely examined, and the various secretions placed in the test tube and under the microscope, yet nothing abnormal could be detected, or at all events sufficient abnormality to account for death.

TREATMENT.—It having never fallen to my lot to treat, or even *see* a case of unquestioned hydrophobia, I am compelled to resort to the experience of others in presenting the question of treatment. It is astonishing to find so little of clinical experience reported by our

known surgeons, and so much by those who are not supposed to possess peculiar opportunities. HELMUTH (p. 338) mentions two cases, each of which died; FRANKLIN appears to have seen none, or at least does not report any. On looking over our periodical literature, I am impelled to repeat what was once thought a hasty expression, *viz*, cures of undoubted cases of hydrophobia are so rare, as to warrant the belief in its actual incurability. Nevertheless there are a few cases of unquestioned authenticity, which were cured with one of a very small list of remedies. From a consideration of these, it would seem that we must look for the similar in either *Bellad.*, *Hyos.*, *Lach.* or *Stram.*, and possibly *Xanthium spin.*

It will not be sufficient to rely entirely upon remedies, however, as many conditions will arise which a failure to recognize would much aggravate the paroxysms. Thus the extreme hypersensitiveness, in which the least noise, sudden movement, current of air, the touch of a fly, shaking the bed, and the like, excite spasms, would at once suggest care to avoid such disturbing influences. The horror of water is due to the pain and spasms caused on attempting to swallow it, and the sight, or sound, of running water — should be avoided also, as it suggests the suffering caused by drinking. It is evident that as the frequent recurrence of the spasms wears out the patient, and may frequently be considered the sole cause of death, much discretion and foresight will be demanded of the surgeon, in addition to ability to select and apply the appropriate remedy. Putting the patient in a hot bath or a vapor bath has been spoken of as curative.

Notwithstanding the great authority of HERING, I am compelled to discourage the use of prophylactics, whether radiated heat, or what not. In cases of so-called hydrophobia, in which the malady was developed a few hours after the bite, the presumption is very strong that there is no hydrophobia present. The condition is either one of tetanus, or hysteria. Excision, cautery, ligation, suction, etc., are valueless; the nature of the accident, and the peculiar latency of the poison forbids any hope of immunity from such measures. We can only exert ourselves to dispel the fear from the mind of the patient, and fortify ourselves for the trying ordeal through which we may be called upon to pass.

The leading indications for the remedies are as follows:

Belladonna.—The prominent indication for this remedy is fearfulness, desire to escape. The eyes are red, sparkling and prominent; the face is bloated and dark red; the pulse is high and strong, and the mouth filled with tough adherent saliva. An analysis of the symptoms will exhibit a remarkably close resemblance between the pathogenesis and the disease. DR. ADAMS (*Ohio Med. and Surg. Rep.*, V. 92) records a cure, in a woman of forty-three, in which the disease was said to be *contracted from her husband without any wound!* the symptom leading to *Bell.*, was the extreme fright, with "holding fast to the bed to keep from flying out through the top of the house." In

a case recorded by DR. OWENS (*Med. Ad.* V. 637), of undoubted authenticity, *Bellad.*, chiefly, but other remedies as indicated, produced a cure. The recurrence of spasms took place about once in every nine or eleven days, from May to December, when they finally ceased.

Hyoscyamus.— The predominant characteristic is combativeness, with furious mania. The convulsions are permanent (tonic), particularly affecting the extremities; face bluish red; tendency to sleep, disturbed by starting, anxious visions and dreams; constant delirium, even when spasms are abated. Attempts to strike and bite the bystanders; great sexual excitement, in both sexes, with lascivious and indecent actions.

Lachesis.—The chief indication is the excessive hyperæsthesia, in which the lightest touch suffices to renew the spasms. Somnolency, awaking from frequent sleep with renewal of the spasms. Face distorted, and dark colored, and spasms more clonic than tonic. Spasms are ushered in with shrieks. In the Transactions of the Philadelphia County Society (*Hahn. Month.*, VIII, p. 438), Dr. Toothaker states that he cured a case of hydrophobia with *Lach.*, in one day.

Stramonium.—The leading characteristic is continuousness, and renewal or aggravation of the spasms by bright light, or flashing of light, or indeed any glistening object. The delirium is violent, so much so that the patient must be held to prevent hurting himself or others. The spasms are both tonic and clonic, or tonic in general, and clonic in particular muscles or sets of muscles. It is said that a popular and successful treatment of the disease in China, is to give *Stram.*, strong enough to produce delirium, when the hydrophobic symptoms pass away, and do not return. DR. J. C. MORGAN, (*Hahn. Month.* VIII, 438) mentions a case cured with this drug, in drop doses.

Xanthium spinosum.—(*Hahn. Month.*, XII, 530). A DR. GRYZMAL, of the Russian Province of Podolien, reports a certain infallible cure, in all cases in which this remedy is given before the "state of frenzy." He has had equally good results in the treatment of canine rabies. He claims to be able to fortify his assertion with one hundred clinical reports. The dose is laid down as three ounces in twenty-four hours, and continued for four weeks.

Whilst other remedies, as *Cantharis*, *Arsenicum*, etc.. have been theoretically prescribed by many of our writers, I have reason to believe that if a cure can be attained at all, it will be with one of these just mentioned. Electricity, in all forms, has been tried without avail; alcohol, ammonia, and radiated heat, have each failed uniformly when applied in practice. In a case of suspected hydrophobia, *from inoculation by the sputa from a patient*, a DR. BUISSOM, (*Raue's An. Rec.*, 1870, p. 308) tried to commit suicide by smothering himself in a vapor bath, but instead cured himself! "When the heat reached 57 Centigrade, all the symptoms disappeared as if by magic, and never

returned. He reports that he has attended more than eighty persons bitten by mad dogs, and saved all by the hot bath."

In closing this lengthy and somewhat unsatisfactory essay, I must repeat what has been said before, that all attempts at prophylaxis are useless, as we have no guarantee that the bitten person had been inoculated, or if he has that he would ever develop the disease. In the instances recorded where prophylaxis failed, we are justified in presuming that the patients were inoculated, and where it succeeded, that they would have escaped anyway.

IV. INTRODUCTION OF SEPTIC POISON.

These wounds are those in which some septic material is introduced, either putrifying animal substances, or some of the products of decomposition. The commoner form are those made by pricking or cutting the fingers while engaged in dissection. As is the case with most poisoned wounds the certainty of infection is in relation to the extent of the wound and the amount of hæmorrhage; hence pricks with a needle, tenaculum, hooks, or sharp spiculæ of bone, are more dangerous than free incisions with more or less copious bleeding. From the necessarily limited experience I have had, it would seem that there are two varieties of dissecting wound, as these injuries are commonly called—one in which the morbid symptoms are due to inoculation with a specific virus, and the other from ordinary septic poisoning. In the first, it has been observed, that the poison is unique, something that cannot be detected or demonstrated, and supposed to be generated in the act of dying. Certainly the danger from such wounds diminishes with the length of time which has elapsed since death; the "older the subject" the greater the immunity. It was at one time supposed that syphilis, erysipelas, scarlatina, variola, etc., were communicated in this way, but it is now generally taught that such is not the case. While bodies of those who have died from certain malignant diseases, are certainly frequently found to inoculate those who wound themselves in their dissection, it is not inoculation with the specific disease; the effects are the same, modified somewhat by the individual peculiarities, in all cases. Erysipelas, the advanced stages of syphilis, peritonitis, and carcinoma of the liver are particularly favorable to septic poisoning, but very frequently the bodies of those who have died from other causes much less malignant, or even from accident while in full health, will induce as severe symptoms as those mentioned.

The inoculation with poison, whatever it may be, is soon followed by symptoms of infection. Usually within six hours there will be smarting and pain in the wound, which will look red and swollen, and red streaks will run up the arm, in the course of the lymphatics. The finger will swell, and become hot; soon the hand will swell, and the whole arm will become involved. The swelling is firm, in most instances, dark red in color, and the pain may be of any degree, from

a slight burning to the most severe and agonizing character. The pulse will become quick and hard, temperature elevated a degree or more, and general fever and discomfort. In severe cases there may be delirium. This stage may continue for ten or twelve hours, and be succeeded by exhaustion, and typhoid, or even typhus symptoms. The whole course is usually run in from three to five days, and when the termination is not in death, boils, carbuncles, or phagadenic sloughing may occur. It is not often, fortunately, that such injuries are fatal, but cases are recorded in which death has ensued in eighteen hours.

Certain precaution should be had, at all times, to avoid exposure to such danger, but some individuals, owing to peculiar idiosyncrasies—develop the symptoms from the least provocation. In making dissections of subjects that might promise danger of this kind, any abrasion of the fingers or hand should be covered with collodion, or the whole hand smeared with carbolized oil. Those who are particularly susceptible, should even wear thin rubber gloves. Extreme caution should be used to avoid pricking or wounding the fingers, but should the accident happen, with a *clean* knife at once enlarge the puncture, and apply some active caustic, such as acid nitrate of mercury, strong sulphuric or nitric acid, or even the actual cautery; the nitrate of silver will be useless, as it cauterizes very superficially. The hands must then be thoroughly cleansed, and remedies given at frequent intervals, until all danger has passed. As a constant remedy in the early stages, before much swelling occurs, *Arsen.* must be used, in doses as often as once in half an hour. If swelling comes on, the lymphatics are engorged, and the color is red or dark red, *Rhus tox.* may be given, but not if *Arsen.* is doing good. Should the swelling become blackish or livid, hard, and pain excessive, *Lachesis* is indicated. In cases in which the later stages are developed, and typhoid symptoms come on, the treatment must be as in simple typhoid fever.

The *second variety* of dissecting wound, in which the symptoms are due to ordinary septic inoculation, the invasion is slower, the course of the disease is more protracted, and the symptoms of much less severity. These circumstances, however, do not in any sense detract from the danger, indeed many consider that the case is much more serious. The symptoms are about as already given, but it will often be twenty-four hours before symptoms of infection are manifest.

The treatment is the same, *Arsenic* taking the first rank among the remedies. In one case in which the patient was much prostrated, cold, covered with a clammy perspiration, and sighing respiration was marked, a cure was effected with *Carbo veg.*

There are a few cases in which the glands in the axilla are primarily affected, suppuration being established without any symptoms at the point of injury. In others, pyæmia will be developed, which must be treated as laid down elsewhere. (*Surg. Therap.*)

VIII. EFFECTS OF HEAT AND COLD.

I. HEAT.

The application of heat to the living body, whether dry or moist, has the effect to completely destroy the vitality of the tissues involved, the parts being hopelessly lost, and cast off as the first effort at repair. Perhaps there are no injuries to which the human body is exposed that in many particulars are so formidable as that under consideration, both from the suffering at the time, the profound shock, and the nature of the sequelæ which at once seriously disfigure and cripple, to a greater or less extent.

The effects of the application of extreme heat, are technically known as *burns or scalds;* the former when produced by dry heat, the latter by moist. The effect on the tissues, apart from carbonization, are about the same in both instances, and it is the custom for surgical writers to treat the conditions under one head. One fact of much importance, it seems to me, has been either entirely overlooked or has not received the attention it justly demands. The same degree of heat in *moist* bodies, as steam, boiling water, etc., will produce a greater destruction of tissue, both in superficial extent and depth—than dry heat, no matter how long the latter may remain applied. This is a fact, I think, which my experience seems to have demonstrated. Another important consideration is, that the scalded parts are often found entirely stripped up from the deeper parts, and in perhaps all cases are at least detached and loosened. In the case of burns, the eschar is quite firmly adherent, and after days or weeks of pain and suppuration, the slough will be found in the condition that the scalded parts assume in the beginning. Hence we might justly infer that the prognosis should be better in scalds than burns, inasmuch as this prolonged sloughing and eliminating process is obviated, and the danger of pyæmia, septicæmia, or visceral lesions is also much diminished. Experience would seem to bear out this assertion, as the records show more cases of serious scalds followed by recovery, than is the case in equally severe instances of burning. The process of healing, after severe burning or scalding, as will be shown elsewhere—involves first the detachment and elimination of the dead tissue, and secondly the reproduction of the lost parts. While the last unquestionably calls for much vital effort, the first is perhaps surrounded by the greater perils and difficulties. A body that has been called upon to exert all its powers to expel this dead material and at the same time protect itself from morbific influences

growing out of the unnatural conditions of affairs, cannot be in as good circumstances to repair the breach as one that has not been compelled to undergo this preliminary struggle. So from every point of view, supported by the powerful authority of clinical experience, we are fully warranted in the assertion that scalds are less fatal *per se*, than burns. With the single exception, however, of the suppression of cutaneous transpiration, everything that will be said hereafter of burns will apply with equal force to scalds.

It is manifestly important, in the outset, to have a rational classification of burns, both for purposes of prognosis and therapeutics. The classification of DUPUYTREN has formed the basis for the numberless attempts in this direction, and with some slight modifications I have adopted it in my teaching. We will, therefore, consider five degrees of burning, each of which will demand separate mention, before proceeding to speak of burns in general.

First degree, is a simple erythema, or superficial inflammation, from radiated heat rather than the direct application of fire.

Second degree, blistering of the skin, from actual contact with the heated body; an actual loss of vitality, but very superficial in extent.

Third degree, a carbonization of the integument, without involving deeper parts.

Fourth degree, an aggravation of the preceding, in which the soft parts, muscles, etc., are involved.

Fifth degree, complete charing or destruction of the whole part, *all* the tissues to the bone being equally devitalized.

In brief, it will be observed that the degree of burning is in relation to the degree of heat, the nature of the heat, (gaseous, liquid, or solid bodies), and the length of time the part has been subjected to its influence.

1. Burns of the *first degree*, are not at all times such slight affairs as might be supposed. The cause is usually the flashing of explosive substances, such as gun-powder, alcohol, etc., or gas. When a small surface is implicated, the case is usually of no moment, unless there be some dyscrasia that might have a tendency to inaugurate some morbid process. When a large surface is involved, however, the case becomes one of considerable gravity. The devitalization of the integument will prevent transpiration, and the need therefore being much increased by the inflammatory tension of the blood vessels, the danger of visceral effusion is great. Of course the location of the burn will exercise a very important influence. Thus when the head is injured, cerebral effusion is imminent; when the chest, we may look for similar trouble in the lungs; and in the abdomen, there will be hepatic, renal, or intestinal irritation, with danger of disorganizing processes. The pain is violent, smarting and burning, and the shock is usually severe. Desquamation will at once afford sensible relief, but when the denuded surface is large there may be much suppuration, irritative fever, and convulsions very prolonged. The actual

condition of affairs is death of the epithelial layer, without detachment from the deeper layers.

The first indication is to relieve pain. We have two or three agents for this purpose, either of which will be found to act promptly, and a choice is simply a matter of convenience, *i. e.*, which is most available or ready to the hand.

Urtica urens tincture, ten drops in two ounces of water, applied by wetting strips of lint, is a very efficient remedy.

Cantharis, in the same manner, is useful when the injury is slight, but the effects are not as satisfactory as the preceding.

Nitrate of Silver, a saturated solution applied with a brush freely, will give prompt relief; in fact it seems to be the most prompt of either of the three.

Carbonate of Soda, in the proportion of half a pound to the quart, is a remedy much used, and is very prompt in quieting pain and allaying the inflammation.

Whatever may be said of oil, flour, chalk, etc., in other degrees of burning, my experience has been that they are all useless if not hurtful in those of the first degree. The chief indication is to subdue pain, and the second to exclude the air; both can be fulfilled by either of the above methods.

2. Burns of the *second degree*, while an aggravation of the first, are frequently less serious and produce less constitutional disturbance. The causes are the same, but the heat has been longer applied, or is more intense. The epidermis is not only destroyed, but is detached from the deeper layers, and forms blisters filled with the disengaged serum. This escape of serum has much influence on the modification or prevention of visceral effusion, and the greater the extent and size, the greater the relief. When the surface is small, and the blisters well formed, it is a good rule to avoid destruction of them, as the fluid preserves the pliability of the dead tissues, and lessens the irritation of the deeper parts. In large blisters, however, which cover a large surface, it is proper to evacuate them partially at least, with a needle or fine trocar, and allow them to fill up again. When the part becomes dry and hard, it is no longer a protection, but an element of danger, and had better be removed, and the raw surface kept carefully excluded from the air. In many cases, however, where proper precaution has been had, the new skin will be found nearly formed when the dead parts are removed. The pain is to be allayed by the same measures given above.

3. Burns of the *third degree*, represent the maximum of such injuries to the integument. The parts are carbonized, and all function at once and forever destroyed. The prognosis depends upon the depth to which the charring extends, as far as integrity of the part is concerned, and the location and superficial extent in reference to promotion of life. The former, the depth of charing—may be told with some degree of certainty by observation of the pain. On making

pressure with the finger, should the whole substance of the skin be destroyed, there will be no increase of pain; if only partially so, the pain will be excessive, and much increased by pressure. This is accounted for by the extent of the lesion to the cutaneous nerves, which will give rise to exquisite suffering when but partially destroyed, but lose to some extent their sensitiveness when completely so. The part will be found dry, hard, glazed, and either yellow in color, or black. There will be an angry areola, at once established, fading off into the healthy skin; the margins of the eschar will be very painful and sensitive to pressure; and the constitutional disturbance severe. The complete destruction of the skin, must, as a matter of course, cause extensive visceral complications, and the more extensive the surface the greater the danger to life. It is said as a rough estimate, that when more than one-third of the surface of the trunk is involved in the burn, death is certain; when one-fourth, imminent. This is sufficiently accurate for all practical purposes, and experience seems to prove its truth almost unfailingly. At least I have never seen a case injured to the extent indicated that has recovered.

The dead tissue must first be removed before any serious attempt is made at repair, and indeed its presence exposes the sufferer continually to erysipelas, pyæmia, septicæmia, and other dangers. Instruments should not be used to effect this, as the blood vessels are occluded, and it is impossible to tell, at first, whether the loss of tissue will cease at the margins of the eschar or extend far beyond. Poultices must answer the purpose, however imperfectly, and at all events they will serve to keep the carbonized parts moist and pliable. There is no objection to linseed oil in these cases; it is an excellent lubricant. When the slough is loose, it must be removed, and the ulcer treated with *Calendula* as in the case of lacerated wounds. Suppuration will probably be profuse, and attention must be paid to maintaining its normal character; on the first indication of suppression, or pyæmic symptoms, give *Arsen.*, as laid down in another place. The pain must be treated as already laid down; probably the Carbonate of soda dressing will be found the most useful under the circumstances. It is a question in the minds of some, how far removal of the eschar would relieve visceral complications, if done at once, as soon as the limits of the burn and its effects can be defined. There is some authority for it, and it might be considered good surgery to do so when the eschar seems to be detached from deeper parts; under other circumstances, I dare not council it.

4. Burns of the *fourth degree*, represent a very serious accident, and one that admits of little hope of recovery when at all extensive.

Here we have the soft parts, integument, muscles, nerves, blood vessels, tendons, etc., completely destroyed, either carbonized entirely, or to a considerable depth. When the trunk or head are so injured, death may be confidently predicted; when an extremity, no matter in what portion of its continuity, the entire part is hopelessly lost from

an indefinite distance above the eschar throughout its whole extent downwards. A consideration of the condition of the organs of life in such grave injuries, will at once account for the loss of tissues below the point of injury. The blood vessels and nerves being destroyed nutrition and inervation are at once arrested below the point of injury, and the inflammatory action above, will have a tendency to cause the same trouble in that direction. If this were not so, in all cases, the bone itself, while not directly injured, soon takes on morbid action from arrested nutrition; and necrosis is almost inevitable. The constitutional symptoms are very severe, the shock most profound, and the visceral lesions are extensive and almost inevitable. It will not be necessary to go into the character and nature of these lesions, at this time, as it will receive more attention later. The indications to be fulfilled are few in number, and suggest themselves. The first, of course, is to quiet the pain and induce reaction. *Hypericum*, in any attenuation, given internally, will in most cases rapidly subdue the pain, and at the same time bring about reaction. In some instances it *may* be necessary to treat the shock directly, even to use stimulants, but it is now well established that chloroform has a powerful influence in such cases. The second indication, is to remove the injured part, when a limb — by early amputation. The point of election should be at least two inches, if possible, above the limits of the burn. If, however, the hæmorrhage should be small, indicating destruction of smaller vessels, a re-amputation, higher up, should be made. When the trunk is burned in this way, or the head — there is nothing to be done further than to moderate pain, as far as possible, and apply cooling lotions.

5. Burns of the *fifth degree*, from the nature of the accident, are almost uniformly fatal, unless confined to a very small member or spot. Here the whole of a part is completely destroyed, even to the bones; limbs burnt off or parts calcined. The fact that the heat must have been intense, and the sufferer long subjected to its influence, accounts for the fact that such cases usually die before any attempt at relief can have been made. When a finger or toe, or a small spot of the surface of the body has been so burnt, as may occur from molten metal — apart from the loss of the part injured, no further mischief may ensue; in larger injuries, however, the case may be at all times considered hopeless. The principles of treatment are the same as in the last degree, and need not detain us longer.

We have now to consider the causes, the symptoms, the cause of death, prognosis, and general treatment.

1. *Causes.*—Burns are produced by various forces, the effects of which are not, in all particulars, identical; if in no other respect there is a wide difference in the extent of the destruction of the parts implicated. Explosion of gases, gun-powder, or volatile fluids, are common causes, and are chiefly concerned in the production of burns of the first degree; the effects are more wide spread, but deeper parts are

not liable to be primarily affected. Sun heat must also be included in this category; when extreme, and the individual has been long exposed to its influences, the effects may be very severe. Next in frequency comes boiling liquids, which induce very extensive mischief, the gravity of the accident being in direct relation to the density of the substance; water will, therefore, produce less serious mischief, under similar circumstances, than oil. Inflammable boiling fluids, which explode, ignite, and are brought into contact with the body while boiling also, such as turpentine, varnish, etc., produce exceedingly grave injuries. Metals highly heated, or molten, are chiefly concerned in the production of burns of the third, fourth and fifth degree, but long exposure to any flame, of any kind, may be equally destructive. Spontaneous combustion is included in the list by many authors, but the evidences of such occurrence are so exceedingly meagre and contradictory, that I have excluded it altogether. It will be observed that the effects as to destruction of tissue are in a rising scale, from boiling liquids to melted metals, but the fatality of a burn has little relation to the nature of the agent inflicting the injury. In other words, as the specific gravity is greater, the mortality increases; as the specific gravity is less, the extent of surface involved increases.

While all molten metals produce great and considerable loss of tissue, for some reason, as yet unexplained, melted copper is generally considered to produce the most disastrous effects.

2. *Symptoms.*—It is convenient to consider the semiology of burns under three heads, as included in three stages, viz., stage of collapse, inflammation, and exhaustion. In the first, constitutional and local conditions and symptoms predominate in about an equal degree; in the second, the constitutional are the most prominent; in the last, local conditions predominate, but at a distance from the seat of injury.

(*a*). *The first stage*, stage of collapse, is characterized by shock, rather proportionate to the region injured than to the extent; thus the trunk being injured, particularly the abdomen—the shock will be greater than when in the extremities, unless the burn is of the fourth or fifth degree. The symptoms are similar to shock from other causes, with perhaps some modification due to the excessive pain. The pain is very severe, in all cases of burn, being a literal burning, with feeling of stiffness of the part. Later the sufferings are more intense, shooting along the nerves, and extorting cries. Primarily, in this stage, there is much distress from a feeling of heat; the blood seems on fire, and the thirst is often unquenchable. Later chilliness takes the place of heat, but the pulse remains quick, and the thirst continues. The duration of this stage is variable, from a few hours to twenty-four hours; perhaps the mean time will be six hours. In burns of slight severity, it may continue for only a few moments, and none of the usual symptoms be distinctly marked, the sufferings being entirely local.

(*b*). *The second stage*, or stage of inflammation, is sometimes called that of reaction, and is chiefly marked by high fever, and the commencement of some visceral lesion, with constitutional disturbance predominating over the local. In the majority of cases, unless the injury is inflicted on the heart or thorax — the gastro-intestinal tract is chiefly disturbed. There will be vomiting, usually quite obstinate, and frequently of bilious matter alone, with much nausea, and irritability of the stomach. Constipation will be the primary condition, but it will soon be succeeded by diarrhœa, often bloody and exhausting. The blood indicates intestinal ulceration, and the diarrhœa, increased activity of the intestinal glands. Many explanations have been offered of this phenomena, but it is still far from being perfectly satisfactory. The majority of those competent to form an opinion are inclined to the belief that the arrest of cutaneous action throw an increased amount of work on the viscera, and that Bruner's glands are particularly active. That this is reasonable, at least, it is sufficient to note that the ulceration is almost invariably in the duodenum. Certainly we must expect the sudden revulsion from the periphery which a burn necessarily causes, will greatly augment the action of other eliminators, and the frequency with which the duodenum is ulcerated sanctions the hypothesis that the glands of Bruner are chiefly concerned. Death frequently occurs in this stage, and not seldom from perforation of the duodenum. When the thorax or cranium are the seat of the injury, we may expect analogous conditions, encephalitis, effusion, or hæmorrhage; or capillary bronchitis, pneumonia, or pneumo-thorax. Having safely passed this stage is no guarantee that life will be preserved, unless there is a marked subsidence in the visceral excitement, and hæmorrhage cease entirely.

(*c*). The *third stage*, or that of exhaustion, is characterized by great prostration, and prominence of local symptoms, but not at the seat of injury necessarily. That is, the visceral lesions will become pronounced, and their importance and severity will obscure all other conditions. In cranial injuries symptoms of effusion, with compression of the brain; in the chest, similar conditions; and in the abdomen, various visceral lesions, will command the sole attention of the attendant. Recovery may ensue when there is a gradual and orderly subsidence of these symptoms, but their sudden disappearance will be ground for fears of a fatal result. This is particularly the case in diarrhœa, more especially if it be bloody. A case may appear to be on the high road to recovery, the stools assuming a normal character, and the general symptoms much improved. Suddenly there is a profuse bloody stool, and the patient rapidly sinks. The time which elapses before death, is exceedingly varied, from secondary conditions, from two days to two or even three months. It must not be understood that all such deaths are due to intestinal lesion; in fact out of 68 fatal cases recorded by HOLMES (II, 13), but four were referred to that cause. Patient's die suddenly, and the most careful examin-

ation and dissection will fail to find any lesion sufficient to account for the termination. It would seem that shock, particularly remote or secondary, might be considered the cause. In a table given by HOLMES (*l. c.*), the cause of death in 68 cases is given as follows:

Local Causes 34.	11.	Cerebral lesions.
	6.	Laryngitis.
	12.	Thoracic lesiions.
	4.	Abdominal.
	1.	Hæmorrhage from carotid.
General Causes 34.	9.	Shock.
	17.	Exhaustion.
	3.	Erysipelas.
	3.	Pyæmia.
	2.	Tetanus.

Enough has been said, however, to show that the subsidence of acute symptoms cannot be considered as evidence of safety, and that for at least three months, after the reception of a severe burn, the surgeon should carefully watch his patient.

3. *Causes of Death.*—From what has been written it cannot be a matter of much difficulty to comprehend these causes, and but little space need be occupied in the consideration of this part of our subject. The causes may be arranged under two heads, as above, and a bare enumeration should suffice.

(*a*). *Local Causes.*—Visceral lesions of all kinds. Ulceration of various tissues. Secondary bleeding on the separation of sloughs, or perforation of arteries by ulceration.

(*b*). *General Causes.*—Inflammation and swelling of important organs of life, interrupting function, *e. g.*, larynx, œsophagus, glottis, etc.

Erysipelas.
Pyæmia.
Septicæmia.
Tetanus.
Shock.
Exhaustion.

In the table given by HOLMES, above quoted, it will be observed that of the total of 68 cases, 40 succumbed from exhaustion and cerebral, and thoracic complications; the remainder, 28, were divided among 7 separate conditions. It will thus appear that the most frequent cause of death, apart from exhaustion (17), the suppression of cutaneous action was responsible for the larger number, or 23. The table is also of value, as showing that while but nine cases are recorded as succumbing to the primary effects of the burn, 59 died from secondary conditions. Under our improved therapeutics, which greatly reduces pain, facilitates repair, and modifies secondary effects, when we have accumulated sufficient data to tabulate, we should be able to show a larger percentage of recoveries than the tables at present available exhibit. I doubt not that with a thorough and accurate knowledge of the pathology of burns, we may even be enabled to show

that primary death is more frequent than secondary. I am free to admit, however, that our meagre statistics render this statement purely hypothetical.

4. *Prognosis.*—What has been said of causes of death, applies equally to this section. The consideration of the classification and semiology will enable any one to form a reasonable prognosis in a given case. The age, habits of life, locality of the burn, nature of the injury, extent of surface, extent of depth, the amount of prostration, and severity of shock, all modify the prognosis. As a general thing the whole matter may be summarized as follows: Having learned that secondary affections are the most fatal, we will conclude the prognosis is unfavorable in proportion to the extent of superficial surface involved. As primary conditions, the depth of tissue burnt, as in the fourth and fifth degree — will render prognosis bad in proportion to extent. The very young, and aged; those enfeebled in any way; and those of intemperate habits, will naturally succumb more readily, than their opposites. Added to what has already been written, this summary should enable the surgeon to form a prognosis with some degree of certainty.

5. *Treatment in General.*—In the treatment of burns, the first thing to be done is to allay pain, and treat shock, as already given—and base further attempts to save limb or life, on the condition of the patient. That is, when the injury is of such a nature that death seems inevitable, it would be unnecessary, and perhaps subject the patient to useless annoyance, to attempt anything further than a mere mitigation of suffering. Supposing a case that is promising, the treatment would be conducted on the following principles:

After selecting the suitable remedy, and removing all dead tissue that is detached, if no necessity for amputation exists, soak *small* pieces of lint, or absorbent cotton in the proper remedy, and apply them to the whole of the burnt surface, one piece slightly overlapping the other, so as to "break joints." Envelop the whole part in cotton, and hold it in place by a few turns of a roller bandage, *lightly applied.* Supposing the hand or foot to be the part injured, each finger and toe must be separately dressed; indeed two raw or burned surfaces must never be left in contact, to avoid union taking place between them. This is a point of the very highest importance, and a failure to attend to it, will indicate want of knowledge and skill in the surgeon. As often as the dressings become dry, they should be moistened, without removing them, thus the latter should never be removed, unless too tightly applied and causing suffering—for twenty-four or thirty-six hours. At the expiration of that time, they *may* be removed, if it seems best, but only piecemeal; that is, remove a small portion of the cotton, and a single piece of the lint, replacing it by fresh dressings before removing another piece. In this way but a small portion of the raw surface is exposed to the air at once, and the cure thereby much facilitated. As soon as repair is fairly inaugurated

and the discharges have become laudable, substitute *Calendula* for the specific remedy, both internally and externally. It must not be forgotten that as the dead tissues becomes loosened they must be removed. When all discharges have ceased, remove all dressings, and simply keep the parts *lightly* covered, to protect the new and tender integument from injury.

The surroundings must be as pleasant as possible; the apartments well ventilated, and the comfort of the patient consulted in every way. The diet should be nourishing, but not stiumulating, and all disturbing influences, both mental and physical, avoided. Complications, as they arise, must be met by appropriate treatment, as laid down in another place, (*Surg. Therap.*). Thus, cerebral lesions, *Apis*, *Hell.*, *Bell.* Abdominal, *Arsen.*, *Phos.* Erysipelas, give a preference to *Rhus* or *Bell.* Pyæmia, *Arsen.* Septicæmia, *Arsen.* or *Carbo v.* Tetanus, *Hyperic.*, *Bell.*, *Stram.*, *Nux v.*, or *Led. pal.* By attention to these items, I am confident our cases will terminate more favorably than is the case generally under other methods of treatment. In short, treat the symptoms as they arise, precisely as we would treat similar symptoms of non-traumatic origin. Remembering the chief indications, subdue pain, remove shock, promote detachment of slough, prevent adhesion of raw surfaces, promote cicatrization, and modify consecutive complications, ordinary medical skill and common sense should enable us to conduct a curable case to a successful termination.

The point of chief surgical interest under this head, is the process of cicatrization. For some reason, scarring is apt to be a source of much future disfigurement, even cause a loss of function. This is particularly the case when the injury is sustained chiefly by the skin, and more especially when the whole substance of this tissue is not involved. The peculiar tendency to contraction observed in all cases, is particularly troublesome in the case of burns, and bones have been dislocated frequently, even such joints as the knee, elbow and shoulder. Attention to the methods of treatment given, will remove some of this danger, but under the most favorable circumstances it will give more or less trouble. The treatment of such conditions is purely surgical, and is fully laid down in the article on *Wounds*. In the *Am. Hom. Observer* (XIV, 295) PROF. W. TOD HELMUTH, relates a very interesting case of an extensive web-cicatrix of the elbow, from a burn, which was successfully treated by him, by means of repeated dissections, loosening of deep attachments, etc., which will well repay perusal. Other cases are found in our text-books and journals, and as such cases are rarely urgent, the surgeon should carefully read up the subject before deciding on methods. When dislocation of *long* standing exists, I am of the opinion the case had better be left alone; but to wait for the cessation of contraction before instituting measures for relief would be worse than useless, as contraction goes on indefinitely.

COLD.

The effects of intense cold applied to the living tissues, are strikingly similar to those from heat, but can never be of the same intensity for obvious reasons. It is a well established fact in physics, that two bodies of unequal temperature, when brought into close relation, have a tendency to equalization of temperature, the warmer body giving up some of its heat to the colder. The effects observed following a burn, are due to the rapid passage of heat from the foreign body into the colder tissues, raising the local bodily temperature far above the normal standard, but can never produce a perfect equilibrium, as combustion succeeds when the temperature is raised beyond a certain point, and the part becomes completely destroyed. In the case of cold, the conditions are reversed, but the process is, to a certain extent identical, viz., *sudden* passage of heat from the warmer tissues, to the colder foreign body. As the lowering of vital temperature below a certain point will be followed by death of the tissues, while no *combustion* occurs, yet an equal amount of devitalization will ensue, the local effects, as far as the integrity of tissue is concerned—are exactly similar to burns. The cause being the rapid passage of heat, to or from the body, it can at once be seen that the conditions are almost exactly similar, except, that more heat can be taken up, by at least four degrees, than can be lost. The tissue-loss, therefore, is somewhat less from cold than from heat, and revitalization is also more probable. We find, in support of this theory, that frostbite may be classed under at least four heads, and it is not improbable that the same classification, into five degrees, may be applied as was done in the case of burns. It will be unnecessary, however, to enter into the discussion of this subject at the same length, as in the last instance, it being sufficient to call attention to the similarity of the conditions, *e. g.*, simple inflammation, blistering of the skin, complete destruction of the skin, destruction of skin and soft parts, and possibly complete loss of the whole part.

The effects of extreme cold can be considered under two heads, viz., primary and secondary; the former being technically known as *frost-bite*, the latter *chilblains* or *pernio*. While all parts of the body are liable to injury in this manner, those of naturally low vascularity, or that are compressed by the clothing, are more frequently affected, at least primarily so. Thus heel, ears, tip of the nose, instep, sole of the foot, and toes and fingers are first attacked, and about in the order named.

1. *Frost-bite.*—The local effects of freezing applications vary somewhat with the nature of the agent employed, with the degree of cold, and the suddenness of the abstraction of heat. When cold exerts its influence gradually, the primary effects are stimulating, calling an increased amount of blood to the surface, which is reddened and somewhat warmer. As secondary effects, the parts turn white, the temper-

ature is lowered, the blood recedes, and the vitality of the part is lost. The sensitiveness of the part is increased in the first stage, passing over into a state of more or less anæsthesia, with an intermediate stage of pricking and numbness.

When extreme cold is suddenly applied to living parts, and *kept* in contact, the symptoms are strikingly different. The part assumes a mottled appearance, due to the congelation of the blood in the capillaries, the devitalization is more complete than in the last instance and there is greater probability that the vitality cannot be restored.

We found that scalds were more severe than burns, that is produced more extensive injury, and we now find that the same rule applies in the present instance. Moist cold produces more extensive and speedy destruction than dry. Thus it was found in Napoleon's Russian campaign, soldiers who were standing inactive in the snow for many hours, at the battle of Eylau, did not present many instances of frost-bite, notwithstanding the cold was intense. In the night, however, the temperature was suddenly elevated, and a rain came on, when great numbers were soon taken to the hospital, suffering from extensive frost bite. The same effects were observed in the Crimean war, as well as in our own late war. One common cause of frost bite in army life has always been the habit of sleeping in wet boots, which the exigencies of service renders almost impossible of avoidance.

In army practice, and also among the lower classes in civil life, those particularly who are ill-fed and housed—the gangrene from frost bite is exceedingly malignant, no instrumental interference being tolerated. MACLEOD alludes to cases in which mere shreds of fascia could not be divided with scissors, even under the influence of Chloroform, without exciting the most violent inflammation, and rapid extension of the gangrene. All instrumental interference was positively prohibited, and all cases treated on a purely expectant plan. This, while frequently the case in civil practice, is not quite so marked, and the practice of early removal of hopelessly dead parts has received the sanction of most of our experienced surgeons.

The symptoms of frost-bite, when a limb is attacked, are about as follows: The part is first painful, and feels heavy; there is a pricking sensation, and at the same time the patient complains of numbness. Later the sensibility is completely lost, and on examination it will be found swollen, darker in color, and hard. As the process continues, the integument becomes white, snowy almost—and in some cases the limit of the freezing is indicated by a red or purple areola. The mental sphere does not remain undisturbed; as the circulation in the periphery is suppressed, the mind becomes dull, and an almost ungovernable drowsiness succeeds. If the victim yields to this, and drops in the snow, life soon becomes extinct. If shelter is reached before succumbing to this influence, the frozen parts soon take on a gangrenous condition, particularly if artificial warmth is applied. The condition of apnœa, or asphyxia, from cold will be considered in

the next chapter, and need not detain us here; we are at present chiefly concerned in the local conditions. If the case should be left to nature, the frozen parts will ultimately become detached, and new tissue will be very imperfectly developed, at all events it will be of exceeding sensitivness, and probably operative surgery will be required to render life endurable.

Treatment.—As said above all direct application of heat must be avoided. If this precaution is neglected the parts will rapidly mortify, and their loss is assured. If the weather is not too severe the treatment had better be conducted in the open air; otherwise an unheated room or shed is to be preferred. The clothing must be at once removed, cutting them off is best—and the frozen parts briskly rubbed with snow, or if that cannot be procured, with cold water. This must be kept up until the parts become pliable and slightly reddened. As soon as warmth returns, the parts must be carefully dried, all wet clothing removed and dry substituted, and the patient put to bed. The pain on reaction is often very intense, and may be met and alleviated by *Arsenicum*, or *Carbo veg.*, if this fails. It will much assist the reaction if strong black coffee be administered, without milk or sugar.

Should full reaction come on, and yet the parts remain hard and cold, it may be concluded that the devitalization is complete and permanent, and the question of amputation must be considered. In military surgery, it has been said above, this must never be done. In ordinary civil practice, when reaction is complete above the line of gangrene, the bodily powers are intact, and the age of the patient will not cause suspicion of arterial degeneration, early amputation is to be preferred for several patent reasons. In the first place, the process of sloughing will rarely leave a good stump, either in shape or other important particulars. The bone is nearly always separated too long, leaving either an insufficient covering of soft parts, or necessitating their production by granulation. The granulating process can only be accomplished at the expense of great vital effort, and will require, in the case of large stumps—weeks or even months. The process of elimination of the dead tissues is also very prolonged, keeping the patient in constant jeopardy, and under the most favorable circumstances making serious drafts on the powers of nature. Among other considerations it must not be forgotten to include the excessive tenderness of the stump when made by nature; a tenderness that renders the application of an artificial limb almost impossible. In fact, for these and even other reasons, early amputation is to be commended on the score of humanity, the formation of a proper stump, by secondary amputation being demanded in ninety-nine cases out of a hundred.

2. *Chilblains.*—As a secondary effect of slight frost bite, particularly in cases in which the parts have been restored to life—we frequently meet a sort of chronic inflammation, with intermittent irritation of

the cutaneous nerves, called *pernio* or *chilblains*. The parts are reddened during a paroxysm, smooth, and very sensitive to pressure or friction. The heel, sole of the foot, metatarsal joint of the little toe, ears, and tip of the nose are the chosen seats, but all parts of the body are exceptionally so affected. There is rarely any solution of continuity in the skin, though there are cases in which erosion or even ulceration occurs. In the majority of cases, however, the symptoms will be mainly subjective, itching, burning, or stinging—chiefly when warm moist weather succeeds cold, but in some instances mainly in the summer, or in wet warm weather at any time of the year. In the majority of instances a single attack, or at most one during the season, will begin and end the whole trouble, but occasionally the affection will become chronic, and seriously annoy and harass the sufferer.

Treatment.—In acute cases, the continued application of snow, with friction, will usually effectually remove the trouble, but when it fails, or the condition becomes chronic, recourse must be had to more effectual remedies.

Silicea, is particularly indicated when there is erosion or ulceration.

Agaricus musc., when warm damp weather, succeeding a "cold snap" brings on an attack.

Antimonium crud., when the parts are glazed, smooth in appearance, hard, and a tendency to minute corns.

Fragaria vesca, when warm weather, at any time of year, bring on the sufferings.

Pulsatilla, under similar circumstances, when the itching is intense, and is relieved by cold applications.

Apis, in acute cases, when there is some œdema, and much biting-stinging.

Rhus tox., when there is much vesicular inflammation, with corrosive smarting or itching.

Arsenic, is valuable in those rare cases, in which the parts are burning (internally), bluish or livid in color, great œdema, and better from warm applications.

Sulphur, will be useful in chronic cases, in which cold applications, (particularly water) are intolerable, and the surrounding parts are the seat of an annoying formication.

There will usually be little difficulty in effecting a cure with one of these remedies, but I have found *Pulsatilla* and *Agaricus* more frequently useful; indeed the latter is often given empirically. It is particularly useful in the tenderness of the natural stump after gangrene from frost bite.

IX. ASPHYXIA. (APNŒA).

ASPHYXIA is a term that refers, etymologically, to a condition "without pulse," and is used to indicate a state of apparent death. From the fact that recent observations have shown that there may be a continuance of heart's action for some moments after cessation of respiration, and that the latter is the more important, if possible, of the two functions, HARLEY (HOLMES, V., 887) proposes the word *Apnœa*, as indicating a condition "without breath." There can be no question that the latter is the better term, from any point of view; but it seems unnecessary to attempt changes in our nomenclature without making it general, and asphyxia is not a whit more illogical and incorrect than many other words that are retained unquestioned. We shall continue, therefore, to use the commonly understood term asphyxia, chiefly because it *is* in general use.

Asphyxia is a condition of suspended life, and *apparent* death—from some impediment to respiration, either through the exclusion of air entirely, or the presence of non-respirable air, as gases of various kinds; either an absence of oxygen, or incapacity to breathe from other causes, as strangulation. The *causes* are various, and HARLEY, (*l. c.*) tabulates them as follows:

1. Mechanical. { (*a*). Accident. { External. / Internal. } / (*b*.) Disease. { External. / Internal. }
2. Absence of oxygen.
3. Inhalation of toxic gases; chemical effect, also, the same.

As far as re-establishment of respiration is concerned, it is a matter of little importance what the cause may be, as the procedure is about the same in all cases; but to prevent recurrence, remove conditions that may induce a relapse, and, in a word, cure your patient, the causes must be carefully investigated and well understood. The diagnosis is not at all times easy, as patients or their friends will often deceive, intentionally or otherwise. A case is related in which a prominent clergyman was found hanging by the neck, in a nearly asphyxiated condition, cut down by his family, and a surgeon summoned. To avoid the scandal attaching to an attempt at suicide, the attendants allowed the surgeon to suppose he had a case of apoplexy to deal with, the symptoms being so similar, and thus placed their relative in imminent danger of losing his life. Under such circumstances, the most competent practitioner may be deceived, but when no attempt at concealment is made, the difficulties are readily overcome.

Inasmuch as cases of this nature, which terminate fatally, are liable to give rise to legal proceedings, it is necessary that the surgeon should be well acquainted with the ordinary post-mortem signs of apnœa, as well as the symptoms of such accident. Before taking up that branch of our subject, let me give a brief account of the process of respiration, in order to show definitely why the heart's action is a poor and misleading guide in forming a prognosis. To some extent reference may be had to the chapter on *Anœthesia*, but there are some features of special interest that were not touched upon at that time. It is well known that the action of the heart and lungs is in the proportion of one to four, but not exactly so; that is, there is a want of perfect synchronism, respiration not being quite one to four, although the interval is exceedingly small. This is supposed to be due to the character of the nerve supply, the lungs being mainly under the control of the cerebro-spinal axis, and the heart under that of the sympathetic. In the majority of instances, death commences in the vegetative sphere, and through cerebral or spinal influences, and the lungs will show this failure of voluntary action first; the chief indication will be a synchronic action with that of the heart, the proportion of one to four being almost perfect. Inasmuch as the heart's action is continued from an irritative condition, through the sympathetic, there may be a continuance of action for some moments after respiration has ceased, and the patient to all intents and purposes dead. From the fact, however, that a few fibres of the sympathetic are distributed to the lungs, and a few of the vagus to the heart, the lungs may partially act through the sympathetic alone, for a short time after cerebral paralysis, and account for the synchronism, as both functions are then under the same nervous action. The irritability of the heart will continue long after death, as experiments are too common to need repetition; even the stimulus of a proper menstrum, after removal from the body, will cause contraction to continue indefinitely. Those who have never made the experiment cannot conceive for what a brief time the respiration can be voluntarily suspended; a minute is the limit of endurance with most persons, and two minutes, I think, is the longest time on record. The continuance of heart's action, therefore, can be no criterion, as establishing the continuance of life, and we must turn all our attention to the respiratory function. The rule is that when ten minutes have elapsed since the last respiration, death may be considered certain, and all attempts at resuscitation hopeless, no matter how much cardiac action may be excited. The stories we read, therefore, of resuscitation after half an hour's immersion, are purely fallacious, and unworthy of belief. The prognosis will, therefore, be dependent upon the length of time respiration has been suspended, and after ten minutes no attempt need be made to restore vitality. Synchronic action of the heart and lungs will also be a very unfavorable sign, but as long as there is the slightest respiratory effort there is hope of life.

We will find that an analysis of the causes given by HARLEY, will not involve many considerations, the fact that from any cause oxygen is not respired being sufficient to account for the condition. Thus under the *mechanical*, (1), head, we will find any mechanical impediment to breathing, as (*a*) constriction of a rope, the hands, the face being held in mud, plaster, etc., or the lodgement of foreign bodies in the glottis, larynx, or trachea, or even compression on these parts from large foreign bodies in the œsophagus: (*b*), From morbid action, as œdema of the glottis; growth of tumors external or internal; very greatly enlarged thymus or thyroid glands; or any other morbid action that would impede the entrance of air: *Absence of oxygen* (2), is an indication met when the sufferer is placed in a position where pure air cannot be obtained; as in an air tight enclosure, where the air is soon exhausted: *Toxic gases* (3), are scarcely to be considered as acting purely by depriving the individual of oxygen, as there is usually some chemical or specific influence that would alone destroy life. Under this head, we find the vapor of Chloroform, or other anæsthetic agents; carbonic acid gas, sulphuretted hydrogen, and other irrespirable gases. These agencies, however, will receive further attention later, and do not require more extended notice at this time.

The *symptoms* of apnœa no, matter what the cause may be, differ but little in different cases, the chief point of dissimilarity being the rapidity with which the asphyxia comes on. We will consider them under two heads, chiefly from their importance in a medico-legal aspect.

Ante-mortem.—There will be a fullness in the *head*, with giddiness, ringing or roaring in the ears, and flashes of light. Sometimes there is a sensation of a bright red glare, or flaming, but oftener simple flashing. Dreams of an exceedingly vivid character, every circumstance minutely detailed—followed by coma, and sometimes general convulsions. In one case under my care, he expressed himself, after resuscitation, as fully conscious of his peril, but the sensations were so delightful that he was disinclined to make any effort to escape. The *chest* feels full and compressed, as if the lungs were filled to their utmost capacity, with no power to expel the air. The *heart* is first greatly accelerated, from the struggle for air, then slower and labored, becoming somewhat irregular, later a mere irritative tremulousness, and then ceasing entirely. After the cessation of respiration, the heart continues to beat for from two to four minutes. The *face* has an anxious expression, eyes protruding, and staring, and the lips blue, and usually covered with a sanguinolent frothy mucous. Before death, varying somewhat with the cause, the face will assume a placid expression, but will remain swollen, and more or less discolored. The *sphincters* will all be more or less relaxed, with involuntary urinary or fæcal discharges, and in some instances seminal emissions, with or without erection. This last symptom depends greatly upon the cause; when death has been preceded by much

spinal irritation, as in hanging with dislocation of the neck, it is more common than under other circumstances.

Post-mortem.—(*External*). The lips are blue, and covered with mucus; the face much swollen, and more or less discolored. The eyes half open, showing a widely dilated pupil. The same appearances are observed in death from apoplexia, or epilepsy, and must not be too much considered. They are simply confirmatory when taken in connection with other indications. The *tongue* will usually be swollen, and frequently marked with the teeth, and may even be bitten, as in the case of epilepsy. The *countenance* is usually placid, and no evidence of previous pain will be discovered. The *surface* of the body, is generally pale, but if death has been rapid may be discolored in spots. Strict attention should be paid to any marks about the body that might throw light upon the cause of death, as finger marks on the throat, dislocations of the tracheal cartilages, or of the vertebræ of the neck; fracture of the thyroid bone, and the like. Much may likewise be told of the time when injury was inflicted, *i. e.*, before death, or after, and to some extent how long before death when the former. Thus it has occurred that the bodies of the murdered have been placed in positions to simulate suicide, or, on the other hand, dead bodies have been marked in attempts to remove them or to restore life. It will be necessary to refer to works on medical jurisprudence to acquire a detailed description of these conditions, but we may note here these points of value. 1. When injuries are inflicted some time before death, as by strangulation, the injured parts are swollen and prominent; the mark of the rope being a welt or ridge, more or less discolored. 2. When continued until life is extinct, a depression will remain, more or less discolored, and, in the case of hanging, the mark of the rope will be distinctly visible, the groove having a seared or glazed appearance. In time, perhaps, from two to ten hours, the groove will disappear, but the seared appearance will remain. 3. Such injuries inflicted after death, will either exhibit a simple groove, or imprint of the fingers, as is seen in œdema, which soon fades out, leaving either no trace, or a white and blanched appearance. *Rigor mortis*, in all cases, occurs early, and is quite marked and long lasting.

(*Internal.*)—On examining the *muscles*, the evidences of asphyxia will, in most cases, be very negative and unsatisfactory. Usually they will appear normal in color, but when carbonic acid gas has been the agent inducing death, they will be a bright red; on the other hand, in the case of sulphuretted hydrogen, they will be dirty black. Apart from these two indications I know of nothing definite in regard to muscular appearances. The *brain* will either be anæmic, or exhibiting much *venous* congestion. When the sufferer has died in an erect position, or with the head high, unless hung or garroted—there will always be a marked anæmia. When the head has been low, there may be anæmia coming on after a time, but first there will be

venous congestion. This last applies, also, to cases of hanging, or death from any cause that would induce venous obstruction. The *blood* will be found usually fluid, the veins, right heart, and viscera engorged, and the left heart either flaccid or filled with fluid dark venous blood. Venous stasis, however, is the particular feature in apnœa. The *lungs*, in cases of drowning, will contain more or less water and particles of floating substances, such as weeds, etc., under other circumstances they will simply exhibit venous congestion. It was long debated whether water entered the lungs or not, in drowning, and the frequency with which no water was found at post-mortem examinations seemed to throw some doubt on the contrary teaching. It is now known, however, that water is taken in freely and as long as respiration continues is rapidly absorbed. The absence of water simply shows that life was greatly prolonged, and the presence of small floating particles conclusively shows that it had been present. Experiments made in England, however, conclusively settles the question, as when a dog was purposely drowned in plaster of Paris (HOLMES, V., 885) minute particles were found all through the lungs, and even the smallest bronchii. A guinea pig, asphyxiated in mercury, was found to have the air tubes filled with the globules of the metal. The mere presence of water will not destroy life; it is the absence of oxygen. In experiments made it has been shown that the lungs can be literally washed out, by a continuous stream of water, and as long as air is admitted, not only will life continue but there will be very little inconvenience.

Before proceeding to give the special treatment in particular forms of asphyxia, I will allude to methods of resuscitation applicable in all. Some writers, particularly in our school, recommend the use of certain remedies in certain cases. It will be sufficient to note that as all the functions of life are in abeyance, there can be no absorption of medicinal agents until vitality is restored, to some extent at least. The first thing to be attempted is to excite respiration, and for this purpose we have a choice of several methods. That which has been in use the longest, and has given, I think the best results, is that of MARSHALL HALL. His method is as follows:

"1. TREAT the patient *instantly on the spot*, in the *open air*, freely exposing the face, neck, and chest to the breeze, except in severe weather.

"2. In order to *clear the throat*, place the patient gently on the face, with one wrist under the forehead, that all fluid, and the tongue itself, may fall forward, and leave the entrance into the windpipe free.

"3. *To excite respiration*, turn the patient slightly on his side, and apply some irritating or stimulating agent to the nostrils, as *Amyl nitrite*, *dilute Ammonia*, etc.

"4. Make the face warm by brisk friction; then dash cold water upon it.

"5. If not successful, lose no time; but, *to imitate respiration*, place

the patient on his face, and turn the body gently, but completely *on the side, and a little beyond;* then again on the face, and so on, alternately. Repeat these movements deliberately, and perseveringly, *fifteen times only* in a minute. (When the patient lies on the thorax, this cavity is *compressed* by the weight of the body, and *ex*piration takes place. When he is turned on the side, this pressure is removed, and *in*spiration occurs.)

"6. When the prone position is resumed, make a uniform and efficient pressure *along the spine*, removing the pressure immediately, before rotation on the side. (The pressure augments the *ex*piration; the rotation commences *in*spiration.) Continue these measures.

"7. Rub the limbs *upward*, with *firm pressure* and with *energy*. (The object being to aid the return of venous blood to the heart.)

"8. Substitute for the patient's wet clothing, if possible, such other covering as can be instantly procured, each bystander supplying a coat or cloak, etc. Meantime, and from time to time, *to excite inspiration*, let the surface of the body be *slapped* briskly with the hand.

"9. Rub the body briskly till it is dry and warm, then dash *cold* water upon it, and repeat the rubbing.

"AVOID the immediate removal of the patient, as it involves a *dangerous loss of time* — also, the use of bellows, or any *forcing* instrument; also, the *warm bath*, and *all rough treatment.*"

Another method, in common use in cases of "still birth," and in some instances quite successful, is alternately raising the body into a sitting posture, and then replacing it at full length, on the back; occasionally turning it on the sides and a little beyond, and back again. The movement must be made about fifteen times to the minute, and persisted in for at least ten minutes.

A method in use by the London Humane Society, and to some extent in this country also, is known as *Silvester's method.* The body is placed on the back, with the head and shoulders elevated, so that the thorax is made prominent. To imitate *inspiration* the arms are to be carried upward above the head, at full length, until the elbows nearly or quite touch; the motion is made slowly. This is found to admit air into the lungs in quantities varying from 9 to 44 cubic inches. It is essential, of course, that the mouth and fauces should be cleared of all foreign material, etc. To imitate *expiration*, the arms are replaced by the side, and pressure made on the thorax to expel the air. The expired air is usually somewhat less in amount than that inspired. These motions must be made at the rate of fifteen to the minute, steadily and continuously, to imitate as closely as possible the normal act of respiration.

Inflation *through the mouth*, by the "mouth to mouth" method, or the use of a conductor, has been used to some extent from time immemorial, and has occasionally done good service. While doubting, somewhat, its value when continued for any length of time, there can

be no question that it may be valuable in the commencement of treatment, to fully expand the lungs, and commence the process of respiration. The chief difficulty has been to prevent the entrance of air into the œsophagus; this is overcome by making moderate pressure backwards on the trachea, thus closing the œsophagus, and at the same time giving a more direct entrance to the glottis.

PROFESSOR PACINI has had much success in the following: "The asphyxiated person is placed horizontally on a bed or table; the operator, standing with the head against his own belly, takes hold of the patient's shoulders, by applying the thumbs on the heads of the humori, and the four fingers behind and close to the arm-pits. He then pulls the shoulders toward him, and lifts them in a perpendicular direction, this admits the entrance of air, and on relaxing the traction, expiration occurs.

DR. BAIN has a method very similar, except that the traction is horizontal entirely.

It will be observed that *all* of these methods have two objects in view, and perhaps one will be as efficacious as the other, viz., to imitate the alternate expansion and contraction of the chest, in the natural rythm of respiration—facilitate the entrance of air through the mouth and air tubes, and handle the "vital spark" *with great gentleness.*

It must not be forgotten to examine very carefully for the cause, as not a few cases occur of impaction of food in the œsophagus, and a suspension of respiration by mechanical occlusion of the air passages.

When respiration is partially restored, we may much hasten its full establishment by applying *Amyl nitrite* to the nostrils, or some similar agent. Even *Ammonia* has proved serviceable. Treatment, at this stage, as in chloroform narcosis is valuable. For instance, traction on the tongue, or passing the finger into the œsophagus. As soon as the functions of life commence to be active, full reaction can be facilitated by the employment of the appropriate remedies, as given below. In all cases, I think, moderately brisk friction, without force or roughness, had better be employed, and continued until the *rigor mortis* disappears entirely. Wet or frozen clothing is always to be removed, and upon reaction coming on put on dry clothing or cover with proper bedding.

We will now consider, in order, some of the commoner forms of asphyxia, and such special indications for treatment as may arise in each case.

1. *Newly born* infants are occasionally asphyxiated, either from the moment of birth, or coming on after one or two respiratory acts. When the cord is found twisted around the neck, freeing it from this constriction will often prove all sufficient. Occasionally it will be from compression of the funis in the parturient strait, and life may be hopelessly lost. Any of the methods above enumerated may be practiced, commencing them, I think, with artificial inflation of the

lungs. Placing them in an electric bath, in which the positive electrode is placed at the head of the vessel or bath tub, and the negative at the foot, attached to the "induced" posts in the battery — may be used. The current must not be too strong, in fact should be barely perceptible, and they should not be allowed to remain immersed more than a moment or two.

2. *Noxious gases*, affect asphyxia in various ways. Thus nitrogen and hydrogen, whilst forming large elements in atmospheric air, are not respirable, or capable of supporting life. Each of them are diluents of oxygen, and will not only take up this gas from the air cells in the lungs, but even abstract it from the blood itself. Some of them, as carbonic acid gas, and sulphuretted hydrogen, have a distinct and specific toxical influence, and the loss of oxygen is much aggravated by this poisonous action. The first indication is to remove the individual from the influence of the gas, into the fresh air, and then to restore the respiration as above. Arsenicated hydrogen acts so rapidly, causing death "quicker than if the windpipe were tied" (HARLEY), that any attempt at resuscitation must almost necessarily fail. There is little hope of neutralizing these agents, as in the case of poisoning generally, and the oxygen contained in ordinary atmospheric air is barely sufficient to make artificial respiration alone successful. It would seem that pure oxygen might be very useful, but the impossibility of securing it when needed, will make it a remedy to be "wished for but impossible to obtain."

3. *Strangulation*, from hanging, "garroting," impaction of foreign material in the œsophagus or wind passages, etc., first demands removal of the causes. All constriction of clothing, and the like, must be removed, and respiration established as above. *Opium* has been recommended, in such cases, probably on purely theoretical grounds, and certainly should be useful in relieving the cerebral congestion. Faradaism is credited with doing some wonderful things in resuscitation from hanging, and an interesting case can be found in *The Medical Investigator*, (VIII. p. 145), occurring in Missouri, in which a measure of success was attained, but further experiment was stopped by the sheriff. In this case the eyes followed persons about the room, and there was some feeble respiratory effort and cardiac action.

4. *Drowning* furnishes the larger number of cases of asphyxia, and is sufficiently noticed in other places. It may be considered the typical form. The nausea attending resuscitation is extreme, and may be controlled by *Ipecac.* According to HERING and others, *Lach.* and *Solan. mam.*, have a decided effect in restoring vitality, but can only be given, with any hope of success, when respiration is partially re-established.

5. *Frost-bitten* asphyxia is a peculiarly difficult condition to manage, as in addition to the suspended respiration, we have a serious lesion at the centres of life, with coagulation of the blood in the periphery.

The first thing to be done is to remove the patient to an unheated room, or, if the cold is not too severe, treat him in the open air. Remove all the clothing, and place the body on a table, or in such a position that the melted snow may run off freely. The body may then be covered with snow to the depth of an inch or more, leaving the face uncovered. If snow cannot be had, cloths wrung out in cold water may be applied, or the body briskly rubbed with snow or the wet hand. This is to be continued until the stiffened parts become pliable, and there is some redness of the surface. Friction must be kept up with vigor, and some one of the methods above enumerated employed to restore respiration. The return to consciousness must be aided by the administration of small quantities of strong black coffee, without milk, and the excessive pain complained of met with *Carbo veg.* or *Arsen.* When the surface becomes warm, respiration restored, and consciousness returns, warm clothing must be put on, and the patient put to bed. For twenty-four hours all application of heat, or admission into a heated room had better be avoided, but after that time, if there are no untoward symptoms, the usual habits of life may be fully resumed. The extremities must be closely watched, as gangrene may invade them, and we must expect to have many troublesome sequelæ, particularly chilblains.

This includes all the varieties of asphyxia usually presented. There is a somewhat analogous condition, though not strictly asphyxia—that cannot well be included under another head, and must be noticed however briefly. I allude to the effects of *lightning.* It would seem that in no sense can this be considered as an agent inducing asphyxia, but as in many cases there is a simple suspension of life, without any visible lesion, it may be considered somewhat related to our topic.

The effects of lightning are various, and as far as my information goes cannot be fully explained. I have seen a number of such accidents, and in no two cases were the conditions even similar. In one, part, or even the whole body, will be found burnt to a crisp; in another the clothing will be stripped off, and no mark will be discoverable on the surface of the body; in others the skin will be blistered; again the bones will be broken in one or more fragments; and in still others, a red mark, like a patch of erythema will show the point of entrance or contact. In many instances single organs will suffer, as the eye, ear, or the organ of speech; and in the large majority there will only be a momentary shock, which passes away without leaving any unpleasant sequelæ.

I have seen one case in which many of these conditions were present; the hand burned to a cinder, the bones of the skull comminuted, and an erythematous patch on the thorax. Cases are mentioned by many authorities of a peculiar photographic reproduction of surrounding objects, as trees, houses, etc.—on the body of persons struck. No explanation can be offered of this occurrence, but it is too well

authenticated to doubt. In a few words the symptoms of lightning stroke, as far as physical effects are concerned, are as various almost as the number of cases; the subjective symptoms vary from a momentary insensibility, to coma, or syncope, or profound unconsciousness, lasting, in one case (HOLMES' II, p. 29), one hour and a quarter. The immediate cause of death seems to be a paralysis of the nerve centres, particularly the cerebro-spinal axis, and, in cases with cardiac dilatation, rupture of this organ. In the majority of instances lightning passes into and through the body without explosion, but it has been observed that when it is induced, that is attracted from a conductor to the body, or passes over through a break in the conducting medium, as a joint in a lightning rod, there is a sensible explosion, and the disorganizing effects are greater. Death is probably painless and most cases will exhibit no change of feature, even retain the position they were in when struck — and no evidence or expression of pain will be observed.

In a case of suspended animation from this cause, the most efficacious *treatment* has been found to be dashing cold water in the face; or burying the body in the ground, with the face exposed and turned towards the sun. Resuscitation is frequently followed by some mental or physical defect, that if not permanent is at all events long-lasting. Loss of the hair, cataract, deafness, aphasia, paraplegia, etc., are common. I have never succeeded in restoring life in these cases, but have seen many fatal accidents, at sea and on land. Many have been "shocked" but recovered without treatment. The burns resulting from this cause, have been exceedingly painful and obstinate in healing, but as far as objective symptoms are concerned do not differ from burns from other causes.

X. INJURIES OF BLOOD VESSELS.

The most important, and indeed the only accident that is likely to befall the blood vessels, is wounding, or in some way sustaining a lesion of the walls, establishing hæmorrhage. It is true that morbid processes may exercise pressure and interrupt the circulation in a part, but in the large majority of instances such occurrences will produce trifling derangements, and even escape recognition, unless the vessel is a large one, and the compression has been established speedily. We have elsewhere(*Surg. Therap.*) shown how arteries and veins accommodate themselves to slowly growing tumors, either by an alteration in their course, or the tumor growing around them; at other times collateral circulation is established without attracting attention, and unless the growth is exceedingly rapid, or the compressing medium is some foreign body, as a musket ball, the condition of affairs will never be suspected. When the circulation is arrested or retarded by pressure from a body like a musket ball, the presumption is that sloughing will ultimately occur, and hæmorrhage come on as in the case of a primary wound. This, however, will receive attention at another place.

There are few accidents that are so surrounded by peril, and that make such imperative demands on the skill of the surgeon, than those involving arterial hæmorrhage, or even venous bleeding when large trunks are injured. The rapidity with which life is exhausted, and the accurate knowledge required to expose the bleeding vessel at a distance from the point of injury, together with the occasion, frequently presented — to apply a ligature on the main trunk, owing to the excessive vascularity of some anatomical regions, combines to make an accident of this nature one of very startling character to the inexperienced or young surgeon. Life has more than once been lost by temporizing treatment, and patients frequently placed in great danger, both to life and limb — by failure to radically arrest the flow of blood. In view of all these circumstances, it is difficult to conceive of an accident that should receive more careful study and attention.

The *causes* of hæmorrhage are various. It will serve a good purpose, probably, to consider them under two heads, viz., *primary* and *secondary*. The former would include all injuries inflicted on blood vessels by cutting, bruising, tearing or piercing instruments, which set up bleeding at once, immediately upon the reception of the injury. The gravity of a case is in direct relation to the size of the vessel injured, and its nature, *i. e.*, whether vein or artery. Small vessels of either character, may under peculiar circumstances bleed freely, and endan-

ger life; particularly is this the case when the extremities are wounded during or shortly after extreme toil, as marching, etc.—when there is a physiological hyperæmia, and small twigs assume the importance of vessels of the second or third magnitude. Under more favorable circumstances such hæmorrhages usually cease spontaneously, and need give no concern. Here is a question of much magnitude, and one that confronts the young surgeon at the threshold of his career. It is only the experienced surgeon who can safely and accurately determine how much blood an injured person can lose without danger. I have seen a mere trickling, in what was almost thought a bloodless operation, place the patient in the greatest danger, and the operator startled, on moving his patient, to find such an immense amount of blood on the table or mattress. Again there will be a sudden gush of a large amount of blood, startling the surgeon and appalling the bystanders, which will soon cease, and not evince any very marked depressing effect on the patient. It is useless to attempt to put in words a reliable account of the line of danger, as far as *quantity* of blood is concerned—nothing but experience can give confidence. What would be a trivial loss in one, would be fatal in another.

The amount of primary bleeding, again, will depend very much on the character of the injury to the vessel. Thus a wound that completely divides a vessel, will usually result in smaller hæmorrhage than when it is only partial. In the case of arteries, particularly, there is always a tendency to retraction, on division, as long as the coats of the vessel are in a normal condition. Atheroma, calcification, fatty degeneration, or the inclusion in new tissues, as tumors or hypertrophied parts, will prevent any retraction and favors continuous hæmorrhage. The retraction, however, will not at all times control the hæmorrhage, in fact in many cases will greatly add to the danger. Thus when an artery is cut and withdrawn into solid muscular tissues, particularly muscles in constant use, bleeding will very likely soon cease, and a coagula form which *may* present a recurrence. But when the retraction is into loose cellular tissue, as the spermatic cord, or the sub-peritoneal fascia, not only will the hæmorrhage continue, but the vessel will be hard to get at, and we may be necessitated to expose and tie the main trunk. In determining, therefore, the necessity for ligation, consider the nature of the tissue into which the vessel has withdrawn. Although, as will be seen shortly—radical measures are to be preferred in all cases.

When a vessel is partially divided, the amount of hæmorrhage depends largely, after consideration of the size of the trunk—upon the direction of the wound with reference to the axis of the vessel. Thus a wound transversely to the axis of the vessel, will allow much gaping of the edges, and the hæmorrhage must be free; longitudinal wounds, if not too extensive, cause little or no gaping, and the bleeding will be less. These facts are mentioned more to guard against an erroneous conception of the injury, than to indicate degrees of danger.

A small hæmorrhage in the region of a large vessel might mislead, and unless the course could be traced to a wound of the vessel, the patient might be left in a dangerous condition; the fact is that *any* partial wound of a large trunk must receive as careful attention as if there was complete division.

Puncture of arteries, while not at all times causing hæmorrhage, are exceedingly liable to be succeeded by aneurism, and when readily detected, the question of obliteration must be carefully considered. A puncture with a large instrument will be equivalent to a transverse wound, but with needles and the like, it may be very difficult to decide on the amount of injury, and the treatment. Perhaps the safe rule would be, if there be no bleeding, wait for future developments; if there be hæmorrhage, no matter how small, secure the vessel.

Finally, under the head of primary hæmorrhage, it must be remembered, that spiculæ of bone in fractures, or the sharp end of an obliquely fractured bone, may cause serious bleeding, and call for ligation at once, the subcutaneous nature of the bleeding not detracting a particle from the danger or the indications for prompt and radical treatment. So also dislocations may tear important vessels, particularly in attempts to reduce ancient luxations — and the indications be precisely the same as if made by a wound with some cutting instrument through the integument.

Secondary hæmorrhage, is that form of bleeding in which vessels bleed after reaction from shock, from the washing out of clots; from the premature separation of ligature; from morbid processes extending to the blood-vessels; or the reaction from local shock, or paresis, of vessels in contused or lacerated wounds. Owing to the retraction of the ends of the vessel into the cut tissues, and the more or less concealment of the source of the discharge, such accidents are very grave, and at times startle the most experienced surgeons. It is in such cases that the main trunk has to be found and secured, and well illustrates the necessity for constant anatomical study. CARNOCHAN, (*Operative Surgery*, Part I p. 63,) relates a case of wound of the plantar artery, in which for secondary hæmorrhage he tried the posterior tibial, popliteal, and ultimately the common femoral, above the profunda, successively, before the hæmorrhage was controlled. Ulceration and sloughing of the soft parts very rarely extends to the arteries, although the vein frequently suffers. The fibrous coat of an artery has the peculiar property to resist such influences longer than other tissues, and we have a familiar example in sloughing phagedæna, where the tissues all rapidly give way, and expose the artery pulsating at the bottom of the chasm. Occasionally from long continued pressure, as from an impacted musket-ball, or some foreign substance, a vessel becomes devitalized, and the dead portion sloughs out. This is also the case in burns, and in vessels which have been grazed by a passing ball in gun-shot wounds. In such instances fatal hæmorrhage may ensue, but as a rule, I think, the vessel is usually obliterated long

before the sloughing occurs. Hæmorrhage of a secondary character in contused and lacerated wounds are quite common, as the suspension of activity from the primary effects of the injury forbids the formation of a very firm coagulum. In a large number of cases, however, the inner walls of the vessel roll up, and secondary bleeding will not occur.

The *symptoms* of hæmorrhage depend somewhat on the character of the vessel wounded, whether vein or artery; and the location of the injury, on a free surface, in a wound, or in subcutaneous parts.

Venous hæmorrhage, other things being equal, is not as serious a matter as arterial. It will frequently cease spontaneously, is easily arrested by moderate pressure on the distal side, and the effects are not as serious unless very profuse; on the other hand, when from any reason, a wounded vein requires ligation, or any other method of a mechanical nature, they are less tolerant of compression, and prone to take on inflammatory action. There is, also, an occasional entrance of air into wounded veins, which is an accident believed to be peculiar to veins, and one of very serious import. Leaving this for the present, we will observe that the ordinary symptoms of venous hæmorrhage are readily recognized, although much modification may arise. The blood from a vein flows in a continuous stream, without "jetting" or any impulse, and is dark in color. As a variation, we may meet cases in which the proximity to an artery will communicate a sort of pulsation to the vessel, but I doubt if the blood will ever be expelled in jets, rhythmical at least. Also when hæmorrhage has continued for a long time, particularly from a large trunk, the veins may become emptied of blood, and the color of the flow assume a brighter tint. When a slight pulsation is observed together with this brighter color, the novice might be deceived; but as pressure *below* the wound at once controls the flow, and the exhaustion is notably less than from the same loss of arterial blood, there need be no difficulty in making an accurate diagnosis. The constitutional symptoms of hæmorrhage are the same, although in a somewhat minor degree, as in the case of arterial hæmorrhage, and may be found under the latter head. The same may be said of treatment, although it may be mentioned at this place, that a compress on the vessels below the wound, and a light bandage about the part, will be all that is usually required. If at the expiration of ten or twelve hours renewed hæmorrhage should follow the removal of the bandage, other means, as in the case of arteries, may be employed, giving acupressure the preference.

The entrance of air into the veins is an accident of somewhat rare occurrence, but as MR. MOORE says (HOLMES I, 856), it has occurred "sufficiently often to allow of our arriving at some conclusion in regard to it." The accident usually occurs during the operations in the neck or axilla, or where any of the large trunks leading to the heart may be met and injured. The accident is announced by a whistling, gurgling, or bubbling sound, distinctly heard by the bystanders, and

the sudden appearance of alarming symptoms, indicating disturbance of cardiac action. The gravity of the accident varies, with the amount of air introduced, from alarming symptoms as above, and immediate death. VELPEAU (*Operat. Surg.* I p. 30,) discusses this question at great length, and agrees with Nysten, 1809, that the symptoms are due to the entrance of the air into the heart, and not from any action on the vein as Bichat taught. This is the belief at present, quite generally so, but the mode of death from this cause has been much argued, by Erichson and others, and still no definite conclusion has been reached. The fact that all the veins in the body become flat when exposed to the air, with the exception of those in the neck and axilla, which remained rounded, was recognized as the reason for the rarity of the accident, but it was VELPEAU and BERARD that determined the reason for this. They found that these large vessels was so firmly attached to the sternum, clavicle, and other parts, by plastic adhesion, that flattening was prevented. Also that the motion of the chest in respiration had the effect to cause a "venous pulsation" or wave in these vessels, which with their patency had the effect to greatly favor the entrance of air. This, however, did not account for its fatal effects, and MR. MOORE (l. c.) after carefully weighing all that is said on the subject, comes to the following conclusion: "* * the largest quantity of air is always found in the right side of the heart. The most sudden deaths occur when the most air and the least blood are discovered in the right auricle and ventricle, and when the two fluids are least intermixed." The circulation is assumed to be arrested in the right heart, and the explanation thus given. "When air enters the right ventricle, and the ventricles contracts, a part only of its contents passes into the pulmonary artery; the remainder regurgitates into the auricle. For the wet tricuspid valve is not raised from the ventricle by so thin a fluid as air, and consequently does not close the auriculo-ventricular opening. In subsequent dilatations of the ventricle, additional air enters it from the auricle, and either is forced by the systole, or floats into the pulmonary artery. That which first occurred with the tricuspid valves now happens to the pulmonary, they stick to the walls of the artery and are useless. The ventricle, thus deprived of all assistance from the valves, communicates both in its systole and diastole, with both its orifices, and draws in from, and restores to, both artery and auricle, the contents of both. The blood and air advancing and regurgitating at both the orifices of the ventricle, the circulation is nearly at a stand." When death occurs from this cause, it is usually very sudden, the patient expiring almost as soon as the condition is recognized.

The *treatment* of this condition must be both cautionary and curative. For the first indication, veins cut in the dangerous regions must be secured at once, before air enters; if there should be an admission of air, early closure of the vessels will limit the amount introduced, and in the same proportion lessen the danger. When air has entered,

place the patient at once in the supine position, and aid the hearts action by friction, and stimulants. Improvement commences at once, when at all, and after the lapse of five minutes all danger may be considered past. I will relate, in the absence of any personal experience, a case mentioned by MR. MOORE (l. c.): "On November 22, 1822, Dupuytren excised, without difficulty or hæmorrhage, a tumor from the posterior and lateral part of the neck of a healthy young woman. As an assistant was raising the tumor, and the operater was separating its last attachments, a prolonged noise was heard in the wound, like that of air rushing into an exhausted receiver. If it were not that I am far from the air tubes," said Dupuytren, "I should have supposed we had opened them." The words were hardly spoken when the girl exclaimed 'Je suis morte;' she trembled, and fell dead. The right auricle was distended like a bladder with air, which rushed out unmixed with blood when the auricle was opened." He also gives a case from MOTT, in which life was preserved. The patient had convulsions, much distortion of the face, and laid as if in *articulo mortis* for "near half an hour," he then recovered with hemiplegia, which lasted a whole day.

(*b.*) *Arterial hæmorrhage*, in general, can readily be distinguished from venous, but circumstances may arise that would mislead the inexperienced. The blood is usually bright red in color, hot, coagulates quickly, is expelled in jets, synchronous with the action of the heart, and can be arrested by pressure on the proximal side of the wound; cases occur in which the hæmorrhage has continued for a long time, where considerable blood has been lost, when the impulse of the flow is lost, and it runs in a steady stream as in the case of venous hæmorrhage. The color of the blood may also become darker as the arteries are emptied, and nothing but the fact that proximal pressure will arrest the flow, or an actual view of the vessel, will convince the attendant that it is an artery that has been wounded. When a large vessel, as the aorta, or iliacs has been injured, a few moments suffice to extinguish life, the body soon becoming emptied of blood. When smaller and deep seated vessels, particularly those situated in muscular parts—hæmorrhage is usually very free until the hearts action has been weakened somewhat, then becoming sluggish, coagulating somewhat about the wound in the vessel, and the patient faints. While the syncope continues hæmorrhage ceases and some progress is made to prevent its reccurrence by the coagulation of the vital fluid. The bleeding reappears, however, on restoration to consciousness, syncope again comes on, and so with successive faintings and renewals of bleeding, the life is lost. Even when the vessel ceases bleeding after the first attack of syncope, the coagula are so very readily washed away; the barrier is so feeble, that cases in which, sooner or later, secondary bleeding does not occur, are exceedingly few, and the greatest caution must be exercised to guard against shock. motion, or anything that

would excite a more forcible circulation of the blood, or motion in the muscles surrounding the vessel.

What has been written above applies particularly to hæmorrhage on a free surface, as the surface of a wound, when the source of the hæmorrhage is readily detected, and its nature at once made out. We have now to consider, briefly, a more obscure condition, in which the hæmorrhage is concealed, or occurs within some of the closed cavities of the body.

(c.) *Concealed hæmorrhage*, whether venous or arterial, is a most serious accident, one that is frequently difficult in detection, and in the large majority of instances almost incurable. Of course the size of the vessel, and the nature of the injury will exercise much influence on prognosis and diagnosis, but there are few cases in which the surgeon can be positively certain of the condition of affairs. The causes are many, as gun-shot injury; rupture of aneurismal sacs; punctured wounds; injury of arteries from fragments of fractured bones; rupture of the fallopian tubes in tubal pregnancy; or the retraction of cut vessels into one of the cavities. The region affected will very greatly modify the symptoms, as where the hæmorrhage is into the cavity of the cranium, symptoms of compression of the brain will be prominent; when the chest, dyspnœa; of the abdomen various symptoms, particularly peritonitis, etc. In all of these, I think there will be a feeling of flowing; in one case of death from rupture of the fallopian tube, the patient felt certain that there was some discharge into the vagina, and could scarcely be convinced by actual inspection that she was mistaken. As a general thing the symptoms are as follows, but when the hæmorrhage is slight they will more gradually make their appearance, and not be as marked and severe: Great prostration, with increasing pallor of the surface, sighing respiration; intense internal heat; unquenchable thirst; restless, and tossing about; the features assume a pinched expression; the pulse becomes weaker and quicker, until it cannot be felt at the wrist; there will be ringing in the ears; dimness followed by loss of sight; a cold clammy perspiration will cover the body; the breath will be cold; the nose, ears, fingers and toes will become icy cold; and fainting. In severe cases the fainting will be the prelude to death, consciousness not being restored; in other instances there will be a succession of fainting fits, each one lasting longer, and more profound, with convulsions at the close. Should the hæmorrhage cease, the most positive injunction must be given to avoid motion, and every precaution taken to avoid mental excitement, or motion either active or passive.

Treatment.—The treatment of hæmorrhage has for its first indication to cause obliteration of the wounded vessel; secondly to establish collateral circulation. The means to be employed for these purposes will be given shortly, but we must first consider the changes that occur in the wounded parts, and the manner in which the vessel becomes occluded.

A wounded vessel that ceases to bleed spontaneously, as is said, will be found plugged by a mass of coagulated blood, within its canal, called an *internal clot;* there will also be a coagulation of the blood poured out into the surrounding tissues, which is called the *external clot.* Such an arrest of bleeding is too often temporary, the external clot becoming disorganized and carried off, which frequently carries the internal clot with it. It is a very undesirable method, but when deep vessels, particularly in some of the cavities, are concerned, we must be thankful for that much. Apart from the imperfect character of such a barrier, the danger of suppuration, septicæmia, and pyæmia, that will be a constant menace when the clots commence to break down, will always render this method of controlling bleeding undesirable. The rational, scientific, and only safe proceedure, is to firmly close the cut end of the vessel, by surgical means, and secure the formation of an internal clot alone, and a permanent occlusion of the vessel by its organization. When any constriction is practiced at the cut end of a vessel, the blood current is at once arrested, and the following changes occur. The column of blood rushing down to the

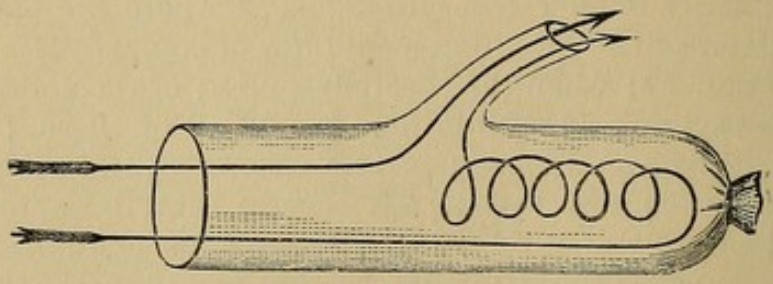


FIG. 3. Spiral Clot.

point of constriction, is repelled back again, the conical form of the vessel at this point, giving the current a spiral motion. The imprisoned blood finds an exit at the nearest collateral branch, which rapidly becomes augmented in size, until it will be of the same dimensions, or nearly so, of the parent trunk. As the collateral branch becomes enlarged, a noteworthy change occurs in the column of the blood; it seems to be in two parts, one of which passes straight down the tube to the bottom, and returns by a spiral movement as high as the collateral outlet; the other passes down to the outlet, and then finds exit. The peculiar spiral or churning motion thus communicated to the blood, can be well shown by the following simple experiment. Take an ordinary test tube, and fill about one inch of its bottom with fine sand. About half an inch above this layer of sand, make an opening in the tube about one half the diameter of the same. Now by pouring water steadily in at the open end, at a sufficient height to give such force, and in sufficient quantities to keep up a steady supply and fill the tube completely, the motion of the sand will show the double character of the flow of water, and the churning process below the point of exit. This churning in the artery, has the effect to rapidly coagulate the blood, by separation of the

fibrine and forms a firm clot effectually closing the end of the vessel. In time, varying with the size of the vessel from three to perhaps thirty days, in exceptional cases—the clot becomes firmly organized, the vessel converted, below the collateral outlet, into a fibrous cord, the ligature cuts through the vessel and is discharged. This is the object to be attained by ligature or radical treatment of wounded arteries, and unless the part is unusually vascular, which would call for ligation at a distance from the wound, or the vessels themselves are the seat of some morbid process that prevent a ligature holding, the end desired is almost sure to be attained.

The methods employed to control hæmorrhage may be arranged under two heads, *temporary* and *permanent*. The former are employed in surgical operations to prevent bleeding during the operation, but in exceptional cases may be continued afterwards in place of more efficient methods. The most prominent of these is the tourniquet, of various patterns; the elastic bandage of Esmarch; digital compression on the main trunk; or forced flexion. The tourniquet of Petit,

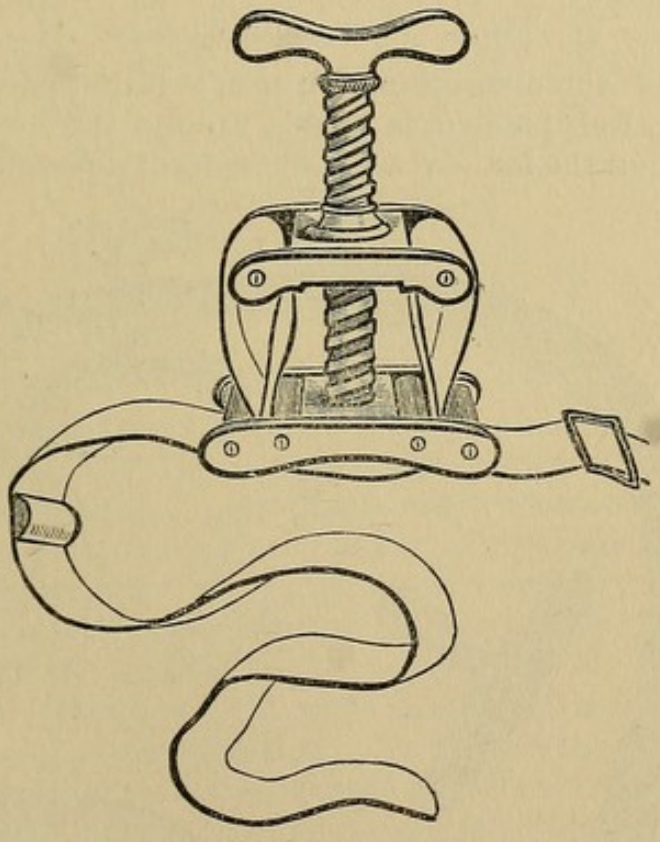


FIG. 4. The Tourniquet of Petit.

a strap encircling the part which is tightened with a screw—is familiar to all practitioners. The principle of construction is that of exercising compression, and when not available, in cases of great emergency, it may be imitated effectually, in what the sailors call a "Spanish windlass." Tie a simple overhanded knot in the centre of a folded handkerchief; place the knot over the main artery of the limb, and tie the handkerchief firmly around it. Introducing a stick, or any similar article, as a ramrod, sword blade, etc.—between the

ligature and the integument, as much pressure can be exercised by twisting the stick as is needed. When twisted tight enough, the end of the stick can be secured with a piece of twine to the bandage, and allowed to remain as long as desirable.

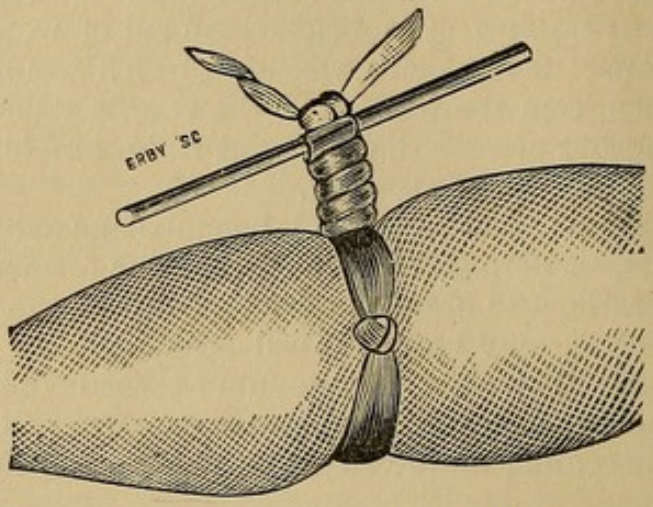


FIG. 5. The Spanish Windlass.

A number of compressors are in use, to a limited extent, in which a metal band, well padded, is passed around the limb, and pressure made directly on the main vessel by means of a padded thumb-screw.

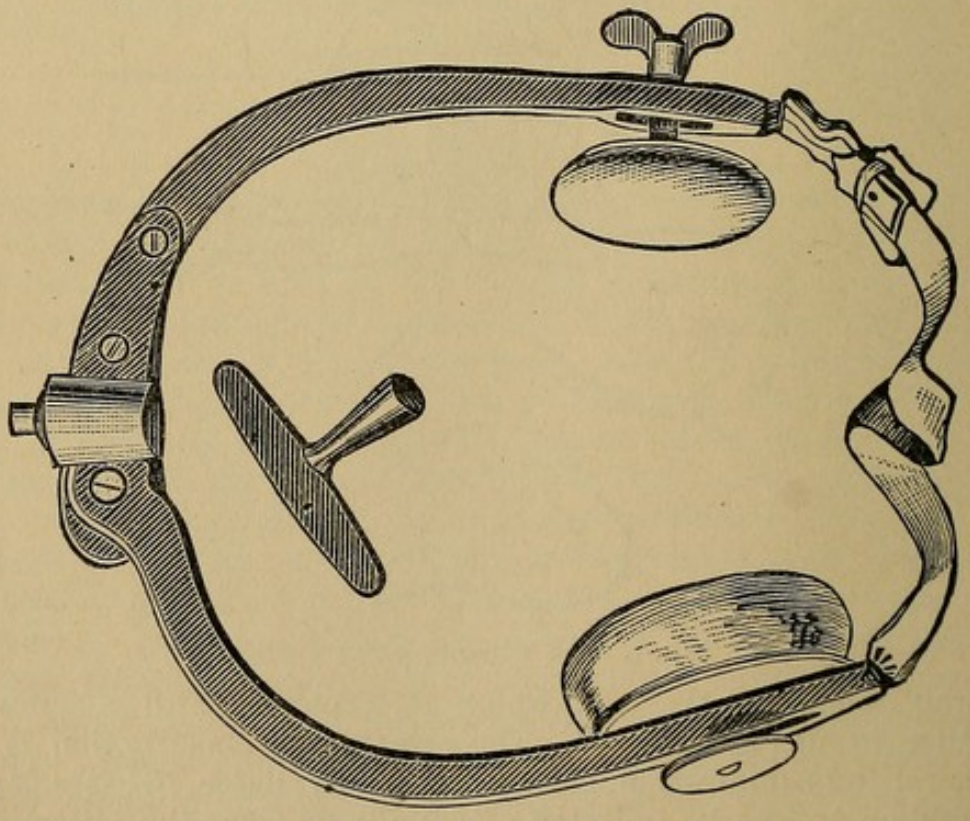


FIG. 6. Maw's Compressor.

The same effect can be attained by placing a roller bandage under the strap of the ordinary tourniquet, immediately beneath the screw.

Digital compression is often necessary, in controlling bleeding from

the large vessels given off from the aorta, when a tourniquet cannot be applied. The handle of a large door-key, well padded, may be substituted for the fingers; or a properly constructed compressor may be made.

Forced flexion, by compressing vessels in the flexure of joints, may be useful in exceptional cases, but I have not seen occasion once for the practice. It has been used with success in wounds of the radial, ulnar, or digital arteries, but I can conceive of no benefit to be derived from it that could not be secured in a far greater degree from more radical and less painful methods. In this the limb is flexed far beyond the voluntary capacity for flexion, and retained in position by bandages.

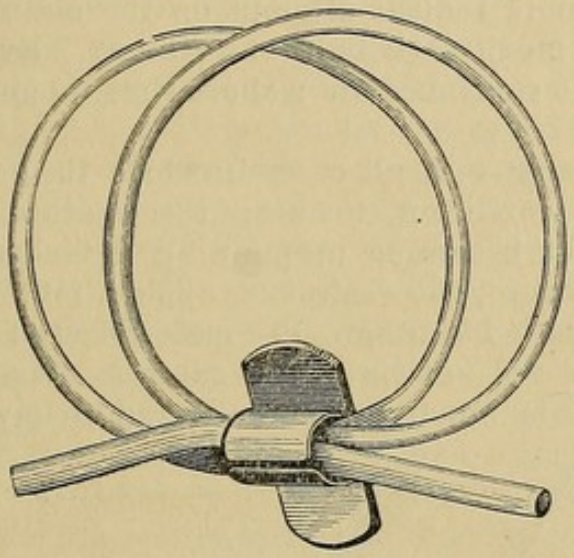


FIG. 7. Esmarch's Bandage Clamp.

Esmarch's bandage, for operations, is the most satisfactory of all the methods of controlling hæmorrhage with which I am acquainted. The apparatus sold by the instrument makers is more costly, I think, than need be, and I have long used a partly improvised one, that fully answers every indication. The bandage is an ordinary elastic webbing two inches wide, and five yards long. This is applied by commencing at the extremity of the limb to be operated upon, and applying it by tightly drawn turns, as high as is needed, or a few inches above the point selected for the operation. No reverse turns are to be used, but the edges must be carefully covered as the turns are made. When carried high enough, the limb must be encircled by two or more turns, *not* overriding, of ordinary half inch rubber tubing, which is tied tightly by means of strings or tape attached to the ends. This tube must have the first turn applied so that the edge of the bandage will be lightly held by it. The bandage is then removed, and the part will be found bloodless. When the bandage is carried above the knee or elbow, the flexure of the joint should be filled with lint or cotton, or the vessels in that part will not be compressed, and the venous hæmorrhage, particularly, will be very annoying. Should the bandage not be long enough to go as high up the limb as desired, put on

the rubber tubing, remove the bandage, and commence again a turn or two below the tube, which is then removed.

As a purely temporary check of bleeding, or to facilitate surgical operations, any of these measures are legitimate; but to continue them for any length of time for ordinary hæmorrhage from injury, would be decidedly unsurgical, and bad practice. In the first place, the pain will soon be unendurable; and secondly there is danger of destroying the vitality of the part. With the means we now possess to control bleeding in softened and diseased arteries, it can never be necessary to resort to such temporizing measures as those mentioned above. There may be a single exception to this rule, in the case of concealed or internal hæmorrhage, where the bleeding vessel cannot be reached, or any more radical attempt on the main trunk would be fraught with too much peril to be entertained. Even here the pressure could only be continued for a short time, to enable a clot to be formed.

Permanent measures.—In all cases in which the coats of the artery are in a healthy condition, to bear the ligature without cutting directly through or becoming prematurely detached, ligature is the best, the most secure, the easiest of application, and permits less danger of subsequent bleeding. The material used is either twisted saddler's silk, *unwaxed*—or carbolized cat-gut. The former is in more common use, and is much too be preferred in my opinion. Many

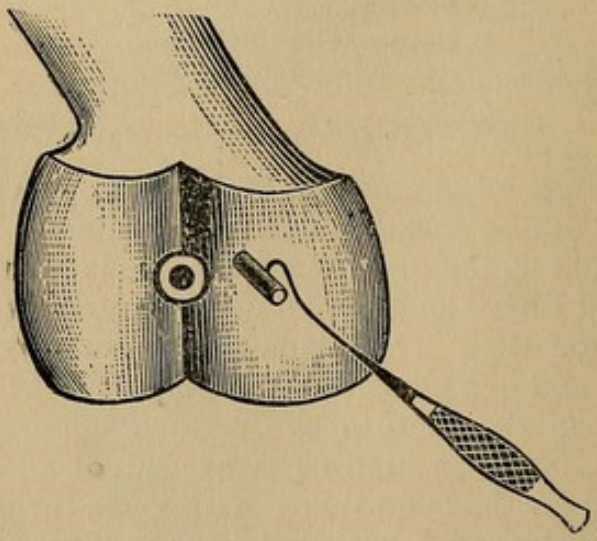


FIG. 8. Drawing out the Artery for Ligation.

excellent surgeons use the carbolized cat-gut, but it is asserted by many observers that as the knot becomes loosened in a few hours after the application, the constriction of the vessel is incomplete. Its advantages are, that the wound may be at once closed, the ends of the ligature being cut off close to the knot. The many instances in which it has been employed must strongly commend it to the profession, but unless in the case of abdominal wounds, where a ligature leading from the peritoneal cavity might be undesirable, I am strongly in favor of the time honored silk, which may be treated with carbolic

acid if desired. The cat-gut is prepared by working it in the hands, with carbolized oil (in the proportion of one to three), until soft. It is then kept in tin boxes until needed.

Whichever agent is used, an artery may be tied at its cut extremity, or in its continuity above the wound. In the first instance the instruments needed are artery forceps, or tenaculum, and scissors. The vessel is seized with either instrument preferred, separated from its relations with near parts, as nerves, fascia, etc., drawn out from a quarter to half an inch, and encircled by a single turn of the ligature, tying with a square or reef knot. The first portion of the knot must be drawn sufficiently tight to separate the inner tunics of the vessels, which are felt to give way under the finger. The two forefingers are applied back to back close down to the knot, the remainder of the ligature being held in the other fingers, and the knot tied by separating the fingers. The second part of the knot is tied in the same manner, drawn tight, and one end of the ligature cut off near the knot, the other being brought out at the most dependent angle of the wound. When more than one vessel is tied, the main trunk should be indicated by a knot in the ligature. When several vessels spurt, the main trunk should at least be tied, the others *may* receive other treatment. In small vessels, the ligature will separate in from three to six days; larger vessels will require all the way from ten to thirty. After the proper time has elapsed, the ligatures may be tested at each dressing, by twisting them between the thumb and finger, and making *slight* traction; when found loose they may be withdrawn. Should the vessels tied be the seat of any morbid action, it is better to let the ligatures be discharged spontaneously, than to risk secondary hæmorrhage by making traction. On dressing the wound, bring all the ligatures out in the same angle, unless some of them will be drawn through the whole length of the wound, then take them out at the nearest point. Secure the ends with strips of adhesive plaster, and caution all who are in attendance to avoid pulling on them, or in any way endangering their premature extraction. When a ligature is retained longer than usual a good plan is to draw it quite tightly, and attach the end to the skin with adhesive plaster. Usually, the continued traction thus set up will cause its separation in a day or two.

To tie a vessel in its continuity, at a distance from the wound, is the proper procedure in all cases in which changes in the vessel at the point of injury make ligation at that point undesirable or difficult. Thus atheroma, calcification, fatty degeneration, or any morbid action that would cause the ligature to be prematurely disengaged, or that would soften the vessel so that the ligature would cut through, would call for ligation of the main trunk when it can be done safely. The sole consideration against this operation, would be the danger, in certain cases, of causing death of the tissues from cutting off the entire blood supply. In some instances, however, as when the main trunk would be the aorta, it would be impossible. Other conditions

calling for this method, would be the deep retraction of the wounded vessel, so that it could not be reached; or the excessive vascularity of the part, which could not be controlled without placing a large number of ligatures. Having decided that the proper treatment would be such an operation, the first thing to do is to determine which vessel to tie; thus in a wound of one of the tibials, shall it be the popliteal, the femoral, or above or below the profunda. The decision will be entirely based upon the anatomical knowledge of the operator. The fact that the hæmorrhage will usually weaken the arterial pulsations greatly, makes it difficult to trace a vessel with the fingers, and will much embarass those not familiar with the relations of the parts. This can be to some extent obviated by applying a tourniquet, which should always be done, or making pressure above the wound, by causing turgidity of the artery, and restoring a certain amount of pulsation. The artery found, and the location for the ligature selected, the vessels must be exposed and taken up as follows: The instruments required are a scalpel, director, probe-pointed bistoury, metallic retractors, dissecting forceps, and either a silver seton-probe, or blunt aneurism needle. The course of the vessel being marked out by the eye, or if this cannot be trusted with a pen and ink —an incision is made slightly oblique to the axis of the vessel, only

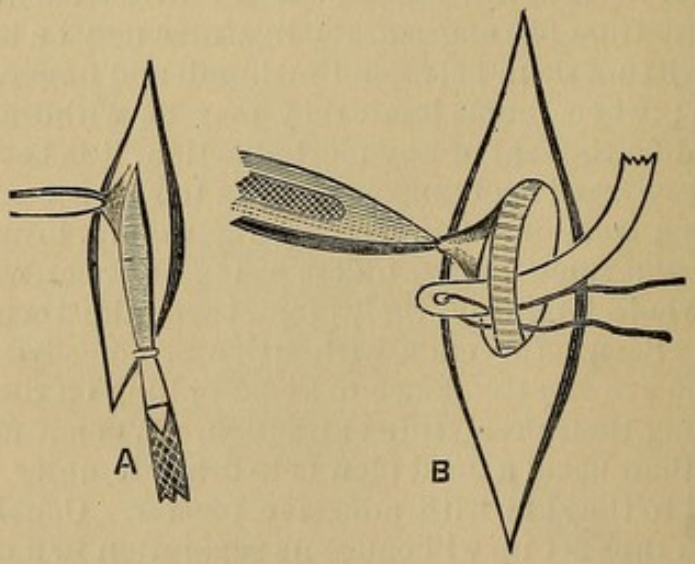


FIG. 9. Finding the artery (A), and passing the ligature (B).

through the integument. The length of the incision will depend upon the depth of the vessel sought, varying from two inches, in superficial vessels, to three or more when deeper. It is better to have the incision too large than too small. The direction of the incision should also be paralel to the course of the muscular fibres of the part, and as far as possible designed to separate the muscles, rather than to separate the fibres. With the forceps pinch up a fold of the fascia, near the lower extremity of the wound, and nick it with the scalpel; insert the director in the opening, and with the bistoury divide it the whole length. Proceed in this manner until each layer of fascia has

been divided, and the muscles exposed. With the handle of the scalpel now separate the muscles, holding them by means of an assistant — to one side with the retractor. When the sheath of the vessel has been reached, open it, as in the case of the fascia, but only to a limited extent, that is only sufficient to afford room for the passage of the ligature. The artery must be separated from the nerve and vein, and the ligature passed and securely tied. In passing the ligature some precautions are necessary. Arm the aneurism needle or the eye in the probe, by leaving only about an inch of the silk protruding, on one side. On passing it under the vessel seize the short end with the forceps, and *withdraw the needle before unthreading it*, thus avoiding any injury to the vessel; it is unthreaded by drawing it along the long end of the ligature. The vessel is to be firmly tied, and one end of the ligature cut off, and the wound closed as in ordinary incised wounds. The tourniquet is now to be loosened or the pressure removed, and if no hæmorrhage occurs in the cut artery, the operation is a success; if bleeding *should* occur, either the wrong vessel has been tied, or there is an unusual anastomosis. In either event the operation must be repeated higher up, or another vessel selected. The operation, it must be understood, is to be made *above* the tourniquet, which is not applied to guard against hæmorrhage from the operation, but from the cut vessel during that procedure.

Finally, it may be said, this method is frequently called for in punctured wounds of arteries, or where the wound is too small, and the vessel too deep to admit of any other method. When a vessel is tied in the wound, particularly if the division is not complete — it will be safer to tie both the distal and proximal extremities, as reflex hæmorrhage may be severe.

When a large vessel has been tied, the parts supplied must be kept warm by bottles of hot water, hot bricks, flat-irons, etc., and the establishment of collateral circulation hastened and aided by friction. As soon as pulsation is felt in parts below the wound, and the surface becomes warmer, these measures may be discontinued. It is well to observe this precaution in all cases, but particularly in the case of the old, when it should never be neglected.

Torsion is a method employed by many surgeons, almost exclusively and whilst I have used it to some considerable extent in wounds of small vessels, I have never felt justified in injuries of greater magnitude. In vessels as large as the radial and ulnar, I have frequently employed it, and found it highly satisfactory. The process is as follows: With a pair of artery forceps draw out the artery for a quarter of an inch or more; with another pair seize the vessel close to the tissues, applied transversely to the axis of the vessel. With the first forceps make from three to five rotary turns of the vessel, twisting it until the inner coats are felt to give way. The torn inner tunics roll up and plug the extremity of the vessel, and at the same time greatly facilitate the formation of a clot. On the removal of the

forceps, if hæmorrhage still continues, repeat the operation. If not successful at the second trial, ligate at once.

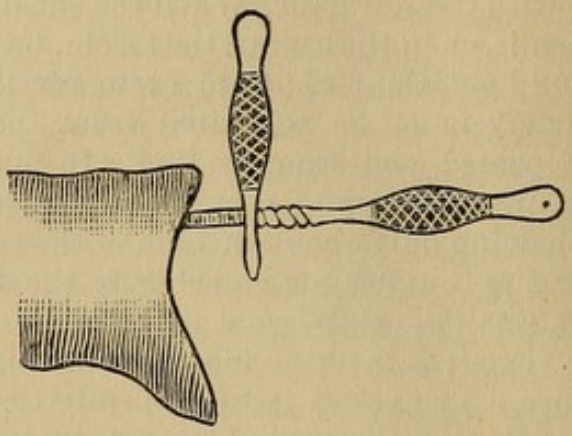


FIG. 11. Torsion of the arteries.

Acupressure, devised by SIR J. Y. SIMPSON in 1859, is becoming very popular, and certainly takes rank in importance and efficacy next after ligation. It is made by the introduction of stout accupressure pins into the tissues in such a way that compression is exercised on the bleeding vessels. Whilst the method is chiefly to be selected in cases in which the arterial coats are diseased and incapable of supporting a ligature, the chief advantages claimed for it over the ligature, are the speedy closure of the wound; the absence of any foreign body in the wound; and the diminished suppuration. Whilst ligatures are sometimes weeks or months in becoming detached, and the healing process is arrested during this period, the pins can be withdrawn on the second day, or after forty-eight hours, in nearly all cases, and frequently in twenty-four hours. It is also possible to secure superficial vessels without cutting down upon them, which in many cases, particularly of great emergency, will be appreciated by the experienced surgeon. It can safely be predicted, that if the ligature is ever abandoned it will be for the accupressure pin.

Whilst many surgeons have given different "methods" for the

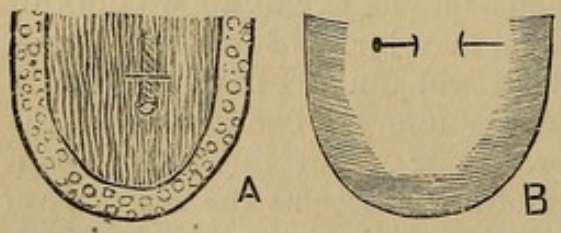


FIG. 12. Acupressure. 1st method.

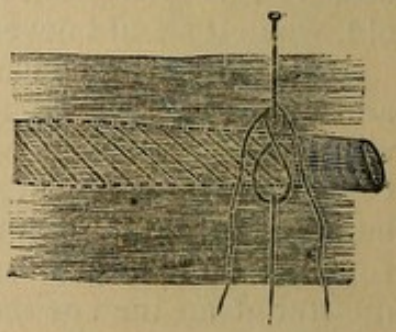


FIG. 13. Acupressure, 2d method.

introduction of the pin, ranging from three to nine, those more constantly useful may be included under four heads, others that might be useful in exceptional cases being readily improvised by any practi-

tioner of common ingenuity. The principle once understood, the variations may be numberless. I have selected the four principal methods, which may be described as follows:

1. To secure a vessel through the integument, enter the pin about a quarter of an inch from the vessel, pass it underneath, and bring it out through the integument on the opposite side. The artery is thus firmly compressed between the needle and the integument. If this seems insufficient,

2. Without removing the pin, pass a rubber ring around both extremities, thus increasing the pressure from each side; or pass a

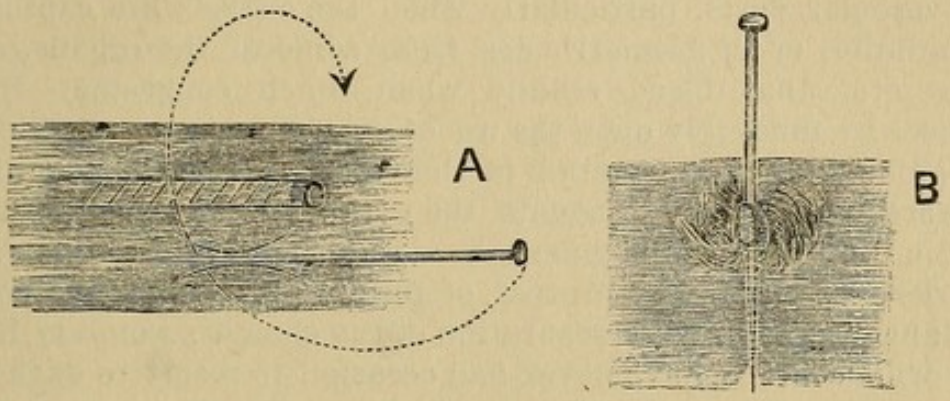


FIG. 14. Acupressure. 3d method.

ligature in a "figure of eight" around the pin, as in the case of hare-lip.

3. To secure a vessel on the raw surface of a wound, introduce a pin through the fascia close to the vessel, parallel to it, including say a quarter of an inch of surface; next change the direction of the needle so that it crosses the artery at right angles, and bury the point in the tissues on the opposite side. Should this prove insufficient,

4. Insert the pin, transversely to the vessel, at a distance of half an inch from the vessel, carry it across the artery; raise it vertically, enter it in the tissues close to the vessel on the opposite side; depress

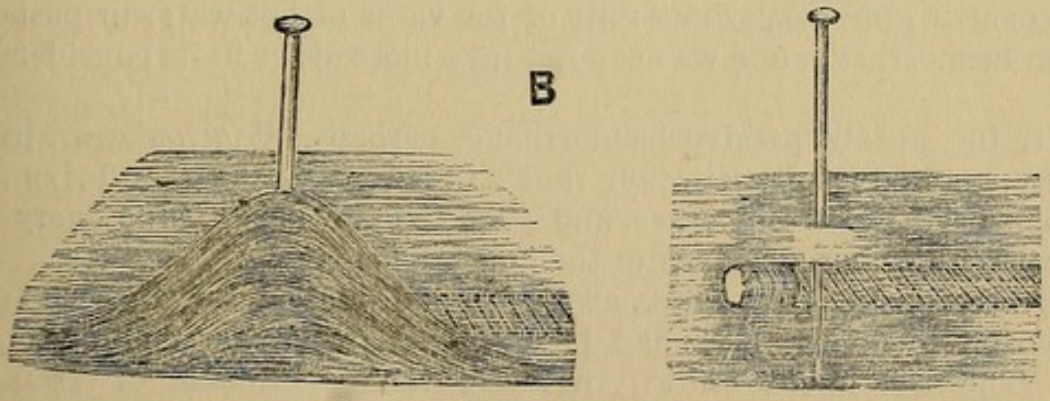


FIG. 15. Acupressure, 4th method.

it still farther, thus carrying the tissues first enclosed across the vessel; bring the pin flat to the surface, and cause the point to emerge on the original side of entrance, half an inch from the vessel. (15.)

When a vein has been wounded, and it is not deemed advisable to ligate it, and bleeding is excessive, this plan is the best that can be devised. It will cause speedy obliteration and no inflammatory action will be likely to succeed.

There is a species of hæmorrhage that cannot well be arrested by either of the processes already mentioned, without exposing the patient to great danger by cutting off the circulation of large parts entirely, or using so many ligatures that it will be hopeless to attempt a closure of the wound, as the mass of ligatures acting as a suture will cause profuse suppuration. Such cases occur in wounds of excessively vascular parts, particularly when the vessels are capillary or very minute, or in hæmorrhages from some of the organs, as the uterus, etc., that bleed readily when much congested. In such instances we must rely upon the use of *styptics* as they are called — or agents that induce contraction of the vessels, and rapid coagulation. There are another class of agents, the various cauteries, either acid or metallic, but their employment is rapidly becoming obsolete. The cauteries act by a double process, of forming an eschar, and coagula. The danger is that on the separation of the slough secondary hæmorrhage will occur. I have never had occasion to resort to such measures, and much doubt if their use is warranted in the present state of medical science.

Among the styptics, hot water seems to be the most generally satisfactory, and is certainly the most Homœopathic of any. Dr. Emmet, (*Prin. and Prac. of Gynæcology*), says that he has used it largely, in uterine hæmorrhage, and at the suggestion of Dr. Pitcher, of Detroit, of whom he says: "His explanation was that, as the clot formed in the mouth of a vessel dilated by the heat, it would be so firmly held by the contraction of the vessel, when reaction took place, that secondary hæmorrhage could not occur." He later says, "then I applied the hot water to bring about a further contraction of the vessels by reflex action," which is good Homœopathy. Nearly all of our advanced Homœopaths know experimentally of the value of hot water in post-partum hæmorrhage, and we need not take more space in its consideration.

Next, for purely passive hæmorrhage, perhaps, *Erigeron can.*, in tincture, applied locally will take rank; *Crocus sat.*, *Sabina*, and *Arn.*, are each used in certain cases, and *Carbo veg.*, in epistaxis is everywhere recognized as a remedy of the first importance.

Mild styptics, as alum, etc., are occasionally called for, but when the above remedies fail, we had better resort to harsher methods at once. The best agent known to me is the persulphate of Iron, either in powder or saturated solution. It has some escharotic effects also, but not sufficient to cause any uneasiness of secondary bleeding.

It will be observed that all mention has been omitted of cold applications, and it is intentional. It will always disappoint, under the most favorable conditions only exerting a very temporary influence,

and the secondary bleeding, on reaction, will be severe. The rule in surgical practice must be inflexible, to *securely* tie any wounded artery or employ acupressure, and under all circumstances, other than purely capillary bleeding, the most radical measures are the best, and will inure more to the credit of the surgeon, and the comfort and safety of the patient.

XI. INJURIES OF NERVES.

In many important particulars, nerve lesions are a very serious class of injuries. This is readily comprehended from a consideration of nerve function. The functional life of the organs of the body, the propulsion of the blood and the continuance of muscular action are all dependent upon the nervous integrity. Whilst, therefore, the accidents to which they are liable, are similar to those of any other tissue, the consequences are quite different, varying from temporary and local paresis and trifling disorders of function, to general paraplegia, and even sudden death. Considering the brain as the centre of the nervous system, or at least that portion of it most exposed to external influences, it would be proper to consider, in this chapter, injuries to that organ; but as injuries to the head will form a separate chapter, and brain lesions develop conditions somewhat unique and peculiar, consideration of that topic will be postponed until we reach *Head.*

In addition to symptoms peculiar to the nature and extent of the lesion, all injuries of nerves are liable to develop peculiar symptoms, known as *immediate* and *remote.* There is no necessary sequence in this, as many intractable conditions come under the head of remote symptoms, where there were no primary symptoms whatever, and, in many cases, no recollection of injury at all. On the other hand, there are numerous instances of severe and prolonged primary sufferings, which pass away without being succeeded by any remote consequences.

I. The PRIMARY RESULTS *of nerve lesion* are quite dependant upon the nature of the injury, but to a certain extent all actual structural injury, or impediment to function — will develop definite and peculiar symptoms. Among the most prominent of these are the following: Lowered temperature; cutaneous changes and eruptions; secretory changes; periodical swelling of joints; muscular atrophy and contractions; and consequent distortion of joints.

(*a*). It has long been observed that among the more constant symptoms of nerve lesion, is a lowering of temperature of the part supplied, both subjective and objective. This is not so marked when the injury is confined to terminal nerves, as when main trunks are involved. In some instances the patient will complain of positive coldness in the part, when the thermometer will show a very trifling fall; in others the reverse obtains, when the falling is a degree or more, and no subjective sensation of cold is felt. No adequate explanation for this phenomena exists, although many attempts have been made;

as the parts supplied by the nerve, and not the mere point of injury, show this loss of heat, the inference is that the arrest of the nutritive changes in the part is the cause. It will be observed, as in all symptoms due to nerve lesion, that when a trunk is injured in its continuity, the coldness extends downwards to the peripheral distribution of the nerve, and upwards to its origin; while when the root of the nerve is wounded, the effects are not felt above, but solely throughout its distribution. Not only will we find this loss of temperature not overcome by the application of external heat, but soon even inflammation will rarely raise the heat above normal. There is a positive loss of vitality in the part; exposure to cold, or other disturbing influences, producing changes that other and equally exposed parts do not show. While the individual experiences only a general pleasurable exhiliration from the frosty atmosphere, the tissues affected by the nerve lesion will suffer, greatly, even take on inflammatory conditions and ulcerate.

(*b*). *Cutaneous changes* are another very common primary result of nerve lesions, and are better understood than the last. The degree or kind of change depends largely on the extent of the injury. Thus when a nerve is completely divided, complete loss of function must follow in all parts supplied by that nerve. Thus we will find that the integument assumes a peculiarly glazed appearance; all hair will fall out and not be reproduced; and anæsthesia will be more or less perfect. The skin of the part will be preternaturally smooth, not wrinkled, of various colors, usually pinkish; sometimes the epidermis will fall off entirely; the nails, when the fingers or toes are involved, will first become remarkably incurvated, as in the case of tuberculosis, and arched laterally, soon becoming roughened, cracked, and cast off. The cause is readily seen to be a disturbance of nutrition, or even complete suspension, with a possible obliteration of smaller blood-vessels. When the division of the nerve is only partial, the symptoms are quite different. There will be the same evidences of impaired nutrition, but an irritative condition is very prominent. Thus we will have hyperæsthesia, in many instances, rather than anæsthesia; much pain, more or less constant in character; the same smoothness of the skin, loss of hair, and possibly destruction of the nails; a tendency to ulceration or excoriation of the parts; and a contraction or distortion of the joints, due to the irritation of the muscles.

There are occasional exceptions to the loss of hair from such injuries, as BARON LARREY (*Clinical Surg.*, I, p. 200) relates a case of a soldier who had a wound of the supra-orbital nerve, when cutaneous hyperæsthesia and symptoms of tetanus came on; the hair on that side of the head and face became thick and coarse, erect and excessively tender; a year afterwards the nails fell off. Other cases are recorded where hair grew luxuriantly in places formerly destitute of such a growth, and a number in which the hair remained, and was so sensitive (or the parts from which it grew), that the slightest touch could not be tolerated.

The *eruptions* succeeding such injuries are chiefly erythematous, still eczema, erysipelas, and herpes are quite common. According to PAGET, a "blotched, pink, or ruddy" appearance, "as if with permanent chilblains" is the prevailing appearance in serious injuries to the nerves. While unable to give an *exact* account of the pathology of such conditions, the necessarily impaired nutrition, and frequent irritation, will furnish a reasonably accurate explanation.

(*c*). Changes in the *secretions* of a gland or part, come next in order, and can be comprehended without entering into a prolonged explanation. In cases in which *complete section* of the nerve is had, the skin is usually dry, and the function of the glands elsewhere is suspended; the glands themselves ultimately undergoing atrophic changes. A familiar illustration is afforded in paraplegia, which most medical men are familiar with. When the section, however, is only *partial*, the secretions are modified or changed in many ways. The irritative condition following these injuries will readily account for this, as also the changes in the reaction of the cutaneous secretion, which usually becomes markedly acid. Most of us are familiar with the sour odor which is observed about those who are suffering from paralytic conditions. In some instances this "vinegar" smell is not present, but a urinous takes its place.

(*d*). *Periodical swelling of joints*, which is quite a frequent sequence to nerve lesions, is very intractable, and little understood. It resembles both rheumatism and gout very closely, and will usually result in anchylosis. From the fact that idiopathic and traumatic neuritis frequently presents this embarrassing complication, we are justified in concluding that in the case of nerve lesions the section must be incomplete, a puncture, or contusion, setting up neuritis. Like arthritis, anchylosis is only established after a succession of paroxysms, each one continuing for a number of days, with periods of remission varying from a few days to many weeks. The joint, or joints, become swollen, red and painful, the swelling not entirely disappearing on the cessation of the attack. But one joint may be affected, or all the joints in a limb below the seat of injury may partake, those nearest the lesion becoming first affected. The condition, either in the acute or chronic stage is exceedingly difficult to relieve, although a restoration of the nerve will much improve it.

(*e*). *Atrophic, or other changes, in the muscles*, and distortion of the joints, must necessarily be of frequent occurrence when complete section of nerves is had, and indeed is to be feared even when the section is partial. It can be at once understood that the suspension of nervous supply to co-ordinating muscles, must result in distortion of movable parts from the contraction of muscles deprived of opposition. In time the muscles become permanently shortened; the joints are partially luxated, and in the case of very young people the bones are bent or twisted. The paralyzed muscles, from disuse, become atrophied, and even when nerve action is again restored, if it ever is,

the great length of time that must necessarily elapse cannot fail to render the condition almost hopeless of alleviation. Other muscles, not those concerned in the movement of joints, will become atrophied; and in all cases where the paralyzed muscle is not one of a system, the loss of function must soon become practically permanent. Manifestly when a nerve twig that only supplies one of a number of associated muscles, as the large flexors of the thigh or leg—is injured, the loss of one muscle may not seriously impair function; the nerve trunk being injured, however, as the sciatic or popliteal, all the muscles must suffer. A nerve being partially divided, there is likely to be irritation, rather than loss of function; and the symptoms are so marked that a mistake can rarely occur. Thus, should the sciatic nerve be completely divided, we would find inability to flex the limb, preternatural extension, and ultimately either anchylosis of the knee, with extreme flexure of the foot, (talipes calcaneo), or forward luxation of the knee, with exaggerated extension. Should the nerve be but *partially* divided, we will have more or less permanent contraction of the flexors, with extreme extension of the foot (talipes equinus) ending in ultimate permanent distortion of the leg, unless the nerve is afterwards restored, when, even then, the restoration of the limb may never be permanently effected.

To repeat what was said earlier, while one or more of these conditions are very liable to follow nerve lesions, there are many cases where there is nothing to indicate any injury to the nerves, and the wound will heal without any untoward symptoms.

Before considering the *remote* consequences of these injuries, it will be necessary to take up the varieties of lesions, and the indications for treatment, both for the purpose of healing the wound, and averting, as far as possible, sequelæ. The injuries to which nerves are more particularly exposed are as follows: Contusion; compression; laceration; division.

(*a*). *Contusion* of nerves can hardly occur without contusion of contiguous tissues, and little doubt can exist of the nature of the injury. The symptoms depend largely upon the degree of contusion, both primary and secondary. In all degrees of contusion, less in extent than actual division of some of the fibres, the most prominent symptoms will usually be pain, primary anæsthesia, and secondary symptoms in great variety. The pain is usually neuralgic, and when the effusion is large, the condition may become chronic from some degree of organization in the effusion, particularly when the plastic material is within the nerve sheath. Should there be partial division of the nerve, symptoms as given above will come on, more frequently the parts supplied by the wounded fibres will suffer from paralysis. We thus find muscles partially paralyzed a common occurrence; paralysis of one portion, while another is intact. I think this is particularly the case in penniform and radiate muscles, less so in the fusiform. In contusions where the effusion is largely hæmorrhagic, the

suspension of function is likely to be of shorter duration than when it is serous, but should resorption not be fully secured, the impairment of function is often permanent. When the resorption of effused blood is long delayed, it occasionally happens that the nerve undergoes some destructive change, softening, ulceration, etc.—and the worst symptoms of partial section of nerve appears, such as irritation, muscular contractions and atrophy, distortion of joints, and permanent loss of function of the parts supplied. Complete division of a nerve is productive of the same conditions as when nerves are divided by other means, with the additional danger of the formation of neuroma about the ragged extremities. The nature of the injury, also, which crushes the fibres so as to induce devitalization for some distance above and below the point of division, adds to the complications; there is danger of the torn extremities forming attachments to near parts, thus keeping up constant irritation and tension; the loss of nerve-supply lessens the probabilities of repair of the neighboring parts injured, favoring sloughing and ulceration; and the detachment of the dead fibres threatens abscess, and pyæmic complications. Occasionally, even without visible division of the fibres of the nerve, its function is altogether lost, and atrophy or softening come on, with corresponding atrophy and wasting of the organs supplied. This is probably due to the unrecognized changes induced by concussion; up to the present, however, all theories explaining this lesion are purely hypothetical, and we are forced to recognize the fact without comprehending the actual condition. Finally, it will be observed, that any degree of contusion is exceedingly prone to give rise to persistent neuritis, neuralgia, or even to the formation of neuroma. Referring to what has been said of these conditions elsewhere, (*Surg. Therap.*), the pain will perhaps originate at the point of injury, but will be more continuously felt at the distribution of the nerve. Hence trace up the nerve until a point is reached where pressure will aggravate the sufferings, and there you can nearly always locate the maintaining cause. This will frequently be found to be adhesions of the nerve; small coagulæ, or plastic formations in the sheath, neurilemma, or surrounding parts; or a simple chronic thickening with inflammation.

The *treatment* of contusion of the nerves is to be conducted on the same general principles as in contusion of other tissues; *viz.*, abate pain, promote resorption, and guard against secondary conditions as far as possible.

Arnica, will be found a remedy of the first importance when the pain is aching, not very acute; effusion large, and chiefly hæmorrhagic. No other remedy acts as promptly in causing resorption of the blood.

Hypericum, when the pain is acute, effusion small, and there is evident division of the nerve fibres; particularly when the section is incomplete.

Ledum pal., is more or less useful in all cases of injury to the nerves, but particularly in complete division, with great coldness of the parts supplied, both subjective and objective.

Stramonium, will be indicated when tetanus threatens, with local muscular spasms.

Other remedies may be called for in special cases, but in the large majority one of these four will fulfil all the indications.

In the secondary symptoms, particularly indicating adhesion or irritation from coagulæ or plastic formations, I have reason to speak strongly in favor of exposing the nerve, by a free incision, and stretching it, at the same time removing, as far as possible, all irritating material or bodies, and cicatricial tissue as far as possible. The procedure is becoming too common to need reference to cases, but the pamphlet by my friend PROF. HELMUTH, on nerve stretching, will furnish abundant clinical testimony if not otherwise available. I can refer to one case in my practice, of reflex spasms from irritation of the popliteal nerve, which was cured completely by dissecting out the cicatrix, stretching the nerve, and the use of Stram. 30. I would suggest, on purely theoretical grounds, the propriety of administering *Hypericum* after such operations, with the hope to ward off the excruciating pain so commonly complained of.

(*b*). *Compression* of nerves, as the result of accident, is more frequently due to dislocations, fractures, lodgement of foreign bodies, or inclusion in a ligature applied to an artery. Apart from accidents, the growth of tumors, aneurism, neuroma, etc., are the prevailing causes. The consequences of compression are many and various. In some instances tetanus, in others neuritis, in still others neuralgia, but in all, to some considerable extent, atrophy of the parts supplied, and paralysis will be an immediate consequence. Stretching of nerves, from similar conditions, as dislocation, tumors, etc., will produce exactly similar symptoms, and is to all intents and purposes the same condition as compression. The more remote consequences of compression or stretching, are atrophy of the nerve, perhaps ulceration, and consequent loss of function of parts supplied. It has been observed that small interstitial growths between the bundles of fibres, will cause more pain and suffering than when large solid masses compress the whole trunk from without. Ligature of a nerve is always productive of intense pain, and has frequently produced death from tetanus. It has occurred by inclusion of a nerve in the ligature of an artery. The first indication in such a case, I think, when it can be accomplished with any degree of safety, is to remove the ligature and re-apply it. I have never had such an accident in my practice, but have seen it in one or two instances.

The indications for treatment are quite readily comprehended, and need not detain us long. Discover the location of the offending body and remove it. Remembering that the primary pain is at the point of injury, while the secondary is at the distribution of the nerve

there need be no difficulty in detecting the cause, if the attendant is as familiar with anatomy as he should be.

(*c*). *Laceration* of nerves are the most serious, in some important particulars, than any other form of lesion. The force inducing the laceration must be greater than in other instances, and the frequency with which nerves are torn off at the root makes it a matter of much moment. The causes are usually as were given when speaking of lacerated wounds, as well as efforts at reduction of ancient dislocation, or in attempts to break up anchylosis. The nature of the accident leaving an exceedingly ragged extremity to the torn nerve; subjecting it to extreme tension before giving way; the liability to lesions at the origin, and the serious injury simultaneously inflicted on other tissues in the neighborhood, combine to make these accidents peculiarly severe. Apart from this the symptoms and results are as in other cases of division of nerves. In the case of an individual in good health, the lesion may be repaired without trouble, and no unpleasant consequences remain; but under the most favorable circumstances we would expect to have neuroma, neuritis, and restoration of function, if at all — only after a long time. The *treatment* is as in the case of lacerated wounds, with *Hyperic.*, as the remedy particularly indicated to subdue pain.

(*d*). *Puncture* of nerves, as said elsewhere, is a frequent cause of tetanus; the pain, primary, of such injuries, is usually greater than from either of those mentioned above, and is oftener confined to the point of injury, at least is more intense there. Usually pain is felt immediately upon the receipt of injury, darting along the nerves both upwards and downwards, with remissions varying from a few moments, in recent cases, to days in those of a more chronic character. The symptoms in general closely resemble incomplete section of a nerve, with those of compression added. Individuals of an excitable "nervous" character, are prone to have hysteria follow slight punctured wounds, and it occasionally requires all the skill of the surgeon to determine the precise condition.

Ledum pal., has done me better service than any one remedy, in a number of such cases, particularly when administered early, and before any spasms or symptoms of trismus, when *Bellad*, or *Stram.*, will be called for.

(*e*). *Division* of nerves, with cutting instruments, has already been sufficiently described in the beginning of this chapter. It is only necessary to note, that nerves may be divided completely, even when very essential to life, but no impairment of function will follow, or at least any immediate danger to life. This is chiefly the case when the nerve has associated action, as the par vagus. In this instance the nerve on one side has been completely divided, and all its functions perfectly performed by the other.

We have next to consider the *method of repair* of nerve lesions. It may be laid down as a rule that unless the gap between the divided

extremities of the nerve is too great, and the external wound is not too large and free, perfect restoration will ultimately occur, and all functional life and activity be completely regained. As a matter of course much time must elapse before the nerve tissue is reproduced, and the paralyzed parts may have undergone extensive atrophic changes, which will require further treatment to correct. When the wounded nerve is exposed to the air through a free incision, the breach will be filled by cicatricial tissue, which will have a tendency to greatly prolong the reproduction of nerve fibres. When the wound is practically subcutaneous, as in the case of tendons, the breech is filled with nucleated blastema, which results in the formation of fibres, is less prone to contract adhesions, and will greatly facilitate the formation of new nerve fibres. The process is described by CLARKE, (Holmes, *Syst. of Surg.* IV, 163) as follows: "Both portions of the divided nerve retreat a little, and their extremities, especially the upper one, enlarge and become more vascular, while coagulable lymph exudes around and between them. In a short time this exudation becomes gradually firmer, and is found to contain cells and neuclei, and then fine nerve fibres, which proceed from the extremity of the central portion of the nerve to that of the peripheral portion, which, on being separated from its nervous centres, undergoes a gradual atrophy or degeneration. These newly-formed fibres are finer and grayer than those of the central portion of the divided nerve, and it is not until a period of some months, that they become fully developed. In the meantime a regeneration of the fibres is going on in the peripheral or atrophied portion of the nerve; but it is a long time before these fibres acquire the normal size and appearance." As said earlier, it may be a long time after the restoration of the nerve before the parts supplied by it recover their function. When this is unusually delayed, or much pain and irritation continue, the presumption is that the nerve has contracted adhesions, and the indications are to cut down upon it, free it of these adhesions, and slightly stretch it. The time that should elapse before a nerve is fully reproduced, varies with the age, temperament, and bodily condition of the individual. The rule is, that it proceeds *pari passu* with the healing of the wound in the other tissues, and should be almost complete when cicatrization is complete. In the case of nerves, therefore, of the size of the ulnar, a fortnight should afford sufficient time to restore the nerve supply, even if the fibres are not fully formed. In larger nerves, as the sciatic, perhaps twice that time. The degree of dispartition is also to be considered. Thus the ordinary retraction will not exceed an eighth of an inch; the time required may be doubled, it has been estimated, for each successive eighth of an inch. That is, if a fortnight will suffice for the ordinary separation, a quarter of an inch will require four weeks.

Quite recently PROF. LANGENBECK has employed fine sutures of carbolized cat-gut, to unite divided nerves. In some cases the cut

ends have been sutured together even after exsection of a portion of the nerve trunk. The degree of success is highly satisfactory, and there can be little doubt that the process will remain a recognized method of treatment in injuries to the nerves.

In the case of contused wounds, when the tissues are crushed down on the bones or some resisting medium, the adhesions by cicatricial, tissue to the deeper parts operates to either entirely prevent the repair of a nerve, or at most an exceedingly imperfect reproduction of fibres In one case like this, in the supra-orbital region, I had excellent results from excising the whole mass of nodular tissue, removing the extremities of the wounded nerve, and closing the gap in the integument by sliding a flap over it. The success was so great in this instance, that I cannot hesitate to recommend it in similar conditions.

II. The REMOTE CONSEQUENCE *of nerve lesions*, such as epilepsy, tetanus, hysteria, catalepsy, progressive paralysis, anæsthesia, and loss or modification of special senses, are all due to causes readily recognized, but the full understanding and comprehension of the morbid action in most instances is not yet, and perhaps never can be accomplished. We recognize the fact that complete section of a motor trunk, with failure to establish union between the cut extremities, must produce incurable paralysis; that partial section, may at first induce irritability, but why atrophy and softening of the fibres not divided should occur in one case, and repair of the divided ones in others cannot be explained.

As a matter of fact all these remote symptoms are due to one of the following conditions:

Adhesion of nerves.

Inclusion in nodular tissue.

Partial division and extreme tension of the undivided fibres.

Plastic formations between the fibre-bundles; organization of small coagula in the same situations.

Complete divisions, and no repair.

Complete division, and partial repair.

Complete divison, and extensive atrophy of parts supplied, which is not corrected when union is ultimately accomplished.

Perhaps there may be an occasional variation in the conditions of the nerve, but it seems, as far as my reading and experience goes, that one of the preceeding must be the cause for all the forms of morbid action.

In the case of paralysis from atrophy of muscles from long disuse and delayed repair of nerve lesions, Faradaism has long enjoyed a reputation as being the best remedial agent. With this single exception, electricity and galvanism, in all forms, and in all degrees of strength, has invariably disappointed me, and I think nearly every one who has ever used it. In every other species of lesion, the treatment must be purely operative, although remedies may be employed in the after treatment with good results. For this purpose I will refer

to the article on paralysis. (*Surg. Therap.*) The nerve must be exposed, freed from attachments, foreign material removed, or cicatricial tissue dissected out. The only difficulty in the majority of cases, will be to determine the nerve involved, and definitly localize the lesion. The success of the practitioner will, therefore depend almost entirely upon his anatomical knowledge, and manual dexterity.

XII. INJURIES OF MUSCLES AND TENDONS.

Muscles and tendons are exposed to many accidents, many of them having already been considered in previous chapters. Those more commonly met with, in addition to wounds, etc., are *ruptures*, and *strains*, and will alone be treated of at present.

I. RUPTURE OF MUSCLES.

While not of very frequent occurrence, the rupture of muscles is sufficiently so to make the subject one of interest to surgeons, and should be well understood by the general practitioner. All muscles, striped or unstriated are liable to this lesion, but the voluntary muscles are more particularly so. It has been observed that after death the muscles are easily torn, and the tendons will sustain great weight and traction without giving way; this had led some of the older writers to infer that muscular rupture was more easily induced than that of tendons. But it has been conclusively shown that in life the conditions are reversed, and whilst tendons are frequently torn with a comparatively slight exertion of force, muscles can only be similarly injured when great force is applied, or sudden unforseen, or spasmodic contraction is induced. It may safely be asserted that no amount of voluntary muscular contraction could produce rupture of the fibres; when the maximum of contraction has been reached, relaxation involuntarily occurs. Sudden forcible contraction, to guard against accident; or forcible extension as when a person falling from a height catches at some object to arrest his fall, are the commoner causes, but tetanic spasms have frequently produced such a lesion. From the former causes any muscle in the body may be torn, but from spasms, careful review of statistics show that the recti abdominis, biceps cruralis, or gastrocnemei are oftener injured. The text-books are full of instances of fracture of bones, the clavicle particularly, or rupture or detachment of tendons occurring rather than muscular laceration, and it is unnecessary to devote more attention to that point at present

We must not be understood as asserting that muscular action is alone responsible for division of muscles. As far as *rupture* is concerned, strictly speaking, this would be true; but lacerations from external agencies, produce analagous, if not identical lesions, except that the injury to the muscle-fibres is more extensive, extending far up into the body of the organ beyond the point of rupture, and even bundles drawn out entirely. Contusions, of the third degree, will likewise produce similar lesions, but we have a crushed and devitalized condition of the tissues extending for long distances above and below the

point of rupture. Incised wounds come nearer to being an exact similimum, as the injury to the part is confined to the point of injury, but they lack that peculiar paralyzing effect of sudden tension and separation. From these considerations, hastily presented, it can be at once seen that rupture of muscles from forcible contraction or extension, is an accident unique in its nature, and demands some consideration apart from wounds in general.

Rupture of muscles may be *partial* or *complete*, having reference solely to the number of fibres torn. Whichever occurs, the accident is one of exceeding gravity, as when proper coaptation is not secured the function of the part will be much impaired, if not completely and permanently lost. It is true, that in subcutaneous lesion nucleated blastema furnishes the bond of union, and results in the formation of fibres rather than the ordinary cicatricial tissue; but the muscular structure is never restored. A small portion of a muscle may be lost and no visible impairment of function follow; but there will be some loss of power, and some atrophy, particularly of the torn fibres must ensue. When the muscle is completely torn across, its functions are forever lost, unless the torn extremities are at once approximated and retained in position until united. Even then, under the most favorable circumstances, the full power and usefulness of the muscle can never be regained. We have already considered the changes that take place in a muscle divided transversely, in many places, and will simply state here, that the loss of function is due to one of two causes, or both together in certain cases. The cicatricial or fibrous tissue forming the medium of union, is non-elastic, and being interposed between the origin and insertion of the muscle, must furnish the point upon which the force in contraction is exerted. To further complicate matters, during the healing process, some atrophy of the fragments must take place, particularly the distal extremity. When the healing process is complete, therefore, we find any attempt to use the muscle is frustrated from the traction being on the new tissue, and not at the point of insertion; indeed the distal fragment makes traction in the same direction. Should the injured muscle be one of a system, as *one* flexor or extensor of the leg or arm—we may not oberve any want of power, as the uninjured muscles in the system will acquire increased strength. As time passes on, the lost function is not restored, as happens in other lesions (as of the nerves), as the muscle atrophies, or undergoes fatty degeneration, and soon ceases to act at all. The *second cause* of loss of function, is the adhesion of the torn extremities to near parts, either bone or fascia. In certain exceptional cases, especially when the nerve supply is interrupted, the proximal fragment may completely disappear, or cease to act, but the distal, from the completeness of the nerve attachment, will retain its function, and little loss will be perceived. This is less frequently the case, as the point of rupture is usually near the tendonous attachment of the muscle, leaving little more than the tendon below the point of divi-

sion. Such muscles as the coraco-brachialis, the brachialis anticus, or the trapezius, might retain useful function, in many instances, but never can escape some considerable loss of power. Should, however, the torn extremities be at once approximated, and retained in close apposition until union is secured, a few muscular fibres may unite by immediate union, and from this a more or less complete restoration effected. The presumption is, in all cases, from the effusion of blood, the retraction of the fibres, and the difficulty of retaining the parts in apposition, that union must be very imperfect, and function not only correspondingly lost, but its re-establishment very problematical. Without reduction, owing to the wide gaping that must ensue, no return of function can be looked for.

Symptoms.—The first indication of muscular rupture will be a sudden intense pain, as if struck with a stick, with either complete loss of motion in the part, or avoidance of motion from the pain it causes. The nature of the pain, and the history of the injury may cause suspicion of fracture or dislocation, but careful examination should readily settle the question. The pain is generally excessive, at first referred to the point of injury, but soon widely diffused, and during quiescence cannot be localized; on making or attempting motion, however, it is readily referred to the point of injury. The distance from a joint, will serve to exclude luxation, and the absence of mobility in the bone and the ordinary signs of fracture, will exclude that supposition. Being in the near neighborhood of a joint, the mobility of the joint, under passive motion, will forbid suspicion of dislocation. On examining the region to which pain is referred, should the rupture be partial an accurate diagnosis can rarely be made, unless the case is seen immediately, and the injured muscle is very superficial. The case will seem a bad strain, and being treated as such will do as well, perhaps, as if the condition was accurately determined. When the lesion is *complete*, however, unless too much time has elapsed, the diagnosis is usually easy. At first there will be a perceptible gap, due to the wide retraction of the torn edges, and apart from the pain, no amount of effort can produce proper action of the muscle. An attempt to produce contraction will further increase the gap, and the torn extremities will be drawn up in knots. When seen later, say after the lapse of two hours, the former depression becomes a ridge or welt, more or less discolored, at first soft and fluctuating, later firmer and doughy. This is due to the effusion, largely hæmorrhagic, and should be recognized by its breaking down under the finger, thus differentiating from the proper muscular tissue. Usually the point of separation will be near the tendon, thus leaving little muscular tissue below.

The treatment will be a relaxation of the muscle, by proper position, and its continuance for some time. Thus if a flexor is torn, extreme flexion is to be obtained, an example being in the calf of the leg. Flex the leg to a degree just short of positive pain, and by attaching a

strap to the heel of a slipper, and securing the other extremity to a circular bandage of the thigh, relaxation can be continued for an

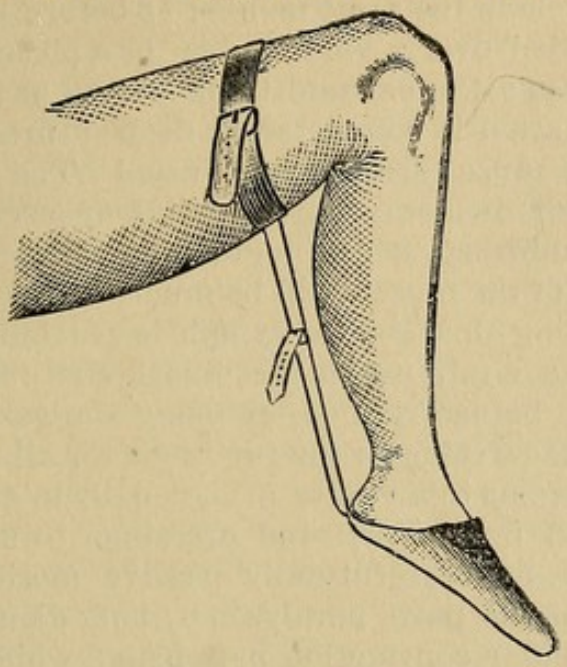


FIG. 16. Slipper and bandage applied.

indefinate time. The jerking of the muscle can be controlled, usually, by *Cuprum acet.*, or if this fails, with *Ruta grav.* The next step is to endeavor to bring the extremities together. In some instances this can be done at once, but in the majority a sufficient time must be allowed for the irritability of the muscle to subside. This will require from one to three days. Under chloroform the fragments must be approximated, and a strong wire suture passed in such a manner as to bring them closely together. It may require some ingenuity to effect this; in one case I proceeded as follows: A long strong needle, fixed in a handle, with an eye in the point, was entered near the extremity of the lower portion of the muscle, in the space left by the retraction, and passed up underneath the upper portion, and through it and the integument. The thread was now withdrawn, and retained, while the needle was withdrawn, and re-entered, though the same opening, passing out of the same opening of exit occupied by the thread, *above*

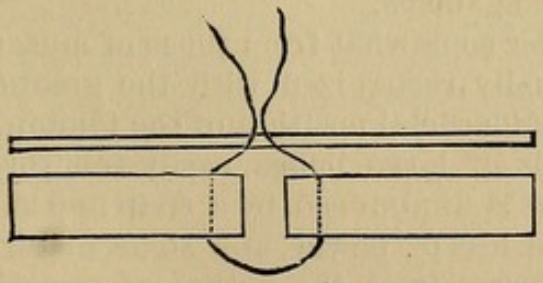


FIG. 17. Entrance of needle.

the muscle; that is between it and the skin. The thread was again passed into the needle, and both withdrawn through the original opening of entrance. We now had the upper portion included in a loop of

the suture. The needle was now armed with the opposite extremity of the suture to that previously used, and passed through the lower portion of the muscle in the same manner as before, and the two ends drawn tight and tied over a small roller or a piece of gutta-percha catheter. This brings the extremities into more or less close apposition, and the coaptation is completed by deep sutures, including both extremities of the muscles, and tied as usual. The sutures are to be allowed to cut their own way out, which may occupy a fortnight. When this is accomplished, whilst union is far from being complete, yet the irritability of the muscle will be much overcome, the remedies given much assisting this, and the lymph is partially organized. In the case referred to, a fair use of the muscle was regained, but how much could never be ascertained, it being the gastrocnemius—the plantaris and soleus carrying on the functions for all three very fairly. When the union seems to be quite firm, usually in about fourteen or eighteen days, and not before—the dressings to secure relaxation should be removed, and careful daily passive motion instituted to restore the action of the parts paralyzed by long disuse, as well as to avoid sudden muscular contraction or tension, which would weaken the band of union, if it did not reproduce the dispartition. Friction several times a day should be practiced, and the limb treated and manipulated as after fracture or dislocation.

II. RUPTURE OF TENDONS.

To repeat what was said above, whilst in the dead body muscles tear easier than tendons, in the living body the reverse is the case. Force that fails to seriously injure a muscle, has frequently caused fracture of a bone, and in many instances tendons have been torn from their attachments, or ruptured in their continuity, the latter with far greater frequency. While all tendons are more or less exposed to this accident, from some reason, probably the strength of the muscles of which they are continuations, the tendo acchiles, rectus femoris, or triceps brachialis are oftener ruptured. The *causes* are precisely similar to those mentioned under rupture of muscles; spasmodic action, sudden forcible contraction of the muscles, or over stretching from external mechanical agencies.

The symptoms differ somewhat from those of muscular rupture, and the accident is usually recognized with the greater facility, chiefly from the generally superficial position of the tendon, and its insertion in or near the heads of large bones, easily felt through the integument. The accident is announced by a snap and shock, with little if any pain, immediate loss of power, and some distortion of the member, in many instances, from the action of opposing muscles. On examination the gap between the torn extremities will be readily detected, and there is much less subsequent swelling than in the case of the muscles.

The *method of repair*, has been frequently alluded to, but may be

briefly recapitulated. There can be no doubt that the fibres of a tendon are largely seperated from each other by a continuation of the saccolemma of the muscle, but whether the fibres are capable of independant action is a mooted question, I think surgical practitioners are now largely to be found committed to the doctrine that they are. That is, a portion of the fibre may become useless, and the remainder continue in full functional activity; this is given by TAYLOR and others, as the cause for talipes, and other distortions of joints, when a part is twisted from an unequal tension by opposite sides of a muscle. Admitting the truth of this, it would seem that we can scarcely look for a complete restoration of a lost tendon; part of the fibres may become agglutinated from plastic exudation between them. When all the fibres are in this condition, as far as mere flexion and extension of a part are concerned, function may not be notably impaired; but under other circumstances there must necessarily be some loss of the mere complex motions, and such I believe to be the case. The retraction is usually extreme, unless the rupture is partial, (which is a very uncommon occurrence,) and the space is soon filled with plasma, which in time fully restores the part. The time required to fill up this gap and reproduce the tendon, varies with each case; it will be very greatly modified by the amount of retraction, the degree of quiescence maintained in the muscles attached , and the bodily health and age of the sufferer. The aged, or those suffering from chronic ailments, dyscrasia, or who from any cause recuperate from depressing influences slowly and imperfectly, must in the nature of things require more time to repair loss than others more hapily situated. The medium of repair being nucleated blastema, fibres will be formed, rather than cicatricial tissue, and while some contraction of the new tissue must take place, it is not to the same extent, nor will adhesions form as frequently as when nodular tissue is formed.

The indication for *treatment* are precisely the same as in the case of muscular rupture, except the use of sutures. We must, therefore, put the parts in the best position to secure extreme relaxation of the muscles, without inducing pain, and keep them there until the new tissue has attained some degree of soli lity. Passive motion must be made for a time, to gradually restore motion, and in all respects treat the case as one of muscular rupture. Unless some accident occurs, or the force producing the rupture was a direct injury, involving the integument, as a contusion, there should be no inflammation during the reparative process.

III. STRAINS.

Strains and *sprains* are commonly spoken of by practitioners, and some text-books repeat the mistake, as being one and the same condition, when in fact there is a wide difference between them, and the prognosis and treatment are different. By the former we understand an injury to muscles and tendons, due to severe over extension, from

accident, etc., with laceration, in many instances, of some few fibres The condition is similar to contusions, and may indeed be considered the same condition. A *sprain*, on the other hand is a sub-luxation, a slight dislocation of a joint, with a condition of straining added thereto.

The *causes* of strain are similar to those producing rupture, but less violent in kind. Severe, long-continued, unusual muscular exertion; sudden, unguarded, forcible muscular action. The fibres are put into violent contraction, or on the stretch, some few may give way, but the general condition will be one of extension short of actual rupture.

The *symptoms* are sudden violent pain, sometimes continuing for days without reference to muscular action, and again lessening after the lapse of a short time, and only felt when the muscle involved is brought into action. This later disappears, and a feeling of weakness and loss of power will remain for a long time, months in some cases. At first there will be some symptoms of inflammation, swelling and tenderness of the part, but it will soon pass off, and unless pressure be made on the part, or attempts at motion are made, no inconvenience will be experienced.

The *result* is usually a complete restoration of function, although when there has been much inflammation, adhesions to near parts may be feared, and a corresponding loss of usefulness.

The distance from a joint, the absence of swelling or inflammation and the absence of pain *in* the joint, as a rule, on passive motion, will serve to differentiate between a spasm and strain.

The *treatment* presents few indications. Quiescence of the part is *sine qua non*. This alone will usually speedily remove all symptoms *Aconite*, should there be much fever; and *Rhus*, for the pain and loss of power, will be all the remedies required in ordinary cases. Cooling applications, or hot ones when there is much inflammation, may be used, but simple avoidance of motion will usually be all that is required. When the muscles are irritable, or the patient is exceedingly nervous or hysterical, bandaging will give much relief, but is must not be continued beyond a day or two, as the muscles may suffer from such confined quiescence in many ways.

IV. SLIPPING OF TENDONS.

Tendons are occasionally dislocated, when they pass over or around bony prominences, or in grooves, and if the accident is neglected serious impairment of function may ensue. Mechanical forces of all kinds, as in the case of rupture, may be the cause, but in the majority of instances, the cause will be a long retained mal-position of a joint, or the gradual distoration from chronic rheumatic or arthritic complaints. A number of cases of slipping of the tendons of the tibialis posticus, flexor longus digitorum, and flexor longus policis, are noted from the habit of wearing high-heeled shoes, and in the case of ballet dancers. When such accidents are acute, from causes such as above,

the cure is not at all times difficult; but when chronic diseases, such as rheumatism, are the cause, it is well nigh hopeless to attempt relief.

The first indication is to replace the tendon, and next to retain it in position. The first is usually easy of accomplishment. The second may require some ingenuity, and no fixed rules can be given, each case requiring especial consideration. The member must be put in a position to relax the tension of the muscles concerned, and kept there. Judicious use of compresses, and light bandaging will be required for complete retention. *Acon.* or *Rhus*, must be used as above, and all use of the member be prohibited, until a reproduction of the accident seems improbable.

XIII. INJURIES OF THE JOINTS.

The joints are exposed to many forms of injury, some of which are peculiar to themselves, and others common to all tissues and organs. From the important nature of their office, their peculiar construction, into which a great variety of tissues enter, and the proximity of important vessels and nerves in most instances, the joints have always constituted an exceedingly important and interesting chapter in surgery, and engaged the best talent in the profession in the study and arrangements of the maladies and accidents to which they are liable. For our present purpose we will consider the following accidents, which will include, I think, all that could properly claim attention in a work of this character: Wounds, contusions, sprains dislocation of cartilages, and dislocations in general.

I. WOUNDS.

Under this head, only such wounds as open a joint can be considered, notwithstanding many authors include all such injuries in their immediate vicinity. The reason for this is obvious. A joint is composed of the articular extremities of the bones entering into its composition; the cartilages interposed between these surfaces; the synoval membranes, and the ligaments. It is true that tendons crossing the joints have much to do, in some instances, with adding strength and protection to the parts, but they are not properly portions of it. For this reason only such injuries as are sustained by the proper articular tissue should be considered.

The gravity of a wound of a joint, depends upon several circumstances, chiefly upon the nature and extent of the injury, and the character of the joint. The dangers are two-fold; in loss, or modification of the joint itself, and placing the life of the patient in jeopardy.

(*a.*) The *wound* is more serious, under all circumstances, in proportion as the cavity of the joint is more completely opened, and the injury to the tissues is the result of great force. Thus a very free incised wound places the patient in greater danger than a smaller one, but a laceration, or contusion of *any* degree, would be far more serious than an incision, even when the lesion is quite extensive. JOHN BELL (*Discourses on Wounds* part III p. 12,) long ago affirmed that to open an inflamed joint was death, and the aphorism is true, to a certain extent, to-day. The records of our large hospitals, and particularly those of our armies during the late civil war, furnish a large mass of material, and it is conclusively shown, that whilst life and usefulness of the part has been preserved after very extensive lesions

of this nature, the mortality is large; indeed when fracture of the joint has occurred, as from gun-shot injuries, the prognosis is always bad, having reference particularly to the size and complexity of the joint. Not to take too much space, let me refer, in this place, to the results of wounds to the shoulder joint as given in the *Medical and Surgical History of the War* (*Surgical vol. part II.*) The difficulty in properly estimating the mortality lies in the fact that all injuries in the neighborhood of the joint are included under this head, some of them not opening the cavity, and others not involving the proper articular tissues at all. There were treated on the *expectant plan*, 505 cases, with a mortality of 139. We read (p. 514.) "It was found that the immediate cause of death was referred to pyæmia in thirty-seven instances—to hæmorrhage in fourteen—to hospital gangrene in seven, to phlegmonous erysipelas in five, to tetanus in five. Nearly half the fatal cases are thus accounted for, of the remainder, some appear to have died from the effects of protracted suppuration, some from 'surgical fever,' others from intercurrent pulmonary disease, while in many instances, no indication of the cause of death is assigned." We are justified in adding the "surgical fever, prolonged suppuration, and pulmonary cases" to the pyæmia group, and thus find the prevailing cause of death in that condition.

Of cases treated by operation, there are reports of 1737, with a mortality of 541. A table is given on page 599, which I will condense as follows:

EXCISION.

Primary	518	Deaths	160
Intermediate	224	"	104
Secondary	92	"	27
Undetermined	51	"	14
	885		305

AMPUTATIONS.

Primary	499	Deaths	117
Intermediate	157	"	72
Secondary	66	"	19
Undetermined	130	"	28
	852		236

EXPECTANT.

Cases	505	Deaths	139

The whole number of such injuries to the shoulder are thus found to be 2242, with a mortality of 680, or nearly one-fourth. The mortality must be considered enormous, when we take into consideration that many, perhaps half these cases, were not properly wounds of the

joint, and that nearly all the fatal cases were those that had the joint opened, We learn several important lessons from these tables. We are first impressed with the exceeding gravity of the accident; secondly that expectancy offers less inducement than more radical treatment; and lastly, that amputation, in military practice at least, is to be preferred to excision. This point will be discussed in another place, but it is sufficient to point to the long confinement, profuse suppuration, and the tardy repair necessarily connected with excision and resections, to enable us to comprehend the reason for the better results from amputation. We can derive much satisfaction by comparing our results with that of foreign armies, and possibly time will enable us to treat injuries of the large joints as successfully as other lesions. The following is condensed from page 607 (*loc cit*), and introduced here as a subject of interest solely:

	Cases.	Deaths.	Ratio.
Crimean War, 1854–6. *Russian.*	20	11	84.6
Crimean War, 1854–6. *French.*	42	24	57.1
Crimean War, 1854–6. *English.*	16	3	18.7
Franco-German, 1870-71. *German.*	126	48	38.
Franco-German, 1870-71. *French.*	24	15	62.5

Whilst injuries to a single joint have been given the above space, the results noted are a fair exhibition of the gravity of such accidents under other circumstances; the knee and hip would exhibit a greater ratio of mortality.

The danger particularly attending wounds of joints has been said to bear some proportion to the nature of the joint, both with reference to its function and its constitution. Perhaps in the majority of instances, the injury inflicted on the synovial membranes is the immediate cause of the violent symptoms characterizing these accidents. From its close resemblance to serous membrane, inflammatory action must spread with great rapidity. Hence, when the part injured is unusually well supplied with this membrane, the menace to the integrity of the joint, or the life of the patient, is greater than when the opposite is the case. Other things being equal, we should therefore expect to find the ankle and wrist to exhibit graver symptoms than joints of simpler construction, and such is really the case; but while the loss of the joint by subsequent achylosis is more certain, than when larger articulations are involved, danger to life is not so great. The inflammation being necessarily attended by a largely increased secretion, the exposure to the air soon induces degeneration, suppuration is profuse, and the other structures of the joint are more or less injured by it. Should the air have been excluded, wholly or partially, there may be less tendency to suppuration, but the plastic effusion predisposes to fibrous or false anchylosis. This point, it will be shown, is of particular interest in connection with treatment.

Next to synovial injuries, fractures of the bones or intra-articular

cartilages adds to the elements of danger. The danger, in this instance, is from bony anchylosis, whilst diffused inflammation, and suppuration, are not a whit lessened.

The injury to the ligaments also plays an important part, and must not be overlooked; they may unite closely, form new and vicious attachments, or even atrophy and almost disappear.

The greater freedom of motion in a joint, the less danger, as a rule, threatens life or function. This is, however, solely with reference to its nearness to the trunk, as while injuries to the hip are sufficiently serious under existing circumstances, if the joint were one like the knee or ankle, in the same locality, the danger would be infinitely greater. Thus in forming prognosis, the following guide may be taken as indicating in a rising scale, the degree of danger to life: Hand, toes, wrist, ankle, elbow, shoulder, knee, and hip. Other things being equal, joints of limited motion, as the knee, elbow, tarsus and carpus, will be more certainly followed by more or less loss of usefulness, than any of the others mentioned above.

(*b.*) The *character of the wound*, whether punctured, lacerated, contused, or incised, must enter into our prognosis largely. The rule may be stated, that the danger is lessened in proportion as the cut is smooth, and of sufficient size to give free exit to discharges without injuring ligaments, or injury to the bones. With proper precautions to subdue or prevent inflammation, and to secure early union of the divided tissues, incised wounds occasionally heal with no considerable loss of usefulness. When the parts are torn, or crushed, or the opening is so small that the discharge cannot readily find exit, but particularly when the bones or articular cartilages are injured, the prognosis is far more grave. The devitalization of some portions of the injured tissues, furnishing many small sloughs, and introducing into the deteriorated secretion many particles of dead tissue, the causes for inflammation are much increased, and the unhealthy character likewise. We must not omit mention, also, of the serious shock that always accompany such accidents. From the complete destruction of the tissues injured, the repair is slower, new tissue being demanded, instead of a simple union of divided parts. Life is placed in danger, therefore, from purulent absorption, shock, diffuse inflammation, profuse suppuration and exhaustion; any dyscrasia that may exist will necessarily place the sufferer in greater danger, the peculiar nature depending upon attending circumstances, as well as the nature of the dyscrasia.

With reference to the integrity of the parts, there are very many considerations. The joint may be lost through anchylosis, which simply entails loss of usefulness; it may assume a position that causes constant anoyance; in some instances, the position may be such that the usual occupation cannot be followed, or even expose the sufferer to frequent danger. These considerations frequently present a question of amputation or resection for solution.

Treatment.—From the foregoing, the indications to be fulfilled are very obvious. First to place the parts in the most favorable position for healing, and to promote union and lessen inflammation. These are to be met as in the case of wounds of other tissues, bearing in mind the readiness with which inflammatory action is set up, and the rapidity with which it extends. It is thought by many excellent authorities that the danger or certainty of inflammation is directly proportionate to the degree of pain, and probably, to some extent, caused by it. If this is true, and my own experience inclines me to that opinion, *Hypericum* should prove a remedy of great value. Whether it is due to the use of this remedy, or that I have had a remarkable selection of cases, certainly I cannot recall a single case of wound of the joints, that did not do much better than the best authorities would lead one to expect.

The second point of interest and importance, is to prevent anchylosis. There are two methods in practice, radically opposed to each other, the respective merits of which have for some time past been the subject of animated controversy. Anchylosis being, for the most part, a result of inflammation, the question has been whether it is better to maintain perfect quietness and immobility until union of the divided parts has been secured, or institute gentle passive motion. Unquestionably voluntary motion of the joints would exert inflammation from the complex character of the mechanism put in operation, and the derangement, that must take place, of the parts undergoing repair. Gentle passive motion, made at long intervals, and to a slight degree only, cannot be open to the same exception, and when care is had, so far from the inflammatory action being increased, the tendency will be to prevent lymph organization, and also assist its resorption. With this view of the case, I make it a practice to wait for the subsidence of the more acute symptoms, and then commence by gentle flexing and extending the joint, to a very limited extent, and only for a moment. Each day, when the operations of the preceeding day are found not to have induced irritation, increase the degree of motion, and lengthen the time. Should there be any untoward symptoms, as pain or inflammation, further treatment must be suspended until they are subdued. Gentle friction might be conjoined with this, or be alone practiced for a day or two in the commencement.

Should all means fail, and anchylosis appear to be unavoidable, we can only attempt to secure as useful a position of the part as possible, with reference to the occupation of the patient. In the absence of any special indications of this kind, a slightly flexed position is the best, and when the elbow is concerned, also semi-pronation.

When in spite of all that can be done, muscular contraction, vicious tendonous attachment, or loss of tissue in the joint produces deformity, that is not only unsightly but may endanger life or limb from exposure to accident, operative surgery must be resorted to, and ampu-

tation, excision, or some other operation practiced, according to indications laid down elsewhere, as well as in text-books in general. Caries, necrosis, chronic abscess, sinus or fistula, and many other chronic conditions may arise secondarily, and must all be treated on general principles, the cause not entering into the consideration of the case to any extent.

Symptoms as they arise must be met with the appropriate remedy, and the many forms which they assume, and their varying importance in persons of different conditions and habits, forbids any consideration at this place. They must be regarded precisely as if no wound existed.

II. CONTUSIONS.

Contusions in the neighborhood of the joints, are of interest chiefly from a diagnostic standpoint, the symptoms being at times so similar to much more serious accidents, that an accurate conception of the condition is almost impossible. Apart from this contusions present no special point of interest, at least with the exception of the possible results. A contusion of the first degree will be likely to provoke some articular inflammation, but in the absence of any dyscrasia, the effects are not usually serious. Contusions of greater severity have all the effect of wounds of the joint, with the exception of the admission of air. The nature of the injury, however, has an especial tendency to set up suppuration, and the absence of an outlet, with the obscurity of the symptoms (from the dense nature of the tissues,) makes such an occurrence one to give the surgeon much concern. This lack of distensibility in the proper articular tissues, greatly favors some destruction of the bones and cartilages; escaping this, there is a possibility of the pus finding its way, through quite minute openings, to distant parts, forming long sinuses, and quite seriously crippling the member. Pyæmia, septicæmia, irritative fever, metastatic abscess, and even tuberculosis being each readily set up from severe contusions, or even those of the first degree, in dyscrasic or cachectic individuals, renders the subject one of particular and especial interest to all experienced surgeons.

The *treatment* does not differ from that of contusions in general, unless it be in the event of suppuration. Immediately that the presence of pus is recognized, any surgeon would evacuate it; the difficulty will be to determine this point. An exploring needle or aspirator must be appealed to in every case about which there is a shadow of a doubt, as the consequences of opening a joint are serious and not to be lightly encountered.

It was said above that contusions often simulated other and graver accidents; this is of frequent occurrence, particularly in the hip-joint, and fracture or dislocation has often been suspected. The pain resulting from severe contusions will often be so severe that all motion of the part will be impossible; at other times, with less pain, perhaps

the injury sustained by the nerves will induce a paralytic condition that prevents muscular action on exertion of the will. Such cases must cause a suspicion of dislocation or fracture, and careful examination must be made. For this purpose place the patient under the influence of chloroform, and examine on principles laid down later under *dislocations*, and in another place under *fracture*. In the majority of instances, the symptoms will more closely resemble fracture, as moving the part, when under chloroform will not exhibit any rigidity. There will be, however, no alteration in the radius described by the head of the bone on motion, when compared with the opposite side, and no shortening of the limb, no deformity, and no crepitus as a rule. There may be apparent shortening or deformity, due to malposition of the pelvis or shoulders, which will disappear when the parts are placed in proper position. There may be crepitation, due to synovial inflammation, but it will be more of a crackling than grating; furthermore there will be no displacement of the bone during the effort to excite crepitus. The elicitation of these negative signs, therefore, will usually suffice to exclude the hypothesis of fracture. On the other hand, there are a few cases in which we find preternatural rigidity, due to nervous irritation and muscular contraction, sometimes even continuing after partial anæsthesia. Profound anæsthesia, however, will invariably cause relaxation, and the absence of the rational signs of dislocation, as given elsewhere, will at once establish the diagnosis. Nevertheless cases occur which will deceive the most experienced. Two are given by MR. HOLTHOUSE, (*Holmes* II p. 838,) and numerous others are found in the text-books, and scattered through the journals. I have not had the privilege of seeing such a case, and have no personal experience to offer.

III. SPRAINS.

A sprain is a sub-luxation of a joint, usually a very trifling displacement, and in most cases of only momentary duration. The inelastic nature of many of the tissues entering into the formation of a joint and in the case of large joints the complexity of the parts, makes a slight displacement productive of much pain, and even when the parts immediately return to their natural position, they can hardly expect to escape scathless. When the joint is one that has free motion, the displacement may be greater, and should the injury be severe, may be complicated with a strain, or even actual muscular rupture. Arteries may be ruptured; nerves torn or stretched; synovial membranes pinched or contused; inter-articular cartilages displaced or fractured; tendons partially or wholly torn from attachment; and even the bones slightly fractured. Whilst, therefore, any sprain is a very painful accident, and in the case of persons in poor health even a menace to life or the preservation of the part, the symptoms and their significance must depend upon the extent of the injury, and the character of the joint. The symptoms, all things being equal, are

more severe in joints of limited motion, as the knee, elbow, wrist, and ankle, but when other joints, as the hip or shoulder are involved, the force applied must have been greater, and the general symptoms will be more severe.

The *causes* are usually from indirect application of force, by which the joint is twisted, or bent in an abnormal direction. That is force applied directly to the joint, will rarely cause a strain, contusions or dislocations being more common. The accident is usually produced by the foot, or hand, being caught, as by machinery, and the limb wrenched or twisted. The same conditions are fulfilled when the foot is caught when walking, or a false step is made with some degree of violence; in fact anything which fixes one extremity of the limb, and the motions of machinery or of the body twist or violently pull the other..

The *symptoms* are immediate pain, and loss of power, with swelling more or less discoloration, and heat. The discoloration will be in proportion to the arterial or venous lesion; when the vessels are not torn, it will appear as a secondary symptom when the circulation of the part is interrupted by the swelling. The pain is at all times severe, but is greater or less in proportion to the degree of the primary displacement, the extent of injury inflicted on the nerves and other parts, and the function of the limb. When quiet, after the first few days, the pain is insignificant or even wholly wanting; the slightest motion will, however, excite it again. Thus in the case of joints contantly in use in locomotion, or the ordinary exigencies of life, pain will be greater and more constant than under similar circumstance, elsewhere. The swelling depends upon many circumstances; chiefly upon the laxity of the surrounding and proper articular tissues, the degree of injury inflicted upon the synovial membrane, and the blood-vessels; and the extent to which impediments to circulation exist. The duration of the primary symptoms may extend from twenty-four hours, or less, in the lesser joints, to weeks or months in the larger; indeed, some impairment of function will continue for an indefinite time in all cases.

The *treatment* cannot be entirely medicinal, in all cases at least; rest, proper position, and some bandaging or local applications being frequently called for. In sprains of any severity, the part must be at once put into the position that gives the greatest freedom from pain, and retained so, if necessary, by proper bandaging, or even splints as in fracture. The dressings must be frequently inspected, so that they may be loosened if too tight, or tightened when becoming loose from subsidence of the swelling. As a matter of fact it is best to postpone bandaging until the primary symptoms and swelling have abated. *Rhus tox.* is the remedy that will first suggest itself to any student of materia medica. The doses should be given at intervals of an hour, until some relief is experienced, and then gradually diminish in frequency.

Ruta grav. is of value when there is more of a feeling of weakness, than positive pain, but should always be given, I think, if relief does not follow in a few hours from *Rhus*.

Arnica, may be given should there be much effusion of blood, more particularly if the injury was direct.

When the more acute symptoms have subsided, gentle passive motion may be made, but full use of the member must never be permitted until it can be had without pain. Some authors recommend cold applications; some hot; some alternating these rapidly; others friction; others again perfect non-interferance. Combined with the use of remedies as indicated, this latter is the safest. I have seen no good results follow any of the other methods in vogue, and have of late settled into reliance on remedies, perfect rest, and exceptionally bandaging. Many cases have been treated in this way, some very severe of the lumbar spine, knee and ankle, and days have sufficed to produce a perfect cure, when weeks or months are consumed under other methods.

IV. DISLOCATION OF CARTILAGES.

The semi-lunar cartilages of the knee are occasionally displaced, partially or completely, as far as their attachments are concerned, and not only constitute a very painful accident, but establish a habit which more or less cripples the sufferer, as well as gives rise to secondary affections that are often serious in their consequences. There is a condition in which there is an unusual laxity of the ligaments, permitting lateral motion in the joint, and occasionally the sub-luxation extends so far to one side that the condyle of the femur rides up over the thick border of the cartilage, and is sometimes replaced with difficulty. This is not what I consider a luxation of the *cartilages*, although GROSS, and some other authors of unquestioned reputation, so consider it. HOLTHOUSE (*Holmes* II p. 916,) does not agree with these authorities, and MALGAIGNE, COOPER, LARREY, HEY, and many others, describe cases in which the cartilage is displaced, without any displacement of the bones of the articulation. All of these eminent writers agree that with a normal condition of the parts such an accident cannot occur, and state that chronic inflammation is the chief predisposing cause, which thickens the cartilages, and at the same time somewhat weakens their attachments. The accident having once occurred is liable to be frequently reproduced, on very slight provocation, and ultimately will render locomotion almost impossible, unless the joint is supported by elastic bandages, or some artificial aid. Another frequent consequence is, the fracture of the cartilage, small particles being broken off and detached, forming what are called false or "floating cartilages."

The *cause* is usually a twist of the foot, by a misstep in walking, by which the leg is rotated inwards. The accident is announced by a sudden violent pain in the knee, with loss of motion, and flexion with inability to extend the leg. If the case is seen at once, tactile examin-

ation will reveal the edge of the cartilage projecting beyond the edge of the head of the tibia, and some swelling of the part. Later the pain *may* abate, though never entirely disappear, and the joint will become swollen, to almost any extent. Occasionally reduction will be effected spontaneously, particularly when the displacement is slight, or the accident has been frequently repeated. After such an accident has been repeated a number of times, the patient also will become so accustomed to reduction, that he rarely applies for surgical assistance.

The indications for *treatment* are few and simple, and ordinarily readily fulfilled. In the majority of cases firm pressure with the thumbs, joined end to end, the remainder of each hand grasping the joint, will induce reduction, which is announced by a disappearance of the projecting ridge, and a complete subsidence of pain, with restoration of mobility. When there is some associated partial luxation of the knee, extreme flexion, with sudden extension and combined external rotation will usually be all that is required. It will be necessary, particularly when such accidents have not been frequently repeated, to give a few doses of *Aconite*, after reduction, followed by *Rhus*, if the pain does not abate. When the ligaments are lengthened and the joint liable to partial displacement from that cause, judging from its action on the ankle joint, I can strongly recommend *Brucea*, or *Pinus syl.*, as mentioned in *Talipes* (*Surg. Therap.*) An elastic bandage should also be worn, as an additional support, and movements that experience has taught will induce the accident are carefully avoided. Should false cartilages be found in the joint, and no symptoms of chronic inflammation, I should have no hesitancy in fixing them, and cutting them out. Indeed I have done this in several instances, and have observed no ill-efforts to follow.

When an accident of this nature occurs in a person of debilitated or cachectic habit, more particularly on its first occurrence, dangerous inflammatory affections may be set up, such as caries, suppuration, or even necrosis. Each succeeding attack, however, whilst they naturally weaken the joint, lessen the danger of inflammation, until finally they are scarcely noticed, and cause but momentary inconvenience.

V. DISLOCATIONS IN GENERAL.

A dislocation is a displacement of two or more bones entering into the composition of a joint, with or without injury to near or associated parts. All surgeons of experience are agreed that there is no department of surgery that makes such demands upon the resources of the practitioner, that necessitates more accurate and profound knowledge of anatomy and mechanics, or of physiological and pathological processes. In fact HAMILTON (*Fractures and Dislocations* p. 499,) says: "Let a man practice any other branch of surgery if he will, without experience or scientific knowledge, but he must not attempt to reduce dislocated bones. The most learned and the most skilful we shall find falling into error, embarrassed by the uncertainty of the diagnosis, or

successfully resisted by the power of the opposing agents; what then can be expected of those who are both ignorant and inexperienced, but failures and disasters?" This is the universal testimony of those qualified by experience to speak, and it is evident that too much care cannot be taken in mastering the elements of this subject. I shall in this chapter, therefore, confine myself to the consideration of dislocations in general, leaving the special or local features until we reach injuries to special organs or parts.

Dislocations are classified with reference to the condition of the parts, as simple, compound, and complicated; to the degree of displacement, as partial, and complete; to the duration, as recent and ancient; and with reference to the time elapsing since exposure to the accident, into primary and secondary.

(*a.*) *Simple luxations*, are those in which the bones are simply altered in their relations, without injury to other structures. This would constitute the mildest form, and in the majority of instances can only represent a partial dislocation, unless it occur in joints like the hip or shoulder, and then only with unusual laxity of the ligaments. It is true that most practitioners consider this variety to be one in which there is no unusual injury to near parts, but it is impossible, in many instances, to determine the amount of laceration of the ligaments.

(*b.*) *Compound dislocations* are those in which the soft parts are lacerated or wounded, producing a wound leading down to the joint, or through which one of the bones protrudes. Such an accident represents the maximum of force applied, and all the parts concerned in the formation of the joint are more or less injured, and the consequences may extend to long distances from the point of primary lesion.

(*c.*) The *complicated* form, is one in which arteries, nerves, or the bones themselves are seriously injured, but without any wound in the integument. Fractures of the articulating surfaces, or of the shafts of the bones near the head, are of frequent occurrence, and will be at once recognized as adding very greatly to the importance of the case. Arterial lesion cannot at all times be readily detected, and of necessity expose the sufferer to great danger. Nervous lesions are of even greater obscurity, as symptoms of compression are similar to those of division, and great judgment and considerable experimental knowledge will be demanded to recognize the true state of affairs.

(*d.*) A dislocation is said to be *complete*, when the articular surfaces are completely displaced, either not in contact at all, or very greatly out of their proper relation. Thus when the internal condyle of the femur is resting on the outer edge of the outer articulating surface of the tibia, the luxation is just as complete, as if they were not in contact at all.

(*e.*) *Partial dislocations* are those with a less degree of displacement, without any special reference to the extent; perhaps anything from a sprain, to a degree less than half complete.

(*f.*) *Recent dislocations* are those seen and recognized within a few days after the accident, before there has been any secondary changes in the parts, as filling of the glenoid cavity or acetabulum, formation of new socket; atrophy of muscles, or absorption of the bone.

(*g.*) *Ancient dislocations* are exactly the reverse; or those in which there has been secondary changes of some kind, and the parts have become somewhat accustomed to their new relations.

(*h.*) A *primary dislocation* is one in which the parts remain in the position into which they were thrown at the time of the accident, or one in which the displacement occurs at the time, and from the immediate effects of the injury.

(*i.*) *Secondary luxations*, are those in which the displaced bones are forced into a different position from that into which they were thrown, either by attempts at reduction, or muscular contraction. The term is also used to indicate a dislocation due to injuries inflicted on the part which did not induce primary dislocation, but weakened the natural supports of the joint so that displacement occurred subsequently from ordinary movements or muscular contraction. For instance, the rim of the acetabulum may be broken, or some of the ligaments of the knee joint wounded, and no immediate luxation occur; but hours, days or weeks afterwards, from consecutive injury to the parts, or other purely physical causes, the head of the bone is thrown from its normal position. Some authors, and with perfect propriety, it occurs to me, consider dislocations due to morbid action under this head; as in morbus caxarius, or chronic rheumatism where the progressive muscular contraction draws the articulating bones out of relation.

Such is the classification usually adopted by surgical writers, and is not arbitrary, nor is it at all a matter of little consequence. Each variety will be found to present indications for treatment peculiar to itself, and to demand special consideration in prognosis.

The *causes* are both predisposing and exciting, the first constituting a very important element in differential diagnosis.

1. *Predisposition* to dislocation is often a question of *age*. Many writers on surgical diagnosis give as a rough statement that fractures are more common in advanced life, and dislocations in younger persons, from the same exciting causes. As stated, this is a fatal error. Prior to the age of puberty, there *may* be less disposition to fracture of the shafts of long bones, but it is well known that separation of the epiphyses will be produced by an exertion of force that would induce fracture in old persons, and dislocation in those a little older. It may be stated, therefore, that from the twenty-fifth to the fortieth year, dislocation is more frequent than fracture, *where the force is indirect;* from *direct* injury, the chances are greatly in favor of fracture. In very early life, either fracture or dislocation is rare, from the elastic and semi-cartilaginous character of the bones, and the laxity and at the same time elasticity of the articulating ligaments; but separation of the epiphyses is easily produced. This state of affairs will

continue until the age of puberty, when the induction of either of these is entirely dependent upon the nature of the injury. In old age, on the contrary, fracture is far more frequent. Nevertheless, in doubtful cases, in which the symptoms of fracture and dislocation are combined, neither predominating—the older the patient, after the period of middle life—the greater the presumption of fracture; and the younger, whilst still above twenty-five, the presumption is to be in favor of luxation. Debilitated individuals, those of lax fibre; those who have always been troubled by weakness of the joints, from long or weak ligaments; or paralysis, are peculiarly liable to dislocation on slight provocation. In short, anything which has a tendency to weaken muscles or tendons, or cause relaxation or destruction of ligaments or articular cartilages, must be considered a predisposition to this accident. Occupation is likewise to be considered in this connection. Anything which compells the long retention of the arms or legs in unnatural or strained positions, will result in weakening of some of the ligaments or supports of a joint. Thus is the Tyrol and parts of Switzerland, the habit of carrying heavy weights on the head, which obliges the arms to be extended upwards for a long time in supporting the burden, must predispose to luxation, and it is said luxation of the shoulder are unusually common in those countries. Athletes and gymnastic performers, whilst in full vigor, are not subjects of luxation oftener than others; but when debilitated by old age or sickness, they pay the penalty for their indiscretion, in easy production of dislocations, which, however, are not as serious or painful as when occuring in persons of greater muscular developement.

2. The *exciting cause* may be divided into *direct* and *indirect*. The former are all such applications of force as are expended directly on the joint, as blows or pressure. In some instances a very slight force will dislocate large joints, when the parts are placed in a favorable position. In 1862, I saw a case of pubic luxation of the hip, caused by an apple, falling from a tree, striking the trochanter while the leg was fully extended backwards and outwards. As a rule, however, dislocation from direct violence is not as common as from indirect, and presents a much more favorable case. The muscles or other tissues are always more or less injured, thus rendering the prognosis more grave, and very materially complicating the case.

Indirect violence, is when the extremity of a limb is fixed, and the part violently twisted or put on the stretch, precisely as in the case of sprain. Next to accidents from machinery, the more common cause of this accident, is when the foot or hand is caught, while the body is propelled forward or thrown down.

Muscular action frequently induces luxation, either slowly or quickly; producing, in the former instance, what is known as spontaneous dislocation. We meet such instances in those suffering from chronic rheumatism, or spinal conditions which favor continuous or tonic muscular contraction. Examples of luxation of the fingers are very common, and nearly all practitioners have seen many. Closely

similar, though different in some particulars, is the distortion of joints from cicatrical contractions, as after burns or extensive wounds. Spasmodic muscular action frequently causes dislocation, even of the larger or largest joints. HAMILTON (*loc cit* 495) considers muscular action to play a very important part in *all* dislocations, and says: "The limb being driven obliquely across its socket by external violence, is seized by the stretched and excited muscles with such vigor as to contribute not a little to the unfortunate result. Thus it will be found that the same force which is adequate to the production of a dislocation in the living and healthy subject, is wholly insufficient to accomplish the same in the dead; and a man who is fully intoxicated seldom suffers a dislocation." I might add, that the difficulty in effecting reduction without anæsthesia, or otherwise counteracting or relaxing the muscles, is almost insuperable.

Finally it will be noted, that while ball and socket joints are more easily dislocated than ginglymoid, the position and exposure of a part must be taken into consideration in determining the frequency. Thus the elbow is oftener dislocated than the hip, notwithstanding the latter is more easily placed out of relation.

3. The *pathology* of dislocations, or, more properly speaking, the extent and kind of lesion sustained by the articular tissues, varies greatly with the nature of the force, whether direct or indirect, and the kind of motion of the joint. When a joint is drawn out of position by the gradual contraction of the muscles, the ligaments are usually simply put upon the stretch, without any separation of the different fibres, and no external injury to the vessels, nerves, and other organs and parts in the neighborhood. The same negative conditions will also occasionally be observed when the muscular contraction has been spasmodic. When, however, the latter causes operate to produce luxation, the abscence of gradual traction and preperation, extending over weeks or months, makes the parts liable to injury, and which they rarely escape.

In other instances, when the force is direct, or even indirect when violent—the ligaments will be found torn, sometimes partially, at others completely—muscles, nerves, arteries, tendons contused, lacerated or divided, and the tissues filled with extravasated blood. The rim of the acetabulum or glenoid cavity, or the edges of the articulating surfaces in other regions, may be more or less broken; articular cartilages dislocated or fractured; and all parts not sustaining an actual lesion, are either painfully on the stretch, or compressed. Of course the degree of injury inflicted upon the parts, is proportinate to the amount of force applied; its nature; the degree of displacement; the character of the joint, and the habit and bodily condition of the patient. It is manifest that a complete luxation of the elbow must produce more injury to the associated and contiguous parts, than one of the hip or shoulder.

4. The *symptoms* of dislocation, while to a certain extent unique, yet many times are very obscure, and so mixed up with fracture that

an acurate diagnosis is almost impossible. The usual semeiology, when no complications exist, is as follows: In cases of any doubt, and in fact under all circumstances, it is well to put the part and patient into the best position for examination; remove all the clothing from the injured part, and the corresponding part on the opposite side. Have the trunk placed perfectly straight, hip and shoulders on a straight line. The dislocated joint will at first appear flatter, or at least there will be a notable change in form, but later the swelling will obscure this to a considerable extent. On making examination with the hand, the heads of the bones may be felt in their new position—sometimes they can be seen—and not only will the joint itself be obviously unlike its fellow, but the whole limb will have an unnatural look. Thus, when the knee is dislocated inwards, the leg will incline outwards; the thigh downward, it will be directed outwards and rotated in the same direction. On making careful measurement, the part will usually be found shortened; at times, as in downward dislocation of the hip and shoulder, there will be lengthening. In making these measurements, great care must be taken to have the hips and shoulders square, as a slight deviation from a straight line would greatly lengthen or shorten the limb. On attempting motion of the part, it will be found that there is preternatural rigidity, and when it is procured the radius described by the enlargemcnt near the head of the bone, is larger than on the uninjured side. The rigidity, however, is purely a primary symptom, as after an uncertain time there is a restoration of mobility, even abnormal. The pain is usually intense, much more so than in the case of fracture, and is largely due to the extention and compression the parts are subjected to by the expanded heads of the bones. Swelling comes on early; it is partly due to the abnormal position of the bones, and partly to effusion, serous, hæmorrhagic, or both. Discoloration is usually present, but may be purely secondary. That is, when no blood-vessel is torn, the primary swelling will be colorless; but when the compression of the heads of the bones, and the increasing tension of the swollen tissues produce venous stasis, the parts will assume an ecchymosed appearance. Occasionally crepitus can be elicited, and when evidently not due to synovial inflammation, or the slipping of tendons, fracture may be suspected. A small scale of bone chipped off with a ligament, occasionally will give such distinct crepitus, that fracture may be diagnosticated. It is in such cases that we will experience the greatest difficulty in making a diagnosis. Finally, the parts when placed in position again, will remain in place without support, as a rule, unless there is coexistent fracture.

What has been said is particularly applicable to recent dislocations of ball-and-socket joints. When the luxation is ancient, the symptoms will undergo many modifications, due to the gradual accommodation of the parts to their new position. Thus a dislocated joint unreduced, will ultimately resume its functions to a certain extent. The old socket will be filled up; a new one will form; ligaments will

form new attachment, and with some degree of deformity, useful motion of the part may be regained. All this, however, must be deferred until we reach special dislocations.

We will also find that the visible signs of dislocation of ginglymoid joints, will render a diagnosis comparatively easy. In place of a loss of natural prominence about the joint there will be an exaggeration; and the generally superficial position of the parts will greatly facilitate the diagnosis. Other joints, as the head of the radius, the carpal extremity of the ulna, the fibula, or some of the short bones, present so few symptoms, as a rule, apart from some particular loss of symmetry and impairment of function, that no general description of symptoms can be given.

As compared with fracture, the leading differential symptoms may be given as follows: Preternatural rigidity; absence of crepitus; remains in place when reduced; limb often shortened; natural axis with socket changed.

5. The *prognosis* depends upon the nature of the joint, the extent of the injury, the completeness of the dislocation, and the time elapsed since the accident before reduction is attempted. Under all circumstances, it may be laid down as a rule, a joint once dislocated is never completely restored, and is liable to frequent reproduction, the facility increasing with such successive luxation. This is due to the incomplete union of torn ligaments, some of them never uniting again, and the changes that take place in surrounding parts. The ligamentum teres frequently atrophies completely, and is lost, and it is fair to suppose that other ligaments which fail to find new attachments early, likewise disappear. When much time has elapsed since the accident before attempting reduction, the parts become somewhat accustomed to their new positions; the muscles are either shortened or atrophied; blood vessels and nerves are correspondingly shortened or find new positions, and in time useful motion of the part may be regained, while some of the motions are exaggerated, some are restricted. For instance, luxation of the head of the radius, which is rarely reduced and retained, ultimately allows preternatural extension of the arm, while flexion is quite restricted, circumduction may be unchanged. Long pressure on nerve trunks may induce serious neuritis, ulceration, softening, or other atrophic changes; pressure on arteries causes ulceration or other changes in parts supplied; on muscles, atrophy; and the consequences of allowing a dislocated joint to remain unreduced are so serious from every point of view, that life itself may be jeopardized.

Treatment.—Having recognized the accident, the next step is to attempt reduction, and to secure retention until perfectly healed. Simple as these indications appear, they are exceedingly difficult of accomplishment, and in no single instance should reduction be attempted until a perfect comprehension of the mechanism of the joint is had, and the accuracy of the diagnosis unquestionably determined. In ancient dislocations, great caution must be exercised in

attempts at reduction, imparable injury being done by lacerating shortened vessels and nerves, and in young persons, fracture or separation of the epiphysis readily induced. No matter what method is selected, the patient should always be placed under an anæsthetic, and the injured part fully exposed and divested of all clothing.

There are three methods of reduction that may be practiced, each of which has particular advantages, but neither, I think, can be used indiscriminately: 1. Instrumental. 2. Mechanical extension. 3. Manipulation.

(1.) There are cases, occurring very seldom, in which reduction is absolutely impossible from the interposition of tendons, ligaments or muscles. At times, the head of a bone will be engaged in a rent of the capsular ligament, and no amount of force can tear it sufficiently to allow extrication, nor can it be freed by any manipulation put in operation. Other cases in which the extremity of the bone has become engaged underneath a tendon, or tightly stretched muscle, the only possible method that can be practiced is subcutaneous section of the impediment. This must not be attempted by the novice, nor by any until due consultation has established its absolute necessity. The objection to the practice is, that it to some extent converts a simple dislocation into a compound one, and lessens the chances for a future useful joint, by destroying or weakening what *may* be indispensable to full success. Whilst a proceedure perfectly warranted in exceptional cases, it is one that must be held in reserve as a last resort, and always undertaken with hesitancy.

(2.) *Mechanical extension*, is a method that has been in use from the earliest historic times, and while not as frequently employed to-day as formerly, is still occasionally the proper treatment. It is made by the use of pulleys, mechanical adjusters, the "Spanish windlass," or traction made by the hands of the surgeon or his assistants. The principles are the same in all cases, the sole consideration being the degree of force required in particular instances.

The patient is placed in the position most favorable, *e. g.*, lying down, in hip dislocations; sitting in a chair in shoulder cases, etc. The hip or shoulder, or part with which the dislocated bone articulates, is fixed with a counter-extension bandage, which leads in as direct line as possible with the line of proposed traction. The dislocated bone is to be drawn into its place, by leading the traction in a direct line into the socket. All things being in readiness, commence with the mildest measures first, which will be manual extension. The surgeon may apply his hands to the parts, making traction in a direct line, with a slightly rocking or rotating motion to the member. In the case of the shoulder, seize the arm about the elbow, with the forearm flexed; in the hip, the thigh with the knee flexed. If no progress is made, take a sheet, or long towel, and fasten it, by its middle, to the limb with a "clove hitch." This is made by passing the sheet rolled up, under the limb, and drawing one end through until the middle has been reached. Next cross each end over the

upper part of the limb, drawing it quite tight) carrying the right hand end up, and the left hand down, so as to have the two parts cross. Pass the right hand end under the limb again, and pass it through its own part, and draw the knot thus made as tight as is

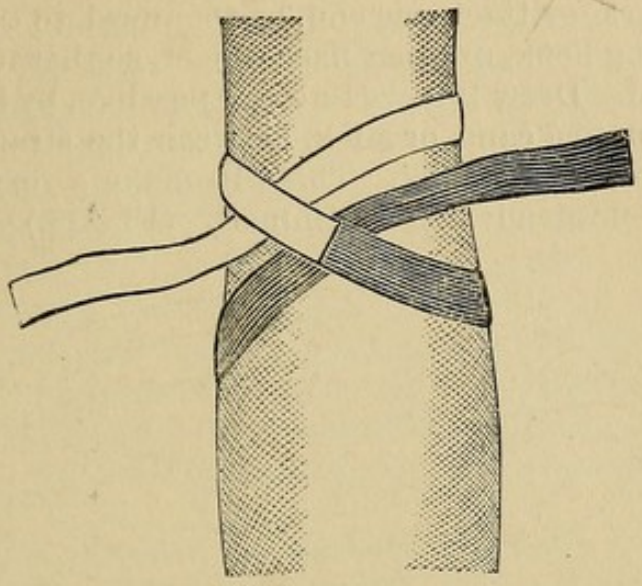


FIG. 17. Clove-hitch.

desired. Such a knot will not slip, and will not jam tighter from the kind of traction made. Pass one of the ends now over one of your own shoulders, the other under the opposite arm, and knot them on the back as short as is desired. By having the counter extension band well fixed, you can now make very powerful traction, by bracing the feet, and both hands are at liberty to mould the parts into shape. If

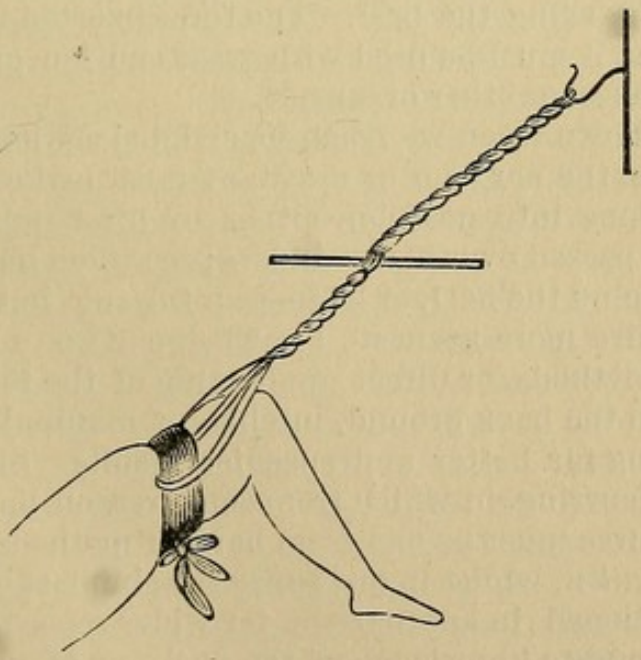


FIG. 18. Spanish windlass.

required, an assistant may make the traction, while the surgeon superintends the associated manipulations.

Failing in this, attempt reduction with the "*Spanish windlass.*" Place a bandage smoothly around the part from which extension is to be made, and attach to it, by a clove-hitch, a strong towel. Take an ordinary clothes line, or other small rope, and double it to at least four thicknesses. Attach one end, by the towel, to the limb, and the other to a strong hook, or other fixed object, so that it will lead in the line of traction. Draw this as tight as possible, by hand, before fixing it. Now place a cane, or stick, between the strands, and twist it up by revolutions of the stick. This will make a very powerful traction, and also one steady and continuous. (Fig. 18.)

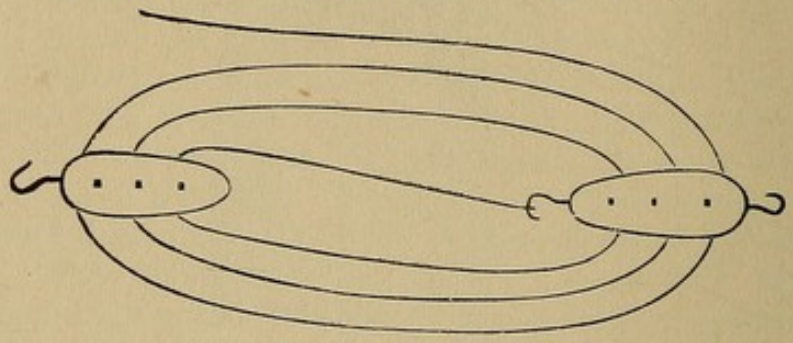


FIG. 19. Pulleys.

Failing in this, pulleys may be employed, attached to the limb as above, and some fixed point in the line of traction. Care must be taken to make the traction steadily, without any jerking, and to retain all that is gained without "coming up" the strain in the least.

All of these means failing, some one of the adjusters must be used, that of JARVIS being the best. The force exerted by the adjuster is very great, and it must be used with great caution, or damage may be done to the bones, or other organs.

As will be shown when we reach special dislocations, while traction is being made, the surgeon or assistant must make efforts to lift the head of the bone into position, either by his hands, a folded towel around it and passed over his shoulders; or, when making traction by his hands, placing the heel, or knee, as a fulcrum in the axilla.

As we acquire more accurate knowledge of the mechanism of the joints, harsh methods, or direct application of the force, is more and more placed in the back ground, intelligent manipulation being capable of securing far better and speedier results. Still instances are continually occurring, in which from some reason manipulation fails, and then resource must be had from harsher methods.

(3.) *Manipulation*, whilst in one sense the simplest of any of the procedures mentioned, in another and far wider sense it is the most difficult. An accurate knowledge of the anatomy of the parts is imperatively required in all cases, but the requirements in this instance are if anything greater. We must accurately comprehend the position of the head of the bone; the structures that engage it; the obstacles to be surmounted in turning it into its socket; and the effect on the chang-

ing position of the bone at each succeeding step in the manipulations. Supposing the joint to be a ball and socket, and the patient completely Chloroformed, proceed in this way: Grasp the limb, with the right or left hand, according to circumstances, at the joint below the one thrown out, as the knee or elbow. The other hand is to be applied on the shaft of the bone, or over the dislocated joint. The first motion is to slightly increase the deformity, by carrying the part to the side to which it is already directed. Next make full flexion followed by rapid extension combined with a rotary motion of the whole member. The direction of rotation varies with the variety of dislocation. Thus when the hip is luxated and the head of the femur is thrown backwards, rotation will be outwards, to raise the head towards the acetabulum. Attention must be paid to the impediments found in certain structures, as the illeo-femoral ligament, and the tendon of the obturator, and the manipulations must be modified to suit each case, as will be found laid down when we reach special dislocations.

In the case of the shoulder, particularly in axillary dislocations, the knee or heel in the axilla, as a fulcrum, will very materially aid in reposition. Other joints, are to be reduced by attention to the same general principles; the nature of the joint will prevent any attempt at rotation, but the particular manipulations must be deferred until later.

Whilst manipulations unaided by machinery has always been a recognized proceedure in surgery, its full developement is due to the labors and studies of PROF. BIGELOW, of Boston, which will be found fully set forth in his work on *The Hip*. Each day adds to the number of cases recognized as falling within the limits of this method, and the time cannot be distant when nothing else will be attempted. The chief consideration, to avoid involuntary muscular contraction, expedite the reduction, and facilitate repair, is to avoid harsh treatment; this can only be met by adopting this method in all possible cases.

After reduction of compound or complicated dislocations, or luxations of large joints, the parts must be kept at rest, by judicious bandaging, and even confined in splints if there is any disposition to re-displacement. The time required to secure perfect repair varies from ten days to two or three months, depending upon the extent of the injury. After the dressings are completed, *Arnica* should be given, if there is much hæmorrhagic effusion, and continued until the swelling has abated, when *Rhus tox.* should be used, a dose two or three times a day, until full recovery. *Rhus* may be given in the beginning, if there is no hæmorrhage. After the swelling has subsided, and the more acute symptoms have passed away, daily passive motion must be instituted, and kept up persistently until all the natural motions can be made without causing pain, or throwing the bone out of place.

XIV. INJURIES OF THE BONES.

The bones are liable to few accidents, but their importance in the economy, and the serious results so frequently occurring, renders the subject one of unusual interest and importance. In this place we should consider only contusions and fractures; wounds, which some of the older writers include in this category, being simply a variety of fracture.

I. CONTUSIONS.

Contusion of the bones, both with reference to the effect on the bone, and the associated injury to the soft parts, is an interesting study. Such an accident can rarely occur without the exertion of force sufficient to more or less implicate the soft parts, which, indeed, are more extensively injured than the bone. Bones situated very superficially, as the spine of the tibia, and frontal bone, may sustain severe contusion, and the integument not exhibit any extensive lesion; but when situated deeper, an actual contusion of the osseous tissue can only be accomplished by inflicting great injury on the muscles. The effect of such contusion being to devitalize, to a greater or less extent the laminæ involved, abscess is almost sure to be established, from the exfoliation of dead particles.

The immediate and remote consequences depend largely upon the portion of bone injured, the extent of the injury, and the habits and constitution of the patient. Osteitis is invariable, which may be followed by suppuration, caries, or necrosis according to circumstances. When the injury is sustained by the portion of bone above the entrance of the nutrient vessel, or at some distance from it in either direction, necrosis can scarcely be averted. In syphilitics, strumous persons, or those debilitated from other causes, some destructive change must follow; in the majority of cases necrosis will be the particular form, but caries is not at all uncommon. There is also, as a remote consequence, great danger of pyæmia, which is greater when the abscess is slowly formed, is not early recognized, and occurs in the cancellated portion of the bone.

In persons of robust constitution, a slight injury to the bone of this character, may establish a hyper-ostosis (hyperplasia) which will result in the formation of exostosis, or some other benign form of tumor. The same thing may follow exfoliation of the dead laminæ, if there is no dyscrasia, and repair is instituted vigorously. In some instances, one certainly in my experience, despondency due to long confinement and business reverses, what had commenced as an inno-

cent growth took on carcinomatous degeneration, and amputation was called for and performed. If my ideas of the genesis of tumors are correct, this result is to be feared in such cases, as well as in the case of those debilitated from any cause.

The treatment is to be conducted upon the same general indications, laid down in another place, as contusions in general. There is one point, however, that must early and seriously engage our attention; this is the certainty of more or less suppuration, and the imminent danger of pyæmia. At the first symptoms of suppuration, therefore, if the exact locality can be determined, it would be good practice to cut down on the bone, and remove any dead particles that can be reached or are found loosened. The wound should be kept open, by tents if necessary, until suppuration has ceased, and all dead bone has been removed. In making the incision, care must be had to avoid large blood vessels or nerve trunks, and, indeed, vessels that would require ligation must not be wounded. In slight cases, *Arnica*, as in contusions of the soft parts, will arrest all future trouble, and rapidly induce resolution.

II. FRACTURES IN GENERAL.

All surgical authors are agreed, that there is no more difficult department of practical surgery than that of fractures, both with reference to accuracy of diagnosis, and to satisfactory results of treatment. It is well known that a large proportion of suits for damages for malpractice are brought for deformity from what are popularly known as "badly-set" bones. The difficulties in diagnosis, while sufficiently formidable, are still far from being as great as in the case of dislocations. The results, however, even when the greatest skill and experience are brought to bear on the case, are far from being uniformly satisfactory. Age, bodily health, social position, occupation, and a multitude of other modifying and embarrassing circumstances and conditions, all have more or less to do with preventing perfect success, and the remark of MALGAIGNE, that no fractured bone, in which complete displacement had occurred, was ever completely restored, may be considered literally true. As far as function is concerned, or even the absence of notable deformity, many a case, perhaps the majority, would present no indications, to the uninformed, that a fracture had ever existed; but in every instance, it may safely be asserted, where there has been complete displacement, there will be found, on close inspection, some deviation from perfect symetry. Remembering the powerful effect of certain muscles to draw fragments out of position, the frequency with which the instructions of the surgeon are disregarded, and the thousand and one accidents that may undo in a moment what nature and art have been days or weeks in accomplishing, we must exercise charity in giving an opinion on cases of deformity, and hesitate long, and weigh all the circumstances impartially before giving testimony that would impeach the skill of the brother

practitioner. It is only the novice and braggart that would speak of a fracture as a simple thing. The accomplished and experienced surgeon will always approach such a case, no matter how simple, with some uneasiness and concern.

The word *fracture* means "a break," but technically it refers to a broken bone, unless some quallifying prefix or affix is added.

(*a.*) *Causes.*—The causes of fracture are both predisposing and exciting. The former includes morbid processes, a question of age, season, sex, and form and function of the bones.

Morbid processes, may be considered under two heads, viz., those affecting the bones themselves, and those of a general character, in which the bones partake. Under the first head, we find such conditions as erosion from the pressure of tumors, aneurism, and the like; caries, or even necrosis; suppuration of bone or any morbid action which removes osseous tissue, leaving that which remains too weak to resist the ordinary emergencies of life, or sudden muscular effort. It is true, as said elsewhere (*Surg. Therap.*), that destructive osseous diseases are usually accompanied by an attempt at repair. Nevertheless this effort is frequently inadequate to supply as much tissue as is lost, and when it does equal or exceed it in bulk, it is usually less dense, and not at once fully organized. Thus, while as far as *amount* of tissue is concerned, destructive diseases may present no notable loss in bulk; the powers of resistance are greatly weakened, owing to a want of full organization.

Under the second head, we find all morbid processes that are general in their character, not only affecting the whole osseous system to a considerable extent, but the other organs and tissues as well. We would include in this category, such diseases as rachitis, mollites ossium, fragilitus ossium, carcinoma, gout, syphilis, and even alcoholism. There is still another group of causes coming under this head, which will, after all, be found to be similar to those above mentioned. These are known as "intra-uterine" fractures. They are due to some defect in developement usually, some dyscrasia on the part of the mother, or may be the result of accident of various kinds, as powerful contractions of the uterine walls. The number of such fractures in one fœtus varies from that of a single bone, to as many as 112 noted by CHAUSSIER.

Age has much to do with predisposition to fracture. Usually the changes induced by advancing age, by which there is loss of the organic elements, and a corresponding preponderance of the inorganic, will render the bones more brittle, and cause them to yield on the exertion of comparatively slight force. There are exceptions to this rule, as some of the diseases of old age will have a tendency to induce a sort of cartilaginous metamorphosis of the bones. In general, however, when an individual has passed the period of middle life, he may be said to have attained the "age of fracture." In childhood, the preponderance of elements is in the opposite direction, but the incomplete union of the epiphyses with the shaft permits ready separ-

ation, but it cannot be considered a true fracture, notwithstanding the general effects are the same. As will be seen later, not only is the liability to fracture greater at certain ages, but the form or variety is likewise modified greatly by that circumstance.

The season of the year, necessarily exercises an important influence on the frequency of fracture. It was formerly supposed, and is yet by some writers, that in winter the bones were more brittle. This seems to be an error, at least it is unsupported with satisfactory evidence. The presumption is, that the slippery walks, the amount of clothing worn, and the habit of carrying the hands in the coat pockets to protect them from cold, at once increases the liability to severe falls, and lessens the facility to protect oneself from accident. There can be no question that more cases of fracture occur in cold weather, but the reason must be found, it would appear, in the above circumstances.

Sex, has been included among the predisposing causes, but apart from the nature of their occupation affording less exposure to accidents liable to result in fracture, women present no immunity whatever.

The *form and function of the bones* has much to do with predisposition to fracture. Thus the long bones, or those engaged in locomotion, must be more exposed than those of different construction, position, or function. Parts exposed in certain occupations, as hands and arms, are more liable than others also, and as all these are generally long bones, in an anatomical sense, that form of bone may be considered particularly predisposed, whilst *all* bones, wherever situated, or whatever their office, are liable to fracture.

Exciting causes.—These may be considered under two heads : viz. direct, and indirect, a possible division of the last into two varities being recognized by many authorities.

Direct causes, are those in which the force is applied to the point of fracture, as a contusion or wound. Such a fracture is always more serious than others, inasmuch as the injury to the soft parts is much greater, and there is more danger of comminuting the bones. In civil practice this form of fracture is comparatively rare, whilst in military surgery it is the prevailing form.

Indirect fractures, are those made by application of force at a distance from the point of fracture. They are usually accomplished by applying force at the free extremity of a long bone, the other being fixed at its articulation, the shaft being bent by the force tending to bring the extremities together, the bone gives way at its weakest point. Examples are found in fracture of the neck of the femur from falls on the knee or foot ; of the humerus, from falls on the elbow and hand ; also from sudden muscular contraction, as in spasmodic affections. It is frequently observed that bones that have not been weakened by morbid action, give way from sudden muscular effort; in fact fracture will more readily occur, under such circumstances, than muscular or tendonous rupture. The clavicle has frequently been frac-

tured by throwing the hand backward; and the olecronon process of the ulna from forcible extension of the forearm.

A species of indirect fracture, known as *contra coup*, is quite frequent in the bones of the head. It is made on the principle of transmitted force, and can be illustrated by experiment with a melon or pumpkin; on dropping it to the ground, from a sufficient height, it will be found that the fracture occurs on the upper side, and not the side coming in contact with the ground. So fractures of the base of the skull are common from falls on the feet or buttocks; of the occipital bone, from blows on the frontal, or *vice versa;* and of one parietal bone from injury to the opposite. The two last occurrences are somewhat rare, however, but the former, or basilar fracture, is quite common. A blow being received on one extremity of a long bone, nevertheless, the opposite being fixed, will usually produce a fracture *near* the point of injury, unless there be some weaker point more distant, as the femoral neck.

(*b.*) *Classification.*—Fractures are classified, with reference to the *extent of injury*, into simple, cominuted, complicated, and compound. To the *direction of the fracture*, into transverse, oblique, longitudinal. With reference to *displacement*, complete, partial, impacted. Other forms, depending upon *the nature of the injury*, are stellate, incised, perforating, and depressed.

Simple fractures, are those in which the injury is confined to the bone, the neighboring soft parts not being involved. There may be displacement or not, or the break may be in any direction, the sole consideration being that the bone itself is alone injured, and only at the point of fracture. Such fractures must nearly always be from indirect causes, chiefly from muscular action. In studying the methods of repair, this form is taken as the type.

Comminuted fractures are those in which the bone is broken into a number of fragments, from three or more distinct pieces, to pulverization. It is rarely that such an injury is uncomplicated by more or less extensive lesion to the soft parts, as the causes are usually direct, although secondary lesion to near parts may be produced by the sharp angles of the fragments of bone. Probably in the aged, or in those who from any cause have an unusual brittleness of the bones, indirect force may produce such a fracture, in a person below middle life, and in ordinary health, such an accident may always be considered the result of direct injury.

Complicated fractures are those in which important organs or parts are injured, either from the force producing the fracture, or from the sharp angles and points of the fragments. Ordinary muscular lesion can hardly be considered as constituting this variety, as to some extent it is impossible to avoid such accidents. We must have some injury to blood vessels large enough to call for measures to arrest the hæmorrhage; of nerve trunks, that to some considerable extent impair function; of muscles and tendons, or other important structures, sufficent in extent to call for special treatment and consideration. Unless

the fracture is oblique, with the sharp point of bone driven into the tissues, such accidents must always be the result of direct injury. Such an accident is exceedingly grave, as the impairment of nutrition may not only jeopardize the union of the broken bones, but place the life of the sufferer in danger.

Compound fractures, are those in which there is a wound in the soft parts and integument, through which one or both fragments may protrude, or leading down to the fracture. Unless it be some of the more serious forms of the complicated variety, these are the most dangerous and severe of any form of fracture. To the usual complications of the last variety, we have added the admission of air, complete displacement of the fragments, and usually profound shock. Compound fractures are spoken of as primary and secondary, as involving important prognostic considerations, the classification being very important, and not by any means fanciful and arbitrary. A compound fracture is said to be *primary*, when the wound in the soft parts is made at the same time, and by the same force inducing the fracture. Thus a fracture made by an axe, a sword, or some cutting instrument, would be a primary case; one in which the force had produced contusion, which subsequently sloughed, would also be primary, but perhaps in different sense. A compound fracture is said to be *secondary*, on the other hand, when the fracture is produced indirectly, and by muscular irritability, and by contraction one of the sharp extremities was subsequently forced through the tissues. If in no other respect, there is a marked difference here, in the degree of injury inflicted on the soft parts; in the first instance, showing the extremes of force applied, promising greater devitalization of the parts, and consequently much impairment of nutrition.

In general, however, compound fractures may be the result of either direct or indirect force, probably the former slightly preponderating.

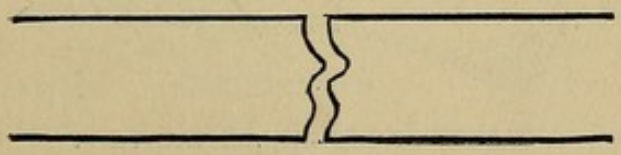


FIG. 20. Transverse Fracture.

Transverse fractures, are those in which the bone is broken directly across, and is a term that is used to indicate the general direction of the "cleavage." MALGAIGNE (*Fractures*) denies that a bone is ever broken directly transverse; that one fragment is more or less conical, the other marked with a corresponding depression. He uses the term *en rave*, or radish-like, and while the facts are exactly as he states them, yet custom has sanctioned the word transverse, and we have no single word in the English language that will take its place. In childhood and old age, notwithstanding the proportion of elements is radically different, the majority of fractures are of this form. Indirect force is the prevailing cause; indeed direct force could scarcely produce such an injury. An accurate representation of the direction

of the fracture can be obtained by seizing a ripe radish by each extremity, and snapping it in two.

Oblique fractures, are characterized by the line of fracture being more or less oblique to the long axis of the bone, although true and perfect obliquity seldom occurs. MALGAIGNE (*l. c.*) finds that a portion of the bone is separated transversly, and the section completed by splitting off in an oblique direction, like the mouthpiece of a flage-



FIG. 21. Oblique Fracture.

olet. He terms this form, therefore, *bec de flute*, but for similar reasons already given, we continue to use the older term. The causes may be either direct or indirect, oftener the latter, and those in middle life present more instances of this variety than either the young or old. The peculiar form of the fragments making retention in position difficult, the sharp points produced by the splitting off the bone, and the fact that the larger long bones to which powerful muscles are attached are oftener so injured, makes secondary compound fracture very common in this form.

Longitudinal fractures, are produced by direct force, when occurring in army practice, from perforation by musket-ball, bayonet or sword stabs, and the like, and are characterized by a splitting of a bone, for, any distance, without transverse fracture. Under such circumstances they are always compound, and have always been recognized as a

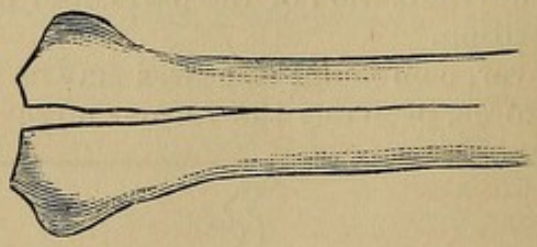


FIG. 22. Longitudinal Fracture.

peculiarly dangerous form of fracture. When occurring in civil practice, or from other causes, there is usually a partial transverse fracture, the bone splitting lengthwise in both directions from that point. Indirect force is then the prevailing cause, the bone being bent almost to the point of complete fracture, when the force is expended or remitted. Severe compression of a bone, the force being applied at the point of fracture while the extremities are fixed, is also a common cause, when from direct injury. For some reason, as yet not fully determined, this form of fracture is supposed to place the life of the sufferer in unusual danger. It is supposed by many that the extensive injury to the medullary substance, and the extensive injury done to the vessels of the bone predisposes to septic or pyæmic conditions, and I know of no other rational explanation that has been offered.

Certainly there is extensive injury done to the marrow, breaking it up into small particles, and the extent of surface capable for absorption exposed, would greatly facilitate the introduction of the particles into the vessels.

Complete fractures are those in which the whole substance of the part is involved, the fracture extending completely across the bone and completely separating the two fragments, although there is not necessarily displacement of the parts. It is the usual form of fracture, particularly in those past the adult period, and who have sustained direct injury.

Partial fracture, otherwise called incomplete, greentwig, willow-stick, etc., is the reverse of this. Here the bone has been bent until fracture has occurred through a portion of its thickness, and then

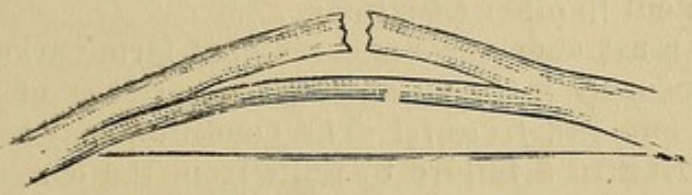


FIG. 23. Willow-twig Fracture.

split up, longitudinally, in both directions. It is a fracture peculiar to youth, or those whose bones have undergone some change, by which they approach a cartilaginous character. The exact condition can be accurately seen, by bending a green twig, as a willow switch, until it gives way on one side. In older persons, in good health, the ribs are frequently broken in this manner, from a force that strongly compresses the chest. The force applied, is usually, therefore, indirect.

Impacted, is a term applied to fractures, in which one fragment is driven into the other, as when the point of an oblique fragment is engaged in the medulary canal of its opposite. It is not an unusual form, but from the absence of the common rational signs of fracture is one that causes much embarrassment in diagnosis.

Stellate fractures are peculiar to flat bones, and are produced by a force that does not completely detach any fragments, but causes splitting of the bone, in a radiating manner from the point receiving the blow. They cannot be diagnosticated during life, and are of no practical interest whatever. They may be the exciting cause for exostosis, or some form of osseous tumor, but can never be differentiated from a contusion.

Incised fractures are those made by a blow with some cutting instrument, as an axe or sword, and are sufficiently described by the name. There may be a simple separation of the bones divided; a fragment may be driven in, or carried away; or the wound may extend only through a portion of the substance of the bone, and the margins of the cut be compressed. There is usually some exfoliation after such injuries, but unless there be some dyscrasia, no further untoward results may follow.

Perforated fracture may be similarly described, the effects being identical; the cause being usually musket-shot, or injury from pointed instruments. Unless the force and velocity is very great, however, the perforation will only exist in the outer table, in the case of flat bones, the inner table being splintered, or large masses torn off. When such injuries are sustained by the bones of the cranium, the effects on the brain are usually very severe. Perforating fracture of the long bones, is usually conjoined with longitudinal fracture; and the short or irregular bones are frequently extensively comminuted.

Depressed fracture is a term applied to fracture of the flat bones, particularly the cranial, with a fragment entirely or partially detached, and driven in on the viscera. It is simply equivalent to fractures with displacement in other situations.

Finally, we must consider an occasional termination of fracture, which is erroneously included among the varieties of this accident. We allude to *ununited fracture*. The condition may be secondary or primary, referring to a failure to unite from the commencement, or from causes operating after union has made some progress or been completed. The causes are manifold. In primary cases, there may a portion of tendon or muscle, interposed between the fragments; in comminuted fractures a portion of bone may die, and keep up irritation sufficient to prevent the organization of callus, or acting as a foreign body, may keep the parts asunder. From the loss of nutrient vessels, or extensive injury to vessels or nerves, nutrition may be arrested or much modified. The violence of the force producing the injury may devitalize the parts, and caries or necrosis destroy the bone; or suppuration may be established in compound fractures, which will have a similar effect. In short, the primary causes are so multitudinous, that it would be impossible to mention all of them. We must not neglect to mention, however, the common cause, frequent re-fracture, or displacement of the fragments, either through gross carelessness on the part of the patient, or injudicious meddling on that of the surgeon.

The *secondary causes*, while not equally numerous, are much more important. These embrace all varieties of morbid action that would have a tendency to destroy the vitality of the bone, prevent the formation of callus, or arrest its organization after it had been thrown out. Under this head would be included struma, scorbutis, syphilis, mercurialization, rachitis, gout, and a host of other and kindred maladies. From the deep-seated character of these processes, and their usually chronic form, it can be conceded that the expectation of securing at least speedy union, must be often disappointed, and union of any character frequently unattainable.

In some instances the failure to unite is only partial, false joints forming from plastic exudation, but in many instances the ends of the bones will become rounded, covered with a provisional cartilage, and no union of any kind take place.

(c.) *Semeiology.*—The symptoms of fracture are mainly objective, and while strikingly pathognomonic when taken together, are of little value, as a rule, when considered singly. With few exceptions any one or two of the prominent indications are common to many other conditions, and the difficulty in eliciting the whole array, or satisfactorily accounting for the absence of one or more, makes the diagnosis exceedingly difficult at times.

Swelling comes on early, in most instances within the first hour, and may gradually continue to increase for two or more days. It continues from two to ten, twelve or more days, and generally subsides slowly. It is due, in the absence of injury to the larger blood-vessels, to inflammatory action, set up by the irritation from the fragments of the bones, and the injury done the soft parts by the force producing the fracture. The swelling is usually quite firm, the skin more or less reddened, and the temperature raised slightly.

Pain is an accompaniment of all fractures, to some extent, being greater when the fracture is complete, with displacement, and dependant upon the amount of compression or irritation to which the nerves are subjected. The character of the pain varies greatly, being aching or dull, in some instances, acute, pulsating, shooting, or pricking in others. There is usually much muscular irritation, with jerking and twitching of the muscles, which adds greatly to the pain by disturbing the fragments. After the first hour or two, in cases with slight displacement, the pain will sensibly abate, and may disappear entirely, but any attempt at motion of the part will excite it anew. In fracture from direct injury, the soft parts will be painful as a matter of course, but it is not a pain peculiar to fracture.

Deformity must at all times constitute a very important symptom, and will occasionally at once and alone settle the diagnosis. When a bone is superficial, or so situated that its form can be readily outlined, any notable departure from the proper shape, in the continuity of the part, must at once point to fracture. But very many cases occur in which the bone is situated deeply, and in which there is simple fracture without displacement. In impacted fractures, also, the appearance of the part may be unaltered, and the only difference between it and its fellow on the opposite side being shortening, a suspicion of dislocation may well be entertained. It may be considered, therefore, the most certain signs of fracture, while unfortunately one that is very often wanting.

Mobility, like deformity, is one of the most certain evidences of fracture, but is not always present. When a fracture occurs in the shaft of a long bone, and there is no impaction, mobility must be a positive symptom, but when it occurs near the articulating extremities, while still a symptom of value, caution must be used to avoid too hasty conclusions. It is true that preternatural mobility, is the chief point of difference from dislocation, where there is preternatural rigidity, but there are many instances in which extensive laceration of the muscles and ligaments occurs in dislocation, and the immobility is

wanting. So, also, ancient dislocations show an unusual mobility. In flat bones, some of the short and irregular bones, as well as in cases of impaction, this symptom will either be entirely wanting, or very obscure. Even with impaction, however, in the case of long bones, there will usually be slight mobility, fully enough to settle the question unless the part is very muscular, or the bone deeply situated. Yielding of the muscles on pressure may well mislead the most experienced. When it exists, however, any loss of resistance in the continuity of the long bones, must be considered an indisputable sign of the fracture.

Crepitus, has long enjoyed the reputation of being one of the most constant and positive symptoms of fracture. While this is true, to a certain extent, there are numerous contingencies that may arise that will either make it of negative value, or entirely prevent its elicitation. In the first place, except to educated ears, crepitus can scarcely be distinguished from the crackling characteristic of serous inflammation, or the slipping of tendons. On gently rubbing the fractured extremities together, there is a peculiar grating or rasping sound heard, or in many instances only *felt;* in deep seated bones it will be very indistinct. It cannot be described; nothing but actual experiment can give a correct idea of it. When heard, or felt, at a distance from the joints, it may be considered conclusive; it may prove a source of embarrassment when occurring in an inflamed joint. There are many occasions, also, when no attempt should be made to elicit it, as when the fragments are not displaced, and any motion of the part would have a tendency to disarrange them. This is particularly the case in fractures of the neck of the femur or humerus, when every precaution should be taken to avoid disarranging the fragments, as once displaced they may never be brought into relation again. Impaction, depression of the flat bones, and fracture near the heads of the long bones, must all be diagnosticated without this symptom; in the first two instances it cannot be produced, except in very exceptional cases, and in the last, the freedom of mobility in the short fragment, will prevent it by the exertion of any force that would be possible or justifiable. When unmistakably present, however, particularly when conjoined with deformity and unnatural mobility, crepitus may be considered one of the most certain symptoms of fracture. Even when taken alone, with all other signs wanting, and nothing but the history of the case and the nature of the injury to cause a suspicion of fracture, it has occasionally enabled expert and experienced surgeons to make a positive diagnosis. As its existance, however, presupposes complete fracture and some degree of mobility, it is difficult to understand how it can be the only symptom, as many assert, in numerous instances; there must be some mobility, however small, and the surgeons perception must be unusually acute to discover it.

There are very many other symptoms, jactitation of the muscles, loss of voluntary muscular action, and a pain distinctly located in the bone on any attempt to make a movement in the part, or on pressure

over the seat of the fracture with the finger. Indeed, in the absence of more positive signs, many surgeons consider this last a highly important indication; by touching the bone with the finger, with considerable force, the seat of injury will be often indicated by the patient giving evidence of pain when the point is reached. In all manipulations used for the purpose of diagnosis, gentleness should be the first consideration, both from considerations of humanity, and to avoid displacement of the fragments. In my own experience more than one sufferer has gone through life with a seriously deformed limb, from the harsh methods of examination instituted by a former attendant. While an examination should be thorough, in all doubtful cases particularly, too much care cannot be had to avoid rough handling; examination, therefore, should be made, as much as possible, without anæsthesia, as the patient's sensations will be a very useful guide.

The *differential diagnosis* between dislocation, contusion, and fracture, may be tabulated as follows; and while the usual symptoms will be found fully noted, many minor considerations and indications will readily suggest themselves from the foregoing:

Fracture.	Dislocation.	Contusion.
Mobility.	Rigidity.	No mobility.
Crepitus.	No crepitus.	No crepitus.
Difficult retention.	Easy retention.	No displacement.
Pain moderate.	Pain excessive.	Pain severe.
Pain slight or absent during quiescence.	Pain constant.	More on motion.
Jactitation of muscles.	Muscular contraction—tonic as a rule.	Muscles quiet.
Swelling secondary.	Swelling primary.	Swelling, secondary, ecchymosis; primary colorless.
Injury direct or indirect.	Injury direct or indirect.	Injury direct.

(*d.*) *Pathology.*—The condition of the bone fractured, and the contiguous soft parts, depends upon the form of fracture, the degree of displacement of the fragments, and the nature of the force producing the injury. Without displacement, and when the fracture is produced by indirect force, the injury will be confined to the bones. As a rule, the periosteum is torn, although cases have occurred in which it remains intact. The nutrient vessels may be torn, but without displacement; unless directly in the line of the fracture, they escape without serious lesion. There is in all cases, however, more or less effusion of blood between the fragments, and between the periosteum. Later there is an active hyperæmia developed, which may readily pass over into a state of inflammation. When there is displacement, the periosteum is always torn; sometimes a simple separation in the line of fracture, at others stripped up for long distances. In compound and complete fractures, injury to the soft parts may be to almost any extent, and variety; muscles, ligaments, tendons, blood-vessels and nerves being contused, torn, stretched, or perfor-

ated. In all extensive fracture, not compound, particularly when from direct injury, there is much effusion of various kinds, and while the difficulties in diagnosis are thereby much increased, the period of repair is correspondingly prolonged, and the prognosis much more grave. In short, the symptoms, prognosis, and actual condition are the same as in the severe forms of contusion, with the additional element of danger and embarrassment, a broken bone.

(*e.*) *Repair.*—A bone once being broken, with displacement to any extent, it may be safely asserted that complete restoration of symmetry is never attained. The loss or defect may be very slight, not sufficient, in any sense, to impair function, but still exists, and can readily be demonstrated. The amount of deformity, and loss of usefulness, can be foretold with some degree of accuracy, with reference to the extent of displacement, and the variety of fracture. Other things being equal, an oblique fracture, comminuted, compound, and impacted, will be almost certain to be followed by deformity. Of course the treatment, and the bodily condition of the patient, will greatly modify the results, but under the most favorable circumstances we must expect failure to secure perfect symmetry and usefulness.

The methods of repair are similar to the healing of wounds in the soft parts, viz.. immediate union, by first intention, and a process analagous to granulation, that is, formation of new tissue to fill the gap. Cases are frequent, in which transverse fracture without displacement, or extensive lesion of the periosteum, have united immediately, without the interposition of new tissue; but such favorable circumstances do not occur as often as could be desired. In other instances, the bond of union forms early between fragments that have not been displaced, and we have a process clearly analagous to union by first intention. The usual proceedure, however, is by what might be called second intention, and is thus affected.

There is at first a period of apparent inaction, in which no progress seems to be made in the union of the bones, but which is nevertheless highly essential for placing the parts in proper condition. During this time all foreign material is being removed, blood-clots and effusion but particularly from between the fragments. The duration of this period varies with the amount of swelling and the extent of injury done to the soft parts. In some instances, as in fractures of the face, particularly the nasal bones, osseous union commences at once, and the processes of absorption and consolidation go on *pari passu*. In most instances, however, no attempt is made to unite the fracture, until the swelling commences to subside. For this reason our primary dressings, as will be seen, are intended to prevent displacement, rather than to facilitate union.

The next change in the parts is the formation of callus, which is at first provisional, to hold the fragments together, but later becomes enduring or definitive, undergoing osseous organization. It was formerly supposed that the periosteum alone furnished this material, and that it was its peculiar function. It is now known that the soft

parts, periosteum, and the fractured extremities of the bones alike furnish the supply, just as other tissue is furnished to repair solutions of continuity in other injuries. The provisional callus does not appear in any quantity until after the foreign material has been to some extent removed, and is deposited between the extremities, in the medullary canals, and also surrounding the fracture like a ferule. This forms, when at all, (not being required in immediate union), after the third to the tenth day, and remains from twenty days to six months, or longer, before ossification is complete.

Definitive or permanent callus, is probably formed by an ossification of the provisional product, or may be a secondary formation after the first is complete. At all events, it is far less in amount than the former, and when fully formed is much harder and more dense than the original bone. While the bone may acquire a considerable degree of firmness in a few weeks, sufficient to allow full use of the member, it will take from eight to twelve months for the permanent callus to be fully formed. When the definitive callus is complete, or nearly so, the provisional deposit is absorbed, or as much of it as may not be needed for the consolidation of the fracture. The process is now complete, and the point of fracture is the strongest part of the bone.

During the earlier part of the healing process, there is much muscular irritation; the twitching and jerking being strong enough, at times, to cause much discomfort and pain, or even to displace the fragments. Later, there is usually an intermittent pricking and stinging, which while somewhat annoying is not sufficiently so, as a rule, to demand any special consideration.

There are many accidents that may interfere to modify or completely prevent union, some of them purely mechanical, while others are of a vital character. Some of them have been referred to under "ununited fracture," and need not be repeated at this place. A frequent occurrence, and one that calls for constant watchfulness on the part of the surgeon to prevent, is the bridging over, from one bone to another, by the callus, which may permanently cripple the member. This is frequently the case in fractures of the bones of the forearms, and those of the leg near the ankle. In each case, however, there will be, as a primary condition, displacement of one fragment inwards, that has never been reduced. The amount of callus, or the effect of over-riding of fragments, may likewise impair motion of the part from its bulk; having all the effect of a tumor of the bone.

Even after complete consolidation which has existed for years, disease may reproduce the fracture, without any injury, simply from destruction of the new tissue. Scorbutis is particularly liable to produce this, and naval surgeons have many instances to report. Dr. Kane, in his *Arctic Explorations*, particularly refers to this fact, and speaks of fractures that had been consolidated for years being reproduced. Renewed activity in dormant strumous complaints, has

occasionally reproduced fracture, as well as mercurial complaints or syphilis. As a rule, however, while such morbid processes may retard, or prevent union, it is very rarely that they produce such disastrous results as above.

(*b.*) *General treatment.*—The principles involved in the treatment of fracture, involves four considerations: Reduction, retention, mitigation of suffering, and promotion of union. To each of these we will devote as much space as possible at this time, many minor points needing special attention in special cases.

1. *Reduction*, or placing the fragments in apposition, or as near it as is possible, is not at all times an easy thing to do. As in all manipulations, gentleness must be practiced, as much so, at least, as is consistent with the end to be obtained. In cases without displacement, nothing is needed further than to retain the parts in position. The first thing to be done, is to determine what muscles have a tendency to draw the fragments asunder, or will resist efforts at reduction. These must be fully relaxed, or as much so as circumstances will permit, by attention to position of the part. When the bone is a large one, and powerful muscles are attached to the fragments, or the patient is intolerant of pain, either through constitutional timidity or from irritation of the parts from prolonged displacement, Chloroform had better be administered. Under other circumstances, or when an anæsthetic cannot be readily procured, relax the muscles by attention to position, and at the moment of exerting force endeavor to attract the attention of the patient to other matters.

Have the upper fragment firmly held by an assistant, and grasping the lower slightly increase the deformity. By a simultaneous movement make traction, and bring the parts into line. That is, the manipulations are of a threefold character, but made as one motion: slightly increase the deformity, at the same time make traction, and draw the parts into a straight line. If successful the bones will slip into place with an audible snap, or a slight grating noise. Cases undoubtedly occur, in which the reposition is not so easily made as this would imply, and the traction must be made with great exertion of force. Some of the methods noted under dislocation must then be employed; the most frequently useful will be that of fixing the upper fragment, and making traction with a towel or sheet, clove-hitched around the lower fragment. When reduction has been secured, the hands must be kept applied to the seat of fracture, or the part steadied by some means, until the retentive apparatus is applied.

As to the time to be selected for reduction there was formerly much controversy; at present, however, all authorities are agreed that no delay should be granted; it should be made at once, regardless of swelling, and apart from securing bleeding vessels, in complicated cases—the first indication is always to place the bones in position. A neglect to do this, or allowing time for the swelling to subside, will result in adding greatly to the difficulties, already more than sufficient, by the muscles becoming shortened, and so irritable that their resist-

ance can only be overcome by profound anæsthesia, and retention rendered doubly difficult from the same cause.

2. *Retention* is secured in many different ways, almost every practitioner having his own method. The indications to be fulfilled, in all cases, is to securely protect the parts from external influences that might displace the fragments; to secure quiescence of the part and the associated muscles; to have the dressings light, unirritating, and of such a character that inspection of the part can be readily had; and to apply materials that are readily accessible and inexpensive. Whichever method may be preferred, under all circumstances, I think, the dressings are of two kinds: temporary, and permanent.

The former of these are to be applied immediately after reduction, and to be retained only until swelling has abated, and repair has been

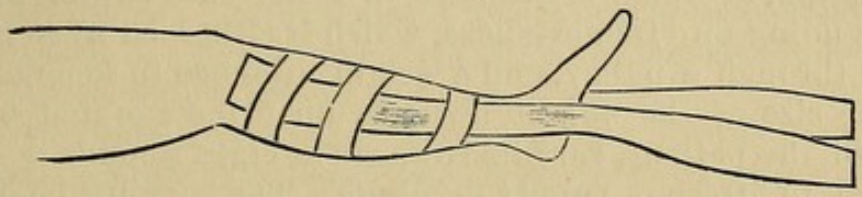


FIG. 24. Buck's Extension Dressing.

fairly inaugurated. After this period the muscles will be found to have lost their irritability, and apart from accident, or the external application of force, no danger of re-displacement exists. Improvised dressings of various kinds, shingle-splints, moulded, paste-board, etc., are to be selected with reference to the prejudices of the surgeon or his source of supply. For my own part, my choice is limited to two varieties of apparatus, depending partly on their availability, and partly on the nature of the case. When the nature of the accident and the conformation of the part will allow, I decidedly prefer the method of Dr. Buck. His dressing is now extensively used, and is quite generally known as the "American method." It is as follows: Supposing the leg to be fractured, shave the integument as high, and

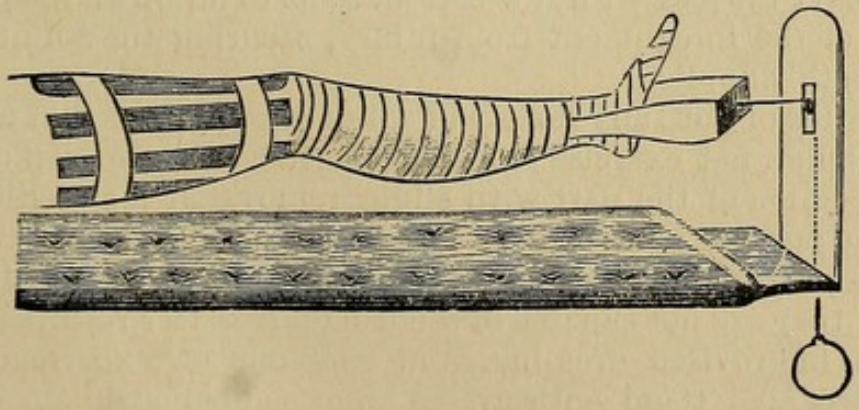


FIG. 25. Buck's Method.

a little higher than the line of fracture. Cut a strip of adhesive plaster two or three inches broad, and long enough to reach from the line of fracture, or an inch above, around the foot, leaving a loop at least six inches long, and to a corresponding point on the opposite side of

the leg. Attach this smoothly and evenly to the limb on each side, leaving it unattached at the malleoli, and the loop free under the foot. Give this additional support by a nicely applied bandage, and when the malleoli are reached, pass the roller *under* the plaster, and finish by expending it on the foot and around the ankle, smoothly and evenly. Next apply your counter extension band, which is made of half-inch rubber tubing, filled with cotton or tow, and covered with flannel. This should be about three feet long, passed around the groin, on the injured side, and the ends secured firmly to the head board of the bed, low down, *i. e.*, in the plane of the body. In the loop of adhesive plaster, left under the sole of the foot, place a light piece of wood, about five inches long, and the width of the plaster, to keep the straps off of the malleoli, and attach to it a short piece of rubber tubing, to which is attached in turn a cord two or three feet long, depending on circumstances, which is either led over the foot-board, or through a pulley, and a weight attached to keep up extension. The size of the weight depends upon the age and muscular strength of the patient, varying from six or eight pounds in the case of children, to fifteen or twenty in adults. The leg must be placed in a position that will be the most comfortable, the extension and counter-extension lead in a straight line, and further supported by long narrow bags of sand or gravel applied to the sides firmly. This latter precaution is necessary to guard against lateral motion. A great advantage in this method is that the parts are always open to inspection, and irksome positions can be changed without danger of disarranging the fragments. I have found this method perfectly applicable in fractures of the arm, forearm, leg, and thigh, notwithstanding it was designed for the latter exclusively, and make use of it in all cases where it can be applied.

My second choice, is pasteboard splints, which are applied as follows: Take a piece of binders-board, or stiff pasteboard, cut it to the required length, and mould it on the part by dipping it in hot water. Cover the part with raw cotton, so as to fill up all inequalities, and protect the integument from injury, securing the splint with a roller smoothly applied.

As a matter of fact, any variety of splint or apparatus that will keep the parts quiet, not exercise too much constriction, and will admit of some inspection of the part with slight removal of the dressing, will answer the purpose as a temporary appliance. It is a positive waste of money, to procure a set of patent moulded splints; they will not fit all cases; they are not capable of securing any better results than the homeliest improvised dressing, and surgeons of experience have almost discarded them entirely. A well-padded strip of wood, a shingle or cigar-box cover, will fulfil all the indications as well; and with pasteboard, or Buck's apparatus, the surgeon and patient will be perfectly satisfied.

As soon as the swelling has subsided, the acute pain and other

symptoms passed away, the time has come for applying a permanent dressing.

Under the old *regime*, this consisted in re-applying the bandages, and making everything smooth and "snug." To-day, it means giving the patient more freedom of motion, and even in fractures of the thigh, permitting him to move about. I think I am justified in stating, that the so-called *immovable dressings* have entirely supplanted all former methods. In applying these, the surgeon has a choice of several articles, the merits of each being decided solely by reference to weight, imperviousness to moisture and air, and availability. They are starch, plaster of Paris, silicate (liquid glass), and gum arabic. The starch is only used when nothing else can be readily obtained, as it requires a long time to become dry, and is very heavy. The silicate dressing is air-tight, and is objectionable when a large surface is to be covered. For all purposes, I think, the weight of testimony to-day will be found largely in favor of gypsum or plaster of Paris. Whichever substance is used, however, except the silicate, the dressing will be applied in either of two ways; rubbed into the meshes dry, and hardened by wetting the bandage after application; or mixed and painted on the bandage, with a brush, as it is applied. The former is the better way, in all respects. The fracture being reduced, and all ready for the dressings, if there is no wound in the integument, first envelope the part in cotton batting, to fill up all inequalities. In the case of large bones, narrow strips of pasteboard, or sheet tin may be laid on this, perhaps four or five, an inch wide, for a limb as long as the thigh. The bandage should be of flannel, or some open meshed fabric, and be applied quite firmly, commencing below and bandaging upwards, avoiding, as much as possible, reverse turns. It should be put on in from three to six thicknesses, and fastened with a needle and thread. It should then be wet, with a sponge, until wet through all the thicknesses, and allowed to dry; if the plaster has not been previously rubbed into the bandage, a thin mixture should be painted on after completing each layer or thickness, and a dry ordinary roller applied over all. In the case of compound fractures, an opening may be made over the wound, cutting three sides of a parallelogram through all the thicknesses, leaving the fourth for a hinge. When it has become fully dried, it may be cut up, with strong pliers, along its whole length, and thus it can be opened, or tightened, as the swelling increases or diminishes, being held together by tapes, or a roller outside of all.

With this dressing, the patient can move about on crutches, with the foot supported in a sling fastened around the neck. With care a single bandage may remain in use throughout the entire treatment; but as soon as it becomes broken, or too pliable to afford support, a new one may be applied. There may be instances in which it would be impracticable to employ such a dressing, and splints be called for. Such cases will receive attention when we reach special fractures, but as a rule all unyielding apparatus, like the old splints, must be

avoided. They cause much annoyance, and even excite and maintain muscular irritation.

Special varieties of fracture must receive slightly different treatment, particularly the compound and complicated forms. In the former, the external wound will naturally demand primary consideration, but the reduction and retention of the fragments must not be neglected. The primary dressings must be applied in such a way that the wound may be left exposed for special treatment, or if it has been closed, the splints must be *arched* to avoid pressure. In the BUCK apparatus this is easily done. The wound must be treated as wounds in general, with a preferance for *Calendula*, in the absence of any special indications. The same remarks apply to complicated fracture, which injury should receive the first attention depending entirely upon its nature. Thus wounded arteries must be secured; lacerated tendons, muscles, or ligaments, must be placed in the most favorable position for union; and other injuries receive appropriate attention. But when the associated injury is of minor importance, or does not imperil life or the usefulness of the limb, the fracture must engage our first offices.

3. *Relief of suffering*, such as pain, jactitation of muscles, and excessive pricking and stinging during the process of consolidation, is a very essential feature in the treatment, and we have means at hand to effectually accomplish the object. *Cuprum* and *Ignatia* have more than once allayed the muscular irritation, but I am unable to give any special indications. I am in the habit of commencing with *Ignatia*, and if no relief is had, resorting to *Cuprum;* but it is seldom that any change is needed. The pricking while quite conclusive evidence that union is progressing actively, need not be of sufficient severity to annoy the patient. Under the action of *Symphytum* or *Ruta*, this is in most instances much modified, in some cases entirely dissipated with no cessation of the healing powers. We will also find it very essential to have the parts well supported, and placed in a position that is as comfortable as circumstances will permit. When we realize the fact, that pain alone may and does seriously impede repair, we will pay strict attention to means for its avoidance and mitigation. The dressings should be so arranged that change of position can be easily made when confinement becomes irksome.

4. *Repair is much facilitated*, by the use of appropriate remedies, as well as attention to the above for the avoidance of pain. The remedy first in importance, and one that I have never neglected to employ, is *Symphytum off*. It not only materially hastens the organization of callus, but very greatly lessens the pricking and stinging attendant upon that process. In cases in which there has been severe direct injury, *Arnica* will be useful in hastening the subsidence of swelling and inflammation, particularly if the soft parts are much contused, or there is ecchymosis. When the inflammation runs very high, *Acon.*, or *Bell.*, or *Rhus.*, should it assume an erysipelatous type, will be

needed, the indications being precisely the same as when due to other causes.

Before closing this chapter, some attention must be given to the treatment of ununited fracture. Of course the cause being recognized, it must be removed; but unfortunately this will not always secure union. The ends of the bones, in old cases, become rounded, covered with provisional cartilage, and a false-joint forms. Struma, mercurialization, scorbutis, or syphilis, may all be cured or reduced to an undemonstrative form, but the changes in the part forbid union of the bones. When such an accident occurs during the continuance of treatment, that is the active development of any of these processes, *Calc. phos.*, or other indicated remedies, may be given, and a continuance or re-establishment of the organization of callus secured. But we have particularly to do with ancient cases.

The authorities are divided between the excitation of the dormant function by the introduction of irritants, rubbing the ends together, or the use of the seton, and more radical measures, as resection. For my part, exsection of the ends of the fragments would always be my choice. In a few cases in which this has been practiced the results were perfectly satisfactory; indeed out of perhaps a dozen cases, I can now recall but one failure. I am aware that many excellent, even eminent surgeons, discountenance this practice, but Homœopathy furnishes so much in the way of remedies to hold unfavorable action in check, that I have no hesitancy in recomending it strenuously. The authorities have agreed that after all other means have failed, excision is to be practiced; as all other means, so far as my experience goes, generally *do* fail, or worse than that, greatly aggravate the difficulty, I feel justified in placing this measure first on the list. Many cases have failed to secure perfect union after this and other operations, from too much impatience on the part of the surgeon. Time enough has not been given. The part should be firmly secured, and absolute immobility maintained for a long time. One case required six months, before positive symptoms of union could be detected. After this time, the parts having been kept absolutely immovable, and the fragments closely in apposition, if no union can be detected, the operation may be set down as a failure.

The driving in of ivory pegs, passing a seton between the fragments, and all such other proceedures, have not been touched upon, as my experience has been that they are generally valueless.

XV. INJURIES OF THE HEAD AND SCALP.

Injuries of the head and scalp will be considered under three heads: *viz.*, of the scalp, cranium, and cranial contents. The nature of the tissues involved, the frequency with which injuries to the region occur, and the serious consequences occasionally following lesions of the brain, combine to make the subject under consideration one of much practical interest. While the general principles of treatment are the same as in similar injuries elsewhere, there are many special points of departures, due to the nature of the parts injured, many of them, whilst appearing trivial, perhaps, being of paramount importance, as is amply proved by experience.

I. OF THE SCALP.

Contusions.—Contusion, without wound, is an exceedingly common injury to the scalp, and may occur with or without associated injury to the bones. Cases are not wanting, in which glancing blows have produced fracture of the external or internal tables, or both, and inflammation and suppuration of the diploe, without notable injury to the scalp. The loose attachment between the scalp and pericranium, even the muscles having more of a dermal than an osseous attachment, and the abundant blood-supply of the part favors extensive extravasation of blood, and detachment of the scalp. In contusions of the first degree there is usually more ecchymosis than in cases of the same degree of severity elsewhere, from the greater vascularity of the part, and the resistance afforded by the cranial bones; while in the graver forms it is scarcely possible to avoid fracture of the cranium, or some lesion of the brain. Erysipelas and suppuration are quite frequently observed as a sequel, and in cachectic and broken-down individuals, the consequences may be exceedingly severe. The symptoms vary with the degree of force applied, and the extent of the effusion. In all cases, however, the boundaries of the ecchymosis are wider than in similar injuries elsewhere, but the vitality of the parts will not be so uniformly threatened. Usually the accident is of no moment, but when the injury to blood-vessels is extensive, or there is a wounding of the integument, very serious consequences may ensue. As far as the injury to the scalp itself is concerned, extensive disorganization may occur, and ultimate recovery be secured without much difficulty; in some instances extensive sloughing has taken place, and no noteworthy loss of function or even symmetry occurs. Some cases are reported in the *Medical and Surgical History of the War* (*Surgical volume*, pt. I, p. 63), in which a singular change took place in the effu-

sion: "There were also examples * * * * of effusion of blood in the meshes of the condensed cellular tissue connecting the common integument with the occipito-frontalis aponeurosis, producing that remarkable condition in which, the effused blood coagulating imperfectly, the portion in the centre remaining fluid, and the scalp being apparently depressed at this point, a depressed fracture is closely simulated." These "bosses" were always found over the lateral regions. When the effusion is considerable, the blood usually settles to some dependant point, the supercilliary region, or the posterior attachment of the occipito-frontalis.

Treatment depends upon the degree of injury. In simple cases, with moderate hæmorrhage chiefly or entirely capillary, which ceases spontaneously, simple applications of *Arnica*, or the same remedy given internally alone, will be all that is required. When the hæmorrhage continues, and the swelling gradually augments showing that blood is still being poured out, the source of bleeding must be sought, and ligature or pressure applied to arrest it. From the facility with which pressure can be made, in the cranial region, exposure and ligation of a vessel can seldom be required. If compression alone fails, accupressure is a very radical measure that can rarely fail, and which obviates the necessity for an incision, and exposing the effusion to pyogenic disorganization. Occasionally the effused blood will remain fluid, with no tendency to coagulation, seeking a dependant position, hæmotoma. *Hammamelis*, with or without associated pressure, is here indicated. In the army during the late war (*loc cit*, p. 62–3), pressure by appropriate bandaging, or through sheet-lead, was found very efficacious to hasten resorption. In the anamolous cases, alluded to above, in which partial coagulation occurred, "the plan proposed by Champion, of suddenly compressing the tumor by a blow severe enough to rupture the sangineous cyst and to cause the blood to be infiltrated into the neighboring cellular tissue, was employed with good results. In these cases, a peculiar crepitation, due doubtless to broken fragments of fibrinous coagulæ, was observed." When the clot is firm, and its boundaries are readily discovered and traced, there is a strong temptation to cut down upon it, and turn it out. This should never be done; suppuration, or erysipelas will be an almost certain consequence.

Large collections of blood frequently occur under the tendon of the occipito-frontalis, and very often suppuration is then established. The first symptoms of suppuration must call for incision, but large openings are not at all necessary. In such instances diffuse erysipelas will usually occur, but recovery is usually rapid, and in the absence of any dyscrasia, no solicitude need be entertained.

In cases of very severe contusion, in which the tissues are pulpified, even without an actual wound existing, disorganization may be so extensive that sloughing is inevitable. It is impossible to accurately describe the amount of lesion that would necessarily completely

devitalize the part; it is solely to be determined by experience, as the blood supply makes the scalp tolerant of injury that would be fatal to other tissues. When such a case occurs, however, poultices must be applied to hasten the sloughing, and cicatrization promoted as in similar instances in other parts.

WOUNDS.

Wounds of the scalp are usually of the contused or lacerated variety, probably owing to the species of injury to which the head is exposed. Incised and punctured wounds occur in army practice, to some extent, but since the modern weapons of warfare have come into such general use, wounds from swords, bayonets, and the like, are quite infrequent. Perhaps the cases oftener seen, are those occurring in manufacturing districts, where the belting of machinery tears up the scalp. There are two points of much practical interest, and while somewhat contradictory are to be considered in every instance. These are the unusual rapidity and facility of repair, and the disposition to suppuration. Both conditions can be accounted for by reference to the anatomy of the part. The scalp is practically dermal in structure, but includes with the fascia and aponeurosis of the occipito-frontalis, all the soft parts in this region. We have, therefore, a much larger blood-supply than obtains in other purely integumental structures, and while this favors an abundant supply of reparative material, it at the same time affords all the requirements for suppuration. In cases, however, that exhibit no dyscrasia, and are simple uncomplicated wounds, repair should be speedy, and such is actually the case in the large majority of instances.

There is no necessity for going at length into the causation of these injuries; they are sufficiently obvious to every student, and for the description of the wounds themselves, reference can be had to the earlier chapters. The extent of the injury may be from a small puncture made by the corner of a hard substance, to a complete detachment of the scalp. I have seen two cases in which the line of the wound extended from the superciliary ridges in front, around the sides of the head on a level with the parietal protuberances, as far as the superior curved line on the occipital bone; the whole vault of the cranium being exposed, and the scalp turned back and hanging down on the neck; several cases, in which the detachment was in the opposite direction, the scalp hanging over the face. In spite of the extent of the lesion, and the injury necessarily inflicted on the parts by a force sufficient to produce such an extensive wound, all of these cases recovered promptly, without untoward symptoms of any kind. In every such case, however, the cranium must be carefully inspected for fracture, or the condition of the brain inquired into, concussion or contusion being a somewhat frequent complication.

The *treatment* is to be conducted on the same general principles laid down under wounds in general; one or two points of a special charac-

ter, however, requiring notice. The wound should be carefully cleansed of all foreign material, every clot of blood, and the fine particles of sand or grit carefully removed; owing to the unusual tendency to suppuration this should receive much more attention than usual. Every bleeding vessel should be secured, preference being given to accupressure or torsion, in all cases where simple exposure to the air fails. In fact there are few instances in which arterial bleeding will give trouble, partly owing to the nature of the injury not favoring hæmorrhage, the vessels being torn or contused, and partly from the facility with which compression may be exercised. The parts must then be carefully adjusted, each little scrap placed in position (unless they are evidently devitalized), and secured there. The margins of the wound should be divested of hair, by shaving, for a distance of about an inch. There has long been a controversy as to the means to be employed to retain the parts in opposition; some vehemently denouncing sutures and others as warmly defending them. Some theorists have advised tying the hair together, from opposite sides, to keep the edges approximated; I call them theorists, because I have never seen a knot tied in the hair that could be made to hold. The experience of the late war where thousands of cases were treated, and my own personal experience, which has not been small, convinces me that metalic sutures are not only borne well, but that they are indispensable to success, particularly in securing early and prompt union. When adhesive strips alone are used, the edges of the wound become inverted, the cicatrix is unavoidably unsightly, and the growth of the hair irritates the raw surfaces to such an extent that union is not only delayed, but suppuration or erysipelas is almost certain to be induced. The sutures must not be so close as to interfere with the discharges, (say from an inch to an inch and a half apart,) the interspaces to be supported by adhesive strips.

The remedies indicated are as in wounds in general, with a preference for *Calendula* on account of its action in suppressing the pyogenetic tendency. At the first symptoms of pus, the wound must be opened sufficiently to allow it to escape, or if it is at a distance from the line of the wound, a *small* incision must be made.

In some few cases the scalp has been completely torn off, and the arch of the cranium exposed. In none of them in my practice, or in that of our surgeons during the war, did a failure to cure result. Granulations sprang up around the edges, from the small islands of tissue remaining at other points, or from the pericranium itself, and in most instances cicatrization went on to completion. In one or two instances the attempt was abortive, but cell-grafting soon set things moving on again. In all cases of cell-grafting great assistance was afforded by the use of the constant mild galvanic current, as laid down in the chapter on *ulcers* (*Surg. Therap.*) which I will transcribe here for the benefit of those who have not access to the other volume.

Cut a piece of silver foil to the size and shape of the denuded por-

tion. Attach a copper wire to this six or seven inches long, to the opposite extremity of which attach a piece of sheet zinc as large as the silver plate, or at least more than half as large. Attach these metallic disks to the parts by adhesive plaster, silver to the sore, and the zinc to the integument, interposing a piece of kid or buckskin soaked in vinegar between the zinc and the skin. If the denuded surface is larger than a silver dollar I am of the opinion an effort should be made to heal a portion at a time; so that the silver plate should not exceed these dimensions. The leather should be wet with the vinegar as often as it becomes dry.

WOUNDS OF ARTERIES.

It has already been remarked that few wounds of the arteries of the scalp will require ligation, or any measure to arrest hæmorrhage other than ordinary bandaging. While this is strictly true as regards the arteries of the vertex, and perhaps a large portion of the occipital region, yet on the sides of the skull, and some other points, are found vessels too large to warrant any trifling, or waiting for spontaneous arrest. The vessels that are particularly liable to furnish dangerous, or at least troublesome bleeding, are the occipital, the three branches of the temporal, and the superior orbital. Under exceptional circumstances, other vessels may attain a magnitude sufficient to call for mechanical treatment when wounded, but in most instances simple exposure to the air, or the compression exerted by the dressings will be all sufficient. The rule should be, however, that hæmorrhage with the characteristic arterial jetting, demands radical treatment.

The *occipital artery*, is given off from the external carotid, immediately opposite the origin of the facial, and passes upwards and backwards, under the digestive and sterno-mastoid, piercing the trapezius immediately below its insertion into the curved line of the occipital bone, taking an exceedingly tortuous course, and giving off numerous branches, being distributed over the posterior portion of the scalp particularly. Unless wounded low down, it can rarely furnish blood enough to cause uneasiness, but under other circumstances, it may place the life of the patient in jeopardy. Immediately after its exit through the trapezius, it divides into two branches, and the common trunk thus made is the point of election for the application of a ligature, or an accupressure pin. When the division is above this, in one of the branches, by making pressure with the finger at the point of hæmorrhage, the vessel will enlarge and pulsate sufficient to make its detection easy. When this cannot be done, either from swelling or otherwise, the line of the vessel may be traced with sufficient accuracy, by drawing a line continuous with the posterior border of the sterno-cleido mastoid, for one inch above its attachment.

Should the wound be in the common trunk, and the vessel completely divided, there will be retraction of the lower portion under the

trapezius, and the vessel must be sought either at its point of origin, viz., the first posterior branch of the external carotid, immediately after its division from the common trunk, or under the sterno-mastoid, at about the centre of the muscle. The vessel being wounded in this locality, the hæmorrhage will be under the trapezius, the clot extending down the back for some distance.

The *temporal artery*, is the continuation upwards of the external carotid, passing upwards immediately in front of the ear, but cannot be easily reached until after it has passed above the zygomatic arch. It can readily be felt, unless there has been great loss of blood. After leaving the zygoma, it immediately divides into two large branches, given off nearly at right angles, but which soon curve upwards, and are distributed, after many subdivision, to the forehead, vertex, and temporal region. If the bleeding orifice cannot be found in the wound, ligature, or the accupressure pin, must be applied on the main trunk, immediately in front of the tragus of the ear. As a rule, however, it will be found a very formidable operation to attempt ligation of the vessel below the tragus of the ear, and I am not aware that it has been attempted, at least it is not of such common occurrence as to find its way into our text-books. In applying the ligature as above, care must be taken to avoid the auriculo-temporal nerve, on the portia dura, and for this reason, as SKEY says (*Operat. Surg.*, p. 245), it should be fully exposed before a ligature is passed. I will add, also, that for the same reason, accupressure should not be attempted.

The *superior orbital* is a branch of the ophthalmic, which is in turn an important branch of the internal carotid. It passes out, about the centre of the supercilliary ridge, from beneath the orbicularis palpebrarum, and will rarely afford dangerous hæmorrhage. When the bleeding is free, and not perfectly controlled by pressure, it may be taken up, and secured by an accupressure pin, but the danger of including the supra-orbital nerve in the compression will make this last a very undesirable procedure.

It is possible that minor vessels may, in exceptional cases, cause dangerous bleeding when divided or wounded, but my experience does not furnish any such, nor am I able to find any in our text-books.

II. OF THE SKULL.

The injuries inflicted on the skull are contusions and fractures, and are of sufficient magnitude and importance to have enjoyed the especial study of the most eminent surgical writers. In a work of this character it is impossible to devote the space necessary to the consideration of a subject of such importance, and we must rest content with a presentation of the most salient and practical features, refering those who desire an exhaustive treatise to the works of GUTHRIE, POTT, ACERCROMBIE, and others.

CONTUSIONS.

The skull is exceedingly tolerant of severe injury, but in certain cases slight accidents will be followed by the most extensive and formidable morbid action. Much will depend, as a matter of course, on the bodily condition of the sufferer, any dyscrasia, cachexia, or notable departure from the standard of health, predisposing to more or less extensive morbid action. Syphilitics, those who have been mercurialized, or have been subjected to influences affecting the bones particularly, are peculiarly liable to secondary chronic difficulties, the nature and extent of which are dependant upon the particular form of dyscrasia present.

Contusions of the skull may be inflicted, and of a severe form and degree, with little or no evidence of injury in the scalp, the force being usually a glancing blow, or made by a broad flat body. The lesion may extend through both tables, be confined to but one, or even to the diploe alone. The consequences may be considered under two heads, immediate and remote, the former being of an acute character, the latter essentially chronic.

The *immediate consequences* are similar, in all respects to contusion of bone as laid down in the preceding chapter, with a possible incomplete fracture of one or both tables. Such fractures are usually stellate, when confined to the outer table, and cannot be diagnosticated during life; when the inner table is involved, any form of fracture may exist, probably what might by appropriately called comminuted, being the most frequent.

The frequency with which *fracture of the inner plate* occurs, without perceptible injury to the outer table, is remarkable, but is explained by the exceedingly brittle character of the structure, whence its synonym "vitreous table—and the transmission of the force as in fracture by *contra coup*. An accident of this character is not readily recognized, the symptoms being so much mixed up with those of compression and concussion (*vide Surg. Therap.*), but the history of the case, and the fact that symptoms of compression come on at once, with no depression of the external table, and with more rapidity than would occur from effusion, may serve to throw some light on the case. When the fragment displaced is of some size, compression is soon, in fact immediately pronounced; but when it is small, perhaps only small spiculæ or fragments, the symptoms will more closely resemble irritation, concussion or contusion of the brain. When speaking of injuries of the brain, in the next section, this will be returned to, but at this time it can only be observed that the detection of the accident can only be secured by an intelligent consideration of the causes, and the rapidity with which symptoms of cerebral lesion come on.

The *diploe may become inflamed*, and proceed to suppurate as a primary consequence of contusion of the calvarium. The word primary is used to indicate a condition due to the injury directly, and not

dependant upon constitutional causes; it has no reference, in this instance, to the time elapsing since the infliction of injury. The condition is uniformly considered one of exceeding gravity, threatening extension of the inflammatory process to the meninges and the brain, with particular danger of purulent absorption. Having never had the privilege of meeting this complication in my practice, I shall quote the semeiology and description from the article on INJURIES OF THE HEAD, by DR. PRESCOTT HEWETT, (HOLME'S *Syst. of Surg.*, II, p. 249).

"The patient having recovered from the immediate effects of the injury, may for a time appear to be in perfect health; and thus matters generally go on for a fortnight or three weeks, when a change, slight at first, takes place. When there is a wound, it loses its healthy aspect, and this is accompanied by feverishness and pain in the head; then follows a spontaneous secession of the periosteum; and the bone, if denuded, becomes dry and discolored. Such are the first indications of mischief; and now, should the inflammation spread from the internal table of the bone to the dura mater, this membrane secedes from the affected bone, and its outer surface is covered with lymph or pus. Thus far the mischief is circumscribed; but when the inflammation reaches the parietal arachnoid, it spreads more or less over the free surface of this membrane, and soon involves the visceral layer of the arachnoid, the pia mater, and the corresponding surface of the brain. Meanwhile the symptoms become more and more marked—increased feverishness, repeated rigors, intense pain in the head, sickness, drowsiness, occasional wandering, coma, and sometimes paralysis."

These symptoms particularly refer to suppuration occurring when the inner table has given way, the dura mater is likewise destroyed, and the pus is extensively diffused over the arachnoid. These are cases in which the arachnoid becomes adherent to the dura mater, or the layers of the arachnoid to each other, by plastic exudation, and the pus is thereby confined within definite limits, giving all the indications of circumscribed abscess. We recognize this condition by the prominence of brain symptoms, and more particularly when hemiplegia is developed. When the condition can be otherwise made out, in place of cerebral conditions there is pyæmia, the presumption is that the pus is confined in the diploe, and has not come into contact with the dura mater, the inner table remaining intact. It is important to recognize this, if possible, as much of the success of treatment, particularly instrumental, depends upon the fact whether the dura mater has given way or not.

Injuries to the outer table are followed by symptoms and conditions exactly similar to contusions of other bones, and apart from the stellate fracture, and possible destruction of the periosteum, need not occasion any anticipation of future trouble apart from any constitutional disturbance of a chronic character. It must be borne in mind, however, that contusion of the outer table will, in most instances, at

least those severe enough to be brought to the notice of the surgeon, be associated with some lesion of the diplœ, internal table or encephalon; while fracture of the internal table, and suppurative inflammation of the diplœ may readily occur without appreciable injury to the outer table.

In the *treatment* of these primary conditions, *Arnica* must always take first rank; it alone, used either topically, internally, or both combined, will in the majority of instances remove all symptoms in the abscence of dyscrasia. In the latter case, as a matter of course, special indications will arise, which it is impossible to particularize. Should there be fracture of the internal table, with depression uncomplicated by splintering or complete detachment of the fragment, *Arnica* will have a tendency to raise the fragment by a restoration of the elasticity of the membranes, lost from the concussion. Should relief not follow in reasonable time, say in twelve or fourteen hours, the presumption amounts almost to a certainty, that there are fragments driven in on the brain, and the dura mater is torn. In this event trephining must be practiced, the depression elevated, and loose fragments removed.

Suppuration of the diplœ may be averted by *Arn.*, *Bell.*, or *Merc.*, according to circumstances and special indications. which cannot be given at this place, as the indications vary with each case. When pus has once formed, however, the case must be treated as one of pyæmia, erysipelas, or diffused abscess. It would seem that evacuation should be a first indication, but since the time of POTT the results of this practice have always been disastrous. It is supposed that the cases seen by this celebrated surgeon, were circumscribed abscess, or at least those in which the internal table was intact without destruction of the dura mater. At all events, whether from an unfortunate selection of cases, failure to recognize the state of affairs before the meninges became implicated, or some extensive pyæmic modification had arisen, certain it is that all applications of the trephine have been followed by death of the patient. Accordingly the operation has been almost completely abandoned, and we must trust entirely to medicinal and conservative treatment.

The *secondary or remote consequences* are many and interesting. They are uniformly developed as some chronic disease, either in the nature of an hyperostosis, without actual morbid action or deterioration of the tissue; development of bone tumors of various kinds; caries; or necrosis. In fracture of the vitreous table it may occur that the reparative process may cause an unusual amount of provisional callus, which remains as definitive, and an enostosis is produced. I am of the opinion that this is the method of development of this form of tumor in very many instances. At other times the whole, or a large portion of the skull, will become uniformly thickened. One case is mentioned by MR. HEWETT (*loc cit*) in which the bones attained a thickness of eleven lines. In other cases necrosis or caries will be

developed either from purely constitutional causes, or the extensive disorganization of the periosteum. HEWETT refers to cases in which, as in that of Norris, "the disease attacked both tables of the whole of the calvaria, and extended even as far as the foramen magnum." He also states that the case of SAVIARD "is the most extraordinary. In this case, two years after a blow on the head, the whole skull-cap came bodily away."

The *treatment* does not differ from that indicated in the same conditions from other causes.

Caries indicates a constitutional vice, and must be treated accordingly (*Vide Surg. Therap*).

Necrosis may be of purely local origin, and maintained by disorders of local nutrition. All dead particles must be removed as they become loosened, and free exit for pus and detritus be provided. Treatment must be instituted to limit the extension of the morbid action, as laid down in another place (*Surg. Therap*).

Tumors are to be treated precisely as tumors in other situations, or from other causes. It is manifest, however, that enostosis must demand early removal, as its continuance must keep up much irritation of the brain, and may even result in suppuration and death. In one case the results were so eminently satisfactory, that I should not hesitate to resort to the same treatment in any future case. Some months after the reception of a violent blow on the head, in the right temporal region, a man commenced to complain of paroxysms of intense pain, with subsequent loss of consciousness. The paroxysm would last for a day or two; the pain continuing for twenty-four hours before unconsciousness came on. The attacks were at first at intervals of two or three months, and were supposed to be due to periodic accessions of growth of a recognized tumor. The intervals gradually became shorter, and the suffering were correspondingly increased in intensity. He finally was completely broken-down and took to his bed. After much urging, an operation was consented to; a trephine applied over the painful spot, and a tumor the size of a cherry removed in the ring of bone. The dura mater was *not* perforated; it was thickened and softened. The whole aspect of the case at once changed, and during the five years that he was more or less under observation, no return of the paroxysm occurred, and he appeared to be in perfect health.

FRACTURE OF THE SKULL.

For convenience of description simply, it has been thought better to divide this topic in imitation of the article in HOLMES' *Surgery*, viz., into fractures of the vault of the cranium, and those of the base.

Fractures of the cranial vault are usually from direct violence, with an occasional instance of fracture from transmitted force. There are a few instances in which a blow has been received on the parietal bone on one side, and fracture has occurred on the opposite side of the

head. There is always a doubt, in such cases, whether the fracture was produced *centra coup*, or the patient in falling struck on that side. That the former is a possible occurrence, there can be no doubt; that it is at all frequent, is certainly problematical.

However produced, the fracture may be of any variety, with or without displacement, simple, comminuted, or compound, or a simple fissure or separation of the sutures.

Fissures are not necessarily confined to the point of injury; they may be a simple separation of the sutures, particularly in young subjects, without an actual fracture at all. At other times there will be a stellate, incomplete fracture at the point receiving the blow, the fissure extending, to any extent, on either side. There are numerous instances of such a lesion extending through both tables, involving the whole arch, and reaching to the base of the skull.

Comminuted fractures are usually much less extensive, representing a more concentrated blow, and are mostly confined to the point of injury. It is not unusual to find extensive fissure coexistant with comminution, but during life it is impossible to determine this, unless the separation is so complete, on all sides and angles, that some mobility is present.

Compound fracture is the common type, as a wound of some kind is nearly always present leading down directly to the fracture. In such cases the fracture will usually be found directly at the point of injury; while in other cases, without a wound, while the principal lesion is at the point receiving the blow, it may extend far beyond these limits. In short, the greater the concentration and force of the injury, that is the greater the force with a small surface inflicting the injury (as the corner of a brick, musket-ball, or sharp body), the smaller the extent of the fracture, the greater the injury to the bones, and the greater certainty of a wound in the integument.

Whatever the variety, it may be limited to the external table, or the internal; in the large majority of cases, however, both tables will suffer. The nature of the accident will be an important consideration, some forms inevitably fracturing both plates, while others injure one or the other according to circumstances. Blows with cutting instruments, as swords, hatchets, axes, etc., or those which perforate the skull, as musket-shot, must fracture both tables, but not necessarily to the same extent. I think most cases, certainly so in gun-shot accidents, the external table will sustain the least extensive injury, the velocity of the missile being materially lessened in its passage through the dense outer plate. In cases in which the force is directed from within outwards, as in shot wounds through the mouth, as in cases of attempted suicide, or through the orbit, the inner table may exhibit a slight injury, as far as extent is concerned, while the outer will be extensively shattered. On the other hand, a blow with a broad flat surface, as a board, or in falling on the head on the smooth ground or pavement, the external table may escape any lesion, while the inner will be extensively fractured.

A fracture, of either table, may exhibit displacement of the fragment, or not; the displacement also may be outwards or inwards, of either table alone, or both tables. The outward displacement is quite infrequent, particularly in civil practice. In the army, sabre wounds occasionally raise a portion of skull in the flap, or gun-shot injuries through the mouth or by a glancing shot. In civil practice attempts at suicide frequently show outward displacement, as when the shot enters the mouth or orbit; also when a shot traverses the head, the point of entrance may be a simple perforation, or depression, the point of exit showing an outward displacement. Hatchet wounds, wounds from cutting tools falling from a height, frequently produce outward displacement, but the occurrence is so rare as compared with depression, that they may be noted as exceptions to the rule.

Either table may be driven in, or both; in the majority of instances the whole thickness of cranium will be implicated, the outer table depressed and the inner splintered. The degree of injury sustained by the vitreous plate can be approximated by consideration of the region. Thus over the frontal sinuses there may be much depression with no injury to the deeper parts.

There is much variety in the displacement, the prognosis and treatment depending very much on the actual condition of the parts. Thus the fragment may be entirely detached, and lying loosely on the dura-mater; the fragment may be attached at both sides, and completely fractured in the centre, so that it bends down like the leaves of an open book. The more constant form, however, is when the bone is broken into several fragments, more or less triangular in shape, with the points driven down and wedged together. In cases in which the fragments are free and unattached, unless some associate lesion is inflicted on the brain, the indications for treatment are few and simple, and the prognosis good. When the depression is fixed, the fragments wedged closely together, it is very rarely that recovery can be secured without resort to operative measures. On the other hand, as will appear shortly, a considerable depression, with much immobility of the fragments, can frequently be reduced without resort to instrumental measures.

The *symptoms* of cranial fractures, of the vault, are not at all times pathognomonic, but when pronounced are of a nature to forbid errors in diagnosis. In the large majority of cases occurring in civil life, symptoms of contusion will predominate, and the evidences of fracture will be so obscure that the most experienced will frequently hesitate long before pronouncing a positive opinion. The two chief considerations will be, the location and the extent of the injury.

Injuries to the temporal region, or other parts of the skull where there is a covering of powerful muscles, will greatly obscure signs of fracture. I have seen two instances in which the surgeon in attendance has mistaken wounds of the temporal muscle for depressed cranial fracture; and one in which the dense temporal fascia was mis-

taken for the bone, and the existance of fracture denied, when subsequent events revealed extensive injury to the bones. Such an error could only be made in injuries of the temporal region, the remainder of the cranial vault being practically subcutaneous; at least such would be the case if inspection were made a short time after the reception of injury. In a little time, the swelling and ecchymosis will render the diagnosis somewhat obscure. Under favorable circumstances, where the bones can be distinctly felt, extensive fissure, or any form of fracture with displacement, should be readily determined; and if the integument is wounded there should be no particular difficulty in establishing a diagnosis, at least as far as the external table is concerned. And right here comes in a question of much importance, and one that I am unable to answer from personal experience. Which table of the skull is broken with greater frequency? The compiler of the *Med. and Surg. Hist. of the War* (*Surg. Vol.*, pt. I, p. 140) says that one hundred and thirty-eight cases of "alleged" fractures of the outer table alone were reported, but he is "disinclined to admit that the outer table of the skull is ever fractured in the adult without injury to the inner table, either by projectiles of war or any other external violence," except from blows on the supercilliary ridges zygoma, occipital protuberance. The question is still far from being settled, but the presumption is that our author is right, as will appear shortly. The prevailing opinion has always been, that fracture of the inner table was due to its greater brittleness, and that opinion has been expressed in a former paragraph. Unquestionably the structure of this plate has much to do with the frequency of fracture; but the actual fact seems to be as stated by TEEVAN (*Brit. and For. Med. Chir. Rev.* xxxvi, p. 189, and *l. c.*, p. 157), "That fracture always *commences in the line of extension, not that of compression.*" Thus when force is applied to a body, as a stick, the point of compression is rendered more dense by a crowding together of the particles; separation *commences* on the opposite side, or the side of extension. Should the force be long-applied, or violent, complete fracture will occur; but when of brief duration, but one side will give way, and that opposite the seat of pressure. DR. OTIS (*loc cit*, p. 158) gives the result of numberless experiments on the skull, in which he had never experienced difficulty in producing a fracture of the inner table by blows upon the outer, or the outer by blows upon the inner. We must conclude, therefore, that in injuries of the skull, from without, when one table alone gives way, it will be the inner; when from within, the outer table will yield.

Symptoms of cerebral injury are present, as a matter of course, in cases of fracture with displacement, but are oftener confusing than otherwise. It is almost impossible to differentiate between compression from depressed fracture of the inner table, and from effusion. Perhaps the rapidity with which such symptoms come on after injury may serve to differentiate, but it would be a very uncertain guide.

Attention must be given to the nature and degree of the injury, and the region. Thus when there are no signs of fracture whatever, but compression is established slowly, if the blow was received in a region, as the temporal or parietal—where an artery of size might be torn, as the meningeal—we may assume that hæmorrhage is at the bottom of the mischief. Under other circumstances, when no artery of size is in the neighborhood, and no signs of fracture in the external table, compression coming on rapidly will indicate fracture of the inner table. Difficult as it will be found to determine with accuracy the existence of depression of the inner table, when irritation of the brain is developed, it is almost impossible to decide whether it is due to laceration, or impaction of splinters from the vitreous plate. The evidence is altogether presumptive. The persistance of the symptoms, and the nature and location of the accident, will aid somewhat, in forming a diagnosis, but under the most favorable circumstances much doubt hangs about the case, and the most experienced will often be led into error.

The *prognosis* of fractures of the vault depends upon many circumstances. *First* the location of the fracture. It has been found that fractures of the lateral and occipital portions of the skull, are more fatal than similar accidents to the vertex or frontal region. This is partly owing to the danger of inter-cranial hæmorrhage, the vessels in these regions being large, and readily injured. Thus of sixty-four fractures reported during the war, the ratio of mortality was as follows:

Frontal bone, or region,	22	cases;	10	deaths;	Ratio	47.6
Parietal	"	"	"	33	"	15	"	"	48.4
Temporal	"	"	"	7	"	6	"	"	85.7
Occipital	"	"	"	2	"	2	"	"	100.

The *extent of the injury*, both as to the bones and the cranial contents, is next in order. Fractures that are very extensive, expose the patient to extraordinary danger from pyæmia, caries, or necrosis. When the dura-mater is wounded, hernia cerebri, abscess of the brain, etc., are more frequent. When fragments are driven into the brain substance, abscess is to be feared. Severe concussion or compression, seriously complicates the case; and so through the whole list of casualties. In brief, the prognosis is good, in proportion as the fracture is simple; no displacement of the fragments; abscence of impaction when displacement occurs; cerebral injury slight; abscence of intra-cranial hæmorrhage; and the patient's bodily health is good.

The *results* of fracture, as to local conditions and preservation of life, may be stated as follows: Formation of enostasis; necrosis of fragments of the skull; or hypertrophy. There may be abscess of the brain; encephalitis, or protrusion and loss of brain substance. Epilepsy, tetanus, hemiplegia, aphasia, and other symptoms of cerebral lesion may occur as remote or near consequences. Death may result

from pyæmia, erysipelas, or any of the above mentioned, as secondary upon the lesion; or immediately, from compression, concussion, or other serious lesion.

Treatment.—The treatment of fractures of the cranial vault, of all varieties, is to a large extent to be conducted on the expectant plan, and in very many cases there will be no necessity for treatment at all, as far as fracture is concerned, unless the cerebral lesion is of sufficient gravity or prominence to direct attention to it.

Incised fracture demands different treatment under different circumstances. Thus when the portion of bone is completely detached from the cranium, its connection severed with the scalp, and extending through both tables, it should be removed. In young cases, or those in which the loss is small in extent, the opening will ultimately close up by ossifice deposit, or a fibrous material, as in the case of trephining. When, on the other hand, the attachment to the scalp is continued, or there is some connection with the skull, whether osseous or periosteal, it should be replaced, and union will usually take place. As a matter of fact, little injury will result if a short time is allowed before condemning the fragment, as its situation allows prompt removal on the first symptoms of necrosis, or evident failure to unite is assured. It has occurred that, in large fragments, a portion has united, and the remainder perished. The treatment should then be conducted as in cases of necrosis from other causes; the sequestrum should not be disturbed until it becomes loosened. Remedies mentioned in "*fractures in general*," should not be forgotten, they having a powerful influence in promoting union.

Fissures, or other forms of incomplete fracture, that is fractures without displacement, will need little if any treatment. When the separation of the bones is so complete that there is mobility, the parts may be drawn together, and retained by appropriate bandaging, which may be made more efficacious by moulded paste-board splints.

Fractures with depression, when the inner or both tables are driven in, demand more careful and particular attention. Depression of the external table over the frontal sinuses, the zygoma, or the occipital protuberance, will frequently be found not to include the inner table, owing to the space between them, and unless cerebral symptoms come on, or the depression is so great that serious deformity is threatened, the treatment may be purely expectant. The question in other cases is, shall trephining be practiced or not? It is almost impossible to answer categorically, as circumstances of various kinds will very materially affect the indications. Perhaps it would be safer to say "yes" than "no." While it will be seen that a large number of deaths occur after the application of the trephine, probably as many as fifty per cent. of all operated on, yet the fatal result is worse to be attributed to the nature of the accident calling for operation, than the operation itself. In some cases it is delayed inexcusably on that universal plea of timid ineficient surgery, "giving the patient a

chance to rally before resorting to the last resource." In others, the injury is necessarily fatal, and any treatment would be futile. In still others, happily very few, unskilful use of the trephine may be credited with the result.

It is a matter of the first importance to determine, if possible, what cases imperatively demand the aid of operative surgery, but it will be found exceedingly difficult to do so. It may be stated in general terms that an operation is demanded, when the skull is driven in on the brain, and the fragments impacted so that they are immovable; when the fragment is completely detached, and driven under the skull so that it cannot be reached; when the inner table is extensively splintered, and fragments are driven in on the brain; in short, in all cases in which there is compression or irritation of the brain from depressed bone, which is not relieved in one or two hours by spontaneous elevation.

It must not be forgotten that there are very many instances, where the fragment is either completely detached, or movable, in which spontaneous elevation occurs, from the elasticity of the meningis on which it rests. Many theories have been offered to account for this occurrance, the most plausible being that the dura mater has been temporarily "stunned" by the blow, and upon restoration of its tonicity, the displacement is corrected. Whatever the facts may be, it is certain that very many cases of depressed fracture are thus reduced without the interposition of the surgeon in any manner; many more can be added, from the use of *Arnica*. It must not be understood that this is the case in impacted fractures; it is only observed when the fractures are movable, either completely detached from the skull or retaining only a slight attachment. The elevation of the depression will not always induce a cure. The continuance of cerebral symptoms afterwards, will indicate, very often, that there are some fragments of the inner table still in contact with or imbeded in the brain. The trephine must then be applied, and search made for the fragments.

Finally, all fragments of bone, in all forms of fractures of the cranial vault, that are completely detached, must be removed; the wound in the soft part accurately closed; and remedies administered to hasten the repair of the breach, as well as to subdue morbid action on the brain.

FRACTURE OF THE BASE OF THE SKULL.

For surgical purposes the base of the skull includes all that portion corresponding to the base of the brain. A line drawn from the occipital protuberance to the orbital plate of the frontal bone, would describe quite accurately the boundaries of this region. For this reason many fractures that would come under this head, would appear to be not basilar; as of the orbits, temporal-bone, lower portion of the parietal, etc.

These fractures are the result of either direct or indirect injury, and to some extent are produced by *centra coup*. In fractures of the vault it was found that they were nearly always from direct force; in the base, while examples of both occur, they are more frequently indirect. There are very many regions where the bones are so thin, that slight exertion of force will cause them to yield, and apparently trivial injury to the parts will be succeeded by alarming or even fatal symptoms. Many instances of death following wounds of the orbit are noted, some of them most remarkable in character. Punctured wounds in the nostrils, have occasionally proved fatal, and examples are not wanting of the condyles of the lower jaw being driven into the cavity of the skull, and the patient dying from encephalic abscess directly caused by the accident. Among a large number of cases given and quoted by different authors, one related by MR. HEWETT (HOLMES *Syst. of Surg.* II, p. 277) will serve to illustrate the frequently slight evidence of injury, that conceals a fatal lesion. He says: "Whilst fencing with a walking-cane with one of his comrades, a soldier was hit on the nose; but the only appearance of injury was a small puncture, not larger than a leech-bite on the left ala. The man died a few days afterward, with brain symptoms; but the exact nature of the case was never even suspected. At the post-mortem examination, however, the brass ferrule of the walking-cane was found in the skull, close to the left side of the sella turcica, and this had led to the extensive inflammation of the membranes of the brain."

Recognizing the fact, therefore, that serious or fatal consequences may ensue upon the slightest injury, in every case where symptoms of brain lesion come on, and there is the least traumatic history, careful examination must be had, and the skull should even be opened if other means fail. As a rule, however, apart from the regions indicated above, the bones in relation to the base of the brain are of sufficient density to effectually protect the parts from slight injury, and their position precludes the application of direct force, except under very exceptional circumstances. The natural conditions, therefore, are highly unfavorable to fractures from direct force, and need not detain us longer; particularly is this the case, as when such accidents do occur, the consequences are identical with those of the vault from similar causes, excepting a much greater fatality.

Indirect fractures were formerly supposed to be due, in the large majority of cases, to *contra-coup*, and indeed the opinion prevails quite generally to-day. In fact, until very recently, I had entertained the same opinion myself. While such an occurrence is far from being impossible, it is much more infrequent than many suppose, and until I gave the subject special attention, it seemed reasonable to refer all such accidents to that cause. There are instances, numerous certainly, but when compared with the whole number of fractures very few, in which blows on the occiput, vertex, or frontal bones, has pro-

duced fracture of the base of the skull without any lesion, at least that could be detected, in the intervening tissues. So also violent compression on the occiput and frontal region, has caused the basilar process to give way. The numerous instances of fracture of the base from falls on the feet or buttocks, seems to induce fracture by forcibly propelling the spine against the cranial bones, rather than by transmitted force. The fracture by contra-coup, therefore, while perfectly feasible, may be considered at least a comparatively rare form of injury.

Inasmuch as fractures of the base of the skull are of common occurrence, being the cause of death in a large proportion of cases in cranial injuries, and we have seen that direct fracture must be exceedingly rare, it follows that indirect force must be exerted in the large majority of cases. Experiments made by MR. HEWETT, notably by DR. ARAN (French), and others, show that injuries of ordinary severity will result in basilar fracture confined to the anterior, middle, or posterior fossa, as the force was applied to the frontal, vertex, or occipital region of the vault. In all cases, as a rule, there was more or less fracture at the point sustaining the blow, which extended to the corresponding portion of the base. In injuries of greater gravity and severity, the fracture may reach over into either or both of the other fossa, but in all cases, without exception, it originated in the fossa corresponding to the cranial region receiving the injury. MR. HEWETT (*loc cit*, 279), in his own cases, proved that the fracture was limited to the anterior zone (fossa) in five cases; to the middle, in fourteen; and to the posterior, in six. In ten years sixty-four cases had occurred, and all three fossæ were implicated but ten times; the middle was more frequently injured, either alone or as the initial lesion in more extensive fractures, and was broken no less than fifty-three times. It has not been my fortune to see many cases; perhaps fifteen or twenty, both in practice, at post-mortem operations, and on the dissecting table. In each instance, however, when but one fossa was injured, it has been the middle, and more frequently the basilar process of the occipital bone was broken.

The *symptoms* of basilar fracture, are few, and while of prime importance are not at all times easily elicited, and in exceptional cases, we may often remain in uncertainty as to the actual lesion until post-mortem dissection reveals it. The most conclusive are as follows: Hæmorrhage, escape of fluids, escape of brain matter, and cerebral symptoms evidently due to trauma. Under the latter head we may well include lesions of the cerebral nerves.

Hæmorrhage to be of any particular value must be of such a character and from such a source, that it can be seen. It may appear through the nose, ears, or mouth; or be simply an effusion into the cellular tissue. Thus the eye, lower lid, or the integuments about the neck and throat may become ecchymosed, and the rapidity and degree of the swelling and discoloration must enter largely into our diagnostic

scheme. Unquestionably many cases occur of sudden and extensive ecchymosis, when recovery follows; the presumption would be that there had been no fracture. The fact is, however, that a basilar fracture is not necessarily fatal, even when very extensive. I have seen two instances, on the dissecting table, where union of such fractures had taken place, and evidently long antecedent to death.

A glance at the anatomy of the base of the brain and skull, will readily furnish sufficient reason for the hæmorrhage. The many important blood vessels, both contained in bony channels and lying free, renders it almost impossible that complete fractures should occur without wounding or severing one or more of them. Frequently however, the blood will be effused into a cavity of the skull before appearing externally, except when ready exit is given it, as through the ear or nose. The late appearance of subcutaneous effusion, therefore, must not exclude the diagnosis of fracture.

Watery discharges, frequently from the ear, nose, or mouth, comes next in importance, and for a long time it was a matter of question whence it came. Mr. Hewett, (*loc. cit.*) as far as the discharge from the ear is concerned, which is a constant symptom in fractures of the petrous bone, has satisfied himself that it was cerebro-spinal fluid, in very many instances. In some cases the line of fracture could not have given exit to the fluid, and some other source must be sought. The question is far from being settled; many, however, who have had opportunity for studying it, are of the opinion that it is the serum pressed out by a contracting blood coagula. This is rendered more plausible from the fact that such instances, that is fractures which do not cut "across the meatus internus and" communicate "with the tympanum, a laceration of the tubular sheath of the cerebral membranes surrounding the seventh pair of nerves within this meatus, and a laceration of the membrana tympani," do not occur until after the cessation of the hæmorrhage that was a primary symptom. This discharge, while not uncommon in other regions, is more frequent from the ears, and admitting the many difficulties in determining its source in some cases, it is universally recognized as one of the most certain signs of fracture of the base, and also indicating an accident of exceeding gravity, one, in fact, commonly considered necessarily fatal.

From the *nose*, the presumption is, from the analysis of a number of cases, that the discharge is derived from the arachnoid space. There are some cases, however, in which the dura mater was unwounded, and the source was referred to the pituitary membrane; a sort of coryza to which certain individuals are greatly liable. When unquestionably of cerebral origin, the prognosis is bad, but there is much unavoidable difficulty in determining this point.

Finally the discharge may occur directly from the vault, from wound of the scalp, fracture of the cranium, and associated fracture of the base. The dura mater and parietal arachnoid must be more or less torn in such cases, and there need be no hesitancy in determining the fluid to be cerebro-spinal.

Escape of brain matter through the fissure, if it is primary, must be conclusive evidence of fracture. Brain substance has been driven through the auditory meatus, the nostrils, or in the subcutaneous tissue, which last must be of little value in diagnosis, from the difficulty in detecting it. Inspissated mucus from the posterior nares has been mistaken for brain matter, but care should prevent the frequent occurrence of such an error. While such an occurrence must render the prognosis of greater gravity, there are numerous instances of recovery having taken place.

Cerebral lesions, and those of cerebral nerves, must be deferred to the next section, it being sufficient at this time to call attention to the fact that the associated lesion will be either concussion, compression, or irritation of the brain, or such modifications of nerve supply as would follow section of the important nerves in this region.

It can require little argument to indicate the exceeding gravity of fractures of the base of the skull, or to account for the great mortality. The number and importance of blood vessels; the number of primary nerve trunks having control of the most important vital functions; and the severity of the force necessarily applied to produce such a lesion, causes a feeling of surprise that recovery should ever take place. Even in the absence of alarming symptoms, the fact of fracture once made out, we must view the case with much solicitude, and recognize the probability of a fatal termination.

The *treatment*, as far as the fracture is concerned, is purely expectant. Nothing can possibly be done, unless it is to assure quietness, and thus avoid any extension of the injury already done the important organs and parts. Our attention must be directed solely to the cerebral symptoms, and endeavor to modify existing lesion, or ward off the infliction of others. It is utterly impossible to suggest any possible treatment, as the symptoms are so various, and so many different remedies will be called for. Each case must be viewed as a case by itself, and the treatment conducted on principles laid down in preceding sections, those to follow, or contained in a former volume (*Surg. Therap.*) under *Diseases of the Head*, or by reference to the experience, skill, or ingenuity of the attendant. *Arnica*, however, must at all times take first rank, both to hasten resorption of effused blood, facilitate the arrest of hæmorrhage, and repair lesions to the brain substance. Other remedies are to be given as indications arise, and will probably be, in most cases, *Bell.*, *Acon.*, *Stram.*, *Lach.*, or *Hyos.* Perhaps *Apis*, or *Helleb.*, would do good service, when the serous effusion is large, but the almost utter impossibility of determining this fact make it exceedingly doubtful. The great difficulty in selecting a remedy will be found to lie in the fact that the symptoms of specific lesion will be so much mixed up with those of trauma, that sharp-cut indications will be wanting.

III. OF THE BRAIN.

Whether from contusion, fracture of the vault, or base of the skull, the brain is liable to injury of various kinds and degrees, the most frequent being inflammation, concussion, compression, laceration, irritation, suppuration and hernia cerebri. The meninges are also exposed to wounding and inflammation; and the cranial nerves to contusion, compression and division. Each of these will demand a few words only, in passing; and some of the lesions, both as to descrip- and treatment, are sufficiently noted in preceding paragraphs and chapters, as well as in another volume of this series, (*Surg. Therap.*)

Inflammation of the brain is perhaps the most common lesion of any of those to be considered, and oftener follows the lesser injuries. It will be the danger of suppuration that makes it a special subject of interest, as the sufferings, while sufficiently severe, are not as acute as from other morbid processes. The pain will be throbbing and pulsating; the eyes red and injected; carotids full and throbbing visibly; the head hot; and there is an involuntary attempt to hold the head with the hand. Compression by the hands, from the hands of others, or from bandaging, usually affords sensible relief, although there are cases in which the least touch is unbearable. In the early part of the attack there is indisposition to move; noise is intolerable; and light is offensive. There is some fever, the pulse beating strongly and frequently, and the temperature elevated a degree or more. The urine is scanty, and may be almost suppressed. As the inflammatory action increases, the fever will rise in intensity, and the mind becomes disturbed. There may be coma, but delirium is more frequent, and varies in character, from a slight wandering to furious, raving mania. Through it all, however, the attempt to hold the head in the hands, is a marked and peculiar feature. As the attack subsides, the fever and delirium will abate, and if no untoward symptoms arise, there will be great prostration, which gradually disappears.

The *treatment* is entirely medicinal, with the exception that any irritant must be removed. The remedies are many, but those most commonly indicated are as follows:

Belladonna.—This remedy must at all times take the first rank. The symptoms given above might almost be transcribed from the materia medica, and as they are quite constant, there can be no question that the choice is often limited to this single drug. The differ ential indications will be, for the most part, those of delirium, and they come on, usually, only as secondary phenomena. *Bell.* will remain the remedy when there is desire to escape; frightened; and a merry mood alternating with them. Taciturn, or extreme talkativeness, talking very fast, everything is done in a hurry; drink being offered, it will be taken ravenously.

Hyoscyamus will be needed when the delirium is furious; rage; tries to bite; to go naked. The pulsations are so violent that the head is

shaken. Is thirsty, but expresses no other wants. The face is distorted. bluish.

Stramonium will be useful in cases somewhat similar to the last, when there are spasms alternating with delirium, which are renewed by light or sight of glistening objects. Between the spasms great loquacity, with an expression of fear on the face.

Glonoine has been of service in a few cases of somewhat exceptional character, when there is fullness in the head as if it were expanding and contracting, as if made of rubber; the brain seems to be moving in mass. Feeling as if the head were encircled with an elastic band, and a pressing weight on the vertex.

Acon. may be useful in the commencement, and later there may be a sphere for *Apis.*, *Arn.*, or *Opium.*

Suppuration of the brain, while not of very common occurrence, is still a natural sequel to traumatic inflammation, more particularly when some foreign material, as a spicula of bone, remains imbedded or in contact with the brain. The symptoms are exceedingly obscure, and many have gone down to their death from the impossibility of detecting the true condition. In general there will be some mitigation of the more acute signs of inflammation, with a continuance of the delirium, and frequent rigors. The symptoms gradually yield to those of compression, which will be given below—and if there should be an opening in the skull the membranes may be pouched out into it. The symptoms of compression might lead one to expect hæmorrhagic effusion, but the usual symptoms of suppuration being added thereto, should facilitate a diagnosis. It is well known that suppuration once commencing in the brain, it extends with great rapidity, as is the case in all organs of loose texture. Never having seen a well-marked case, I will quote one of a typical form from the article by Mr HEWETT, (HOLMES' *Syst. of Surg.* II, 353.) "A young man was struck on the top of the head, in a brawl, with a knife, the blade of which broke in the bone, after having perforated the skull; but the exact nature of the injury was overlooked by a surgeon, who simply brought the lips of the wound together. The wound healed readily, and everything went on well for several years, save some occasional pains about the scar. This man was subsequently admitted into the Hotel Dieu in a state of stupefaction, into which he had suddenly fallen. On examining the scar, (DUPUYTREN), a foreign body was clearly felt underneath it, and this, when laid bare, proved to be the point of the knife. The trephine was applied; the symptoms, nevertheless, continued, and paralysis of the opposite side of the body made its appearance. The dura mater was now laid open; nothing was found under this membrane; a knife was therfore plunged into the brain, and immediately a large quantity of matter flowed out. That very night all the symptoms disappeared, and the patient ultimately recovered."

It needs nothing to be added to this to indicate the proper treat-

ment. When the point of lesion can be discovered the trephine should always be applied, and the imprisoned matter let out. A number of successful cases are on record, many of them mentioned by the author above quoted; in some the incisions were carried very deep, and in one, Dr. DETMOLD'S, one of the ventricles was laid open. VELPEAU, led to that opinion by the records of one or two cases, did not favor incision of the brain, when the abscess was not plainly discernible, but counselled section of the dura mater, and waiting for a spontaneous discharge. Good results have followed this practice, but it would seem that the patient must be exposed to great danger from the delay.

Compression of the brain, whether due to hæmorrhagic effusion, abscess, or depressed fracture, presents the same array of symptoms, differing mainly in the rapidity with which the indications come on. In the greater number of depressed fractures, symptoms of compression appear immediately upon the receipt of injury, and continue until the pressure is relieved; in other cases, they appear gradually, increasing in intensity as the degree of compression increases. In compression from morbid growth, I have seen a few cases in which the symptoms were remittent; the tumor appearing to have periods of active growth, when the signs of compression would appear, going off again, after a time, to be again renewed at uncertain intervals. It is possible that the cerebral hyperæmia had more to do with this than the growth of the tumor, but sufficient data are wanting to establish the fact. It would seem that long continued depression of the tables of the skull, if no irritation results, might gradually induce absorption or atrophy, and thus function be restored, to some extent the brain-mass accommodating itself to the intruder. In no other way can we account for the restoration of a fair degree of health without elevation of the depression, instances of which while rare are not entirely wanting.

The *symptoms* are as follows: Cold pale (?) face, clammy perspiration; a peculiar pumping action of the larynx; frothing at the mouth; coma, stertor, and immovable pupils, either contracted or dilated. The face may ultimately become red, the eyes injected, and pronounced symptoms of encephalitis come on. The ordinary condition, however, is profound unconsciousness, the patient not responding in the slightest degree, to external impression, sound, light, or rough handling. (*Vide Surg. Therap.*)

Treatment must always be directed to relief of pressure, as a first indication; secondarily, to remove the effects. For the first purpose, the trephine is the proper instrument, and I have no hesitancy in insisting on its use in *all* cases of compression, whether primary or secondary, coming on from accidents, or as the result of morbid action. As the result of compression from accident, even when reposition of depressed bone has been immediately secured, we must expect inflammation, either meningeal or encephalic, or possibly sup

puration. When the inner table has been splintered, or the brain torn, irritation will probably occur, but with the complete reduction of the depression, the removal of all spiculæ or other foreign material, and the judicious employment of proper prophylaxis, such complications may be averted.

Immediately upon the removal of pressure, therefore, *Arnica* should be administered in frequently repeated doses. If inflammatory symptoms nevertheless come on, *Bellad.*, *Acon.*, or the indicated remedy may be substituted, according to indications.

There are a number of instances in which depressed fractures have been reduced spontaneously, as said above, and many cases reported in our journals in which *Arnica* has been credited with the reduction, even without any operative treatment. It is impossible to determine what an effect *Arnica* may have had, in view of the frequency of reduction without it, but it seems to me a question that is hardly worth deciding. None can avoid the admission that trephining is a very serious operation; and none on the other hand, certainly those of any experience, that the continuance of the compression, or failure to employ the trephine exposes the patient to great danger, is a fact also universally admitted. The question is, then, which exposes the patient to greater danger, delay, or early instrumental treatment. I am of opinion that the former is by far the most hazardous, and that statistics will show a greater ratio of mortality in cases treated by the expectant plan. Let it be an unfailing rule, therefore, to apply the trephine in cases of compression.

Concussion of the brain, popularly known as "stunning," is a suspension of consciousness, due to trauma, varying from a momentary confusion of ideas, to almost complete insensibility lasting for hours or even days. There is probably in all these cases, some actual lesion of the brain, but in the great majority of cases, there is no satisfactory evidence of it. There is some secondary inflammation and suppuration, but not to the same extent as in the case in compression.

The *symptoms* may be arranged in two groups, immediate or primary; remote, or secondary.

The *primary* symptoms are: coma, to a greater or less degree, but rarely, if ever, to the point of complete insensibility; when spoken to loudly, or shaken, will answer, but immediately relapse into unconsciousness; the answer will not always be intelligible; if more than a monosylable it will remain unfinished. Pulse weak, sometimes irregular; sphincters relaxed; involuntary urination or defecation. Muscles relaxed, and loss of contractility, or co-ordination impaired. The surface is cold, temperature reduced from one to three degrees, or more; when more than three degrees, a fatal termination may be expected. The pupils are widely dilated, but immovable. The symptoms closely resemble shock, and to a large extent, probably, that is the actual condition.

The *secondary* symptoms, are those of reaction. The stage is usually

ushered in with vomiting; surface becomes warmer; consciousness returns; the pulse comes up, running higher than normal; and when the concussion has been severe, or the primary stage is of some duration, fever will come on, of a synochal type. Delirium in this case, is a prominent symptom, and under favorable circumstances inflammation of the brain may be looked for.

The *treatment* (*Vide* "Shock" and "Disease of the Head," *Surg. Therap.*) is mainly medicinal. Bleeding, stimulation, or harsh treatment must be avoided, and attempts to pour fluids down the throat must not be made. The suspension of muscular action renders any attempt to introduce fluids dangerous; the patient may easily be strangled. Stimulation by olfaction may be employed, and such agents as Amyl nitrite, or Ammonia will be found very useful. As soon as consciousness returns, remedies may be given, as in the case of *shock*, giving a preference to *Arn.*, *Opi.*, *Camph.* or *Verat.* The continuance of the delirium beyond a day, or at most two, with evident signs of inflammation must cause uneasiness: and when symptoms of compression come on, the presumption is that suppuration has been established.

Laceration of the brain, may proceed from contusion, or concussion, as well as compression, and will be found a condition only recognized with difficulty, and in most instances rather suspected than determined. The symptoms are as in either of the above conditions, depending upon the amount of effusion, and the extent of the lesion. In all cases they will be so mixed up with those of irritation, that when the latter appear, we may safely conclude that the brain has been wounded. For this reason we will include under that head both conditions.

Irritation of the brain is a peculiar condition, one just short of inflammation, due to slight injury in those of a vicious habit of body, or a highly nervous temperament. The patient lies in a semi-conscious condition; answers all questions put to him, but in a peevish, irritable manner. He is perfectly indifferent to external affairs, and is unobservant of what is going on about him. He lies curled up, or twists about, as if in pain, and the hands twitch, or there may be convulsive paroxysms. The eyes are tight shut, and any attempt to open them is resisted. The face wears a frowning expression, and on endeavoring to fix the attention, there is an expression of pain. Sometimes there is delirium, the patient shouting and screaming, or muttering, particularly about his business. The skin is cool; face pale; pulse slow and feeble, except when roused, or during convulsions, when it becomes quick. There are no symptoms of inflammation. In extensive laceration, these symptoms give way to those of compression, indicating effusion of blood, and in severe cases encephalities comes on later, with evident signs of inflammation. In many essential particulars the symptoms very closely resemble *mania a potu*.

Marked and characteristic as the symptoms are, they are rarely of

much duration, soon giving way to those of general cerebral injury.

When the injury has been one of any violence, symptoms of irritation almost invariably indicate some degree of lesion.

The *treatment* is purely medicinal, unless signs of compression come on, when other measures must be at once inaugurated. *Acon.* will be the main remedy, I think, at least in the beginning, as the symptoms give way to those of inflammation, other remedies will be needed (*Vide Surg. Therap.*)

The differential diagnosis may be tabulated, as below, the symptoms of each of these conditions being unique and pathognomonic, when compared with each other:

COMPRESSION.	CONCUSSION.	IRRITATION.	ENCEPHALITIS.
Comes on slowly.	Comes on at once.	Comes on slowly.	Comes on slowly.
Pupils immovable, either contracted or dilated.	Pupils dilated, immovable.	Pupils contracted. Twists and curls about.	Pupils dilated. Holds head in hands.
Eyes shut.	Eyes open.	Eyes *tight* shut.	Eyes open or shut.
Coma.	Coma.	Answers, but peevish.	Delirious.
Stertor.	Answer when spoken to loudly.	No sign of inflammation.	Evident inflammation.

HERNIA CEREBRI.

One of the rather infrequent results of compound fractures of the cranium, more particularly, it would appear, after trephining operations, is a protrusion of the brain substance, variously spoken of as "hernia cerebri," and "encephalocele." From the reports of cases I have read, and in conversation with the few who have seen such complications, I infer that such protrusions never appear without some lesion of the dura mater. In the majority of cases, the protrusion appears only after suppuration occurs in the brain mass, or meninges, or when the dura mater is softened by some morbid action and gives way. It may occur primarily, when the original injury penetrates the brain, thus wounding the dura mater, but is not invariably produced even then by any means. In fact the proportion of such accidents in which no encephalocele occurs, is much greater than the opposite; perhaps the quite uniform fatality of such accidents, however, may in part account for the rarity of the complication.

The diagnosis is not difficult. There is a protrusion of a pulsating soft, reddish-gray mass, pulsating synchronously with the heart, which can be pushed back into the cavity of the cranium, but induces faintness, nausea, and diplopia, in most instances. Later the mass becomes darker in color, covered with pus, and sloughs off. Occasionally the disintegration is molecular, and gradual; at other times it occurs in masses. The amount of brain substance lost in this manner is sometimes enormous; cases are reported in which a quantity equal to half the size of the brain is lost, the mental faculties, for some unexplained

reason, not showing marked signs of impairment. Many authors assert that the greater portion of the protrusion is an inflammatory product, and not brain matter.

The prognosis is nearly always bad. In the records of the war, we learn that of 29 cases 22 perished, a mortality of 75.8. Dr. PRATT (*Hahn. Month.* XVI, p. 352,) reports a case, in a child five years of age, occurring after a compound fracture, in which a deep abscess had formed, and perforated the dura mater. Under gentle pressure in six weeks the mass was lessened in size, ultimately disappearing, and full recovery ensued with no visible impairment of mind.

All authorities agree that the treatment must be purely expectant. Symptoms are to be treated as they arise; any abscess that may be formed opened, and gentle pressure maintained. Under the most favorable circumstances we have no data to warrant a hopeful prognosis.

INJURIES OF THE CEREBRAL NERVES will always produce symptoms analogous to division, i. e., a suspension of the function presided over by the nerve. At the same time there are cases in which neuritis or neuralgia follow contusion, effusion into the sheaths, and the like, and a knowledge of anatomy and distribution of the organs will assist to accurately localize the lesion. It will be impossible to go into this subject at any length, and I will simply indicate, very briefly the nature of functional impairment in each case.

First pair, loss of smell, in division; greatly exalted sensibility, in irritation.

Second pair, loss or impairment of sight.

Third pair, more frequently, there will be ptosis of the upper lid. It is impossible to account for this singular fact, why one branch of the nerve should so frequently be alone affected when the main trunk is injured.

Fourth pair, the pathetic, is rarely, if ever affected. Its situation seems to protect it from injury so completely that I can find no case reported where its functions were interrupted.

Fifth pair, is frequently injured, and many cases of ulceration or sloughing of the cornea are noted. All the tissues of the face may give indications of innervation.

Sixth pair, has been injured, inducing convergent squint.

Seventh pair, very commonly injured in basilar fractures. Deafness and facial paralysis are the frequent indications.

Eighth pair, associated with the *ninth* are seldom injured. The symptoms are "dysphagia, aphonia, dyspnœa, with contraction of the muscles accessory to respiration."

As a matter of course little can be done in these cases, farther than to await the gradual restoration of lost tissue, or to meet special indications as they arise. What has already been written (*Inj. of Nerves*), should be consulted in this connection.

In closing this imperfect although long chapter, I will insert a

table of interest in establishing prognosis, taken from the *Medical and Surgical History of the War, Surgical Volume, Part I*, p. 308. It will not require any comment.

Injury.	Cases.	Deaths.	Dis-charg'd	Duty.
Wounds of scalp. Incised	282	6	68	208
Wounds of scalp. Incised (?)	28	1	10	17
Fracture of cranium. Incised	49	13	12	24
Wounds of scalp. Punctured	18	2	4	12
Fracture of cranium. Punctured	6	5	1	0
Contusion and laceration of scalp	331	0	21	309
Concussions, from falls, etc	72	14	43	13
Fracture of skull. Similar causes	105	57	28	17
Gun-shot wounds. Scalp	7739	162	1176	3689
Gun-shot wounds. Contusion of skull	328	55	173	100
Gun-shot wounds. Fracture. Outer table	138	10	66	62
Gun shot wounds. Fracture. Inner table	20	19	1	0
Gun-shot wounds. Fissures	19	7	12	0
Gun-shot wounds. No depr ssion	2911	1826	651	309
Gun-shot wounds. Depression	364	129	190	42
Gun-shot wounds. Penetrating	486	402	65	19
Gun-shot wounds. Perforating	73	56	17	0
Smash	9	9	9	0
Contra-coup	2	1	1	0
Aggregate	12,980	2,774	2,539	4,821

XVI. INJURIES OF THE EYE.

BY D. J. M'GUIRE, M. D.

Some apology from me for thus appearing before the profession seems but proper.

Some months since, during a conversation with the author of this volume, he remarked that he thought of writing a work on surgical accidents, and in case he did, wished to know if I would not furnish him with chapters on the organs which form my speciality. I thoughtlessly said I would, and now find myself called upon to fulfill my promise.

The frequency of the loss of vision after accidents, in cases which might have resulted favorably had proper measures been employed at the proper time, will be an additional and I trust sufficient apology for this attempt to place in the hands of the general practitioner, some suggestions by means of which his own reputation will be less endangered, and the happiness and welfare of his patients promoted, and which for lack of time and special training he could not gather from existing text-books.

This not being intended for the use of the specialist, I shall not enter into discussion of any of the theoretical questions in ætiology, etc., as they will arise, but endeavor to present only practical matter.

I have drawn freely on the best authors, endeavoring to deduce therefrom the best ideas and reduce them to single and simple methods. As far as seemed proper giving credit by reference to particular names.

In the treatment of the accidents described, I have with only a few exceptions, confined my therapeutics in the more immediate results of the injury, or where general principles were alone involved have left the treatment to be disposed of under its appropriate head, (as inflammation, ulceration, etc.,) in the main body of this volume, and in the operative measures to a description of the more simple ones only, presuming that he who will undertake to make the more important operations will have some of the leading text-books at hand, in which the details of the method to be used will be given.

INJURIES, WOUNDS, ETC., OF LIDS.

While wounds of these parts are governed by the laws and rules regulating *general* surgery, yet from their results, which in many instances lead to serious disease changes in the tissues of the bulb, and thus to impair vision, special care, and especial management are often called for in order to avert these results.

(*a.*) *Ecchymosis.*—This condition, commonly called "black eye," is of very frequent occurrence, and chiefly occasioned by a fall or blow hence frequently met with in pugilistic encounters. The dark, livid discoloration being due to a sanguineous effusion into the cellular tissue of the parts. It generally occurs within a few hours after the accident, but many come on at once, the discoloration extending from the eyelids to the surrounding parts. These facts serve to distinguish this form of ecchymosis from that produced by counter fracture of the orbit; in this latter the discoloration shows itself after a much longer interval and gradually extends to the lids; together with the effusion of blood into the areolar tissue of the lids there may be much serous infiltration and swelling of these and the surrounding parts. Indeed swelling may exist to the extent of firmly closing the eye. The discoloration from being dark and livid, gradually undergoes various changes of tint turning bluish-red, green, yellow, etc. While a "black eye" will gradually disappear in two or three weeks, the absorption may be accelerated by the use of remedies, also the early application of a cold compress may limit the extent of the effusion.

Treatment.—The first object of treatment in a recent case will be to limit the effusion; this indication will be met by the cold compress, which will best be made by wetting a piece of lint in a cold lotion composed of *Arnica* tr. and one part to twenty or thirty of water; fold the lint to a proper thickness, bind it firmly on with a roller bandage, and if the injury be severe the remedy should be given internally at the same time. Should suppuration threaten at a later period, *Rhus tox.* in the lower attenuations will often render the most signal service.

In other cases where absorption of the blood or serous effusion is very tardy, *Con. mac.* has seemed to assist us; *Hamamelis* and *Ledum* are also recommended in these injuries.

(*b.*) *Lacerated or punctured and incised wounds.*—These wounds of the eyelids are serious according to situations, extent, and also according to whether they are simply incised, or are punctured and perhaps accompanied by considerable bruising of the parts.

If the wound is an *incised* one of the skin only, and in a horizontal direction, the proper approximation by means of a fine suture, and adhesive plaster will assure a speedy and good result by primary union or first intention.

But if the wound is more extensive, involving perhaps the cartilage and more or less of the fibres of the levator palpebræ, the result may be, not only a considerable degree of ptosis, but on account of the supervening suppuration and union by granulation, a sufficient amount of contraction and shrinking of the integument may ensue to cause an obstinate ectropium. If the direction of such a wound be vertical, slitting the tarsal edge of the cartilage, the result may be an unsightly gap or coloboma. If the cut is near the inner angle of the eye the canaliculus may be divided and separated from the punctum.

In case of *punctured wounds* of the lid the ball should always be carefully examined to ascertain whether it is implicated or not, for while a slight punctured wound of the lid will readily heal without danger, it is very different if the former is also involved, when most serious consequences may follow. Also if a punctured wound has extended to the cellular tissue of the orbit, a troublesome, if not dangerous suppuration may follow.

WELLS stated, some years since, that wounds of the infra-orbital nerve had been known to be followed by amaurosis, and with the present "neurotic theory" of eye diseases we can readily conceive of a wound of either the first or second division of the fifth nerve giving rise to serious disturbance at the fundus either of a direct or of a sympathetic character.

Treatment.—Wounds of the lids whether superficial or deep, should always be brought accurately together by means of sutures, supported if of considerable extent, by adhesive strips. The parts kept cool by means of compress and bandage, using also a lotion of *Calendula* or *Arnica* according as the wound is an incised or lacerated and contused one. If the tarsal edge has been divided it will be necessary to exercise the greatest care in approximation of the edges and their retention in apposition. In order that the margin may become closely united, it will be necessary to apply one suture as near the edge as possible, this to be supported by one or more deeper ones. The needle will of necessity need to be a fine one, and if the edges of the wound are at all ragged, they should be carefully pared previous to attempting coaptation. If the canaliculus has been divided, the best result will be obtained by slitting it up into the sac, this may be done by entering a director and following it with a cataract knife, or the ordinary canaliculus knife may be used.

SCALDS AND BURNS.

Agents affecting the lids either by their high temperature or by chemical action, so readily affect the shape or function of the eye by their results, besides so frequently is it the case that the tissues of the bulb are immediately acted upon by the same agent, that I have considered it best to give a special section to this class of injuries, rather than to treat of them as we come to the different tissues in course of the adopted classification. The more superficial injuries of this class are produced by boiling hot fluids, water, tallow, molten metals. Scales from iron at a red or white heat, burning cigars, explosions of gun powder, matches, etc., while deeper cauterizations are produced by acids, such as nitric and sulphuric, or alkalies such as potash, lye, lime, mortar, and possibly by the introduction into the conjunctival sac of corrosive sublimate, cantharides, or tobacco powder.

The gravity of results must be estimated by the depth to which the tissue is affected and not by its surface extension, for in very small

but deep wounds a failure to supply the wasted parts or an excessive reaction during elimination with extension of suppuration to adjacent parts, may produce a cicatrix capable of sufficient contraction to cause serious deformity.

In *scalds of the lids* the edges may be much affected, so as to lead to adhesions and thus the formation of a more or less complete anchyloblepharon, or where the conjunctiva is also involved, contraction may follow producing symblepharon, and a burn of the lid sufficient to produce a dermal eschar extending through the skin or down to the cartilage, be it never so small, may produce serious results in a malposition of some of the cilia or of a punctum, or may lead to a very obstinate ectropium. This is especially true where the injury is of the lower lid, where if it is severe, destroying the greater portion of the cutaneous body, leaving perhaps nothing but the cartilage and conjunctiva the ensuing contraction and lagophthalmos will lead to such a degree of inflammation of the cornea and other structures of the eye that the organ is soon destroyed.

In the treatment of these injuries to the lids, while I will refer the reader to the chapter on burns, found in the main body of this work, for the general indications and the remedies and means with which to meet them, yet we here find some *special* indications and changes, which must be likewise met.

If the burn or scald be of only superficial extent, and no loss of tissue to be anticipated, the ordinary, simple, cold dressings, followed by dressings to exclude air, etc., will suffice. But if the deeper tissues are involved, then in addition to the proper application to exclude air, as *Vaseline, oiled cotton*, solution lunar caustic (applied with brush), or any other which may meet the indication. After the surgeon is assured of the integrity of the eye ball and conjunctiva, and their freedom from all foreign matter, a compress bandage must be carefully applied to keep the lids on the stretch, thus anticipating contraction by favoring the formation of a dermal covering.

According to ARLT, (*Injuries of the Eye*, p. 166), it is well to keep both eyes closely bandaged during the stage of granulation, in order to favor this dermal production. Also, for this purpose, he suggests the propriety of transplantation of epidermis, according to Riverdin's method. Where the tarsal margins are not involved, instead of using the bandage, the lids may be carefully stitched together, the stitches being allowed to remain until the epidermic covering has formed, this method being the suggestion of DEBROU, and later of VON GRAEFE. However, when the tarsal margins are involved this cannot be used, and they must be kept carefully annointed by vaseline, as well as carefully and fully separated frequently, in order to prevent their union (anchyloblepharon.)

SCALDS AND CORROSIONS OF THE EYE.

(*a.*) *Of the Cornea.*—There is not the usual formation of vesicles after scalds on this body, but a dense white or opaque spot will be observed, and if most of the corneal surface is involved, it may pre sent a corrugated appearance. The symptoms of reaction usually appear quite early, such as ciliary injection, redness and swelling of the conjunctiva, pain, photophobia and lachrymation, varying according to the degree of the injury, and in different cases; while loss of sensibility, and chemosis or a dried state of the injured cornea, must be regarded as particularly ominous.

(*b.*) *Conjunctiva.*—In scalds of this membrane, produced by liquids, the ocular conjunctiva more frequently suffers, in which case the injured part appears white, somewhat resembling diphtheritic membrane.

If, however, the burn has been produced by molten substances, as any of the metals, wax, tar, etc.—such that it is possible for the lid to have closed over a portion, or that it should have passed into the cul-de-sac of the conjunctiva, by which a more or less deep eschar will have been developed in both the ocular and palpebral portions—the result will almost surely be a more or less broad symblepharon. After burns from these latter substances, the conjunctiva should be carefully examined to see that no portion has been retained.

In burning from gunpowder the principal dangers to be apprehended are, that particles of the powder, or of sand and metallic fragments, may become imbeded in the conjunctiva, or cornea, (or even pass to the deeper structures), thus changing the character of the case very much, as also the indications for treatment.

Substances Acting Chemically.—Injuries to the conjunctiva from freshly slaked lime in the form of mortar, are of frequent occurrence, and may result seriously, by the formation of a symblepharon, or by exciting a violent inflammatory action. *Aquæ ammonia*, also, is an agent which frequently causes injuries similar to those last mentioned.

Sulphuric acid is a violent agent of this class, and is generally met with in criminal cases, in which the lids as well as the conjunctiva usually are involved.

Prognosis.—The consequences of either scalds or burns, of course, depend upon extent and situation.

(*a.*) *Scalds and Burns of Cornea.*—Should the cornea, after a scald, appear only slightly hazy, a simple desquamation of the epithelium with complete restitution, in a period of about two weeks, will be the result; and even where that body presents a deep, pearly-gray appearance, if suppuration is avoided we may, according to ARLT, expect a complete restitution. But if the cornea presents a dry and shrivelled appearance, a gangrenous necrosis will be the result, changing the form of the globe.

It usually happens that with a scald of the cornea, there is also a

similar injury of some portion of the palpebral conjunctiva, in which case it is almost impossible to prevent union of the two surfaces taking place. And if in addition to the cornea, a portion of the adjacent ocular conjunctiva be injured and become puffy, it may push forward on to the cornea, and becoming attached, lay the foundation for a pterygium.

(*b.*) *In burns of the conjunctiva*, the prognosis depends upon the depth and area of the injured tissue; as destroyed conjunctival tissue, beyond the epithelium, is never reproduced, and consequently, restoration only takes place through contraction of neighboring parts, which may cause the lids to become curved in, the conjunctival sac to be reduced in depth,and thus the motions of the ball interfered with. If the wound on the ball be deep, and extend so far into the cul-de-sac as to meet with a wounded surface of the lid, a scleral symblepharon will be formed, on the extent of which will depend the feasibility of an operation for ultimate relief, the chances for freeing the ball being very much less than where no fusion of the cul-de-sac has taken place, as evidenced by our ability to pass a probe behind the symblepharon.

Treatment.—After scalds or burns of the eye the first care must be to ascertain whether any of the offending matter still remains in any portion of its tissue, either imbedded, or lodged in any of the conjunctival folds. If the injury has been caused by a molten liquid or one of considerable consistency, the eye should be carefully syringed with warm water. If by acids, a solution of soda or potassa should be used to neutralize it, after which olive oil, or preferably, on account of less liability of being rancid, vaseline should be dropped into the eye.

If lime or mortar be the agent, we should remove as much as possible at once, by mechanical means, then drop into the eye olive oil, vaseline, milk, weak solution of vinegar or some article which will unite with the lime to form an innocuous compound. Water will only aggravate, and should never be used. The removal of mortar from the conjunctival sac is frequently attended with great difficulty; collections of sand may be best removed by means of a Daviell's scoop and gentle irrigation. The removal of cooled metal fragments or scales, frequently requires the use of considerable force, which may give rise to corresponding irritation. "In a case of Ammons," reported by ARLT, (*Injuries of the Eye* p. 174) "a drop of molten pitch adhering to the cornea was floated away by repeated instillations of luke warm oil, and the external application of pieces of linen saturated with it, after other mechanical measures had failed." According to the same author (p. 175,) GOSSELIN recommends frequent instillations of a strong saccharine solution, to dissolve and remove particles of lime, especially when they adhere to the cornea.

In all cases where the injury has been severe, the patient should be confined to the bed, or at least in doors, in a darkened room, in order

to avoid the use of either eye and thus ensure perfect quiet to the affected one until after the danger of an iritis is passed; and in many cases, especially where the cornea is implicated it will be best to anticipate iritic trouble by the use of a solution of Atropia one or two grains to the ounce. Ice cold compresses should be used to control the reaction, also lotions of *Aconite*, *Calendula*, or *Hamamelis*, as indicated, may be applied by means of thin pieces of cotton, or linen cloth, or better, surgeon's lint, at same time, these or other suitable remedies will be administered internally.

The involvement of the cornea will modify the treatment in proportion as it is affected, as any threatened loss of tissue there will demand that the treatment be such as that called for in suppurative keratitis.

To favor the elimination of the eschars, moist warm applications may be applied for twenty minutes, at intervals of one, two, or three hours. One of the chief duties of the surgeon is to *prevent the adhesion of opposing wounded surfaces.* Already during the first few days or perhaps even hours, plastic bands may be observed in the cul-de-sac, or the region of the falx, which must be broken up. Strong rotation of the eyeball in the opposite direction may suffice; if it does not, then a scoop or probe must be used to this end. Bands which are quite large and firm may be broken in this early stage by passing a probe behind them and pressing out. Various have been the devices to prevent these unions, where large surfaces were involved; such as the use of plates of enamel, wax, lead, etc., but as a rule the degree of irritation already existing forbids their employment, besides, where the cul-de-sac is involved they can be of no avail, cicatrization beginning as it does at the bottom, the foreign body is forced out before the cicatrizing process. The measures which will give greatest satisfaction are, frequent separation (once or twice daily,) of the injured surfaces, either by traction where that will avail, or by use of the probe, followed by instillations of oil or vaseline

Prof. Otto Becker, "(*Weiner Med. Worchenschrift*," 1874 No. 46. Graefe's Archive.) has shown that the conjunctiva of the rabbit may be used, (when granulations are rapidly sprouting,) as grafts, after the Reverdin method of skin grafting.

IV. INJURIES TO THE EYEBALL PRODUCED BY SUDDEN COMPRESSION OR CONCUSSION.

In this division we include all those injuries produced by the application of force directly to the globe of the eye through the medium of a more or less blunt instrument, resulting in a solution of continuity or contiguity of certain tissues or parts without penetration by the offending instrument. The organ in such cases will be indented or contused, at some point, or possibly flattened, in cases where the instrument inflicting the injury is broad.

Similar cases are recorded where the eye has been thrown into violent oscillation by some force acting directly or indirectly through the head or body.

Aside from the palpebral changes, the results of such injuries are very concisely given by ARLT as follows: "Extravasation of blood under the conjunctiva; opacity, with subsequent inflammations and suppuration of the cornea either with or without a solution of surface continuity; rupture of the sclerotic coat, near the corneal circumference, (rarely in its posterior portion); hæmorrhage into the anterior chamber; more or less laceration of the iris; paralysis (or more rarely spasmodic contractions) of the sphincter; suspension of accommodation; bursting of the capsule; overstretching, or laceration of the zonula, with various degrees of formative and other changes in the lens; choroidal rupture with hæmorrhage into the vitreous humor," and disturbances of the retinal function by other causes, as extravasation of blood into the region of the ciliary body, which according to the investigations of DR. BERLIN, takes place in sudden compression of the eyeball, but is only demonstrable by post-mortem examination. The resultant changes after such injuries, as hæmorrhage into the anterior chamber or vitreous body, or the later products of reactionary inflammation, together with cataractous changes in the lens, will preclude an early recognition of the entire amount of damage done, and a prognosis may be possible only after months of patient waiting and watching.

I deem it well to suggest that in all cases where the palpebral appearances suggest the possibility of the ball being involved in the injury, the vision should be tested, as the character of the treatment should be dictated by the amount of evidence of internal injury which exists. At this point it will be well to remember that abnormalities frequently exist which are not due to injury; of which the patient has never been conscious; it being a very frequent occurrence in the practice of the ophthalmic surgeon to find the visual power or acuity of vision in one eye reduced by a large per centage, below that of its fellow, the defect being wholly physiological; or, should one attempt to be critical, only a certain portion of the defect is added by the more or less imperfect use of the organ. In order to a better comprehension of some of the lesions, the results of compression of the eye, we will briefly consider its peculiarities of construction and its adjustment to the bony cavity which it occupies.

The contents of the ball; the aqueous and vitreous humors are incompressible, and the tissues surrounding them are only very slightly elastic; this mass of tissue thus composed is inclosed or embraced for its greater part by a thick very elestic cushion of adipose tissue, which renders any pressure of the eyeball against the bony orbit very difficult, thus also providing for an equalization of the force applied to any one part, such that we need not look for the results at a point diametrically opposite that where the injury was applied, and to use the language of another (VON ARLT) "an indentation or flattening of the eyeball cannot plausibly be considered possible, unless the same also changes its form *in toto*.

Suppose we consider the point attacked as the pole, and the direction of the attacking force as the axis of a sphere, then the *equator* of the latter must become longer at the moment of the injury." Hence if the eyeball is flattened at its anterior pole (the most frequent occurrence) it must for the moment become longer in its equator. Anteriorly the choroid is firmly fixed to the corneo-scleral ring by the ciliary muscle; posteriorly it is closely united to the sclerotic around the optic nerve entrance; while in the intermediate region it is comparatively loosely attached, so much so that VON ARLT thinks the choroid can glide upon the sclerotic, intermediate between the points of firmer union. The membranes are again more closely united by means of the vena vorticosa and some connective tissue. Now we can understand that a force sufficient to produce a rupture of the choroid through the flattening of the ball and consequent elongation of its equator, must produce that lesion transversely to the direction of the extending force, or parallel to the periphery of the optic nerve entrance, a concentric rent; an analogous rupture may occur near the anterior attachment of the choroid, but is incapable of demonstration before death. Ruptures of the choroid in front of the equator have only been observed to occur where the injury to this region has been produced by a blunt instrument, "in which case the choroidal rent is explained by the amount of indentation of the sclerotic at the same time rupture also occurs posterior to the equator and in the same meridian and can be explained by the pulling forward of the choroid. "Without question, says ARLT, the greatest difficulties are presented in endeavoring to account for certain lacerated wounds which are found on the anterior zone of the sclerotic, which implicate the *tunica uvea*, and which result from blunt force. It is remarkable that lacerations of this nature, through which more or less of the fluid contents of the eyeball and sometimes even portions of the iris or the whole of the lens escape, always run parallel or nearly so to the corneal margin; and also that they occur almost invariably at the upper part, usually above and to the inside." Many occur below or to the inside. Without entering into the theories as to the manner of production, which have really only a medico-legal interest attaching to them, we will further state that the sclerotic may give way either at the point of injury or counter-pressure, or at some point in the circle of greatest tension which is least protected, this being usually between the points to which force is applied.

An additional reason for the occurrence of the sclerotic rent parallel to the corneal margin is found in the histological fact, that the fibres of the sclerotic coat run parallel to the latter within the confines of the ciliary region. The dilatation of the corneo-scleral ring by the flattening of the cornea is supposed (ARLT) to account for the occurrence of rupture of the iris, laceration of the zonula, rupture of the capsule, changes in the shape and position of the lens. These latter changes, it is said, may occur without the flattening of cornea, in certain cases of

concussion where the relatively heavier lens is thrown into excessive motion. The paralysis of the sphincter iridis and the ciliary muscle as a result of concussion is not satisfactorily accounted for.

(*a.*) *Extravasation of blood beneath the conjunctiva.*—This condition may result from the impinging of some blunt instrument against the eye, also from coughing, sneezing or straining, and may lead to such a degree of tension of the conjunctiva as to cause a very decided chemosis. It may be associated with hæmorrhage into the fundus, and where the external appearance is not observed until three or four days after the receipt of injury, an internal lesion is to be suspected ; hence it is unsafe to omit in these cases, a careful ophthalmoscopic examination, unless the diagnosis is very clear.

The blood usually absorbs in a few days, leaving a yellowish tinge to remain for a longer or shorter time.

Treatment.—For the first few hours the free use of cold water medicated with *Arnica* tinct. ten to twenty drops to the ounce will usually meet the indications and if internal hæmorrhage exists we will not omit to employ the remedy internally at the same time. *Hamamelis* may have a sphere in some special cases, and *Ledum* is highly recommended, having done valuable service in promoting absorption where *Arnica* had failed, (A. & N.) *Conium* also has seemed to do good in persistent cases, aggravated by cough, more particularly in those cases where the organ became sensitive to light and touch.

(*b.*) *Contusion of the cornea.*—This class of injuries is of peculiarly great interest, because of the frequently resultant *keratitis with suppuration*, which usually terminates in *abscess*, or occasionally ulceration, thus becoming one of the most formidable of the diseases of the eye.

The cause is almost always the result of the accidental impinging of some hard substance against the cornea, as a piece of stone, metal, a blade of corn, wisp of straw or any other solid substance ; such disease is more likely to follow, in the case of old people, or those suffering from conjunctival blennorrhœa or blennorrhœa of the lachrymal sac. The bad results in all operations involving the cornea, made in this latter class of subjects, would suggest the importance of doing away with any lachrymal stenosis as early as possible in a case of threatened abscess. This would be done in the manner usual in cases of lachrymal obstruction, by slitting up a canaliculus and introduction of probes at suitable intervals.

Diagnosis.—If seen early after receipt of the injury the small point of excavation from loss of tissue may be apparent only when viewed laterally or by lateral illumination, but later when the ciliary injection is more marked, this point will present as a "light-grayish disk shaped opacity," becoming deeper yellow as the purulent infiltration extends through the different layers of the cornea as they lie behind each other. At this time the pain may be very pronounced, which will be relieved with the discharge of more or less of the pus ; but we

must not on this account permit ourselves to relax our vigilance, for the process will frequently continue to extend. "An ominous prodrome of such extension is a light gray halo which joins and surrounds the infiltrated and tumefied margin of the ulcer (ARLT.)" The formation of pus in the cornea, usually means pus in the anterior chamber also, and with this complication is likely to be developed iridocyclitis, which may give rise to the most excruciating pain, lasting through days and requiring the operation of paracentesis of the cornea for its relief.

The *prognosis* in abscess of the cornea is, at best, only comparatively favorable, as we may always expect a more or less marked opacity to result, and as this is apt to reach to a portion of the pupillary space there will be some degree of diffusion of the rays of light, impairing vision in proportion to amount of opacity. The cornea may be so far destroyed by the necrotic process that even an iridectomy may be of no avail, not to mention the cases in which the process is more violent, leading to more or less extensive suppuration of the ball, and staphyloma or to phthisis bulbi.

Treatment.—For the exhaustive treatment of this class of cases I must refer to the existing text-books in both schools, those of our own school furnishing already very liberal remedy indications. All operative measures being fully described in those of the other.

If the case is seen immediately after the injury, cold compresses either simple or medicated with *Arnica* will always be called for; if there is already some redness and pain, *Aconite* in same way and internally. This remedy will be particularly indicated after injuries occasioned by some hard body, such as bits of steel, cinders, etc., which becoming imbedded have remained for some time in the eye, giving rise to the peculiar irritation with sense of dryness so characteristic of this remedy. At this stage also, if the ciliary injection is marked and pain exists in and around the eye, I think it is always well to anticipate iritic complication by the use of atropine, one-half to two grains to the ounce of water according to intensity of symptoms; besides the immediate tendency of such application will be to diminish ciliary engorgement and thus relieve pain.

In the majority of cases of this class, the above treatment will be all that will be required, of course, always supposing that any substance adhering to or imbeded in cornea has first been removed by means of the spud, or other suitable instrument. If the case progresses unfavorably, with the advent of pus the cold applications must be discontinued, warm being sometimes substituted. If the ulcer is spreading with no attempt to establish vascular supply, (as evidenced by blood vessels reaching up toward ulcer) warmth is imperatively demanded, in form of poultice (slippery elm or flax seed meal) changed often enough to prevent becoming cold, the eye being kept covered by a cotton pad or warm flannel during night, and interval between changes of poultice, as it will at once be evident to any one that much

harm may result from their *improper* use, it will be expected that warm applications will be avoided by those not competent to judge of their effects.

In this latter, or non-inflammatory class, the topical use of Chlorine water often proves immensely advantageous, acting both as a stimulant and disinfectant, it should be applied pure with camel-hair brush to the ulcer, from once to several times daily, according to condition. In the inflammatory variety, it may be called for as a disinfectant, but must be applied with more care, and diluted. In all inflammatory conditions of the cornea *astringent* applications are to be especially condemned.

The existence of an ulcer or abscess of the cornea does not *per se* call for the use of *Atropine;* the complications of iritis or ciliary engorgement furnish the indication for its use, as well does also the situation of the ulcer; if it be central and threaten perforation Atropia must be used of a strength sufficient, if possible, to prevent the iris from falling into the opening. If the ulcer have a peripheral location *Eserin* will be indicated, and in order to maintain a full effect from this drug it must be applied several times during the day, a one per cent. solution being about as strong as it will be well borne, usually.

A very valuable adjunct to the treatment of abscess of the cornea is a carefully applied bandage, the angles of the eye, (internal and external) being well filled out with charpie, the whole being changed two, three or more times daily in order to remove the secretions, and apply Atropia. The bandage is likewise indicated in case of ulceration, but owing to abundance of the discharge, excessive irritability, iritis, etc., its use is frequently not permissable.

Light must be excluded from the affected eye and in severe cases from both. In abscess this will be best effected by means of the bandage; in ulceration by the shade or remaining in a dark room. The local and general condition of the patient, must both be consulted in deciding which of these means shall be adopted.

The surgical measures will have relation, principally, to the state of ulceration. Paracentesis has always been recommended in cases of threatened rupture, but since the introduction of the Sæmisch incision, it is not so frequently made. This latter operation has been, by some of its advocates, brought forward with so much warmth as to be thought to supplant all other operations in this condition; although it was introduced for a particular variety of ulcer. The creeping ulcer (*ulcus serpens.*) The operation is made by means of a Græffe cataract knife, entered in the healthy tissue at one side of the ulcer, passed through the anterior chamber and made to pass out in healthy tissue at opposite side, then by a sawing movement made to cut outward through the ulcer, after which Atropine is instilled and a compress bandage applied. The wound is opened daily for two to four days, by means of a probe or spatula passed through its entire length. A characteristic peculiarity of this and the traumatic ulcer being non-vascularity of the

unaffected portion of the cornea, the same operation seemed alike indicated in both ; but as so large an incision must affect, by its cicatrix, the form of the cornea thus producing irregular refraction, one should not haste to make it, also it has been observed (ARLT p. 37) (CARTER, p. 243,) that in many cases the good result was not permanent ; the cicatrices yielding after a time to the intra-ocular pressure, became sources of pain and irritation, and sometimes ultimately required enucleation of the eyeball." I do not however, wish at present to be understood as condemning the operation, but only wish to limit its application, as I believe iridectomy in a very large number of cases meets every indication better, for the various reasons, that in a large central ulcer the cicatrix will be so large that an artificial pupil will be advantageous if not an absolute necessity, that intraocular tension is successfully overcome, and any existing iritis combatted. To make a gross classification of the cases suited to these different operations we may say that the very indolent, large, non-vascular ulcers will be best met by the Sæmisch incision, while the more active character of cases, with probably a tendency to extension to adjoining tissues, will require iridectomy.

But I must insist that before any of the above operations have been resorted to, the case shall have been carefully studied in the light of our materia medica, as I believe that by the proper use of our remedies in this class of cases many brilliant results will be achieved, which would have been compromised by the use of the knife.

The remedies most frequently called for may be given in the following order. 1st. *Aconite*, *Arnica*, *Arsenicum*, *Ignatia*, *Ham.*, *Kali b.*, *Merc :* 2nd. *Calc. c.*, *Euph.*, *Hepar*, *Rhus*, *Sil.*

For special remedy indications, refer to *chapter on Ulcers*, to ALLEN & NORTON, *Ophthalmic Therapeutics*, and as general systemic peculiarities or dyscrasias must not be overlooked in such grave conditions, we may be led to a comparison of almost any remedy in materia medica.

5. *Injuries to crystalline lens* from blows with a whip or twig to the cornea, or more violent blows over eye, concussion of the cranium or whole body may result in simple concussion of the lens followed by opacity of its substance, or in laceration of the anterior capsule. Also one case observed by KNAPP, (ARLT, p. 57,) in which there was an isolated rent of the posterior capsule. "More frequently however, such injuries result in partial or total stretching of the suspensory ligament; of the lens and in the light of well authenticated cases it seems we may be justified in the belief that such stretching or laceration in the zonula may take its course with ultimate restitution of the functions of the eye. Whether an opacity of the lens can be occasioned by concussion of the eye without rupture of the capsule or laceration of the zonula taking place also, we have only the experiments of BERLIN, (*loc. cit.* p. 47,) from which to judge. In these he found an opacity of the anterior cortical substance to follow after striking the eyes of rabbits with an elastic rod. More frequently as results of these

injuries we have rupture of the choroid or detatchment of the retina; in the former we may have a resultant amblyopia, or in the latter case cataract and synechia without at any time the existence of circumcorneal injection or pain. On account of the various insidious results which may follow such injuries, the physician will only have discharged his duty to the subject of a recent injury when he has carefully tested the field of vision, observed the state of the tension, and canvassed thoroughly the media or fundus of the eye, or both, as the case will admit, by the ophthalmoscope. For upon the early recognition of a choroidal rupture and effusion of blood beneath the retina, may rest the only chances of preventing destructive inflammatory action, or cataractous developments.

6. *Luxation, partial or complete, of the crystalline lens.*—It is the office of the zonula to fix the lens in its place in the patellar fossa or depression in the vitreous; this suspension takes place in such a manner as to permit of excursions, anterior and posterior being made by the lens without detriment to its functions.

The zonula is said to be capable of being stretched to the extent of two millimeters, provided tension is gradual, without rupture of continuity, but by such state of stretching is developed a predisposition to laceration of the zonula more or less complete, which may take place with very slight provocation.

The slighter resistance of the zonula explains why, under the influence of a blow, the capsule rarely bursts, permitting the escape of the lens, but is dislocated *as a whole.* However cases of the former variety do occur, as the following one from my case-book will illustrate.

M. L., aged nineteen years, has this history: One week previous to visit to me while underbrushing, was struck in right eye by a twig or small branch, immediately followed by pain; examination shows only quantitative vision, injection of the sclero-corneal border, iris discolored, a flap like rent in the anterior lens capsule, lens substance protruding through the pupil, iris bulged forward at lower inner quadrant, by a portion of the swollen lens which rests upon it, some semi-opaque lens substance adherent to membrane of *decemet.* Eye was confined with a bandage, and Atropia instilled with view to removing pupillary margin of the iris from lens mass; which owing to inflammatory results was only partially successful; after which the lens was removed through a linear incision made at lower outer quadrant, patient making a rapid recovery without any untoward developments. Of course the proper and only safe course to be pursued in such a case would be immediate removal of lens, before inflammatory conditions develop.

(*a.*) Sub-luxation of the lens may be nothing more than a condition of ectopia in which there is stretching of the suspensory ligament to the extent to allow the lens to become changed from its ordinary shape to one more globular, thus giving rise to myopia and possibly to a tremulous condition of the iris on account of the removal of some of

its support; or the lens may assume an oblique position giving rise to a condition of astigmatism, or irregularity in the refraction. By this inclined position of the lens also we are given an appearance of very great diagnostic value, viz: with this changed position of the lens there is a bulging forward of the iris, caused by that portion of the lens which is tilted forward, thus diminishing the depth of the anterior chamber at that part, by this means rendering this chamber of unequal depth. Also when considerable mydriasis, either as a result of the injury, or artificial, exists, the ophthalmoscope may reveal the oblique position, as the border of the lens will then appear as a dark line against the red back ground.

Lateral displacement of lens.—In this position of this body the character of the injury may be recognized by the unaided eye, on assuming certain positions toward the lens; where the lens border falls within the pupil, the total reflection of the rays of light falling on this border still contained within its capsule, giving rise to the appearance of a drop of oil on water" (ARLT); or where the lens has sunk or passed into the vitreous, the ophthalmascope must be brought into requisition, under these circumstances, with certain combinations between the position of lens and the entrance of light the patient may describe the appearance of a dark ring or disk in the field; or the still transparent lens situated so as to cover a portion of the pupil may give rise to monocular diplopia. In examination of patients of this class the previously existing state of the refraction of the eye should be considered; also we must bear in mind the conditions of spontaneous dislocation. These are divided into *ectopia* and *spontaneous luxation*. By the former is understood a slight degree of displacement of the lens, within the ciliary processes, with a continuance of the normal attachment. Spontaneous luxation on the contrary is a total removal of the crystalline from the optic axis, by destruction or excessive tension of the zonula, and separation of the attachment between the posterior capsule and the hyaloid (STELLWAG).

(*b.*) *Luxation of the lens.*—In this condition there is complete separation of all the lens attachments, but this body may still present, for a time, the appearances of partial luxation; sooner or later, however, it is likely to gravitate to the floor of bulb, or lower portion of the vitreous. It may remain transparent for a considerable time, even months and years, (ARLT.) It may pass from one position into another, being at one time before at another behind the iris. The lens finally becomes cataractous. But the most serious results of its presence in an abnormal postion are the irritation of the uveal tract, leading to chronic or more rapidly developing inflammatory conditions, as iridocyclitis, with all the dangers of sympathetic ophthalmia. It may result in serous exudation into the vitreous humor, in increased tension of the globe, and to a glaucomatous condition of amaurosis.

In the diagnosis of the immediate results of an injury of this kind it must be remembered that in addition to the congenital or spontaneous

displacements, there are predisposing causes resulting from inflammatory action, such as anterior scleral staphyloma, pointed out by STELLWAG, adhesions between anterior capsule and iris, etc., by which a displacement may occur with a very slight accident. Under such circumstances the choroid would be much less likely to suffer, and the dangers of troublesome irritation less also. If an eye suffering from a partial displacement of the lens is moved rapidly about, a tremulousness of the iris at the point where it has lost the support of the lens will be noticed, also it is here somewhat cupped, being correspondingly prominent at the point where the lens is tilted forward against it, the anterior chamber being slightly deepened at the former, and rendered more shallow at the latter point. If the pupil is dilated, lateral illumination, or what is better the direct examination with the ophthalmoscope should be made; with the latter the free edge of the lens will be noticed as a sharply defined, dark, curved line against the red fundus. In the reverse method, the prismatic action of the edge of the lens will be observed, and a double image of the back ground obtained, at same time both images will not be equally distinct; the one will appear hazy, when the other is distinctly defined, requiring a different adjustment of the observers eye and the ocular lens, for the two different images; with such partial displacement the patient will, owing to the different refracting power of the two portions of the pupil, and prismatic action of the peripheral portion of the lens lying across it, have monocular diplopia or polyopia.

In incomplete dislocation there will be absence of reflection from the anterior capsule, and the lens may be noticed at one side of the field, or will pass over the pupil when the head or eye is moved; if the lens is already opaque it will be readily recognized by the observer on account of its color, and by the patient by the temporary obstruction of light when it passes across the field of the pupil. The position will vary with the position of the head; when the latter is held erect the lens will sink down into the vitreous. If the head is bent forward the lens will fall against the pupil, or may pass through it into the anterior chamber; with the ophthalmoscope it will appear as a dark body, generally lying in lower portion of the vitreous humor, the latter being more or less fluid. With the lens entirely out of the pupillary field the eye will be strongly hypermetropic. The position of the lens in the anterior chamber can be easily recognized, for there will be, in this chamber, either a transparent and diaphonous, or white and opaque lenticular disk." The lens may be only partially in the anterior chamber, or a part in the pupil, and the remainder behind. This is an especially dangerous condition, as the constant teasing and contusion of the edge of the pupil will certainly set up an irritation and inflammation of the iris.

(c.) *Dislocation under the conjunctiva.*—This is generally the result of a heavy blow dealt with a blunt instrument, hitting the eye below and knocking it forcibly against the upper edge of the orbit, producing a

rupture of the ball either upwards and inwards or upwards and outwards through which the lens escapes to be retained beneath the conjunctiva. The rupture in the choroid generally occurs quite anteriorly between or in front of the insertion of the recti muscles. (WELLS.) This accident is most likely to occur after middle life, when the sclerotic has lost its elasticity. It will be recognized by the presence of a rather small but decidedly pronounced tumor, which may be dark, from the presence of effused blood beneath the conjunctiva or of a portion of prolapsed iris; or the conjunctiva remaining transparent or only slightly injected, the grayish-white lens will be seen beneath it. In some cases the whole lens will not be expelled, a portion remaining behind.

Treatment.—This will vary with the exigencies of the case, the character of the displacement, and the amount of force used in inflicting the injury. In general terms it may be stated, that with only partial displacement, such that vision is not materialy impaired, or where the lens is free and has passed from the pupillary space, remaining quietly at some place in the vitreous body, no interference should be thought of, other than what is necessary to meet the reaction immediately following the injury. To do this it may be necessary to keep the patient confined to his room, or even bed, with the eye carefully bandaged for a few days, cold dressings being applied if reaction runs at all high, together with suitable internal remedies, as *Aconite*, *Arnica*, or *Hamamelis*. When the lens has passed into the anterior chamber it has been advised to return it, and by means of an iridodesis attempt its retention; while it may be proper under certain circumstances, as in young subjects where absorption may be relied upon to dispose of the greater portion of the lens substance, to restore it to the posterior chamber, and by means of a bandage and the supine position aided perhaps by calabar instillation, attempt its retention; yet if these means fail, if the lens does not remain fixed, or if irritation which may lead to inflammation is developed, there is in my opinion only one operative proceedure to be thought of; *that is removal*, which may be accomplished through an incision in lower part of cornea, *made by a Graffe or Beer's knife. Where the lens lies behind the iris an iridectomy should also be made. In the class of cases above referred to where absorption is thought possible, that process may be facilitated by a slight incision through the capsule, made as in Schicht Staar cases; where the lens lying in the anterior chamber has already excited some irritation, no attempt at replacement should be made, but its removal at once effected. If the lens has passed through a rent in the sclerotic, and is lying under the conjunctiva, an incision should be made through the conjunctiva and lens made to escape, any protruding portions of the iris or vitreous being snipped off, If the sclerotic rent is large and gaping, two or more fine stitches should be introduced.

7. *Ruptures of the eye ball.*—This probably always means rupture of

*For details of operations see Special Text-books.

the sclerotic, as it is doubtful if rupture of the cornea ever occurs as a result of sudden compression, while complete rupture of the sclerotic is a common consequence of a blow with a fist or some instrument wielded with swiftness and force. Such rupture usually occurs either within or close to the ciliary circle, and between the insertions of the superior and external recti muscles. A blow sufficient to produce rupture of the sclerotic will usually cause dislocation of the lens, often driving the latter out through the rent, and if the conjunctiva also gives way allowing it to escape entirely; or where the conjunctiva remains intact the lens will be retained beneath it and we then have a sub-conjunctival luxation. The crystalline body may be caught between the lips of the wound and there retained. Under such circumstances more or less of the iris is likely to be found in the wound, or it may be torn away entirely and expelled along with the lens and more or less of the vitreous body. When this discharge is large there will be more or less injury to the vessels of the choroid, from which bleeding will take place into the vitreous cavity. Thus the conditions may vary from a simple sub-conjunctival rent in the sclerotic to complete disorganization of the globe.

The location of these wounds is such that blood vessels of considerable size are likely to be injured, especially in veins contained in the canal of Schleom, from which profuse hæmorrhage will occur, thus for the time disguising other injuries which may exist, and by itself destroying vision for the time.

Diagnosis.—ARLT gives the following description of this injury. "The sclerotic rent is linear, or slightly arched, more or less serrated, from 6-12 millimeters (3-6 lines) long and usually runs parallel to the limbus cornea, at a distance of from 2-5 millimeters from the latter. In only one case (Schroter, Klinische, Monatsblatter, 1866 p. 248,) did the rent run at an acute angle." The eye ball is of course flaccid, and if the conjunctiva is intact, it may form a sac, the contents being blood, acqueous humor, iris, lens, or vitreous body. The detraction of the iris by which an apparent or real coloboma is produced in the direction of the rent, will furnish a guide to the character and location of the injury in slight cases where there may be no protruding mass.

Prognosis.—The danger is not so much from the immediate reaction reaching a high degree, as it is from the excessive loss of vitreous, by which sub-choroidal hæmorrhage is induced, and later irritation of the iris through impaction in the cicatrix or possibly pressure from the retained lens; these conditions may not only lead to a destruction of the injured eye, but also to *sympathetic disease* of the other. See ("*Klinische Monatsble*, 1871 p. 157, and 1566 p. 249,") According to observations thus far made it seems that in these injuries the force of the blow is exhausted in producing the anterior laceration, leaving the choroid and retina behind the ora seratta unchanged. "There are numerous cases extant, where individuals have, by means of cataract spectacles, after the escape of the entire lens from the globe,

been able to see about as well as patients operated for cataract, and have remained in this condition for years. (ARLT.)

Treatment.—The first object is to secure perfect quiet of the injured organ, this can only be attained by confining the patient in bed with *both* eyes carefully bandaged. The protruding mass of iris, vitreous, etc., may be snipped off, or if this is not readily accomplished, on account of restlessness of the patient, it may be permitted to remain until cicatrization more or less complete has taken place, when any remaining tissue can readily be removed by means of the scissors. Where the conjunctiva is not ruptured it will in all cases, probably, be better not to puncture the sac until after union has taken place, the evidence of which will be improved state of the tension. In cases where the lens has not passed out through the wound, and is by its presence producing pressure and irritation of the iris or ciliary, it should at once be removed. Along with the other measures to produce quiet, cold applications, by means of solutions of *Arnica*, should be freely used until the dangers of severe reaction has passed, also the internal use of such remedies as *Arnica*, *Aconite* and *Bell.* should not be forgotten. But on account of the danger of panophthalmitis as an early result, or the development of a chronic state of inflammation or irritation from the character and location of the cicatrix, or the tension upon the iris from being held in the wound, thus giving rise to sympathetic ophthalmia, the only safe procedure in most cases of this kind of injury is enucleation.

VIII. RUPTURE OF THE INNER TUNICS.

(*a.*) *Rupture of the iris and choroid.*—The pronounced symptoms of this occurrence is hæmorrhage into the anterior chamber, where the iris is lacerated; or where the choroid suffers, the vitreous chamber will be more or less filled with blood. In the former the hæmorrhage may be but slight, and variously situated, being more usually found below, but may be at any other point and only seen by means of focal illumination. Blood in the anterior chamber is usually readily absorbed, but hæmorrhage into the posterior (vitreous) chamber means a very different state of things. Along with the choroidal rupture necessary to give rise to the bleeding, we may have detachment of a portion of the retina, or rupture. A large quantity of blood being thrown out, a mass or clot may be found in the floor of the chamber which will require weeks in which to become absorbed. The diagnosis of retinal detachment during the first three or four weeks or during the presence of the blood mass in the vitreous may not be possible; the method which may be resorted to where an early diagnosis is sought would be to test for the value of quantitative perception of light throughout the retinal field. In doing this the patient is taken into a dark room, and a lighted candle held in different directions so as to test the power of perception in different portions of the visual field; but this

will not distinguish between a dense clot and detatchment; to decide this it is suggested to try to change the position of the clot or to break it up by shaking head, changing its position, etc. If by these manipulations light is perceived in a portion of the field which before, was dark we will at once conclude that the darkness was due to clot and not to detatchment. A discussion of the ætiology of choroidal ruptures is not within the intent of this chapter, suffice to say they are the result of a blow received anterior to the equator of the eye, (contra-coup) usually giving rise to a rent on the temporal side of the optic disk; occasionally, however, it is observed on the nasal side. They vary in degree from a rupture of a few vessels with extravasation limited to the parenchyma of the choroid; or it passes between the sclerotic and choroid; or pushes forward and perforates the overlying portion of the retina and is poured into the vitreous; or with a higher degree of injury, several rents may be formed.

Prognosis and treatment.—The reaction may run very high or it may be only slight. At all events it will be best to keep patient quiet, with both eyes bandaged to exclude light and prevent the possibility of any accommodative effort being made. If retinal inflammation follows, these restrictions may have to be continued through weeks, the diet being also regulated.

The remedies chiefly called for and the order in which they most likely will be indicated will be ARN., *Hamamelis*, *Bell.*, LACH.; *Crotalus*, the two latter remedies are found to exert a very marked influence in promoting absorption in all cases of hæmorrhage from the iris or choroid. If the processes of absorption and repair do not go on kindly, and symptoms of inflammation supervene, we will consult the following: *Acon.*, *Bell.*, *Apis*, *Bry.*, *Gels.*, etc., and with the appearance of symptoms of suppuration, *Rhus*, *Phytollacca*, *Ars.*, *Hepar*, etc. The cases in which the former value of vision is restored are the exception.

The blind spot usually remaining at the site of the injury may according to location affect the sight, also reactionary inflammation, consecutive retinal detatchment, or connective tissue formations in the vitreous.

(*b.*) *Disturbances in the retina as a result of concussions.*—Under this head will be included injuries in which the external appearances as well as the grosser ophthalmoscopic indications furnish no adequate idea of the character of the changes; they result from blows to the orbital margin, and from small blunt instruments driven against the ball; also from lightning stroke, passing cannon balls, etc.

The depreciation of vision was formerly supposed to be due to displacement in the retinal elements, ("probably the rods and cones,") or to vaso motor influences; but ARLT thinks that in all or nearly all cases the ophthalmoscope will reveal changes. Those cases in which the ball has been struck by a blunt instrument they will be observed at a point corresponding to the seat of the injury and probably at a

point directly opposite, where the orbit has been struck ;* symptoms of atrophy of the optic nerve will be observed sooner or later.

The prominent symptoms in this class of injuries, are diminished vision, and spasm of the sphincter iridis, so that it will resist the ordinary action of Atropine. The internal appearances together with all questions of pathogenetic importance can only be of interest to the specialist or one quite expert with the ophthalmoscope, this fact I shall consider as being a sufficient apology for cutting short this otherwise, highly interesting section. The indications for treatment when the case is seen early will be of an expectant character, viz. : Keep the eye quiet, and if irritation develops the further management will be the same as that indicated under choroidal rupture.

c. *Laceration of the iris.*—This usually takes place at the ciliary border, in fact so infrequently does this body become lacerated at any other point that I do not deem it worth while here to consider any other form. It may vary from a degree so slight that it is only recognized from the kidney shaped appearance which it takes after the sphincter pupilla has lost the resistence of the radiating fibres, or the rent may be large enough so that by use of the ophthalmoscope a red reflex is obtained, provided the media remain clear ; more extensive separations (dialysis) gives rise to a second pupil. "A nearly total dialysis, is followed by the shrinking of the iris to an ashy-gray membrane." In these cases the vision will suffer, to any marked degree, only where the natural pupil is unduly dilated, or where owing to the large size of the rent a second pupil is formed which may give rise to monocular diplopia. "Serious iritis is not apt to follow."

Treatment.—There is nothing peculiar in the treatment of this condition ; rest of the eye must be secured with a compress bandage and other measures to promote absorption of the hæmorrhage, such as cold compresses, perhaps medicated with *Arnica*, and if symptoms of inflammatory action arise the remedies called for after choroidal rupture will be indicated. Only in cases of imperfect perception of light, with increase of tension, and delayed resorption of blood, will we think of surgical interference ; then a careful evacuation of the blood from the chamber must be procured.

PENETRATING WOUNDS OF THE EYE.

The foreign body not remaining in the eye.—These wounds may involve the conjunctiva alone. They may involve the conjunctiva and one of the recti muscles. The conjunctiva and sclerotic may be penetrated, or the foreign body may penetrate the cornea.

(*a.*) Such wounds of the conjunctiva, are usually of quite simple import, requiring rest of the eye by bandage for twenty-four to forty-eight hours, in order that an early union may be accomplished. Sometimes, however, a large rent is made, with possibly some loss of tissue,

*The late war furnished numerous instances in which the orbital margin had grazed by a ball or fragment of shell.

in such cases stitches should be applied of sufficient number to insure proper approximation.

(*b.*) *Wounds of the conjunctiva and one of the muscles.*—If one of the *recti muscles* is also divided, the free mobility of the ball is interfered with, giving rise probably to divergence and diplopia. In a recent case these results will be overcome by use of deep conjunctival sutures; in older cases where union has already taken place, the attachment of the muscle being far back, advancement of the affected muscle will be the only remaining resource.

(*c.*) Wounds involving the conjunctiva and sclerotic, are generally complicated by injury to the ciliary body and prolapse of the vitreous or iris or both. Thereby becoming conditions of very serious importance. If the recent wound is large and some exposure of uveal tissue or vitreous, there will be no difficulty in detecting it; but it sometimes happens that it is small, the patient himself not being able to locate it; in such cases the reduced tension, which always exists, will direct to the character of the injury, after which by means of focal illumination if not with the naked eye the seat of the injury will be found.

After such injuries the eye may be destroyed, by excessive loss of vitreous or intraocular hæmorrage, but the feature to be particularly borne in mind, is the danger from sympathetic cyclitis in the uninjured eye, the more liable to occur, the more the ciliary body is involved in the injury.

ARLT (Injuries of the eye, p. 66,) describes cases in which the penetration being far back has resulted in gradual conical contraction, after an apparently favorable course of the cicatrization, leading to gradual impairment, and sometimes loss of vision.

The suture has been used to promote union of scleral wounds, by WINDSOR, BOWMAN, LAWSON, and T. R. POOLEY, (*Allgemein Wiener Med. Zeitung*, 1874, No. 8,) (ARLT.) But in unskillful hands the danger of too great a loss of vitreous, argues against it as a frequent resort, so that the only safe course is to keep patient quiet for a long time, with a carefully applied protective bandage.

(*d.*) *Wounds of the cornea.*—These will be divided into superficial, and deeply penetrating wounds.

Superficial wounds.—To this class belongs those slight scratches and superficial abrasions involving the epithelial and superficial fibrous layers, the result of accidental scratching with the finger-nail, a comb, twig, etc., giving rise to excruciating pain caused by exposure of the corneal nerves, together with the objective appearances of peri-corneal injection and lachrymation, with perhaps photophobia and spasm of the lids. The early application of cold, usually suffices to cause all symptoms to subside in two or three days. But frequently these symptoms recur several times, when it becomes necessary to use the bandage until complete restoration of tissue has taken place, which may be one or two weeks; should the persistence or violence of the symptoms make the use of remedies necessary, we have *Aconite*

and *Arnica* during the early stages, and *Conium* and *Hypericum*, at a later period. The frequent good affects from the use of the latter after amputations, in the experience of Dr. GILCHRIST, leads me to recommend it in these wounds of corneal nerves. These superficial wounds or those not penetrating to the membrane of *decemet* may heal without leaving any permanent opacity. But where the subject is old or from other causes debilitated, or in children of scrofulous habit, they may result in abscess and ulceration (84) thus producing an opacity sufficient to interfere with vision either by preventing rays of light from entering to the retina or by simply causing diffusion.

Deeply penetrating wounds.—Under this head will be included, all wounds in which the foreign body passing through either the cornea or its immediately adjacent parts, as at the corneo-scleral junction or ring, or the ciliary region, remains imbedded in these tissues or passes through into one of the chambers of the eye.*

In the extraction of deeply imbedded broken bodies as pieces of metal or thorns, there is probably no better method than that suggested by Dr. DIXON, viz.: make an incision through the periphery of the cornea, with a cutting needle, then through this opening introduce a small spatula by means of which pressure is made upon the thorn from within while a needle is used externally to lift the fragment out.

After the removal of such bodies the wound is apt to be very sensitive, to allay which a drop of castor oil placed within the lower lid and allowed to diffuse, is very useful. With the advent of inflammatory symptoms we must use *Arnica*, *Acon.*, *Bell.*, etc., together with local cold. When foreign bodies have passed through the coats of the eye into the anterior chamber they may be found lying at the floor of the chamber, may be lodged in either the iris or lens, or may be in the vitreous humor, or have even passed through and out of the eye. If the body is lying in the anterior chamber it should be extracted as soon as the aqueous humor has reaccumulated. To accomplish this, an incission is made at the corneo-scleral junction, as near as possible to the place where the foreign body is lying, with the first gush of the aqueous fluid, it is liable to be carried out also; if however it does not follow the escape of the fluid, then a fine pair of forceps must be introduced, the foreign body seized and thus removed. If, however, it is imbedded in the iris, no attempt should be made to tear it from this body, but the piece of iris containing the foreign body should be withdrawn, and by means of a scissors snipped off as in iridectomy.

If the extraneous substance has lodged in the lens, a cataract will be the result; in young subjects probably inducing absorption, as in the operation of discision. On account of the opacity, the presence in the lens of the foreign substance may not be demonstrable, until after the absorption permits it to drop to the bottom of the lens capsule.

*Or as sometimes happens, the wounding body being long and needle shaped, may pass into the eye even wounding the lens, and by some force acting at the time be immediately withdrawn.

But in old subjects, or persons past middle life, the hardened nucleus will not allow of much absorption taking place, and the presence of a foreign body may only be known positively after removal of the lens. With the foreign body within the eye (vitreous chamber,) the case becomes much more serious, the possibilities for its removal being less. This, however, may sometimes be accomplished, as where the media remains clear, thus permitting the foreigh body to be seen, while its extraction is attempted by means of forceps through an opening in the sclerotic.* When this opening is made for the purpose, it must be done posteriorly to the ciliary body.

Before this manipulation is attempted, the question whether a second particle or body may also have entered should receive due consideration, for with a second body remaining, we will have accomplished nothing for the safety of the eye, and enucleation will still have to be made, or the uninjured organ be lost by sympathetic ophthalmia.

The treatment of a case of injury to the eyeball demands in the *first* instance a *careful* consideration of the possible dangerous results to the other eye. For it must be borne in mind that sympathetic ophthalmia may be prevented by timely enucleation, while a cure is rarely if ever effected.

A large wound of the ball will always leave the vision impaired, and where the ciliary region is not immediately involved by the wound, the resulting cicatrix and contraction (probably involving some of the ciliary nerves,) may produce sufficient irritation through this body to cause sympathetic trouble. When the ciliary body is involved in the wound or rent, or the foreign body is within the eye, sympathetic ophthalmia will surely result, and except, perhaps, under the most favorable circumstances for observation, together with superior intelligence on the part of the patient, enucleation should be made without delay. But if the operation has been postponed, and it is not certainly known that a foreign body is in the eye, the continuance of tenderness over any part of the cillary region, "with flushing of the conjunctiva on slight pressure during examination," increase of intraocular tension, or a sense of bony hardness on palpation of any part of the globe, either of these conditions will be a sufficient warning of the impending danger to the other eye, and enucleation called for as the only remedy. The dangers to the sound eye after injuries in which the ciliary is involved or the foreign body remains within the eye, cannot be too strongly dwelt upon, nor a timely resort to the only means of prevention too strongly urged.

The operation of enucleation is made with the patient in the recum-

*Since the preparation of this chapter (three years ago) the *magnet* has been introduced for the removal of metalic substances, and has already saved a number of eyes. With this instrument the sense of touch can be used; and, therefore, success may be attained when owing to a cloudy vitreous we could uot see to use the forceps. The other advantages of this instrument will at once be apparent.

bent posture and under the influence of the anæsthetic; the lids are separated with the stop speculum. Then with a pair of forceps the surgeon pinches up and divides the conjunctiva and sub-conjunctival tissue close to the cornea, the hook is now passed beneath the external rectus, and it is divided with the scissors, about one-half line from its attachment, this portion is seized with the forceps and the ball rotated inward. A pair of heavy scissors curved on the flat are passed closed along the ball to the optic nerve, when this is felt the blades are opened and the nerve divided close to the sclerotic. The hold on the stump of the external rectus is still maintained, and the remaining muscles and tissues divided, the inferior being divided last.

When the eyeball has been ruptured and its contents evacuated, the operation becomes very difficult especially so if the tissues are already much swollen, great care will then be necessary in dissecting out the sclerotic, the hook and scissors being used to divide the muscles, and the remains brought out with the forceps, and the optic nerve divided.

After the operation, cold water may be showered from a sponge, into the orbital cavity, until any excess of hæmorrhage is controlled; the cavity is then firmly plugged with sponge, and this, secured by a bandage, is allowed to remain for four or five hours. If this precaution is not taken an extensive ecchymosis will ensue in the lids and surrounding tissues which may require two or three weeks to absorb. The application of an artificial eye should then be made as early as the condition of the stump will permit, and certainly it should not be deferred later than six weeks.

"CARTER recommends that the patient begin the use of the artificial eye as early as the fourth day, in some instances, wearing it only an hour twice daily, at first, and longer as soon as it can be done without discomfort."

Foreign bodies on the conjunctival surface, without being imbedded, may give rise to serious irritation. In case of sand or dust in the eye it may be removed by means of the spud, a tooth pick, or, if quite fine sand, it may be flooded off by causing a stream of warm water from a sponge or cloth to pass over the surface.

In all such cases, the lids must be everted and their inner suface carefully inspected. It is only where the object has passed into the upper cul-de-sac that any considerable difficulty may be experienced. Fragments from straw, beards from grain, etc., are particularly liable to be found in this region, or about one line from the inferior margin of the cartilage, and if not removed will soon give rise to serious inflammation. Their removal when on the cartilaginous or palpebral portion will admit of ready removal by the ordinary means, but when in the cul-de-sac, the lid must be strongly everted and while the eye is directed downward, the bent end of a small hair-pin or some similar instrument, must be passed over the surface of the sac and the foreign body flirted out.

The treatment necessary after removal, in recent cases with some irritation will be to drop in a drop or two of castor oil, and possibly a little cold bathing. If there is already a higher degree of irritation, an *Aconite* lotion will be indicated. If there is already an *inflammatory* condition, the treatment described under injuries of the conjunctiva will be applicable.

XVII. INJURIES TO THE EAR.

BY D. J. M'GUIRE, M. D.

These may be considered under the heads of injuries to the external and internal ear, and the membrana tympani. The injuries to the external ear which call for special attention are the result of foreign bodies passed into the meatus externus; these may be articles which have been introduced for the relief of pain, and afterwards forgotten. Such articles are a raisin, bits of medicated cotton, etc., or children frequently force beans, or a kernel of corn into this tube, which by the action of the warmth and moisture, soon swell so as to give rise to serious inflammatory troubles, and are very difficult to remove; small pebbles are also introduced in the same way; any of these solid bodies may be forced through the tympanic cavity, thus giving rise to still more serious difficulty.

This latter accident sometimes occurs during clumsy efforts at removal. Insects frequently get into the ear, and the pain produced by their presence may be most agonizing, but they may, by pouring in a little water, usually be induced to come out, otherwise the use of the syringe and water will always dispose of them.

The removal of the more solid foreign bodies from the ear, has from time immemorial attracted much more serious attention from surgeons, than the real difficulties of the subject have merited. We find hippocrates recommending surgical procedures for their removal. Also Paulus Æginatas has described as early as A. D. 600, an operation which consists of an incision behind the ear to detach the auricle from the canal, thus enabling us to get at the foreign body directly. (Roosa.) This procedure will of course only be thought of when all other means have failed. It may be well to remark, right here, that the apprehension of the patient and his friends after this accident, is often very great, and if we may judge of the state of mind of the family physician by the violence so often done the ear, as the result of unskillful over effort at removal, we must suppose that he, also, many times shares their fears.

Roosa, *Diseases of the Ear* (p. 167) says, "It would be well if this fear of foreign bodies in the ear were transferred to cases where they have entered the eyeball, where the most serious results do occur, from the neglect to promptly remove the foreign substance; unskillful or indiscreet attempts to remove a foreign body from the ear are often more dangerous than the foreign body itself. In the case of a foreign body in the eye, it is the loss of sight that is threatened, and that is usually

the worst that can happen; but it is not a very rare experience that improper attempts to remove a foreign body from the ear have cost the life of the patient." Before making any effort at removal, the physician should assure himself, by careful ocular inspection of the meatus,* that a foreign body is present, as it not unfrequently happens that a patient applies or a child is brought, with the statement that a foreign body is in the ear when such is not the case. It may have been in, but is not now, and any attempt at its removal can only result in a mortifying failure. When it is seen, no violent attempts at removal should be made. The use of any undue force made with instruments, may only force the object through into the cavity of the tympanum or even into the labyrinth. Such cases are on record. As previously stated, there is greater danger from harsh attempts at removing foreign bodies from the meatus externus than from neglecting them entirely. Still they must be removed, and what I wish to teach, is that if the physician finds that he is not likely to succeed without endangering the integrity of the organ, he should see that the patient go to some one provided with the necessary means and skill to succeed. The admission by the general practitioner of lack of skill in manipulating these special organs will be an exhibition of honesty which will generally meet with the hearty approval of his patient, and many times spare him great mortification.

Many instruments have been devised for the removal of substances, foreign and otherwise from this tube. The spuds found in Buck's set of instruments may many times be useful, and in case of solid or hard bodies we may sometimes succeed in passing a loop of elastic wire behind it, which is a perfectly safe procedure.† But the *syringe* properly used is at once the most successful and in all hands the least likely to do harm. It should have a capacity of not less than four ounces, and so directed that the water will be forced upward and backward. The upper portion of the external tube being deficient of cartilage; the more yielding fibrous tissue which supplies its place, permits the fluid to pass behind the foreign body at this point, when it would not otherwise do so.

A few cases are on record, in which foreign bodies have entered through the eustachian tube, and, of course, were followed by destructive inflammation in the middle ear.

Water frequently enters the external ear, and if allowed to remain, may give rise to serious inflammation. Simply inclining the head to the involved side will usually suffice for its removal. Should it not, however, a bit of absorbent cotton passed into the tube by means of a probe, or a pair of angular forceps, will readily take up the few drops therein contained. Should water enter the eustachian, and Valsalva's method fail to remove it, Politzer's air bag must be used.

*The concave mirror, and where the foreign body is deep in the ear, the ear speculum will be necessary, in order to obtain a proper view.

†Various forceps, as those of Pomeroy & Sexton, have been devised, and are useful for this purpose.

Membrana Tympani.—This membrane may be ruptured, as one of the effects of working in compressed air; but rupture of this membrane occurs more frequently as the result of direct violence to the head or membrane itself; four cases of this kind were observed by Dr. Robert F. Wier, and are reported by ROOSA (p. 228.) "In one, the drum-head was ruptured by a blow upon the head by the hand. In another, fragments of rock from a blast struck the head and ruptured the membrane. In the third case the injury was caused by a snow-ball striking the ear; and in the fourth a hair-pin was accidentally forced through the part. TOYNBEE and VON TROELTSCH record cases in which the membrane has been ruptured by straws and twigs entering forcibly through the external meatus; also as the result of blows on the side of the head, administered to pupils by tutors.

The effects of compressed air on the membrana tympani, have been carefully studied by Dr. A. MAGNUS, of Konigsburg, Dr. ANDREW H. SMITH, of New York, and Dr. JOHN GREEN, of St. Louis, during the construction of bridges across rivers at those places—at New York, the East River bridge between Brooklyn and New York; at St. Louis, the bridge across the Mississippi—In building the piers of these structures, the excavations were made, and the entire structure below the water, was built by means of caissons, the workmen being subjected to air pressure, varying from thirty-five to sixty pounds to the square inch, for from four to ten minutes; repeated inflations by Valsalva's method were necessary to relieve pain and pressure, rupture only occurring in those who were unable to inflate the cavity. In those cases in which the eustachian did not open freely, congestions, more or less intense, would ensue in the tissues within the tympanic cavity, which were readily relieved by means of Politzer's method; its repeated use enabling many, who could not otherwise have done so, to continue their work, and as Dr. SMITH further believes, averted, in some instances, the occurrence of serious inflammatory action. Cases of rupture occur during whooping-cough, and sneezing or blowing the nose. In sea bathing, sometimes the force of a large wave striking the side of the head, is sufficient to cause rupture. It is probable that in the cases of rupture occurring from these last mentioned causes, there is always a previously existing catarrh of the eustachian tube and tympanic cavity, which should have received attention. Explosion of projectiles, bags of gas, etc., near the ear, have been known to cause rupture of the drum-head, and then the result to the hearing is apt to be the most serious; as in addition to the rupture, we are likely to have concussion of the labyrinth, or a fracture or dislocation of the ossiculæ, thus, not only endangering the hearing, but the life of the patient also.

In addition to the subjective symptoms of pain and deafness, "the tuning fork" may render valuable service as an aid to diagnosis in cases of rupture, its vibrations being more distinctly heard in the

injured ear than the other, if the labyrinth is not injured. Ocular inspection by means of the otoscope will, of course, not be omitted.

Treatment.—If the rupture is simple, it will be best to let it strictly alone; do not meddle by either syringe or medications, except such internal remedies as Aconite and Arnica, and perhaps Bell.; union will take place in a few days. But if the wound is a ragged one, or from the continuance of pain, or apparent congestion of the membrane, we have reason to expect inflammation and suppuration; then the topical use of *hot* water poured into the ear from a sponge or spoon, while the patient lies on opposite side of head, the application being kept up until the pain is relieved, as it usually will be in ten to twenty minutes; also such medicaments as Aconite and water, or Aconite and Veratrum viride, two drops of each to the drachm of water, dropped into the ear two, three or four times daily, according to amount of pain, and relief afforded. Always, however, bearing in mind, that the indicated remedy will often act with remarkable promptness in controlling middle ear inflammations, and probably, no less so, where they begin in the membrana tympani. Such are:

1. *Aconite*, *Bell.*, *Merc.*, *Puls.*
2. *Apis*, *Rhus*, *Hepar*, *Sil.*

The injuries to the internal ear, causing deafness, are fractures of the petrous portion of the temporal bone, and hæmorrhage or effusion into the membranous labyrinth.

(ROOSA, p. 497.) "It is readily seen that a fracture of the petrous portion of the temporal bone, attended, as it must necessarily be, by laceration of the tissues of the membranous labyrinth, with unstringing of the fibres that make up Corti's organ, must produce great impairment, if not total loss of the functions of the auditory nerve."

Such an injury may be accompanied by hæmorrhage through the membrani tympani; but a case of Zaufal's, quoted by Politzer, shows that a hæmorrhage may occur from the ear after an injury, when the drum-head is intact. In this case a fracture occurred through the upper wall of the pyramid, and the opposite wall of the tympanic cavity, and extended to the upper wall of the osseous part of the auditory canal, without having injured the membrani tympani.

After a fracture of the base of the skull, a serous fluid, which is usually cerebro-spinal fluid, is sometimes discharged. The experiments of Hyrtl, and observations of Fedi, (ROOSA, p. 497), go to show that a serous discharge may take place from the labyrinth, without fracture of the base of the skull.

Hyrtl, after removing the fluid from the canal of the spinal cord, in the cadaver of a child, once found that the injecting material forced into it, passed into the cavities of the labyrinth. He is of the opinion that the labyrinth fluid in this case, was connected with the cerebro-spinal cavity by holes which existed in the meatus auditorius internus, near the entering fibres of the auditory nerve.

The question, whether a communication exists between the cavity

of the spinal cord and the labyrinth, after fœtal life, is still unsettled.

The manner of the production of this class of injuries, and their peculiar character, receive full consideration in the works on general surgery, and will receive only a passing notice here. Cases of sudden deafness occur from hæmorrhage where no accident has occurred, and are generally preceded by giddiness and nausea, or vomiting, although cases are seen in which none of these premonitory symptoms existed.

Concussions.—The deafness occurring among boiler makers, or persons working in a constant din, caused by hammering on large iron plates, also the results of canonading are, in all probability, due to concussions of the fibres of the nerve in the cochlea and tympanum.

XVIII. INJURIES OF THE FACE.

Wounds of the face have always been of interest to the surgeon, from the fact that the part is unusually exposed to injury, the disfigurement that may result is very conspicuous, and the rapidity of healing is so marked, that lesions assume a much different significance than when occurring in other parts of the body. It is said (MASON, *Surgery of the face* p. 68) that "wounds of the face, however ghastly to look at, are not dangerous to life." In many instances the face has been pounded into a shapeless mass; bones have been fractured, dislocated, and the relation of parts so extensively modified that it seemed as if recovery could not take place, yet repair has been speedy, and deformity not always persistent. The fact, however, that in spite of the exposure of the part due to its situation, and freedom from clothing, the head is exceedingly movable, and the hands instinctively attempt its protection when threatened with injury, operates to make severe lesions in this region comparatively infrequent.

To acquire a competent knowledge of the methods of repair, and the aids which surgical science affords to this end, it will be necessary to divide our subject into five parts as follows: Wounds of soft parts; Wounds of arteries; Wounds of nerves; Fractures; and Dislocations.

I. WOUNDS.

From considerations like that noted above, while little anticipation of death may be felt from even the most extensive injuries of the face, yet a knowledge of the principles of repair must always make the surgeon solicitous to secure union with the minimum of scarring. This is particularly true in the case of women, in whom a scar would be a very serious blemish indeed. When speaking of wounds and the process of repair, it was stated the cicatrices frequently assumed, in process of time, characters, if not identical at least similar to the tissue of the part. This while true in a general sense, must be taken with some modification, and the present seems the most appropriate place in which to present the question.

MASON (*Surg. of the face* p. 55) says: "It is, I suppose, an accepted pathological axiom that all scars grow in proportion to the growth of the body; * * * * when a portion of the skin has been destroyed, the cicatrix appears to be persistent through life, and grows *pari passu* with the rest of the body, or rather with the portion of the body over which it may be placed." PAGET further states, "a scar which the child might have said was as long as his own forefinger will still be as

long as his forefinger when he grows to be a man." BRYANT (*Pract. of Surgery* p. 25) says: "The nature of the scar or cicatrix varies with the tissue in which it is found, the new connecting medium or cicatrix under all circumstances having a powerful tendency to adapt itself to the peculiar character of the tissue in which it is placed." HOLMES-COOTE, (HOLMES *Syst. of Surg.* V. p. 561,) uses the following emphatic language: "Whatever the microscope may reveal, the fact is undoubted, that when the entire thickness of the skin has been destroyed, the tissue which replaces it never exhibits the same character of perfection as before. A superficial layer of skin may be disorganized, when repair goes on by granulation, and no trace of the injury after a time is preceptible. But the case is otherwise when the whole thickness of the skin has perished. The smooth white cicatrix retains its own characteristics, and contracts for months or even years, gradually drawing closer around its decreasing circumferance the surrounding integument, and acting, though slowly and gently, yet with a force that no tissue, however hard, can resist, distorting the features, and exercising an influence on the shape of the growing bone and in the direction of the teeth." To some extent these extracts seem conflicting, and are valuable witnesses of the necessity for a complete and exhaustive surgical treatise. They partially teach the same thing, yet separately considered might lead the student to erroneous conclusions. For instance, as time elapses, varying in different cases as to duration the primary cicatricial characters become indistinct, and give place to durable forms of tissue which so closely resemble the tissue of the part that a careless or ordinary observer would conclude that perfect restoration had taken place. The fact is, that whether function is impaired or not, when the whole thickness of the integument is divided, close inspection will show a continuance of the reparative tissue to the last day of life. I have shown in a former chapter, how with *Silicea*, or other indicated remedies, with subcutaneous section of adhering bands, the evil results of cicatrical adhesions may be avoided, and the very minimum of functional loss secured. Nevertheless, the bare fact that some imperfection must always exist, and the size of the scar increase with the growth of the part, must impress the surgeon with the necessity for careful treatment of wounds of the face, and an earnest effort to secure immediate union, or place the parts in such a position that the gap to be filled will be very small.

The first difficulty experienced, in very many instances, will be to determine whether the wound is incised or contused. The sharp edge of the malar bone, or the teeth, will often make a wound with all the characters of an incision, when the external force was a blunt body incapable of producing such a lesion. It is often essential, particularly in cases requiring legal investigation, to determine this question. Usually a wound made by this indirect force, that is the edge of a bone in the face, will not "tail off" as is usual in cutaneous wounds, thus (fig. 26.):

It will assume something of the characters in the annexed cut (fig. 27), the line "a" indicating the surface of the integument, and "b"

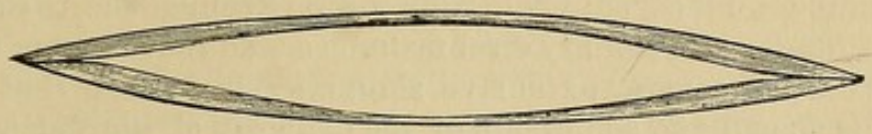


FIG. 26.

the base of the wound. It will be seen that the base of the wound is more extensive (longer) than the surface; the reverse is usually the case in wounds made from without inwards.

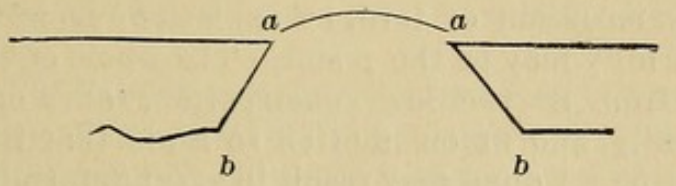


FIG. 27.

Having determined the probable cause of the injury, and the nature of weapon employed, the wound must be very carefully cleansed, and all bleeding completely arrested. Any scraps or shreds of integument or tissue must be replaced, if not entirely detached, and the edges closely and carefully placed together. The tissues of the face are exceedingly vascular, and hæmorrhage may be very profuse. If possible, ligature of bleeding vessels must be avoided, as the silk or other material used will act as a seton, and by promoting suppuration produce bad scarring. If hot water, or other mild styptics fail to arrest the bleeding, accupressure had better be employed, if possible keeping the pins within the wound. The edges of the wound are then to be closely approximated, and held in position with strips of adhesive plaster in preference to stitches. Should the latter be deemed necessary silk is to be preferred to wire, if care is taken not to retain them beyond a day or two. When wire is used there is less probability of suppuration in the track of the sutures, it is true; but the difficulty experienced by young practitioners, until they have acquired expertness by practice, in withdrawing the wire without deranging the wound, and thus interrupting the union, must operate as a powerful argument against their indiscriminate employment. Silk will be easier removed, and if withdrawn on the third day, at latest, the mark will be very insignificant. Harelip pins may be used, as less objectionable than wire sutures, but I cannot conceive in what respect they are superior to fine silk.

Another characteristic of the tissues of the face is its extreme elasticity and what might be called extensility. So great is this that wounds involving much loss of substance may be closely approximated, and little disfigurement result from the readiness with which the parts accommodate themselves to tension. MASON (*loc. cit.*) mentions a case in which more than half the upper lip had been lost, and

simple strapping held the edges firmly together, union taking place with little deformity.

The abundant blood supply of this region secures the tissues from sloughing, under all ordinary circumstances, and indeed from traumatism, even when severe, extensive sloughing is so rare that it may properly be considered as outside of the category of morbid action in the face.

It is necessary to notice the peculiar and distinctive features of wounds of different parts of the face, as far as they present any peculiarities.

(*a.*) The *nose*, apart from fractures or dislocations of the cartilages or bones, is frequently cut or torn, by explosions more particularly, and serious deformity may be the result. The whole of the face, as a matter of fact, from its peculiar construction, takes on reparative action very speedily, and union is often so rapid that the delay of a few hours in closing a wound may result in great deformity. The tissues of the nose present the same peculiarity; and the condition is both desirable and the reverse, as repair is speedily secured when early treatment is instituted, but neglect will much prejudice the success. Portions of the nose have been completely severed, retaining their connection to the face by a narrow strip of integument, and prompt union secured. Indeed SIR ASTLEY COOPER, and others, give instances in which the whole organ has been cut off, and union readily induced. The only points of interest are to place the parts in such a position that deformity is avoided, and function not impaired. To attain the first, always pass the first suture through the free extremities of the wound, when the alæ are incised, or the centre, when the injury is at the bridge. The second indication will be met by attention to the patency of the nostrils; if there is a tendency to obstruction of the nares by falling in of the walls of these cavities, proper moulds may be used, or plugs of lint or cotton employed.

(*b.*) The *lips* are perhaps oftener cut than other portions of the face and under some circumstances may result in serious deformity as well as positive damage to speech and other functions performed by these organs. Very freqently blows on the mouth from a fist, or other blunt weapon, will cause a wound from the resistance of the teeth. Such wounds, whilst having all the rational characters of an incised wound, are in reality contused, and thus of greater moment.

Portions of the lips may be completely lost by accident, or even, as often occurs, bitten off, and the extreme elasticity of the part greatly favors wide dispartition. The retraction is sometimes so extreme that the appearance is as though the whole member had been removed.

However the wound is induced, whether by direct force or by driving the soft tissues on the teeth, the principles of treatment are essentially the same. Perhaps more than ordinary care should be exerted to accurately adjust the margins. In all cases, therefore, in which the vermilion border is involved, the lips being completely

divided vertically, the free extremities of the wound must be first approximated by a fine suture. Should the wound be a ragged irregular one, it may be that this method will induce puckering of the remainder of the fissure. This may be overcome in one of two ways. If the attendant is an accomplished surgeon, the margins of the wound may be excised, as in hare lip operations, and the edges made to come together properly. This should not be lightly undertaken, as much tissue may be unnecessarily lost, and the case even made worse rather than better. Failing these essential qualifications, the wound must be closed as above, the lower suture first applied, *and tied.* The puckering that results may be treated as SKEY recommends for a similar defect in rhinoplastic operations, viz.: shaving it off after cicatrization.

When the lips are not completely severed, or the wound runs transversly, the first stitch must be taken in the centre, care being had to secure the same amount of tissue on each side of the suture.

Partial incision, confined to the mucous surfaces, or the integument, not involving both, are to be treated upon different principles. In the former, when of small extent, they are to be let alone. They heal readily, not requiring especial attention. When larger, and exhibiting a tendency to gaping, the edges may be drawn together by fine silk sutures. Integumental wounds, no matter what the extent may be, had better be approximated by adhesive strips alone. Ragged pieces must not be removed, not that suppuration may be averted, as is the case in scalp wounds, but that cicatricial contraction may be saved. As in all the tissues of the face, wounds heal readily and rapidly on the lips, and the first dressing must be carefully done to avoid disfigurement.

(c.) The *eyelids* while injured with equal frequency as other portions of the face, need no special mention at this place, my colleague, DR. MCGUIRE, having given the subject attention in a former chapter.

(*d.*) The *parotid* region possesses peculiar interest to the surgeon, at once from the important function and size of the vessels and nerves found in that triangle, as well as the somewhat frequent occurrence of a unique condition known as *salivary fistula.* It sometimes occurs that the parotid duct, or even the submaxilary, is cut across, and the cut ends fail to unite. The buccal extremity will ultimately become closed, and the secretions escaping through the glandular extremity, when opening on the integument, will in time produce a permanent fistula, the saliva trickling through keeping the parts excoriated. Should the glandular part of the divided duct open into the mouth, the accident will be completely repaired, and no discomfort will be occasioned. MASON (*Surg. of the Face*, p. 61,) among other causes, and the conditions resulting from the accident, gives the following: "Cases are reported in which the duct of the parotid gland has been ruptured subcutaneously by a blow, and in which the salivary secretion has burrowed in all directions, giving the patient an emphysem-

atous appearance, and causing much disfigurement of the face and neck." In speaking of the method of treatment he has found most satisfactory in a number of instances, and which other surgeons have found quite uniformly successful, he says of one case: "A probe was passed through the mouth and made to emerge from the fistulous aperture in the cheek; then, having bent the instrument slightly, it was pushed along the duct as far as possible in the direction towards the gland. The probe thus fixed was retained for the remainder of the day (altogether about eight hours,) and at night it was removed. Three days afterwards it was again introduced through the mouth, and passed readily towards the gland. After the first introduction the saliva ceased to flow from the opening in the cheek." Such treatment, of course, is only applicable to recent cases, when seen within a few hours of the accident. When the case is chronic, and a fistula fully formed, other measures must be adopted at once to preserve the function and integrity of the gland, and close the opening in the cheek. The method which has yielded the best results, as far my information extends, is that devised by DR. HORNER, of Philadelphia, given in SMITH'S *Operative surgery*, (1852) p. 172. The circular orifice is converted into an incised wound by extending it with the scalpel, in the direction of the zyzomaticus major, above and below. A broad wooden spatula is then passed into the mouth, and held firmly against the inside of the cheek by an assistant. With a *sharp* punch, of a diameter slightly greater than that of the fistula, the indurated tissues are cut out, by pressing the punch firmly against the spatula, and the external wound closed by stitches. This seems to be the most successful of any method known to me at present, and in two cases in which I employed it gave perfect satisfaction.

Contusions.—Contusions of the face, while of very common occurrence, are of much greater interest than similar accidents to many other regions. They derive their importance from the greater vascularity of the parts, the frequency with which subcutaneous wounds are produced, the great muscularity or the integument, and the extensive nerve supply. A contusion, of characters sufficiently important to demand medical attention, will, in nearly every case, be found to be complicated by subcutaneous hæmorrhage; and the loose connection of the integument with deeper parts very greatly predisposes to extensive burrowing of the blood, and its collection in cavities, either natural or artificial; as in the case of contusions of the scalp, we often find a partial organization of the peripheral portion of the extravasation, forming a sort of cyst. The blood in the center remains fluid a long time, and but for the discoloration, an abscess might be suspected. *Hamamelis*, topically and internally, will greatly hasten the absorption of this fluid, but the cyst must be broken by pressure, or a smart blow. This will at once induce a wide diffusion of the blood, but under proper treatment it will speedily be absorbed.

The frequent occurrence of subcutaneous wounds, and the conse-

quent nervous lesions that accompany them, whilst not complicating the case much, must receive attention, as a want of knowledge of the meaning of the symptoms and ordinary termination, may lead the young surgeon astray, particularly in prognosis, giving him needless alarm, and perhaps removing a patient from under his care. As I said earlier, when speaking of wounds in general, subcutaneous wounds heal with great readiness, and with almost perfect restoration of structure. This last will lead us to prognosticate perfect ultimate restoration. The occurrence of facial paralysis, ptosis, pupillary abnormalities, even glosso-pharyngeal paralysis, may be in a marked degree, and yet a promise of complete restoration may nearly always be made. Complete division of large nerve trunks, in this manner, will rarely induce permanent loss of function, but cases are not infrequent in which many weeks, or even months, are consumed in re-establishing innervation. The conditions resulting from such lesions are to be treated on the general principles laid down earlier, (*Injuries of Nerves*), viz: *Hyperic.*, pain and soreness; *Led. pal.*, coldness and paralysis; *Stram.*, reflex irritation and muscular spasm. When the nervous deficiency is plainly due to compression or extension, as in extravasation or effusion, *Arn.* or *Con.* will have an important influence.

Burns and Scalds.—In all burns and scalds, not sufficient in extent of surface involved to endanger life, the chief consideration, surgically of course, is the serious character of the scarring, involving not only great and lasting deformity, but serious impairment of function. If the deformity ceased with the immediate results of cicatrization, the question would be of much less magnitude; but as it continues in operation for months, or even years, drawing bones out of their proper relations, and increasing, the deformity, day by day, it is a matter of the first importance that some means should be taken to prevent this in the beginning, and to correct it when, in spite of all precaution, it occurs. In addition to this consideration, we have one of even greater magnitude, viz: the region particularly exposes the sufferer to danger from cerebral effusions, loss of sight, hearing, or serious lesion to the parts concerned in deglutition and respiration. Attention to the general principles of treatment of burns, as laid down in an earlier chapter, will do much to lessen the degree of deformity; to some extent, at least, it is unavoidable. It will be remembered that the indications are, to relieve pain, to exclude the air, to promote granulation, and to keep raw surfaces separated.

It would be an interesting question to discuss the reasons, why cicatrization from burns is so much more serious than from any other species of injury. A difficulty will be met at the outset, however, viz: want of sufficient data. It is presumed, and the presumption seems reasonable, that there are no specific results of the application of heat, the subsequent contraction being due, rather to the extent of surface involved, and the irregular depth of the lesion, together with

a consideration of the muscularity of the region. It has been observed, I think, that in regions in which the skin is exceedingly muscular, or in which erectile tissue is found, resulting deformity is greater. Others incline to the opinion that the sudden application of intense heat, by chemical action on the albuminous elements, initiates a morbid action that impresses itself upon the process throughout.

The *treatment* of deformity resulting from these accidents, is purely surgical, and demands in the operator the most exact scientific and technical knowledge and skill. If the methods referred to under the head of *Healing of Wounds* are not sufficient, competent special skill must be sought.

II. WOUNDS OF ARTERIES.

The arteries in the face that may be wounded, and which would furnish sufficient hæmorrhage to call for ligature, or other radical method of treatment, are chiefly branches of two vessels, the facial and temporal. When practicable, the vessels being quite small, and, unless some more or less chronic hyperæmia exists, the bleeding usually proving insignificant, the injured vessels may be secured in the wound. If the vessel can be isolated, so that the nerves are not included, accupressure is the far better practice. The vessel having retracted, or from other causes cannot be readily found, it will be necessary to apply a ligature on the main trunk. For this reason the source of the vessel must be borne in mind. The branches or continuations of the facial artery are as follows: Angular artery; masseteric; inferior labial; inferior coronary; superior coronary; and lateral nasal.

The temporal artery gives off but one branch of any surgical interest: transverse facial, which emerges from beneath the anterior border of the parotid gland, and crosses the face transversely, a little above Stenos duct, freely inosculating with the facial artery.

The *facial artery* is found at the anterior border of the masseter muscle, and can be felt as it crosses the lower face at the lower angle of this muscle. It is to be exposed by an incision rather oblique to the course of the vessel, which, at this point, is nearly directly upwards. The facial is a branch of the external carotid, and it may be necessary, in exceptional cases, to secure this vessel to arrest violent bleeding.

The *temporal artery* is one of the last branches of the external carotid, and can be felt pulsating just in front of the ear. It is exposed by an oblique incision. The vessel, also, runs vertically.

It occasionally happens, owing to some abnormality in the distribution, or the confusion arising from the free inosculation of the vessels, that one or the other trunk is tied, and no result is obtained. There is no resource then, but to tie the other. If the hæmorrhage still continues, the external carotid must be taken up, and the ligature applied as low down as possible. The line for the incision is the ante-

rior edge of the sterno mastoid, the vessel being found in the upper third of the distance occupied by this line. The division from the common carotid occurs at the level of the upper border of the thyroid cartilage; in the first third of its course it is superficial, but becomes deeper farther on, until it enters the parotid gland.

Another branch, rarely wounded from accidents, is the *internal maxiliary*. It is almost impossible to tie it in the wound, in cases of accident; the external carotid must be taken up.

III. WOUNDS OF NERVES.

While injury to any one of the cranial nerves will, in some manner, affect portions of the face, the tri-facial, (fifth pair), will often present lesions confined in their results to the face proper, and of such a character that it would seem well-nigh impossible to make an error in diagnosis. The symptoms are those peculiar to nerve lesions in general, and need not detain us long. The facility with which slight changes of expression in the face are noted, greatly simplifies diagnosis; and were it not that the mistake has occurred more than once, a fact would not need comment at this time. I refer to the location of the lesion with reference to the side of the face. When paralysis of one side occurs, the loss of muscular antagonism causes a contraction on the *sound* side, and loss of expression and mobility on the other. Medical attendants have occasionally been led into error, by supposing the deformity was due to spasmodic conditions, and such local measures as were instituted were thus applied to the wrong part. Should there be any reasonable doubt in such cases, (which seems almost impossible), faradaism will set the matter at rest. The paralyzed muscles will not respond to the electric action, whilst the deformity will be increased when application is made to the other side.

The *treatment* must be conducted entirely with reference to the cause and pathological condition, as laid down in an earlier chapter. The leading facts in diagnosis must be carefully borne in mind, *viz:* paralysis, when the nerve is completely divided, or severely contused; neuritis or clonic spasm, when partially divided or contused; neuralgia, when the lesion is extrinsic, as compression from coagulæ, contiguous tumefaction, or continuous pressure from spiculæ of bone or small tumors.

IV. FRACTURES.

Fractures of the bones of the face are of peculiar interest to the surgeon, from the fact that they are usually associated with dislocation; repair, with such rapidity that unless early reduced, great deformity results; the region predisposes to associated cerebral injury; and in many instances, important functions are suspended during the continuance of treatment. They are usually the result of direct force, and with much displacement the nerves are frequently torn, compressed, or put on a stretch to such an extent that paralysis, neuritis,

or neuralgia are very frequent concomitants. The bones usually included under this head are, the zygomatic arch, nasal, nasal septum, malar, superior maxillary and inferior maxiliary.

(*a.*) The *zygomatic arch* is frequently broken, from its exposed situation, and constitutes a deformity, giving rise to peculiar symptoms, that are notably pathognomonic. The usual *causes*, are blows, or the exertion of direct pressure on the arch; pressure on the frontal and occipital, or parietal bones, and, in rare instances, sudden contraction of the temporal muscle. The seat of fracture, in the absence of direct force, is usually in the temporal portion, but occasionally at the symphysis. From the fixed position of the process, when the fracture is single, and the absence of natural mobility, the usual signs of fractures are many of them wanting, but the nature of the accident, and careful examination will generally give a correct diagnosis. When the fracture is double or multiple, which is often the case, the condition is readily made out, particularly if there is complete displacement, and both fractures are complete.

The *symptoms* are in two groups, subjective and objective, each of which may be of particular value in different cases. In the former we will have pain in the temporal region much more severe upon attempting to move the lower jaw, from the action of the temporal muscle on the fragments of the bone. Upon making pressure on the zygoma the pain will be much increased, usually, but occasionally will be relieved. This latter will occur when the displacement is outwards, which we will see is the usual condition. Failing to elicit pain by direct pressure, placing one hand on the temporal bone, a little posteriorly, and the other on the frontal, on the opposite side to the suspected fracture, and making *strong* pressure, pain will usually be felt. This group of symptoms is of value when the displacement is so slight that it cannot be detected, or such a length of time has elapsed since the injury that the swelling of the part masks the lesion.

The *objective* symptoms are mobility, crepitation, and deformity. The two former need no special mention, they being common to all fractures, farther than to note that their importance and prominence will be dependent upon the existance of a double or multiple fracture; a single fracture preventing any mobility in the fragments, and consequently crepitus. Deformity is the most important and constant symptom. In the larger number of instances the displacement is outwards. This is owing to the action of the temporal muscle, and slightly to that of the zygomatic muscles themselves. The two latter muscles have a further tendency to draw downwards one or the other fragment according to circumstances. Even when the force is direct, and of such severity as to force inwards the fragments, the temporal muscle will sooner or later change the displacement to outwards.

Treatment.—The chief indication is necessarily reduction, and unless impaction exists is readily fulfilled. When the displacement is *outwards*, firm pressure on the projecting fragments will readily reduce

the deformity. Should the displacement be *inwards*, more difficulty will be experienced. In the large majority of cases, the action of the temporal muscles will speedily induce reduction. Should it seem insufficient, its action may be increased by causing the patient to chew on a stick of wood, or piece of rubber. In rare instances, particularly when impaction occurs, it may be necessary to cut down upon the fracture and lift the fragments into place with an elevator. I resorted to the elevator in one case, but owing to the fact that the fracture was compound, it was not necessary to make an incision. Students have frequently inquired, why such pains should be taken to reduce these fractures, the bones from which the process springs being immovable. Apart from the great deformity that would necessarily succeed such an accident, the action of the temporal, masseter, and zyzomatic muscles would be seriously hampered.

Retention need cause little concern. The muscles in connection with the parts must be kept at rest for a day or two, and proper bandaging and compresses employed to guard against renewed displacement. Repair is rapid, as is the case in all fractures in this region.

(*b.*) The *nasal bones*, from their exposed position, are not infrequently broken, but perhaps not as much so as is generally supposed. On the other hand there are unquestionably many instances in which the condition has never been recognized, and a permanent deformity result. The slightest deformity in the nose, a slight sinking or prominence of the bridge, a deflection of a line to one side or the other, or the most minute and trivial disarrangement of the parts entering into the composition of this organ, produces such a change in the expression of the face, that too much care cannot be exercised in diagnosing the accident, and applying early the means for relief or cure. In a short time after a blow severe enough to produce a fracture of these bones, swelling comes on to such an extent that an accurate diagnosis is impossible, or can only be secured at the expense of much trouble and care. When the mucous membrane of the nasal fossæ is torn, the admission of air that may take place produces more or less extensive emphysema, further confusing the diagnosis.

The force is usually exerted directly, and in the larger number of instances, the fracture will occur at the lower portion of the bones, not higher than the middle, and without corresponding injury to the ethmoid, vomer, or contiguous bones. The lesion, in short, is usually confined to the nasal bones. When we meet cases presenting brain symptoms, we may suspect fracture about the middle of the bones, with associated fracture of the nasal spine of the frontal bone, and more or less basilar lesion. The degree of force required to fracture these small and fragile bones, in this portion of them, is astonishing; severe concussion of the brain may be induced, extensive fracture of the base of the skull, and the nasal spine of the frontal bone or its orbital plates may occur, and the nasal bones themselves remain uninjured. We may have, it is true, indications of severe brain

lesion, and the lower half of the bones alone suffer from fracture. The fair presumption in such cases is, that the brain symptoms are due to other causes, as a fall succeeding the blow breaking the nose, or some similar complication.

In spite of the swelling, if the case is seen within an hour after the accident, it is possible to make a satisfactory examination if the surgeon disregards the objections of the patient. The parts are always sensitive, particularly internally, which is much increased under the circumstances, so much so, that few, young or old, will submit to manipulation without strenuous opposition. If necessary, an anæsthetic must be administered; at all events a knowledge of the deformity that must result from a failure to replace the fragments, must compel the surgeon to make his examination thorough.

The nature of the accident having been made out, reduction is to be immediately effected. This is best done by using a small probe, suitably bent, in the nostrils, and moulding the parts into shape with the fingers of the other hand externally. Those who speak of a female catheter as a useful instrument for this purpose, can certainly have seen few if any cases. The position of the nasal cavity to be reached will not admit an instrument of that size. Neither should the end of the probe be covered with cotton, for the same reason, want of room. Reduction is usually easy, unless some impaction should occur.

Retention is likewise far from being difficult. The abscence of any muscular attachment to the bones averts all danger of displacement by muscular action, and, unless the fracture is comminuted, no retentive dressings are needed. When there are a number of fragments, however, there may be some difficulty experienced in keeping them in position. Narrow strips of adhesive plaster may be passed over the bridge of the nose, care being had to properly support the sides. If there is still tendency to depression, small pellets of lint, well annointed with cosmoline or simple cerate, and attached to threads, may be passed up, and the number carefully noted that none may be left when finally withdrawn.

Union is usually very rapid, so much so that if two or three days are permitted to pass without an attempt at reduction, the bones will be found quite firmly united. About the seventh or eight day, union is usually firm and complete. Cases have occured in which union has taken place leaving some distortion, and an operation more or less elaborate, will be required to correct it. While the consideration of formal operations is not included in the present volume, I may state that the indications are to reproduce the fracture and commence *de novo*.

(c.) The *Nasal Septum* is occasionally broken, the accident however, taking more of the form of a dislocation than a fracture. The force is usually of the same variety as that producing nasal fracture, but less in degree. The separation usually occurs at the point of union

with the nasal bones, and may include the vomer and perpendicular plate, or consist of a simple bending of the cartilage. In some instances the parts are driven directly inwards, and a very serious lesion is thus produced. From the thinness and elasticity of the part, some embarassment will always be experienced in reducing this fracture, and still more in retaining the parts in position. From the greater room in the nostrils, or as HAMILTON says, "the accessibilty" of the parts, the difficulties are less than is the case in fracture of the nasal bones.

The *reduction* is to be affected, as in the last instance, by the use of probes in the nostrils, and the unoccupied hand externally. *Retention* may be secured by stuffing the nostrils with lint, and moulding a gutta-percha splint to the part externally. The experienced surgeon will expect to find some lateral displacement, in most instances, after removing the dressings, but if the angle is not so acute that nasal catarrah is set up by the compression and tension of the mucous membrane, or to impede respiration, no evil will follow farther than some alteration in expression. More or less lateral deviation is so common, that such a result will not excite comment unless very marked indeed.

In cases in which there is complete detachment of the fragments of the part, perfect resposition and retention has been secured by constructing a bridge of gutta-percha, tin, or even wood, in the form

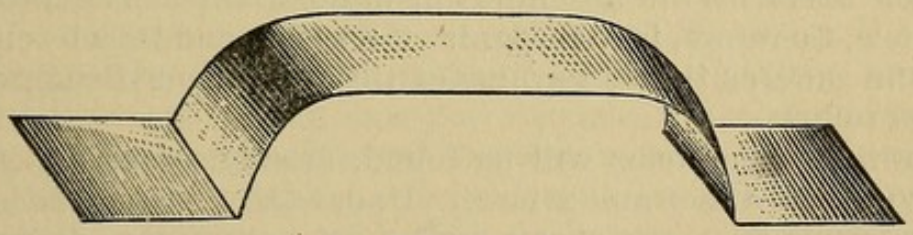


FIG. 28. Splint for nose.

represented in the cut, one end to rest on the forehead and the other on the upper lip. Silk or wire may be passed through the septum, and secured to the bridge; the parts are thus held firmly in position.

(*d.*) The *Malar bone* is rarely fractured, yet custom has sanctioned the use of the term whenever the bone is found displaced; usually the word dislocation would be more accurate. The peculiar relation this bone sustains to the other bones of the face, the formation of the dentated suture, and its immovable character, combine to forbid either fracture or dislocation unless by the exertion of very great force, with more or less injury to contiguous parts. For the same reason, a force sufficient to fracture or displace the malar, is exceedingly liable to produce serious brain lesion. From any point of view, therefore, this injury is at once one of some danger to the patient, and interest to the student of surgery.

As said earlier, a fracture without displacement of the bone will be almost impossible. The only exception to this rule, probably, will

be when the force is of a penetrating character, as a gun-shot, or stab with a pointed weapon. Experiments made by HAMILTON and others on the naked skull and recent subject, have conclusively shown, that the most common luxation accompanying a fracture is a separation of the inter-maxillary suture, opening sometimes the roof of the mouth, *and altering the line of the teeth.* As this last symptom is quite pathognomonic of dislocation of the upper jaw, it may save embarassment if we remember that the injury may be chiefly in the malar and its relations. In other cases the zygoma, nasal apophysis, ethmoid, sphenoid, or indeed any or all of the facial bones partook in the injury. When a fracture was produced without extensive luxation, it was always double.

The amount of force, if it fails in setting up evidences of brain lesion, is so great that much swelling and tumefaction exists, and in this way evidence of fracture is often extremely unsatisfactory. As the swelling subsides the deformity at once becomes apparent, but so much time has been lost that attachment of the fragments in their new relations is quite firm, and reposition almost hopeless of attainment. Indeed it has been found by HAMILTON, that even when fractures were produced on the naked skull, with the free access to the parts thus afforded, it was utterly impossible to reduce such a dislocation or fracture. The difficulty being the impossibility of re-locking the serrated sutures, it will be at once apparent, that in the living subject the obstacles are absolutely insurmountable. The most that can be done, therefore, is to recognize the lesion, and thus be enabled to give the sufferer timely warning of the permanent disfigurement that must follow.

The ordinary spmptoms will be found, usually, occurring in two groups, viz.: the direct and remote. Under the first we will have a loss of prominence in the cheek, and occasionally a deep depression, when the displacement is extreme. In a very short time, perhaps in fifteen or twenty minutes, there will be much swelling and tumefaction, effectually masking the deformity. There is manifestly no crepitus, or mobility; indeed the characters of dislocation enters so largely into the case, that immobility may be considered the constant symptom. When the orbital arch suffers, there will be an alteration in its line. When the ethmoid or sphenoid are involved, there may be serious brain symptoms. The superior maxillary being implicated, will give an alteration in the line of the teeth. Those are the more constant of the direct symptoms.

The *remote* are of various characters. Thus, when the bones about the orbit are chiefly implicated, and there is much effusion of blood, there will be more or less protrusion of the eye, redness or even chemosis of the conjunctiva, and swelling of the lids. There is not infrequently some paresis due to lesion of the malar branch of the trigeminus, particularly the superficial twig, and if the lesion is severe, the functional disturbance may extend to the other branches, but

more particularly to the infra-orbital. In the majority of instances, however, all such symptoms are transitory, and soon pass away. Even in the graver neurosis, permanent trouble need rarely if ever be anticipated. The most persistent trouble will be a neuritis, and when long continued, must suggest an enquiry into the condition of the nerve, whether compressed, lacerated or divided. In such cases the question of stretching the nerve must be considered, or in some mechanical way freeing it from the compression or other abnormal condition.

There are a few cases in which the displacement is so complete that the fragments are freely movable, and reposition has been effected by screwing a gimlet into the fragments. Retention is very difficult, even under these circumstances, but has occasionally been secured.

(*e.*) The *upper maxillary bones* from its intimate relations with the other facial bones, the firmness of the union therewith, and the situation protecting it from ordinary external violence, is somewhat infrequently fractured. From a consideration of the same circumstances, when fracture does occur, it is not infrequently associated with grave lesions of the brain and contiguous parts. As is the case with most of the facial bones, the accident may be considered a dislocation complicated with fracture, or fracture complicated with dislocation, both characters being usually present in each case. The degree of fracture, may be from that of the alveolar process of the dental arch, to a separation of any of the other processes, as the nasal spine, palatal plate, orbital plate, etc., or division of the body of the bone. In millitary practice perforations of the body of the bone by gun-shot are frequently met, thus presenting simple fracture uncomplicated by dislocation, but the associate injury is so severe that recovery cannot be considered probable. Other instances occur in which the whole bone, or both of them, are displaced backwards, as has been said "the whole face driven in;" one such case is noticed by WISEMAN, in which retention was impossible after reduction, by any apparatus then in use, but the parts were finally united by being held in position by relays of assistants. The degree and character of the fracture must depend largely upon the nature and direction of the force producing it. It may be applied from within or without. *From within*, as from the explosion of a pistol in the mouth (a quite common occurrence in attempt at suicide), the injury is generally quite extensive, occasionally more severe in appearance than menacing to life. The palatal bones may be fractured and displaced; the dental arches broken, the antrum opened, and the whole bony vault and boundary of the mouth shattered, yet as long as the lesion does not extend to the base of the skull, and the brain escapes injury, the prognosis may, in the majority of cases, be considered good. The intimate relation between the posterior nasal spine and the vomar, however, frequently facilitates cerebral lesion, and we may therefore conclude that the violence

of the force and not the extent of the fracture must be the controlling element in establishing a prognosis.

The first thing to be done in these cases, is to replace the fragments in position. The nature of the injury, when extensive, is necessarily of a compound character, from the tearing of the investing tissues, and there may be less readiness in union than obtains in other portions of this region. Nevertheless the general rule should be pursued, not to remove fragments, however completely they are detached from the parent bone, or however small they may be, so long as they retain any connection with the soft tissues. Occasionally small fragments thus preserved have necrosed and been thrown off, thus delaying repair; but as a general thing they become firmly and speedily united.

Reduction having been effected, if the injury is confined to the portions of the bone within the cavity of the mouth, retention will require little more than the exercise of self control and patience on the part of the patient, for a few days, and the use of such articles of diet as can be swallowed with the least effort of the muscles of deglutition. After the lapse of four or five days, more liberty may be allowed, and by the tenth day there need be no fear entertained of a displacement of any of the fragments.

When, however, the injury extends to the dental arch and the external face of the bone, retentive dressings must become necessary. Should the suture become opened, the two halves separated to any degree, it will be found next to an impossibility to perfectly close it again. In such cases there will be a separation between the incisors, and more or less irregularity in the line of the teeth. In the majority of cases, after bringing the parts as nearly together as possible, wiring the teeth together, by twisting silver wire around their crowns close to the gum, will be found amply sufficient. If the dispartition had been wide, and any degree of closure effected only by the exertion of considerable force, it will be required to place soft compresses on each cheek, high enough to protect the nose, and a firm circular bandage around the head. If preferred some special form of apparatus may be used, but the rapidity of union necessitating only a brief retention of dressings, it is unnecessary to go to the expense of procuring apparatus. The same may be said of all kinds of moulded splints, of gutta-percha and otherwise, and chiefly because, as in other regions, as the swelling subsides the accuracy of the fit may be so much impaired that they become more injurious than beneficial. In the hands of a practitioner of any fitness for his calling, all kinds of fractures are treated more successfully, if any difference exists, certainly with less parade and expenditure, by means of improvised bandages than with any species of prepared or mechanical dressing.

Fracture of the upper jaw from injuries received *externally*, may be compound or simple, oftener the latter in civil practice. The fracture may consist in a separation of the suture, a detachment of the alveolar process, fracture of the nasal spine or malar process,

or, indeed, assume an almost endless variety of complications. Instances are on record in which the whole bone is driven inwards, giving the appearance of complete depression of the whole face. Unless the fracture is extensive, with considerable displacement, the symptoms are often obscure, as the swelling following external injury to the face is extreme. Union is so rapid, that if the detection of the fracture is delayed until the swelling disappears, deformity is practically irremediable. In the great majority of instances, however, a fracture of sufficient importance to demand treatment will be indicated by some noteworthy alteration of the line of the teeth.

Extensive fracture not extending into the dental arch, being almost necessarily the result of extreme force, the brain complication will usually be of such a severe character that all minor symptoms will be obscured. WISEMAN reports a case in which the whole bone, on each side, was driven in, the palate bones resting on the walls of the pharynx. No retentive apparatus could be devised which would hold the bones in place, and union was at last secured by keeping the patient on his face,and holding the parts *in situ* by the hands of assistants. MALGAIGNE alludes to a similar case, in which a mask resembling a fencing, mask was constructed, to which was attached a hook which engaged the palate arches, and held the bones in position. Other cases have occured in which an incision was needed to facilitate reduction; oftener for the purpose of affording facilties for the application of an elevator. In some instances reposition has been effected by screwing a gimlet or "*tierre fond*" into the bone and raising it up.

HAMILTON gives the following case in full: "The deformity produced by the sinking of the malar bone was very striking, and both the patient and myself was very anxious to have it remedied if possible. We found some of the teeth upon the side of the fracture loose, and we determined to extract them, and press up the bone with an instrument introduced through the empty sockets. The first attempt to extract a molar tooth however, brought down several teeth, and the whole floor of the antrum. The detachment of this fragment was also so complete, that we believed it necessary to remove it entirely, a labor which was accomplished with infinite difficulty, and with no little hazard to the patient, as dissection had to be extended very far back into the throat, and in the end it was not effected without bringing out, attached to the fragment of maxillary bone, a considerable portion of the pyramidal process of the palati." The room thus afforded, rendered reduction very easy, and two years afterwards scarcely a trace of the orignal injury remained.

The extraction of a tooth, or the perforation of the antrum, is a perfectly legitimate procedure, when all other methods of reduction fail, but the opening should be large enough to admit a body as large as the little finger, as smaller bodies can be readily pushed through the thin, bony plates of the orbit, or even into the brain itself. It must

be borne in mind, however, that with separation of the suture, the reposition must at all times be imperfect.

(*f.*) The *Lower Maxillary* bone is perhaps oftener fractured than the other bones of the face, probably from its exposed situation, and liability to accident. From a surgical point of view the accident is one of considerable interest, inasmuch as there is something to be done in way of reduction and retention. Deformity, also, which may succeed an improperly reduced fracture, will not only prove a marked disfigurement, but the important function of the part may be seriously impeded.

Fracture may occur at any part of the bone, body, symphysis, ramus, or neck, depending upon the cause, but in the absence of any special form of force, will oftener be found in the body, at or near the symphysis. The alveolus is very frequently broken in operations on the teeth, but the accident is usually insignificant, and not of any surgical interest.

The force is usually direct, particularly when the body of the bone suffers, the part yielding at the point receiving the blow. A force which compresses the angles or rami towards each other, may cause the symphysis to give way; or one which drives the tip of the chin backwards, break off the condyles, or cause fracture of the angle.

As to fractures of the *body of the bone*, it has been affirmed that disarticulation of the symphysis is an impossibility; there are cases on record, however, which seem to prove the contrary. In the case of young persons there can be no doubt that the accident has occured as a result of pressure; in older persons, as a matter of course, such an occurence will be more rare. Pistol or gun-shot wounds, or even the explosion of a blank cartridge within the mouth, may separate the jaw at this point. In all ordinary cases, however, as far as my observation goes, fractures of the body of the bone are usually single, and a little to one side of the median line. The line of fracture is usually vertical, or vertical on one face and oblique on the other. Occasionly the line is oblique throughout, and in such cases, according to MALGAIGNE and others, "the obliquity is at the expanse of the inner face of the posterior fragment, and the outer face of the anterior." The symptoms of fracture may be considered as follows:

Pain, whilst a constant symptom will not be sufficient to base a diagnosis upon. It varies in intensity with the degree of fracture, and the amount of displacement, as well as with the exact position. Thus with extensive fracture in the neighborhood of the trunk of the inferior dental nerve, with displacement sufficient to put this nerve upon the stretch, the pain will be greater than under other conditions. In many cases, cases in which there is little if any displacement, there may be entire abscence of pain, or a general painfulness of the whole jaw, and the injury being of a character to produce fracture, the pain must be localized. If pressure along the margin of the jaw does not elicit pain, making pressure on both angles inwards, simultaneously,

by causing a separation of the fragments, will cause intense, sharp pain at the point of fracture.

Displacement is far from being a constant sign of fracture, as very many complete fractures occur in which the fragments remain in perfect apposition. The teeth must be carefully examined, in all cases, any displacement being at once indicated by some irregularity of the dental arch. The amount of displacement is dependent upon the force of the blow, the amount of injury sustained by the periosteum, and movability of the fragments as far as muscular attachment is concerned. Sometimes, when the periosteum is intact, and the line of fracture vertical, there is no marked displacement, yet by close attention one of the fragments will be found slightly raised above the other with a slight separation of the dental border. MALGAIGNE asks the question, which fragment is thus raised, and answers by referring it to the fragment receiving the blow, which is displaced in the direction of the blow. He loses sight of, or in fact denies the power, of muscular action to produce this alone. It seems to me impossible to produce a displacement of a fragment against the action of such powerful muscles as the masseter and temporal. The consideration of the fact that fracture of the bone is occasionally due to muscular action, should suggest the power of those organs in producing and continuing displacement. When the fracture is vertical, but extending obliquely through the substance of the bone, there will be overlapping from before backwards; the posterior fragment having its edge beveled off, it will be found anterior to the anterior fragment, the overlapping being proportionate to the displacement. The force and direction of the blow, joined to the action of the muscles attached to the most movable fragment, may at the same time produce upward or downward displacement.

Swelling, at least primarily, is quite inconsiderable, and oftener confined to the point receiving the injury. It is less persistent, and more insignificant than usual in fractures in other regions.

Salivation, while a very common symptom, is not at all pathognomonic, and is of no value whatever.

Loosening of the teeth occasionally occurs, but only when the force applied is extreme, and cannot be considered a symptom peculiar to fracture.

Nervous symptoms of various kinds are of quite frequent occurance, particularly neuralgia or paresis from compression contusion or stretching of the dental nerve. Should the nerve be divided, there will be necessary paralysis, but it will not prove permanent, and will soon pass away.

Having detected the fracture, reduction will usually be quite easily produced, the bone being so placed that manipulation is quite unimpeded. The fragments are to be placed in position, and retained by one of the following methods.

In single uncomplicated fracture, the ordinary sling or cross of the

chin (Vide *Surgical Principles*), will be all that is necessary. It may be well to stiffen this somewhat, particularly when the fracture is so oblique that there is difficulty in keeping the bones in apposition. For this purpose take a piece of stiff pasteboard, gutta-percha, tin, or any other material, about six inches long and two and a half to three

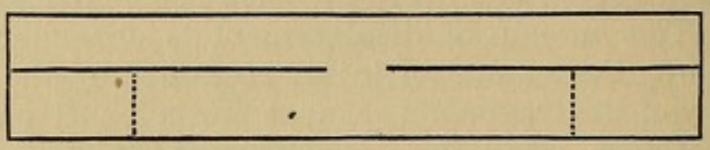


FIG. 29 (*a*).

inches broad. Divide this, as in the cut, (fig. 29 *a*) longitudinally to within half an inch of the center, from each end, and mould it in hot water, or bend it into the shape shown in the annexed cut (*b*.)

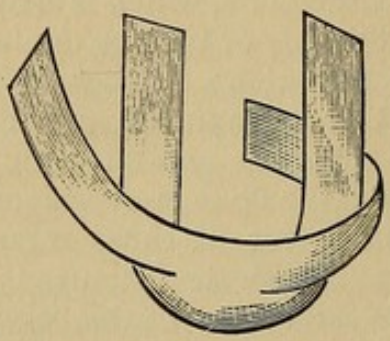


FIG. 29 (*b*). Splint for the chin.

There are very many moulded splints made and for sale in the shops, but they cannot be more useful than the above simple and time-honored dressing. Cover the chin, or line the splint, with a layer of cotton, and secure the whole in place with an ordinary "cross of the chin." To avoid disarrangement of the fragments, fluid nourishment must be used for eight or ten days; after this time, in the majority of cases, the stiffening may be removed from the chin, and some use of the jaw allowed. Full use of the part, or solid food, must not be permitted under three weeks.

Fracture of the Ramus.—Uncomplicated with fracture of the body, this form of fracture is extremely rare. Unless produced by gun-shot injuries, there are very few cases on record. MALGAIGNE alludes to but one case, observed by LEDRUN, but it was not discovered until after death. When it does occur, and displacement is slight, it is extremely obscure. Reduction is not difficult, but retention, owing to the action of the various muscles, is somewhat embarassing. Binders' board, paste-board, gutta-percha, lead, or moulded splints may be used. Union is rapid, and should be complete, for all practical purposes, at the expiration of twenty days.

Fracture of the Neck.—This fracture is exceedingly rare. MALGAIGNE can find but eight cases, to which Packard (his editor) has added two, while Hamilton seems unable to find any others. Direct force can scarcely accomplish this without extensive injury to other bones in

the neighborhood. Thus one of the recorded cases was complicated with fracture of the malar and temporal bones, as well as a double or triple fracture of the jaw. The explosion of a pistol in the mouth, or a blow or fall on the chin, or a violent blow on the ramus, are among the causes oftener noticed. When a fracture is simple, BICHAT gives the following symptoms: "Pain, difficulty of movement, crepitation; inequality sometimes perceptible in the region of the fractured condyle; the facility in burrying it in the zygomatic fossa by pushing it forwards; its not sharing in passive motion of the rest of jaw; and lastly, an almost constant displacement, the condyle being carried forwards and upwards, the body of the bone remaining behind, and the two fragments being separated by an interspace more or less perceptible." These symptoms Malgaigne deems constant, save crepitation and mobility, as in two cases out of the eight he refers to, there was impaction of the fragment, with complete immobility, and of course absence of crepitation. The mobility of the condyle, and its rotation by muscular action, will also tend to render crepitation an infrequent symptom, One important sign is mentioned by RIBES, viz., the chin is drawn to one side. This is also observed in dislocation, but the differential diagnosis is easy, as in luxation the chin is drawn to the uninjured side. The reverse occurs in fracture, owing to muscles drawing the jaw upwards and backwards without opposition. The condyle, when completely separated from the bone, remains in the glenoid cavity, but the pterygoid muscle rotates it upwards, forwards and inwards. It follows, therefore, that a primary indication in reduction, is to divide this muscle. When there is little displacement, the best treatment is to avoid attempts at reduction, merely enjoining perfect rest, secured, if necessary, by a bandage. When the displacement is considerable, the best treatment seems to have failed in restoring the conformation, or even perfect utility of the jaw. I would suggest a modification of Malgaigne's plan, consisting in the division of the pterygoid *first*, then by passing the finger into the mouth, press down the fractured condyle, at the same time drawing the chin forward, and rotating it to the sound side. When the fractured surfaces are thus brought into contact, close the jaw firmly, and apply a bandage. Nourishment must be, in this case also, liquid, and a tooth or two extracted, if required, to facilitate it. Union proceeds, often being complete by the twenty-third or thirtieth day.

V. DISLOCATIONS.

In the case of nearly every bone belonging to the face, whether we say a fracture complicated with a dislocation, or a dislocation complicated by a fracture, we express pretty much the same thing. What has been written, therefore, of fractures of the bones of the face, will necessarily include all that might be said of dislocations, with a single important exception, viz., the lower maxillary bone. This bone, I believe, is the only bone in the facial region that admits of simple

luxation uncomplicated with fracture to some extent, and I will close this chapter with a brief consideration of the accident.

The lower jaw, from its exposed position, and its great freedom of motion is peculiarly liable to luxation, and it is thought that it is oftener spontaneously dislocated, without pre-existing distinctive morbid action, than any other joint in the body. The predisposing causes are general or local muscular atony, and an occasional malformation of the angle or condyle. The exciting causes are applications of force direct or indirect, in the majority of cases, as far as my somewhat limited experience goes, the latter. Such causes will be, blows or falls upon the chin; extreme depression of the jaw, as in spasmodic coughing, or immoderate laughter, or yawning. The direct causes will be force exerted on the angle or ramus at the same time.

The luxation may be *double* (or bilateral), when both heads are thrown out; or single (unilateral) when but one is displaced. The former is more common when the accident results from indirect force the latter when direct. Women, and children together with those who are deficient in muscular tone, oftener suffer from double dislocation. It is not uncommon to meet cases in which such luxations are of very frequent occurrence, and are so easily reduced that medical aid is never required. Each dislocation, it must be remembered, acts as a direct predisposing cause for successive displacements.

The *pathology* of the accident varies somewhat with its nature, whether habitual or not, single or double, and considering the degree. In the milder forms, what might be called chronic cases, there will be a simple elongation and atony of the ligaments and tendons entering into the composition of the joint. In acute cases, particularly those resulting from extreme violence, the capsular ligament is usually torn, oftener in the form of a slit or " button-hole through which the head of the bone protudes; the tendon of the temporal muscle is more or less torn, sometimes completely separated from the bone ; the internal pterygoid may be similarly injured; and the bones in the neighborhood more or less fractured.

The *symptoms* also vary somewhat with the form, e. g., single or double. In each case there is depression of the chin, dribbling of saliva, a depression where the head of the bone should be felt, the tension of the muscles are subjected to, will give a "strained expression" to the face, and the parts will be immovable fixed in their abnormal position. At first there will be a diffused pain all through the infra-maxillary region, which later becomes localized near the insertion of the temporal muscle, in the temples, and about the orbits and the irritation to which the over-taxed muscles are subjected, results in spasmodic contractions of a more or less tonic character. If the dislocation is not reduced, in process of time the rigidity will relax, and a certain restoration of function will occur, but at the expense of a change in the angle of the ramus, which throws the chin too far forwards, so that the teeth do not meet properly. Speech is

much impeded, and deglutition, together with expectoration is either impossible or only performed with great difficulty.

When the dislocation is single, the symptoms may resemble, to some extent, fracture of the neck of the bone. The chin will be thrown to one side, it is true, but in the case of fracture the deflection is to the injured side; in dislocation it is to the uninjured side. In other words, in fracture a line drawn from the anterior edge of the auditory canal to the symphysis of the jaw will be shorter on the side of the fracture; in the case of dislocation it will be reversed, the injured side being the longest. The injured side will be readily recognized by the pain, which is either constant or can be produced by pressure with the thumb.

Reduction is affected in one of four ways, most practitioners prefering the second. When the dislocation is double, one side had better be reduced at a time, but there is no insuperable objection to reducing them simultaneously.

The method that may be employed in cases in which the dislocation has existed for a few days, and the muscles are in a state of extreme contraction, is to place a cork between the two last molars, say such a one as might fit an ordinary two ounce vial. The patient lying on the floor or bed, with the head in the lap of the operator who is seated behind, the chin is to be drawn up steadily, approximating the jaws, taking care at the same time to avoid drawing it forwards. As soon as the head of the bone is freed from the zygomatic fossa, it will slip into the glenoid cavity with an audible snap, and considerable force.

In the majority of instances the following will form the most efficacious. The surgeon being seated in front of the patient, places the thumbs, properly protected with leather, upon the lower back teeth, the remaining fingers of the two hands being placed under the chin. As pressure is made downwards with the thumbs, the chin is pushed up and backwards, reduction being accompanied by a loud snap. If the thumbs are not protected, they must be quickly withdrawn at the moment the head of the bone is felt to be slipping into position, otherwise they may be lacerated by the teeth.

Hippocrates method consisted in slightly increasing the deformity by further depressing the chin, and at the same time making firm pressure directly backwards. Ravaton contented himself with pressure of the chin directly upwards, trusting to the posterior molars for a fulcrum to lift out the head of the bone.

After reduction, by either method, if the case is recent, a cross of the chin, or some one of the dressings used in fractures of the jaw, must be applied, and for at least a week the parts held quite firmly, allowing only liquid food. After this time passive motion must be instituted, but it will require at least twenty days to ensure against a reproduction of the accident on slight provocation. It must not be forgotten that one dislocation predisposes to a repetition, the facility of production being increased with each renewal of the accident.

XIX. INJURIES OF THE MOUTH.

Injuries of the mouth, whilst of frequent occurrence and of great variety, are for the most part quite without interest, repair being speedy, and serious complications quite rare in individuals in ordinary health, and not subjects of dyscrasia. When a lesion is of such extent that bones are fractured, the injury may be considered as taken out of the category of injuries to the mouth, as the bones, for the most part, are those belonging to the face. I will consider, under this head, injuries of the mouth in general, of the tongue, of the arteries of the region, and of the upper portion of the œsophagus and air passages, which last might with propriety, be deferred until *injuries to the throat* in the next chapter is reached.

WOUNDS OF THE MOUTH.

Wounds of the mouth vary in extent and severity from the terrible disorganization from pistol explosions, or contact with heated bodies, to a puncture with a splinter of bone in the food, or the irritation from a broken tooth. It is quite common, particularly among laboring people, to have cases present themselves in which a pipe held in the mouth has been forcibly driven inwards, the stem lacerating and stripping up the mucous membrane, or even as occurred in one case, penetrating the floor of the antrum and orbit. Portions of clay pipe have in this manner been driven into the posterior wall of the pharynx, and caused secondary conditions which have either resulted in death, or placed life in serious jeopardy. In all cases, as far as records have been kept of what may be generally considered trivial occurrences, the injury either presents the characters of a punctured or lacerated wound, incisions proper being of at least very infrequent occurrence.

The vascularity of the parts provides for a very rapid repair of injury, but the frequent irritation the parts are subjected to in eating and drinking, operates, unless guarded against, to retard or modify the process. The comparatively loose texture of the mucous membrane and the connective tissue, with the abundance of fluid secretion, somewhat predisposes the region to diffused inflammatory action, and suppuration or œdema are not seldom concomitants of what otherwise would be considered very insignificant lesions.

The indications for *treatment*, therefore, are quite important, and must at all times receive due attention.

1. The region must be carefully inspected to observe if any foreign material is contained in the wound, if any of the cavities have been

perforated, and if the bones have otherwise received injury. All foreign material must be removed, and if the antrum is opened, it should be explored for any portion of the instrument inflicting the injury that is missing and cannot be accounted for.

2. Any bleeding vessels, if the hæmorrhage is active, must be secured, as will be shown later in this chapter.

3. Strips or shreds of membrane that are torn off and detached, if retaining the *smallest* attachment, must be carefully smoothed down in position, and retained there, if possible, by compress, or sutures if compresses cannot be employed. Union is so rapid, if it occurs at all, that sutures may be removed at the end of the second day, but care must be taken not to disturb the adhesions for at least four days; for this reason, in cases in which the surface is somewhat extensive, fluid food should be used, and some restraint put upon conversation. If some degree of union has not taken place in twenty-four hours, the part has probably become devitalized, and after an additional space of time may be removed as hopelessly lost.

4. Gargle the mouth with a solution of the tincture of *Hypericum*, in the proportion of ten drops to the ounce of water, at intervals of an hour, for from eight to ten hours, to be followed up after that time, at the same intervals, by a similar solution of *Calendula*. Should the parts assume evidences of inflammation, become puffy and shining, dry and hot, *Aconite* must be given in half-hour doses, and the sutures cut and removed if they appear to be exercising much tension. Should the parts appear puffy, and evidences of suppuration exist, the wound must be opened, and free exit afforded the pus. This is particularly important, as pus is liable to dissect up the tissues, burrowing for long distances, often pointing deep in the pharynx when originating in the palatine arch. The danger from such burrowing is two-fold; viz., great impediment to respiration, even inducing apnœa, and imperiling the life of the delicate and important bones in the neighborhood.

In cases which have unfortunately proceeded to suppuration, or in which the detached strips perish, the denuded bone must be covered as soon as possible. *Calendula*, topically and otherwise must be given, which will greatly hasten repair.

Bee Stings, from a bee concealed in honey, or otherwise finding entrance into the mouth, have inflicted injuries resulting in death. Very frequently great discomfort, and even danger to life will ensue, the tissues of the region being predisposed to diffuse inflammation with great swelling and œdema. Should the swelling be in the faucial region, or more particularly in or near the glottis, respiration may become so embarassed that tracheotomy may be called for. In by far the larger number of cases, however, the swelling is as short lived as it is severe, and the properly indicated remedy will soon bring about resolution, unless some constitutional vice interferes.

Apis, despite the isopathic character of the remedy, will usually answer every purpose.

Arsenic, may be employed if the effusion is extreme, and implicates a large surface, with the characteristic thirst and restlessness. Warm water relieves.

Cantharis has done me good service when the swelling is quite firm, the parts dry and hot, and cold water relieves.

A gargle of alcohol and water, or ammonia and water may be used when the indicated remedy is not at hand, but the action is not as prompt and radical.

LACERATION OF THE TONGUE.

The tongue is frequently lacerated by the teeth, either from spasms, as epilepsy, chorea, or tetanus, or a sudden and forcible closure of the jaws from a blow on the chin, fall on the feet from a height, or a sudden jar. The primary effect of such an accident, is great swelling and inflammation of the organ, pain on motion of the part, as in speaking, and salivation secondarily; in some cases, suppuration or even gangrene may be set up; but in the majority of instances, in those who are in good health, no future difficulty will be experienced. Should the wound be extensive enough, cicatrization may permanently impair freedom of function, either from the stiffness and immobility of the organ, or the contraction of adhesions to near structures.

Unless there is injury done to the blood vessels, the most extensive wounds, so that they do not extend beyond the margin or detach portions, heal readily, leave no secondary trouble, and present but few indications for treatment. Hæmmorrhage will be treated of later.

The indications are to subdue pain, prevent or modify inflammation, and promote repair. The first is usually met by the administration of *Hypericum*, both internally and topically. *Aconite*, or *Rhus*, will meet the second, together with warm applications. The last will demand *Calendula*, used either topically or internally, with perhaps a preferance for *Arnica*, if there is much bruising.

Some writers have spoken of cases in which tetanus has supervened, and that presented symptoms of an unusually alarming character, owing to the swelling of the tongue opposing an additional impediment to respiration. I have never seen such a case, but would certainly prefer *steam*, to any other remedy known to me.

WOUNDS OF ARTERIES

The vessels in the mouth, properly considered to belong to this region, are not numerous, and excepting under peculiar circumstances their wounding will not furnish hæmorrhage of an alarming character The ranine artery, which is a continuation of the lingual, and the different palatine branches, mostly derived from the internal maxillary, are the only vessels that may require ligation. The vessels are as follows: Ranine, ascending, descending, inferior or posterior palatine.

Ranine Artery.—This artery is a continuation of the lingual artery, which is the second branch given off by the external cartoid. The artery that takes the name of ranine is contained in the frænum of the tongue, and is really double; the two lingual arteries terminating in the ranine, and inosculating freely. The artery is occasionally injured by the teeth, but rarely; oftener the injury is from some foreign body. In exceptional cases the hæmorrhage may be so free, that the ligature will be called for. If the vessel is injured low down, or divided so that the cardiac end is retracted beyond reach, it may be necessary to tie the lingual. In some instances acupressure, or inclusion in a wire loop, will answer every purpose: indeed I much prefer this method in all cases when it can be employed, as we thereby avoid secondary trouble from cicatrization. In many cases merely applying styptics will answer every purpose; also, in some rare and anomalous cases, hæmorrhage may not be controlled until the external carotid itself is reached.

It must very rarely occur that other arterial twigs in this region will require ligation, or any mechanical measures to arrest bleeding; should the hæmorrhage be sufficiently free to call for such treatment, the almost completely inaccessible position of the vessels would forbid any attempt at individualization and ligation. In such cases, and care must be had that the diagnosis is accurate, the external carotid must be taken up. The line for incision to expose this vessel has been already given, as an extension upwards, to the desired extent, of the anterior border of the sterno-mastoid muscle.

BURNS AND SCALDS OF THE MOUTH.

Among the poorer classes, particularly, children not infrequently sustain serious scalds of the pharynx, from attempts to swallow boiling water. The accident is an exceedingly grave one, and not seldom results fatally. The immediate consequences are, as in the case of scalds elsewhere, dependent upon the degree of heat; the effects vary from simple mild inflammation, to extensive œdema, gangrene, sloughing, and possible atresia, if death is averted. Added to the dangerous symptoms that obtain in all cases of severe burns, the region including such important organs as the œsophagus and larynx renders the accident in this instance particularly alarming.

Inflammation, will necessarily be diffuse, and if twelve hours pass without untoward symptoms, no danger need be apprehended. The fact that children of the poorer classes, and living in confined space often in one room, are oftener the sufferers, there is a lowered vitality which predisposes them to severe secondary affections. In the absence of such complications, and in the case of those that are free from any dyscrasia or other morbid influence, *Urtica urens* will usually be the remedy. The most satisfactory method of adminstration, at least to most patients, is in the form of a gargle, ten drops of the tincture to an ounce of water. *Cantharis*, is to be preferred if the parts assume a dark color, are either very dry, or covered with small vesicles.

Gangrene may follow the inflammation, either from the extent of the lesion, or the condition of the sufferer. *Arsen.*, will be the remedy more frequently called for, particularly when the morbid action is rapid, the involved surface continuously affected (that is not in spots, and there is great prostration. *Lachesis* will be needed should the gangrene appear in spots, giving a mottled appearance of the part.

Œdema of the mucous surfaces generally, may be of sufficient extent to impede respiration, and thus become a dangerous condition. In those of a depraved bodily habit it may, also, be the precursor of erysipelas. The greatest danger to the sufferer, however, is when the glottis becomes invaded.

The impediment to respiration is great, and whilst expiration may be fairly effected, inspiration will be labored: dyspnœa gradually increases, and finally apnœa from toxæmia will come on. At this stage nothing but tracheotomy can be practised, and time must not be lost or wasted in waiting for the worst symptoms to declare themselves. As soon as the breathing becomes greatly embarrassed, and the treatment is evidently unable to arrest the extension of œdema, the time for operating has arrived.

Before resorting to tracheotomy, and afterwards as well, the following remedies will prove useful, and frequently curative. After the operation they will hasten a cure, and thus permit an earlier closure of the wound than could be possible without their aid:

Apis, in all uncomplicated cases, with moderate effusion, will be a prominent remedy.

Arsenicum, is to be administered when the œdema rapidly increases, there is great prostration, and a tendency to gangrene.

Rhus tox. would be thought of when the accompanying symptoms are of a typhoid character, the parts are dark colored, and somewhat vesicular.

Urtica urens will be useful in cases in which the œdema is more in the form of blisters, the blisters appearing almost transparent. As it will frequently be given in the commencement of the treatment, in cases of burns, it will usually avert any secondary œdema.

Cantharis will prove servicable when the parts are fiery red, dry, and hot. It is useless to scarify or puncture the parts, as the relief is very slight, and the irritation from the operation materially aggravates the condition. The only operative measure to be entertained is tracheotomy, which whilst held in reserve as a last resort, must not be too long delayed.

ATRESIA of the œsophagus has occurred in a few instances, and until recently was practically incurable. Rapid or gradual dilatation with bougies, as in the case of urethral stricture, alike failed, almost universally, at least afforded merely temporary relief. A case occurring in the practice of my friend PROF. HELMUTH, will at once be an excellent description of the nature of the accident, and an illustration of the proper treatment to be pursued. It is thus reported by DR. JOHN BUTLER, in his recent work on *Electro-Therapeutics*. "CASE LI

on Dec. 2, 1877, I was sent for by a friend, Dr. Helmuth, to see a young lady patient to whom he had just been called, and of whom he gave me the following history: On the twentieth of June, 1877, at Kingston, N. Y., the young lady swallowed a teaspoonful of nitric acid and kreasote, a mixture which is popularly known as "Palmer's Vegetable(!) Compound," in mistake for essence of Jamaica Ginger. After the acute symptoms resulting had subsided, she discovered considerable difficulty in swallowing; a certain amount of liquid would apparently be swallowed and almost immediately return, to be ejected either through the mouth or through the nose; there was total inability to swallow anything solid. The case progressed so that finally there was no evidence that any thing whatever passed into the stomach. The girl of course, became emaciated, and at the time of my visit was exceedingly prostrated, could hardly sit up, and could make no attempt to walk without assistance. She subsisted entirely upon injections per rectum since the time of the accident."

"On an examination of the œsophagus I found that even the smallest sized bougie could not be inserted through the stricture, which was situated about four inches above the cardiac orifice of the stomach. Above this point the œsophagus was much dilated and pouched. Dr. Helmuth had tried the ordinary rubber bougie, so had the other physicians who had attended her during her sickness. * * * * * * * Being urged by Dr. Helmuth to undertake the case, and try what electrolysis would do, I reluctantly consented. I used an instrument made with a long insulated stem, having a naked metallic bulb on the tip about the size of a pea; this I introduced through the œsophagus down to the stricture, connected it with the negative pole of the *Stohrer* battery, forming a circuit by a large sponge rheophore on the pit of the stomach. I allowed a current of about ten volts to flow and after a while the instrument made its way through the obstructed part. About an inch below this I met another resistance; this one was band-like and elastic to the touch, and after a moment or two, yielded to the action of the current. Almost immediately below this I encountered another stoppage, this resisted the action of the current for about fifteen minutes (twenty volts), but finally the electrode passed into the stomach. * * * * The stricture not being entirely removed" (after four sittings), "I operated as before mentioned on the thirtieth, making in all five electrial applications. After this the patient progressed favorable, and now suffered no inconvenience whatever. In order to prevent a tendency to recurrence, I provided the patient with a full sized bougie, which she introduces herself occasionally. At my first visit her weight was sixty-five pounds. On February, 1st she weighed one hundred and thirty, and is as far as is possible to judge, entirely free from any of the original trouble."

XX. INJURIES OF THE THROAT AND NECK.

The throat and neck, containing many of the most important organs in the body, and being the seat of injury so frequently for homicidal or suicidal purposes, has always formed a chapter in surgery of the deepest interest, and of equal importance to the surgeon, the physician, and the medical jourist. The important nerve trunks, the large blood-vessels, the peculiar and unique character of the secondary phenomena often observed the relation sustained to respiration, and alimentation, not forgetting the important spinal region, renders injuries in this part particularly startling to young practitioners, and cannot fail to cause those of experience some concern. For these and other reasons that might be mentioned, we will consider our topic with some degree of system and thoroughness.

It will first be necessary to speak of foreign bodies, both in the œsophagus and air passages; next in order; wounds of the neck, posterior and lateral; cut-throat; wounds of arteries; wounds of veins; wounds of nerves; injuries to larynx; trachea; os hyoides, and œsophagus.

I. FOREIGN BODIES IN THE THROAT.

Whilst not of frequent occurrance, the arrest of foreign bodies in the fauces or œsophagus is an accident of such a serious nature, the symptoms are of such an urgent character, that a notice of the more salient features must claim the attention of all students of surgery. In a work of this general character it will be impossible to devote as much space to the topic as its importance really merits, and those who desire a more systematic study are referred to the recent work by POULET, on *Foreign Bodies in Surgical Practice* from which many of the observations in this chapter are drawn.

Upon being called to a case suffering from the arrest of a foreign body in the alimentary canal, it is of the first importance to ascertain the character of the foreign material, the treatment and prognosis having a direct relation thereto. All material may be classed under one of two heads, viz., alimentary, and non-alimentary. Under natural circumstances food cannot be arrested in the canal unless one of two states of fact exist; either some unusual character or condition of the food or some abnormal condition, of the fauces or œsophagus. We therefore find that the causes are of two kinds, exciting and predisposing.

Exciting causes may be the size of the bolus of food; a globular form; it may be of adhesive properties, as some kinds of candy; or furnished with sharp points, as a fish-bone.

Predisposing causes, are all such conditions as are either natural or acquired, which offer any impediment to the passage of food that presents some unusual qualities, or that are the result of changes due to age. Thus the œsophagus itself presents a predisposition to the arrest of food in its form, having three marked constrictions; one at a level of the cricoid cartilage, one at the diaphram, and one at the cardiac orifice of the stomach. The most important of these is the first, the tube being prevented by the vertebræ on one side, and the cartilages on the other from dilatation in that direction. A soft compressible body, of much size may pass this point, by distension taking place laterally; but a hard spherical body, while capable of passing along the rest of the tube, will here be arrested. Another predisposition will be found in the loss of teeth in the aged, or their non-appearance in the young, thus preventing proper preparation by mastication; a vicious habit of "bolting" the food is a frequent predisposing cause. Pathological changes, also, play an important part. Thus paralysis of the muscles or parts concerned in deglutition, tumors or abcesses of the pharynx, or spasmodic irritability of the pharynx causing constriction of the œsophagus.

Nearly the same considerations apply to the impaction of substances non-alimentary. They are usually introduced accidentally, as swallowing false teeth during sleep, boastingly as for a wager; or in the "way of business," as in the case of jugglers.

The *results* depend greatly upon the character of the foreign body, and the point of lodgement. In either case they may be considered under two heads, *immediate* and *remote*. Should the foreign body be of large size, and arrested in the upper part of the canal, at the first constriction (which is the point of election), then there will be the usual symptoms of choking, to be noticed further on, and unless relief is speedily obtained death will follow. But, however, should the body be smaller, and arrested in the canal from any sharp point being pushed into the tissues, or engaged from one diameter being greater than the other, as would occur when a flat body like a coin is swallowed, the whole canal not being filled up, the primary symptoms are either very unimportant, or may be totally wanting. There may be some dysphagia, but little if any pain except during attempts at deglutition. The immediate consequences will be first some irritation of the parts, then inflammation, followed by gradually increasing dysphagia, from the swelling of the mucus membrane around the foreign body, and spasmodic contractions of the muscular fibres due to reflex irritation.

The *remote* consequences are destructive changes in the tissues, chiefly ulceration, when the offending material is of the character noted above, whereby blood vessels are sometimes opened, and death results from hæmorrhage. At other times suppuration will set up, the offending material become loosened, and either drop into the stomach, or be arrested at some other point of constriction; in some rare instances the body will be ejected. The danger of ulceration

does not consist alone in perforation of blood vessels; it may open the larynx or other portion of the air passages, the foreign body may pass into the canal, and the case much complicated and aggravated thereby. Should the body be a bolus of food, or some soft but large substance, and its removal has been affected, the remote consequences are trivial, rarely extending beyond a longer or shorter period of irritability and painfulness of the throat, usually only experienced when swallowing.

The *symptoms* produced by a foreign body in the œsophagus, in the upper portion particularly, vary with the nature of the substance. When similar to a coin in form, or when it does not completely fill the canal, there is a natural sensation of "a lump in the throat," and the irritation induced by its presence produces a sensation as if the lump were continually growing larger. There will be an aching, and constant inclination to swallow notwithstandiug the effort causes pain. If the body is not removed, from reflex irritation the breathing will become embarrassed, and in persons of a sensative nervous temperament, convulsions may ensue.

Should the foreign body be sharp, and engaged in the walls of the canal, as a fish-bone, needle or other pointed substance, the pain is usually quite acute, much aggravated by swallowing, which is rendered more necessary than usual from the great salivation, and secretion of mucous in the pharynx. The sputa will be more or less tinged with blood, and the symptoms will gradually assume the characters noted above.

POULET (*loc cit.* I. p. 75) says: " * * * we find that a goodly number of cases present no primary or immediate symptoms. However, these bodies lose their indolence after a given time, and manifest their presence by symptoms which are sometimes of extreme gravity. Almost all the cases of death from hæmorrhage belong to this group. The individuals experienced no malaise after the introduction of the body; they no longer thought of the accident, losing even all remembrance of it, until the time at which the severe symptoms develop. Some examples will throw this fact more in relief."

"*Observation.*—Begin (Recueil de Memoire de Medicine Millitaire. t. 20) reports that a corporal had swallowed a six franc piece, as he had frequently done in bravado. He experienced no inconvenience during the next few days, and thought no more of the coin, which had been lodged at the height of bifurcation of the bronchi, as was rendered evident at a later period. Upon the fourteenth day the man had an abundant hæmorrhage, the blood being semi-fluid. Upon the following day he had a fresh one of four or five pounds, which resulted fatally. At the autopsy the coin was found on edge between two erosions, which communicated with the aorta."

At other times small objects are caught from spasmodic contraction of the muscular walls; in some instances the spasms become general and there are reported cases of tetanus in a violent form, coming on

from the lodgment of a piece of bone, or some small hard substance in the œsophagus.

From large substances, which fill the canal and distend it, the symptoms are somewhat different. Prominent is *suffocation*. In the majority of cases, when the accident occurs while eating, the sufferer will jump from the table, walk up and down excitedly, and call attention to his sufferings more by motions than words; speech is either lost entirely, or much impeded, the voice having a high pitched tone. The face becomes swollen and dark, the eyes protrude, and the countenance expresses the greatest agitation and alarm. In fact the symptoms are those of apnœa in a marked degree. The arrest of breathing is not due to compression of the air passages, as the foreign body when lodged at the first point of constriction, cannot compress the cartilages, from their resisting structure, at least to a degree sufficient to cause embarrassed breathing. It is due to reflex irritation, spasmodic action in the muscles concerned in respiration.

Pain is not a common symptom, at least primarily, unless the foreign body is hard, large, and surface rough. Occasionally pain is felt in the muscles of the neck, a tensive aching, not very acute.

Vomiting, should it occur, will usually dissipate the whole trouble by expelling the foreign body. There will at all times, be an attempt at vomiting, and this very greatly intensifies the symptoms of apnœa, as the glottis is firmly closed at such times.



FIG. 30. Throat forceps.

Should the foreign body be expelled, there will be an immediate subsidence of the graver symptoms, but full recovery will depend upon the duration of the suffocative symptoms; if they have extended over three minutes, some of the methods noted under *apnœa* must be instituted to re-establish respiration.

Treatment.—Having established the diagnosis, the first step is to remove the offending body. If situated below the first point of constriction, it will usually be found at the level of the diaphragm; if soluble, or the substance is alimentary, it may be pushed down into the stomach by a long gutta percha or whale bone bougie. When situated above this point, it may be pushed down, or an attempt made at extraction, depending upon circumstances. When above the level of the cricoid cartilage, or engaged in that portion of the canal, it must always be extracted.

Extraction may be effected in various ways. When the body can be seen, as when high up in the fauces, any instrument that can reach it,

as forceps or tenaculum may be used. When a little lower than this, a proper pair of forceps, like those in fig. 30, may be employed. They should be warmed by dipping them in hot water, not oiled, and passed backwards by a rapid motion. When the obstruction is reached, it must be firmly grasped, and withdrawn by a slight rotary or oscillating motion. The fact that the obstruction has been reached can be usually told by the sensations of the patient; if the tissues of the neighborhood are seized by the forceps or hook, there will be an expression of pain. If the patient is already asphyxiated, in many cases the foreign body can be seen by the aid of a head-band mirror, such as is used with the laryngoscope, and reflected light.

Should the body be found so firmly impacted that it cannot be withdrawn, or from any reason its extraction by the ordinary methods is impossible, there is nothing left but to perform œsophagotomy, an exceedingly grave operation, and one that should not be lightly attempted (*Vide Surgical Operations.*) It has occurred that the asphyxia becomes so profound that death would ensue before the œsophagus could be opened, if some means were not taken to re-establish respiration. In such instances tracheotomy must be performed as a preliminary. This operation is less difficult than that for œsophagotomy, but is far more so than is popularly taught. (*Vide Ibid.*)

After extraction by the ordinary methods, or the foreign body has been pushed down into the stomach, *Arnica*, should be given, in doses at hourly intervals, for at least ten hours, not interfering with sleep, however, which is quite commonly desired. When an operation has been performed, the wound claims first attention, and is to be treated upon the principles laid down in an earlier chapter. It can scarcely need reminding, that if the difficulty has occurred from the existance of any pathological state, as paralysis, tumors, abscess, etc., the condition must be removed, if possible, or its existance being recognized, suitable precaution used in the future to avoid a recurrence of the accident.

FOREIGN BODIES IN THE AIR PASSAGES.

We have seen that the entrance of foreign bodies into the œsophagus is an accident of exceeding gravity; a similar accident to the air passages is even of greater magnitude, not only in immediate effects, but in remote consequences. It will be borne in mind that everything except atmospheric air, and perhaps some bronchial or laryngeal secretion, may be considered foreign to this region; hence an apparently natural division of the subject would be into solid, fluid, and gasseous foreign substances. As the effect of the entrance of irrespirable gases should more properly be considered elsewhere, it will only be necessary, at this time, to consider solid and fluid foreign bodies.

Fluids that are under some circumstances admitted into the air passages, are usually either water, blood, pus, the contents of the stomach when vomiting, various medicinal substances, and morbid products from the lungs or associated parts. The symptoms produced from

the introduction of these substances vary with the nature of the substance, its quantity, and its method of introduction, whether through the mouth, or other channels. Under the first head we would include all such agents as water, medicines, or even the vomited matter from the stomach; under the latter, blood, from wounds in the respiratory tract, tubercles from the lungs, or the discharges from an abscess opening somewhere below the glottis. When introduced from without, the method of introduction is readily explained. A little physiological inquiry, will show that the act of deglutition is a complex one, although purely automatic or involuntary. The moment any substance introduced into the mouth reaches the base of the tongue, the larynx is drawn up under the base, the epiglottis being firmly closed. This effectually closes all entrance into the air passage, and leaves a clear route into the œsophagus. The act being accomplished, respiration is again carried on as usual. Unless an especial effort is made, with proper preparation, it will be impossible to suspend respiration for more than a minute, or even a shorter time, hence the act of deglutition must be brief enough to avoid any prolonged suspension of breathing. When, therefore, fluid is introduced into the mouth in large quantities, and the flow is continued for an unusual time, there will be an involuntary attempt at respiration, when the fluid rushes into the larynx. Coughing, sneezing, or any other functional act which is a simple violent expiration of air, opens the glottis widely; if fluid is taken into the mouth, accidently, at such times, the inspiration which immediately succeeds inevitably draws some of it into the windpipe. The same thing occurs from sudden fright. In vomiting, also, the glottis is pushed upwards and forwards, as in the case of deglutition, remaining closed as long as the individual can endure it; should the quantity of vomit be large, and the effort prolonged, there must be an involuntary attempt at breathing, which at once admits a portion into the air channels.

Another point must not be lost sight of; when fluid is imbibed in proper quantities, and in proper position of the body, the stream divides at the base of the tongue, and flows down each side of the œsophagus. Should the quantity be too great it cannot be swallowed at once, but a portion must remain in the mouth, requiring a gulping attempt at swallowing, until the proper proportion has been restored. This condition predisposes to prolonged arrest of breathing, and the epiglottis is spasmodically raised.

Foreign substances of a fluid character are admitted to the air-passages from within, as has been intimated, chiefly from pathological conditions, or traumatism. Wounds of the larynx or trachea, whether accidental or designed in surgical operations, frequently admit blood. Abscess, either within the passages, or in the immediate neighborhood, may open in them, and suffocate the patient; this has occurred quite frequently. The formation of vomica in the lungs, the rupture of pulmonary vessels, or the wounding of the pulmonary artery, or

large venous trunks, may all pour out fluid in such quantities that breathing is impossible.

Other morbid processes, not confined to or even implicating the respiratory tract, may be considered in the light of predisposing conditions. Thus paresis will notably assume the condition of a predisposing cause, by withdrawing from the respiratory apparatus the protection designed for it in the glosso-pharyngeal tract Partial apnœa, syncope, or incomplete anæsthesia induce similar conditions, and hence the etiology, when properly considered, readily assumes the character of a majority of surgical operations and accidents, and may be arranged under the customary heads of exciting and predisposing.

The *symptoms* are dependent upon the character of the agent, the quantity of the fluid, and the bodily condition of the patient. Other things being equal, the irritation and the violence of the symptoms will be far greater when ammonia or some equally pungent fluid is introduced, than from water. They will all be similar in kind, however, the differences being in degree, as far as the primary effects are concerned. Should the agent be of a character that would induce cauterizing effects, promote ulceration, or a high grade of inflammation, the remote consequences may be serious, ranging from aphonia or chronic bronchitis or laryngitis, to stenosis or atresia of the passage.

The *primary symptoms* are well understood by all, and will be recognized at once. Violent cough, sometimes inducing vomiting; feeling of suffocation, with difficult inspiration; a wheezing sound, or a shrill whoop on drawing in the breath, and a sense of constriction in the chest and pulmonary tract generally. When the quantity is small, and not of a particularly irritating character, the bodily health being unimpaired, in a short time the foreign material is expelled, and apart from a feeling of fatigue in the faucial region, and a little irritability of the glottis and larynx, all the symptoms will rapidly disappear. Should the individual be debilitated from illness the effects will be more serious, and death may even ensue from the violent spasmodic action of the respiratory tract.

The *termination* may be in expulsion, absorption, inflammatory affections, or death.

Expulsion is the more common termination, and may be said to always occur when the fluid is not in large quantities, of a very irritating character, or there is a continuous flow; as in the case of submersion in the water.

Absorption, as has been shown in the chapter on *Asphyxia*, is quite possible, and probably always occurs when the lungs are filled with water, and the patient is seen before life is extinct, and upon being removed from the active cause, as taken out of the water.

Inflammatory affections, as pneumonia, bronchitis, laryngitis, etc., will be developed from irritating substances, or when those who are debilitated are the sufferers, the effort at coughing being more or less

responsible. The duration of an inflammatory attack, as well as its intensity and termination (in resolution or suppuration), will depend greatly upon the health of the individual and the nature of the foreign material.

Death will ensue should the quantity of fluid be so great, and its flow so continuous that respiration is entirely suspended for the space of two minutes or longer. Also in persons of very feeble body, or when the agent is very destructive to the tissues, as some of the stronger acids or alkalies. Secondarily death may be due to the violence of the secondary phenomena, as in pneumonia, etc., or the formation of abscess or ulceration in the air passages.

TREATMENT.—The treatment is both prophylactic and curative. The former is an indication when such conditions as paralysis, tumors, etc., predispose to the entrance of foreign bodies, and in the large majority of instances can not need consideration, as the occurrance is purely accidental, and may never occur again.

Curative treatment consists in the expulsion of the foreign elements, and prevention or modification of secondary phenomena. Usually the unaided efforts of nature will dispose of the foreign body, throwing it off by coughing. Should it prove ineffectual, the patient should lie down on the face, with the head hanging over the edge of the bed, which allows the tongue to fall forward, the epiglottis to rise, and assists the expulsion of the fluid by gravity. Should apnœa have occurred, the treatment must be as laid down under the appropiate head. *Sulphur*, will materially hasten the subsidance of the irritation that remains for some time after the offending material is removed.

Subsequent conditions and symptoms must be treated, as they arise, on general principles, and need no specification at this place. It must be observed, however, that chemical agents must be antidoted; thus an acid should call for an alkali, and an alkali an acid, but the effects will be limited to parts with which the antidote enters into relations. Thus, if an acid, as vinegar, is given to antidote the effects of a caustic alkali, it will exhaust its properties on the tissues outside of the air passages, which have been brought into contact with the alkali; it cannot be introduced within the glottis. The treatment of the conditions within the air passages, must be "constitutional," and when the agent has been introduced in a concentrated form, or in large quantities, the prognosis must always be exceedingly unfavorable.

SOLID BODIES IN THE AIR PASSAGES.

To a limited extent, what has been said of fluid foreign material, might be repeated in the present instance; yet there are so many points of difference that a separate article is necessary.

The foreign material finds entrance into the air passages either through the glottis and larynx, or by traumatism through the chest-walls, of course the former is the more common method, and as

injuries to the external throat and chest will be considered in proper places, we shall only treat, at this time, of foreign substances entering the air passages through the mouth. The greater number of cases occur in childhood, and again in old age. In the first instance it is due to an almost universal childish habit of putting articles in the mouth, in play, and forgetting their presence owing to the "restlessness of their ideas." In old age we have a number of factors, as senile atony of the glottis and larynx, rendering the parts more tolerant of such irritation; incomplete mastication from loss of teeth; or from the paralytic affections, or general loss of sensibility in those of advanced years. The fault, in brief, is in the act of deglutition, some imperfectness either constant or transitory, habitual or accidental.

Among other causes, rapid eating, and attempting to masticate a large mouthfull, by the interference with respiration, greatly predisposes to entrance of particles of the food into the larynx. Sometimes this occurs in a somewhat peculiar manner, and in obedience to physiological law. A portion of food, for instance, is thrown into the posterior nares; a vigorous nasal inhalation, almost involuntarily made, drives the intruder out, and directly into the larynx in many instances.

Pathological conditions, as already intimated, play a very important part in directing foreign material into these channels. In addition to those noticed elsewhere, we may note the glosso-pharyngeal paralysis that so frequently succeeds diphtheria, as well as some other morbid processes in the region. The effects of syphilis, mercurialism, scorbutis, and others, in ulcerative or necrotic action, which may not only deprive the air passages from some natural protection, but even furnish foreign material from portions that become detached and drop into the glottis. Cases have occurred in which cicatricial contractions alter the form of the epiglottis, or cause it to adhere to near parts so that it cannot perform its function. POULET (*loc cit* p. 17) gives one or two cases of interest in this connection.

"Campbell saw a boarder at Sainte-Perrine who died almost immediately after the introduction of a piece of meat into the larynx. At the autopsy it was found that the epiglottis was adherent to the base of the tongue, and that the upper orifice was entirely closed by a piece of boiled beef, which was an inch long, and weighed 8—9 grains. The epiglottis did not by any means have the usual dimensions. The opening could not be covered except by stretching the base of the tongue beyond measure. The accident was due to this retraction or atrophy of the median glosso-epiglottic ligament.. (Arch. generales de Med., 4e serie, t. VII)."

From a comparison of the symptoms noted in the published reports, and an exceedingly limited personal experience, it would appear that the location of the foreign body, its size, and fixidity or mobility very greatly modifies the symptoms, and determines the result. Thus a large body, lodged in the rima glottis, will produce speedy death, with

the most pronounced symptoms of apnœa. A smaller body, not lodged, will be carried upwards and downwards in the trachea with the current of air, and induce coughing, more or less incessant, which may throw it into the glottis, and cause death as in the first instance. Should the body be of any density, as a piece of metal, it will gradually sink lower and lower in the passages, and finally lodge in the bronchia. Even when the body is freely movable, and passes up and down in the trachea, as above, the irritation will rapidly develop into inflammation, and if it is not expelled will become arrested at some point, which will give rise to a variety of secondary phenomena. Unless there is some notable loss of sensibility in the parts, there must always be much irritation developed by the smallest particle of foreign material in these sensitive parts; there are cases, however, which there is wonderful tolerance, so much so that large rough substances are introduced into the trachea and remain there for days without producing any symptoms whatever.

Should the patient survive the introduction of foreign material for some one or two days, and the primary symptoms gradually pass away, a secondary group will appear, which may demand unusual skill and acuteness to interpret, particularly if the primary irritation was so slight that the accident has been partially forgotten. These symptoms, as a matter of course, depend upon the position of the foreign body, whether in the larynx, the trachea, bronchia, or the smaller ramifications of the air tubes. Usually, when the point of lodgment is anywhere above the bifurcation of the bronchia, the symptoms are those of inflammation, which results either in the encystment of the foreign body, or its detachment by the exudation, which may cause its expulsion, or permit it to drop lower, either to find a new attachment or set up symptoms peculiar to the region. When in the upper part of the canal, cough is at all times a prominent symptom, which will be dry at first, soon followed by more or less expectoration, depending for quantity and quality upon the degree of inflammation and amount of exudation. It may be simply mucus in small quantities, purulent, or bloody, depending upon these circumstances. When ulceration is set up the sputa will become purulent, more or less streaked with blood. Should blood vessels of any size be opened, the hæmorrhage will be of corresponding magnitude.

The foreign body lodging in the bronchia, in the majority of instances, will cause paroxysms of pain, at uncertain intervals, usually capable of definite location; there will be danger of pneumonia, which having a material origin will rarely subside without suppuration. In the case of vigorous persons, the foreign body will become dislodged and expelled, by the suppuration. In those of feeble habit, suppuration being once established will frequently continue until life is lost.

There are cases on record in which foreign bodies have remained in the bronchia, or even the lungs, for a long time, months and years

with very little disturbance of health, apart from an occasional attack of hæmoptysis. This is so far from being the rule, however, that the presence of a foreign body, in the air passages, must always be looked upon as an exceedingly dangerous condition, one that is a constant menace of death. As in the case of impacted bodies in the œsophagus, there is great danger of serious arterial hæmorrhage from erosion; cases in which the large vessels, as the innominate, have been opened, with necessarily fatal results, are not at all uncommon.

TREATMENT.—Treatment must be both prophylactic and curative. The former when conditions exist that peculiarly favor the admission of foreign bodies, such as paralysis, tumors, and the like.

Curative treatment consists in the extraction of the foreign body, and the cure of secondary phenomena that may arise. I think, as far as the resources of art are concerned, a foreign body is rarely if ever removed when lodged below the bifurcation of the bronchia. Should it appear that lodgment has occurred in the rima-glottis, it may be removed with forceps, if attempted sufficiently early; death is very rapid, under these circumstances, and unless the surgeon is at hand at the moment the accident occurs, treatment will be unavailing. The absence of any muscular contraction in the air passages, renders it possible to secure expulsion of the foreign body by inverting the patient or at all events allowing the head and thorax to hang over the edge of the bed. Coughing is natures cure, and in the majority of instances will prove perfectly effectual. The patient must be encouraged to assist this expulsive effort as much as possible, and steps should be taken to promote or increase it should it be weak or insufficient.

Failing in these simple and natural means, the only resort is in tracheotomy, which should not be performed unless the symptoms are severe, or the nature of the foreign body such that life will be placed in danger. The description of the operation must be defered to its appropriate place (*Surgical operations*), inasmuch as it cannot, in any sense, be considered a minor operation. The object is not so much to gain room to reach aud remove the foreign body by instrumental aid, as to furnish a ready outlet for it. The irritation the trachea and larynx are subjected to when foreign material is introduced, has the effect to induce spasmodic action of the epiglottis, and faucial muscles concerned in respiration, so that the approach of the foreign body to the glottis firmly closes the outlet. It frequently occurs, particularly when the body is small, and not of such a character as to become attached to the lining membrane of the trachea, that on the completion of the incision, the offending substance is immediately thrown out. Should this not occur, it may be removed with forceps, if not too low down, or will be brought to the opening sooner or later, whence it may be removed.

The operation is also to be performed when the foreign body is

lodged in the glottis, and cannot be removed, life still existing. Respiration is thereby re-established, and time secured to remove the obstacle.

After an operation, the wound is to be treated as an ordinary one taking care that it heals from the bottom, otherwise an ærial fistula may form.

After the removal of the foreign body by other means, the treatment is simply directed to the prevention or lessening of inflammation. Usually a few doses of *Arnica* will be all sufficient.

WOUNDS OF THE NECK.

Wounds of the neck are usually incised or punctured, and derive their principle interest from the anatomical construction of the region, including so many large and important vessels and nerves, and from the fact that the majority of such injuries are the result of homicidal or suicidal attempts. For purposes of description and systematic arrangement, it is convenient to treat this topic under three heads, *viz:* Wounds of the posterior, lateral, and anterior region; the last with particular reference to medico-legal questions, might more properly form the subject of a separate article on cut-throat. In practice such an arbitrary classification will be useless, it is only adapted to facilitate the study of this class of injuries.

WOUNDS OF THE POSTERIOR REGION of the neck are, as compared to those in other regions, infrequent and unimportant. They are mostly the result of accident, and are seldom productive of serious consequences, particularly of a lasting character. If we include under this head, wounds which extend into the vertebral canal, we will find the topic almost inexhaustible; inasmuch, however, as spinal lesions are reserved for a separate chapter we will confine our study to lesions of the soft parts down to the vertebræ.

It was supposed in former times that some impairment of nerve action followed deep wounds of the back of the neck, and old military surgeons had much to say about priapism, and other evidences of nervous irritation, following sabre wounds in this region. There is little question that where a wound is sufficiently extensive to involve the cord, its membranes, or the roots of the spinal nerves, the consequences may be fatal, or at least of a very grave character. Nevertheless there are numbers of cases on record in which the vertebral canal has been opened, the escape of cerebro-spinal fluid rendering a diagnosis reliable, and yet life and function has been preserved. On the other hand concussion of the spine, or even of the brain, may be caused by a blow on the back of the neck with a blunt instrument, such as a dull sword, and without careful examination of the wound injury to the cord may be suspected. In the majority of instances, however, there will be only the wound itself to consider, injury to vessels, particularly the vertebral artery, or serious lesion of the muscles. The support of the head depending so greatly upon the muscles in the neck, their division will cause falling of the head forward,

which by separating still farther the retracted fragments of the muscles may result in permanent deformity.

The *treatment* therefore is not difficult to lay down, the indications being self evident. Thus if there is hæmorrhage, it is to be arrested according to instructions to be given later: if there is nerve lesion, the parts must be placed in a favorable position for union; finally wounded muscles and parts are to be drawn together as accurately as possible, and a position of the head secured that will give the minimum of tension on the sutures. The head must incline backwards, fixed in position by sand-bags, bags of shot, or some apparatus, and the stitches in the wound reinforced by strips of strong plaster. By shaving the head, the plaster may be applied in such a manner that they will aid in keeping the head in proper position, perhaps with suitable bandaging suffice without other apparatus or keeping the patient in bed. After union has well advanced, it will be judicious to keep the dressings applied for an indefinite time, at least until there is absolute certainty that the deeper parts are united, and that the scar is sufficiently mature to resist traction by drooping of the head.

WOUNDS OF SIDES OF THE NECK, are nearly always homicidal, rarely are they self inflicted, and still more rarely, for some reason, are they accidental. When superficial, or involving only the more superficial muscles, the consequences are not grave, and the consideration of treatment is as in posterior wounds. From the nature of the part, the important vessels and nerves in the region, and the thoracic duct on the left side, deep wounds, particularly when punctured, are very serious. In some cases the weapon has entered the upper part of the cavity of the chest, and wounded the lung. In such cases pneumonia emphysema, usually ensue, but if hæmorrhage was not excessive, recovery has been the rule.

WOUNDS OF THE FRONT OF THE NECK, commonly spoken of as "cut-throat," are the commoner injuries in the neck; they are very largely self-inflicted, and their study is at once interesting and profitable. At this time, however, attention will be given more particularly to cut-throat as it involves muscular and nervous structures, incidentally referring to lesions of blood-vessels, nerves, air, and food passages, as many of these accidents will form subjects for separate articles.

When it is remembered that the vessels situated in this part of the neck are of the first size and consequence, that they are not protected by bony structures, and the nerves are of the first importance, it might be a subject of wonder that any recover from large wounds in this region. The facts are, however, that the ratio of mortality is very low, and an explanation is not difficult to find. In the first place most of these wounds are self-inflicted with suicidal intent. The head is usually thrown back, and the wound made high up, almost naturally following the line of the body of the lower jaw; this makes the line of the wound almost parallel to the large vessels and nerves, unless the incision is very deep. It is possible, however, as has been abundantly

shown, that the windpipe and œsophagus can be completely severed and even the vertebræ cut into without touching the large vessels and nerves. Such a case is exceptional, but possible. Another explanation is found in the character of the tissues cut through, or through which the knife must pass to endanger the vessels. The parts are at once elastic and yielding, often being carried inward before the knife without being divided. Then the irritation of the steel induces a tension and contraction of the sterno-mastoids, which presses the vessels lying under them farther back. Finally, as MR. HILTON has shown, (*Anatom. lect.*) "when the windpipe is opened below the glottis, air immediately escapes from the lungs; consequently the chest muscles which act upon the upper extremity lose to a certain extent their support, and the arm falls. Thus, the would-be suicide, if he have the desire, may be deprived of the ability to carry the attempt further." (HOLMES *Syst. of Surg.* II, 441.) Joined to these, there is probably some failure of purpose from the resistance opposed by the tracheal or laryngeal cartilages. There are many reasons, therefore, why wounding of the large vessels may not occur in suicidal attempts.

The wound being accidental or homicidal, there is no such immunity promised. Surgically, in such cases, where the carotids or jugulars, or the accompanying nerves are severed, there is little practical interest, as death occurs very speedily, sometimes in a very few moments, again almost immediately. The consequences and immediate symptoms of these wounds depends, of course, upon their extent, and structures implicated. DURHAM, (HOLMES, *Syst. of Surg.* II) arranges these consequences under twelve heads, and I can do no better than to follow his arrangement.

Hæmorrhage is of the first consequence, whether arterial or venous. When a vessel as large as the common carotid or deep jugular is wounded, unless the surgeon happen to be on the spot, death is almost inevitable, nevertheless there are a few instances of the common carotid having been perforated, and death delaying for some days. Smaller vessels, as the internal or external carotid, the superficial jugulars, or the thyroid arteries may be wounded, and whilst the hæmorrhage is fearful, if the bystanders have sufficient knowledge and presence of mind, life may be preserved.

Asphyxia may be speedily produced by blood flowing into the larynx or trachea, or a coagula may be caught in the larynx.

Air may enter a wounded vein, particularly when the injury is low down in the neck, and characteristic symptoms be produced. As has been shown by many surgeons recently, this accident is far more likely to occur when the wound is *dry* than when blood is flowing. There being plenty of hæmorrhage in these accidents it is a matter of some doubt if air in the veins is a very frequent occurrence. It is not at all necessary that the wound in the vein should be low down in the neck, although the accident is more to be dreaded in such cases; wounds high up, even as high as the hyoid bone, have been the means of admitting air through comparatively small veins.

Suffocation may ensue from some alteration in the air passages from the wound, such as division of the tongue. The divided portion of the tongue may fall back into the glottis; the epiglottis itself, portions of the cartilages, arytenoid folds, or cartilages generally from the larynx, may be partially divided so that the free portions fall into the air passages. The trachea may be divided, the upper portion drawn up by the elevators, and the lower portion downwards by the depressors; the gap further increased by the "plunging downwards" of the lower portion in respiration, and other structures falling into the gap stop the breathing. In one case the œsophagus projected forwards between the cut ends of the trachea.

Emphysema, either from a want of correspondence between the wound in the air passages and the skin, particularly in punctured wounds. The emphysema may be external, extending generally over the body, or internal, of the mucous membrane, when suffocation would occur as in œdema of the glottis.

Aphonia, partial or complete, may occur in many ways. The vocal cords themselves may be injured; the larynx or trachea may be opened below the cords, and expiration occurring though the gap speech is impossible; the laryngeal or other nerves may be injured, and speech lost. When the cords are injured, or the nerves destroyed, the aphonia will be only temporary, unless cicatrization modifies the passages later.

Dysphagia is a common symptom, often from wounding of the œsophagus, and occasionally from nerve lesions, or inflammation secondary upon the wound. The appearance of food or drink taken into the mouth in the external wound, will usually indicate an opening in the œsophagus, but such a conclusion must not be hastily reached; the wound must be very carefully inspected, and if no lesion of the œsophagus is discoverable, the presumption is that nerve lesions are at the bottom of the trouble, whereby the glottis is not properly closed in deglutition. The appearance of food in the wound under these circumstances is always an ominous circumstance.

Inflammation, together with the various modifications of that process, will very likely have an important influence on speech, deglutition and respiration, depending upon the parts chiefly affected.

Suppuration, a natural consequence either of the wound or the resulting inflammation may become a serious menace to life; if the pus cannot find exit through the external wound it may burrow in the loose connective tissue of the parts, or find its way into the air passages inducing suffocation.

Bronchitis, broncho-pneumonia, and other pulmonary affections frequently follow, either from the entrance of foreign material through the air passages, nerve lesions, the extension of inflammation from the wound, or the admission of unwarmed or unmoistened air. The complication is very frequent, and MR. DURHAM (*loc. cit.*) states "in eight out of ten fatal cases of cut-throat, recently treated in Guys hospital, in which the more immediate effects of the injury had been survived, death was due to these affections.

Constriction, or various irregularities in the air passages, may be caused by cicatrization. The well known tendency of scars to contract renders this accident one of some considerable moment, and of increasing importance with the lapse of time.

Fistulæ into the œsophagus, or communicating with the outer air, may occur when portions of the air tube have been cut out. The occurrence seems to be very rare. DURHAM (*loc. cit.*) quotes the following case: "Dr. Gairdner narrates the case of a man who cut his throat with a razor, dividing the larynx at the upper part of the cricoid cartilage, and the œsophagus also. The cut extremities receded from each other to the distance of at least three inches. Attempts were made to unite the divided larynx by means of sutures, and to pass a gum elastic from the nostril into the œsophagus, but without success. Ultimately the man recovered, with an aperture in the front of the neck, through which respiration was performed, and through which liquid nourishment was conveyed into the stomach by means of an elastic tube, introduced at each meal into the lower portion of the œsophagus. Two years after the infliction of the wound, this patient was strong and fat, and had all the appearance of a person enjoying excellent health." (*Edin. Med.* and *Surg. Jour.* XVI. 353.)

If death does not occur immediately, from hæmorrhage or nervous injury, recovery may ensue even after the most formidable wounds. As already intimated inflammation and suppuration, to some extent, is unavoidable; the extent of these processes, the structures chiefly implicated and the intensity determine the results. Escaping death from the wound immediately, and from secondary complications, there is a chance of deformity and distortion of the air passages from faulty union of cut cartilages, or the contraction of cicatrices, and many other unpleasant, painful, or dangerous sequelæ as intimated in preceding paragraphs. Paralytic conditions of the organs of speech are among the most common and annoying sequelæ. the more so that they are frequently completely irremediable.

The *treatment* is as usual in wounds of other parts. Hæmorrhage must first be controlled, in every case by firm ligature in preferance to other means. It has been suggested that torsion is to be preferred to ligature in cases of attempted suicide, as the dangling ends of the ligatures are a constant temptation to the sufferer to jerk them off. As a rule, however, the same practice must be pursued here as in other cases of wounded vessels, *viz.:* tie both ends of a divided vessel vein or artery, or ligature on both sides of a wounded vessel, dividing the vessel between the ligatures. Wounds in the œsophagus are to be closed, if possible, by fine cat-gut ligatures; wounds in the trachea are to be closed in the same way, as a rule, although there are cases in which closure of the tracheal wound brings on symptoms of suffocation, without any assignable cause, in many instances. In such cases a tracheotomy tube must be introduced. The vessels all being secured, œsophageal and tracheal wounds attended to, if any muscles

are divided, and it is possible to do so, they should be sutured. The external wound is then closed. The action of the *platysma myoides*, and other muscles, has a tendency to roll the edges of the wound inward, and much delay healing, at the same time producing a deforming scar. When possible to use it, the quill suture had better be employed, as it counteracts this tendency to inversion of the edges; but when the wound is ragged and irregular, reliance must be placed upon fine interrupted sutures, closely applied, or a continuous suture. The head must be inclined forward, and secured in position by appropriate bandages or apparatus, and in the case of would-be suicides the hands must be secured, or a constant watch kept upon them that they may not tear off the dressings.

As to suturing wounds of the larynx, much must be left to the judgment of the surgeon. Simple single wounds, even with much dispartition, will do better if left alone, as any kind of suture will act as an irritant, and may be a very distressing annoyance. When the wounds are multiple, and the larynx divided into numerons portions, fine cat-gut sutures may be employed to bring them into position, but care must be had to keep them in the external tissues, that is, the lining membrane should not be pierced.

The most important consideration, next to hæmorrhage perhaps, is the treatment of wounded nerves. When it is possible to do so they should be brought together and sutured with fine cat-gut; if not practicable to do this, the parts must be put as nearly as possible in their normal relations, and the chances taken of some kind of union occurring.

As to hæmorrhage a word may be added here. In case ligature of all accessible vessels does not arrest the bleeding, it will be necessary to tie the common carotid, as it is of the utmost importance that hæmorrhage should be completely arrested and prevented. In the treatment of the wound, as to other considerations, the usual indications are to filled.

WOUNDS OF ARTERIES OF THE NECK.

The number of vessels in the neck that may require ligature are numerous, many of them being of such a distribution that it will be necessary to tie them near their origin, which will be necessary in order to control bleeding from small branches. Those which are of greater size, and whose relations should be remembered, are the carotids, common, external, and internal; the thyroid, inferior and superior; the lingual, vertebral, and occipital near its origin. The method of tying the last above its origin, is already given on a previous page, (212.)

1. COMMON CAROTID.—The common carotid artery passes upward in the neck, in the commencement of its course in close relation to the trachea, contained in a sheath derived from the deep cervical fascia. This sheath also encloses the internal jugular vein, and the pneumogastric nerve, the vein being external to the artery, the nerve

lying between them, and somewhat posterior. The sterno-hyoid and omo-hyoid muscles cross the vessel near the middle of its course, the latter covering it in for the lower half. The sterno-cleido mastoid muscle is in relation to the artery throughout its course, its anterior edge forming the guide for exposure of the vessel for ligature. It will require ligature in case of wounds in the neck when the hæmorrhage is uncontrollable by ligature of all visible bleeding vessels, the ligature requiring to be placed as low down as possible. At about the level of the upper border of the thyroid cartilage the vessel divides into the internal and external carotids. The artery may be tied in one of three points, the first being only practiced in cases of very great emergency, as the operation is one of considerable magnitude.

(*a.*) *At the base of the neck* the vessel is deeply seated. Place the patient on the back, the head thrown backwards, and turned slightly to the opposite side. Seek for the space between the two heads of the sterno-mastoid, and make an incision upward, in the course of this muscle, for about two inches from the clavicle. Separating the muscle with spatulas, divide the fascia, and the platysma myoides, when the sheath of the vessel will be visible. The internal jugular vein will be very prominent, and may be recognized by its becoming collapsed when pressure is made upon it with the finger. The vessel having been recognized, the sheath is carefully opened, the vein held on one side, and the ligature passed from without inward, carefully avoiding the nerve. Tighten the ligature slowly, observing the effect on the hæmorrhage. If it does not control it, it is useless to complete the operation, and the ligature must be withdrawn.

(*b.*) *Below the omo-hyoid* the vessel is quite superficial. The incision is made along the inner margin of the sterno-cleido mastoid, from the clavicle up to a level with the cricoid cartilage. The fascia and platysma having been divided, the edge of the sterno-mastoid is found, a spatula placed under it, and the head inclined forward slightly to relax the muscle. The omo-hyoid is now sought for, about the middle of the incision, where it crosses the artery, and the outer edge of the sterno-hyoid and thyroid; with tenaculæ or spatula draw the latter muscles inward, the omo-hyoid upwards, and the sterno-mastoid outward and backward, when the vessel is brought into view as before.

(*c.*) *Above the omo-hyoid*, the line of incision is the same but does not commence so low down; it may be extended farther upward however. The omo-hyoid is drawn downward, the sterno-mastoid outward and backward, and the vessel is brought into view.

2. EXTERNAL CAROTID.—This vessel is a prolongation upward of the common carotid, and terminates at the space between the jaw and the external meatus of the ear, that is at a point corresponding to this on the surface. The vessel may be exposed by continuing the former incision upward, or on a line drawn from the lobe of the ear to the great cornua of the hyoid bone. The vessel is crossed by the stylo-

hyoid muscle, and the posterior belly of the digastric, the point of election being below the digastric. The vessel is easily exposed in this situation by drawing the stylo-hyoid upward. It will rarely require ligature for wounds of the neck, as the thyroid and lingual arteries are given off low down. Care must be had to avoid injury to the lingual nerve which crosses the vessel just below the stylo-hyoid.

3. INTERNAL CAROTID.—This vessel is in the same line as the external carotid, much larger in size, and situated deeply, underneath the external. It can rarely require ligature for injuries to the neck. By separating the areolar tissue carefully interior to the external carotid, and below the parotid gland, the artery will be exposed, and must be tied with a cat-gut ligature, that the wound may be closed at once, and danger of inflammation and suppuration be reduced to the minimum.

The danger of secondary hæmorrhage from ligature of these large vessels is extreme, appearing for the most part when the ligatures become loosened. This occurs from the tenth to twenty-first day, and must be the occasion for unusual vigilence during this period. Means must be at hand to temporarily arrest bleeding at once, should it occur, and no temporizing tolerated. The vessel must be exposed, and re-ligated. The bleeding will usually come from the distal side, and if the proximal side seems firm, after ligature divide the vessel.

4. SUPERIOR THYROID ARTERY.—This artery arises from the external carotid, immediately where it leaves the common trunk, about the level of the thyroid cartilage. It passes inward to the thyroid gland, in a tortuous course. By making an incision as for ligature of the carotid, the cornua of the thyroid cartilage corresponding to the centre of the wound, the vessel is easily reached and tied.

5. LINGUAL ARTERY.—This vessel is the next branch of the carotid above the superior thyroid, the distance between not exceeding half an inch usually. If not expedient to tie it at its origin, by an obvious modification of the previous operation, STEPHEN SMITH, (*Operat. Surg.* 243) proceeds as follows: "Turn the head to the opposite side; make an oblique incision an inch and a half in length, a little above the body of the hyoid bone, and parallel with it, near the median line, and curved backward, outward, and downward, parallel with the superior border of the great cornua of the thyroid cartilage; divide the superficial parts and with the finger recognize the direction of the great cornua divide upon it the aponeurosis that covers the deep parts; this exposes the digastric muscle, the submaxillary gland, hypoglossal nerve, and stylo-hyoid muscle; now isolate the great cornua of the hyoid bone, and the fibres of the hyo-glossus muscle, which are attached at this point, come into view; divide this muscle at the superior border of the great cornua; draw it upward and backward, and the artery is found behind it; the needle should pass from below upward."

6. INFERIOR THYROID.—This vessel is a branch of the thyroid axis, and is found a little behind, and beneath the first part of the common

carotid artery. It may be tied through the same incision made for the common carotid, looking for it behind this vessel.

7. VERTEBRAL ARTERY.—This artery is readily traced, but its great depth renders it a very difficult operation to tie it. It may be reached at three points, before it enters the vertebral foramina, between the atlas and axis, and between the atlas and the skull.

(*a.*) The first portion of the vessel, before it enters the vertebral canal, may be reached by making an incision along the inner edge of the sterno-mastoid muscle, between it and the sterno-hyoid, on a line drawn from the posterior part of the mastoid process to a point on the clavicle one-fourth from its sternal end. The parts are divided as in the operation for reaching the common carotid; the sheath of this vessel is brought into view, which must be separated with the finger from the sterno-hyoid muscle on the inside, and the longus colli behind. The head is now raised, although still turned to the opposite side, which relaxes the muscles, and the wound being held widely open, exposes an aponeurosis connecting the longus colli and scalenus anticus. Search for the carotid tubercle (transverse process) of the sixth cervical vertebra, and half an inch below this point open the aponeurosis for two inches downward, when the artery is discovered lying very deeply, and seeming to pass almost directly backward.

(*b.*) Between the atlas and axis the vessel is quite readily reached, lying in the triangle formed by the rectus posticus minor, and the oblique muscles. STEPHEN SMITH (*loc. cit.*) thus describes the operation. "Turn the head to the opposite side, and incline it forward; make an incision two inches long on the posterior side of the sterno-mastoid, commencing half an inch above the mastoid process; make a second incision, an inch in length, from the upper fourth of the first incision backward and obliquely downward; divide the skin and cellular tissue; then the splenius muscle with its fibrous expansion; a fibrous layer now appears, which must be cautiously divided to arrive at the small arteries which lie beneath it; the edges of the wound being separated, a layer of fat appears, which is cautiously opened with the finger or handle of the scalpel, and the artery is found within; the two branches of the occipital artery are to be drawn aside, as also branches of the second cervical nerve; the artery is isolated, and the needle passed from without inward to avoid the internal carotid artery."

(*c.*) Between the skull and the atlas, the artery may be exposed in the same manner as given above, the incision being extended upward about an inch, the vessel at this point being that distance higher.

The operation for tying the occipital artery has already been given on page 212, and need not be repeated here.

INJURIES OF THE VEINS.

The veins of the neck are frequently wounded in injuries of this region, their size and number making the accident a very serious one in many instances. In fact division of the large venous trunks, as the

jugular, may be as fatal an accident as wounding the carotids. These facts render it a matter of much importance that the bleeding vessels should be carefully secured. When the wound is large, and the cut vessels can be seen, they should be tied, with cat-gut ligatures, on both sides; should the vein be only partially divided it had better then be cut across completely. In case the wound in the integument is small, it may be a question whether to enlarge it, and apply a ligature, or trust to accupressure. My rule would be to employ accupressure in all cases of injury to superficial vessels, and to enlarge the external wound, when deeper vessels are injured, and tie them securely.

The most important consideration in this connection, is undoubtedly the occurrence of the entrance of air into the veins. This has already been discussed on page 139, in a general way, but as the accident oftener occurs through the veins of the neck something additional should be given. It is well known that when veins are wounded, ordinarily, they speedily become emptied by a gush of blood, and collapse. When partially divided, and held in a tense state, or when included in dense tissue, as inflammatory products or morbid tissue, they remain open, particularly on the cardiac side, and there is imminent danger of the entrance of air. Probably this is true in all regions of the body, but the short route to the heart exposes the sufferer to greater danger when the air finds entrance through the veins of the neck. Mr. Treves (*Brit. Med. Jour.* Aug. 1883), has given the matter much attention, and his view will be summarized here as representing the latest teaching on the subject. He finds the first requisite for admission of air, perhaps, at all events a very important one, is dryness of the wound; in wet wounds, whether the fluid be water or blood, the accident is very infrequent. The hissing or whistling sound is succeeded by bubbles of air escaping from the injured vessel, and the appearance of symptoms already given (p. 139.) The first step is to fill the wound with water from a sponge; next seize the cut end of the vessel, if it can be seen, if not the tissues in the part, with a tenaculum; at the moment of inspiration seize the part with forceps, and close the opening in the vessel; when expiration occurs, relax the grasp of the forceps, and have the assistant make strong pressure on the thorax, which experiment has shown will greatly favor the expulsion of the air already taken in; inspiration coming on, shut down the forceps, and continue the process until the air bubbles cease to appear on expiration, keeping the wound all the time filled with water. When no more air is expelled, ligature the vessel, or the tissues in mass, and complete the division of the vein if there is only a partial division. Mr. Treves has pursued this course a number of times, and is quite confident that air may be expressed from the heart, Erichsen and others to the contrary notwithstanding.

INJURIES OF THE NERVES.

The nerves of the neck, being concerned, for the most part, in carrying on the most important vital functions, their wounding gives

rise to the most alarming complications. Inasmuch as they are double, it has often occurred that section of large nerves on one side of the neck has been recovered from, those on the opposite side carrying on the work of both. Thus in the well-known case of DR. MCCLELLAN, in which a parotid tumor was removed, the portiod ura, spinal accessory, and par vagus were divided, even portions of the nerve cut away, and yet life was preserved. Important changes must always accompany and follow such accidents, however, the exact character depending upon the particular nerve or set of nerves injured. Thus the section of laryngeal nerves, would give paralysis of the glottis or vocal organs; their partial division would probably cause spasmodic conditions. So with all the nerves, in this region, the symptoms would be those observed in connection with nervous lesions generally, i. e., irritation when partly severed, paralysis on complete section. Complete section, also, by favoring capillary stasis in the parts supplied, would be likely to result in inflammation; we often find, therefore, pneumonia, of some kind, succeeding injuries of the pneumogastric, of course if large nerve trunks are divided simultaneously on both sides, death must ensue.

Treatment does not differ from that of similar injuries elsewhere; the cut nerves may be united by fine cat-gut sutures, or, if this is impracticable, the parts may be put into as nearly their proper relation as possible, with the hope that the continuity of the nerve may be restored by natural processes; this hope will in the majority of instances be more or less completely realized.

INJURIES OF THE THORACIC DUCT.

Deep wounds of the neck on the left side, have occasionally divided the thoracic duct without associated injury to the subclavian or jugular vein. Probably stab wounds that open these vessels near their junction frequently injure the thoracic duct correspondingly, but the necessarily fatal character of such injuries prevents any prominence being given to the condition of the duct. The consequences of complete division of the duct near its entrance into the veins, must be fatal in character, although death may be delayed for days or weeks. The wound being inflicted close to the vein, as there are a number of vessels at that point in place of the single one found at a distance, a fatal result is not so imminent, yet sufficiently so to call for a very guarded prognosis. The accident may not be apparent at once, if there is much hæmorrhage, the flow of the blood concealing the loss of lymph or chyle; when hæmorrhage ceases, or there is little from the commencement, the chyle will be observed flowing from the wound in somewhat astonishing quantities. There will be progressing atrophy and pallor, if the duct is completely divided, even after the flow of chyle ceases. When the cut extremity of the duct becomes closed, either through coagulation of the chyle, or agglutination of the surfaces, if no other channel is supplied, such as enlargement of the collateral branches of the duct, œdema and ascites will

commence, the patient ultimately dying from exhaustion. The œdema and ascites will be found to be caused by an immense accumulation of chyle, either from rupture of the duct in the abdomen, or the receptaculum chyli, constituting a condition known as "ascites chylosus." The œdema is of a somewhat peculiar character, probably owing to the plasticity of the fluid, the integument becoming hard and brawny, greatly thickened, and resembling very closely elephantiasis. Upon post-mortem section the skin will be found infiltrated with the chyle, which may become of jelly-like consistency, and slightly amber hue. The stomach will soon partake in the derangement, rejecting food, even drink, toward the last

From a consideration of the above symptoms, it is at once apparent that such an accident is of the most serious character, and little can be done in the way of treatment. Admitting the possibility of ability to find and isolate the delicate and thin-walled duct in the neck, its ligature would only transfer the external loss of chyle to a like loss by accumulation in the duct, with subsequent rupture at some part of its course. As a matter of fact, the less the parts are disturbed the better, as the only hope lies in the re-establishment of the communication by a union of the cut ends. This cannot, I believe, be secured by art; if accomplished at all it must be as it were spontaneous. The cessation of a discharge of chyle from the wound, is not always therefore, a hopeful sign; if following this there are symptoms of œdema of the extremities, or ascites, with failing appetite, the presumption is that the wounded duct has become obliterated, and the prognosis is hopeless.

INJURIES OF THE TRACHEA.

The trachea from its exposed position, is exposed to many accidents, and yet the hands are so instinctively used to ward off approaching or apprehended danger, that comparatively few cases of injury are presented. It is also quite infrequently the case that injuries to the neck are confined to the trachea, although such instances are occasionally met with. I have already had something to say of wounds as associated with wounds in the neck, but in a systematic essay the considerations are sufficiently important to demand separate consideration. At this time, therefore, I shall speak of wounds of the trachea, as well as fracture of the cartilages, rupture of the trachea and intercartilaginous membrane, dislocation of the rings, and a peculiar condition called "hernia," but which sustains a close relation to rupture of the membrane.

WOUNDS OF THE TRACHEA.

Wounds of the trachea, without regard to their character, are very serious accidents, partly from the attending hæmorrhage, and partly from the function of the part. The front of the tube is covered with a plexus of veins, in the lower part of the neck it is in close relation to the carotid arteries, which together with the large venous trunks

in the region, and the many important nerves renders all injuries in this part of the body highly important.

Incised wounds, usually self-inflicted, are the commoner forms of injury. The special considerations are the direction, the location, the extent, and the complications,—as to the complications, which include cut-throat, and wounds extending to the œsophagus, reference must be made to other paragraphs.

The *direction* of the wound is of the greatest significance. A wound made in the long axis of the tube will gape less widely, and produce less interference with the respiration, than one made transversely. The cartilages will fall apart in either case, it is true, but when the wound is longitudinal the motions of the trachea in breathing do not have a tendency to disturb the wound, or to cause it to gape more widely. In such cases, therefore, the wound is more quiescent, consequently in a better condition for repair. In such cases, however, there are dangers enough, dangers peculiar to the part. For some reason that I cannot discover, some of the cartilages straighten out when divided, forming a projection externally; others turn in, forming a similar projection into the canal of the trachea. Under either circumstances respiration is more or less modified, and may become so embarrassed as to threaten life. When the wound is transverse, there is separation of the cut surfaces proportionate to the depth or extent of the wound; the violent motions of the trachea in breathing, "plunging" (as some one says,) up and down, has the effect to increase the dispartition, keep the wound continually irritated, and correspondingly retard repair as well as provoke inflammation.

The *location* of the wound, that is whether in the cartilages or the membrane between them, is a matter of considerable importance in treatment and prognosis. In the first place coaptation is more difficult in wounds of the cartilages, and there is more danger of pulling the wound open by the projecting angles coming into contact with other parts during the violent motions of the trachea. Furthermore the low vascularity of cartilage predisposes it to degenerative changes when injured, necrosis not being uncommon after even minor lesions. The wound being in the membranous portion, there is much more facility in coapting the edges, and there is less danger of subsequent disarrangement by the motions of the trachea. The tension, however, has a tendency to tear out the stitches, and the necessity thus arising for stout sutures renders inflammation a frequent occurrence. As to prognosis in this form of wound, the inelastic and extensible character of cicatricial tissue renders elongation of the trachea, at the expense of the wounded surface, quite eminent, which will have the effect to alter the shape of the organ, a fact which may have an unhappy influence on respiration.

The *extent* of the wound is a highly important consideration. A wound that barely open the canal is not devoid of danger to the victim, but one that nearly severs the organ, or cuts it completely in two is

a most formidable affair. Cases are noted in which the lower half of a divided trachea was drawn down out of sight into the chest, and prevented from rising again by becoming caught upon some projection, and doubled upon itself. Asphyxia is a necessary consequence of such an accident. Furthermore, when a wound is very extensive, near parts are likewise injured, the large blood vessels, or nerves, or œsophagus partaking in the accident, and perhaps these associated injuries may be more formidable than that of the trachea.

A *prognosis* may be readily made on the above considerations. As to life, the degree of the injury is important; as to function, the kind. With an accident that cuts off the entrance of air to the lung, a continuance of life is impossible; with one that produces deformity in healing, there must be more or less impairment of function.

Contused and *punctured wounds*, as well as lacerated, are of consequence as regards their size, and the nature of the accident. The greater danger of necrotic processes after such injuries in general is not without peculiar significance here, as there is apt to be sloughing, greater loss of tissue, and of course greater deformity and disability. Such an extensive wound as the tearing out of the whole trachea, down to the bronchia, by falling on a butchers hook, is of course fatal; from this to the scratch from an animals claws, or a bite from their fangs, there is a long list of injuries of this character. The only rule that can be formulated is, that a contused or lacerated wound is doubly important than an incised one of the same extent. As to punctured wounds, their depth is of more importance than their superficial extent, as is the case with this form of wound generally. The chief dangers are from hæmorrhage, injuries to the nerves, and incomplete repair forming an ærial fistula.

TREATMENT.—The first consideration is hæmorrhage. The rule applies, that has already been frequently referred, to securely tie, or otherwise secure, all bleeding vessels, arteries or veins. There is the double danger of death directly from the hæmorrhage, and suffocation from the entrance of blood into the trachea. If there is ever an excuse for failing to arrest bleeding, it does not apply in these accidents; nothing is to take precedence, unless it be to clear the air passages from blood, but even then the bleeding vessels must be temporarily arrested meanwhile. If the œsophagus is injured, it must be attended to first (a later paragraph giving the details,) as it lies back of the trachea. The tracheal wound is now to be closed, cat-gut sutures being preferred to silk or wire, as their use permits the closure of the wound at once, and sensitive structures are not subjected to the irritation of removing the sutures. In cases in which there is a loss of substance, and the tracheal wound is too large to draw together without producing too great deformity, a tracheotomy tube must be introduced, and any deficiency that may exist must be repaired by a formal operation later. When the trachea is completely divided the parts must be united, as closely as possible, but if the tension thereby

produced embarrasses breathing to a considerable extent, the stitches may be loosened, and a tube worn until more tolerance is established, or circumstances are favorable for an operation. Under all circumstances, particularly when the wound is transverse, the head must be inclined forward, so that the movements of the trachea in respiration are as restricted as possible. Absolute immobility cannot be secured for any length of time, but the more restricted the movements of the part, the better promise there is of good recovery.

FRACTURE OF THE TRACHEA.

Fracture of the tracheal cartilages is a very rare accident, particularly up to the middle period of life. It is produced by falls, the neck striking on some hard substance, or by a squeezing force, as a grasp from the hand. It is only after middle life, when there is a sort of ossification of the cartilage, that the accident is easily produced, although there are instances of children having suffered. The point of fracture is rarely at point of compression; the cartilage presses out anteriorily, in a sharp angle, on lateral compression, and it is at this point the separation will be apt to occur. The accident is at once announced by local pain, difficulty in breathing, the act also being painful, and by a marked deformity of the neck. The ends of the fractured cartilage are usually displaced outward, and at each act of expiration the lining membrane is pushed out through the gap, being drawn in again, producing quite a depression, on inspiration. Sometimes the ends turn inward, but this is represented as quite rare. Unrelieved there is soon inflammation of the lining membrane of the trachea, which may extend to the larynx and glottis, impairing the voice, and making breathing difficult, or perhaps extending downward, producing bronchitis, or broncho-pneumonia. Recovery seems to be the rule, but not without some considerable functional loss from the change in shape of the trachea.

The *treatment* will consist in reposition and retention of the fragments, as far as possible, and attention to the resulting inflammation as symptoms arise. In the majority of instances *Acon.*, should be useful, in the earlier stages of the inflammation at least. Reposition of the fragments is very readily accomplished, the parts being subcutaneous; moderate pressure on the projecting points being all that is needed. In the rare cases in which the points are directed inward, we can only "make the best of a bad bargain" and leave the matter in the hand of nature, simply keeping the parts as quiet as possible, as in the case of wound. Retention may often be secured by simple bandaging, placing a soft compress over the projection; if this is ineffectual, a stitch may be taken subcutaneously, drawing the fragments together as in the case of a wound of muscle (p. 163). Emphysema is a common occurrence if the lining membrane of the trachea, is injured and in such an event it is laid down as an inflexible rule, by GROSS and others, that tracheotomy should be at once performed, as GROSS says, "even if the patient has ceased to breathe." The swelling

and ecchymosis that may arise later, must be treated as usual, with *Arnica*, *Hamma.* or *Con.* according to indications, that is, as the extravasation is coagulated, fluid, or serous.

RUPTURE OR LACERATION OF THE TRACHEA.

This accident is produced by extreme violence stretching or pulling the trachea outward or laterally. The lesion is in the intra-cartilaginous membrane, and may separate the trachea from the larynx, or divide the tube, completely or partially at any part of its course. It cannot be considered a lacerated wound, as there is no opening in the skin in the typical form of the injury. Having never met wiih a case in my practice. I quote from DURHAM (HOLMES *Surg.* II, p. 464,) a case related by Mr. Long of the Liverpool Infirmary: "A railway laborer, aged twenty, while connecting two railway carriages, was caught around the neck by the coupling irons. When brought to the infirmary, there was some abrasion of the skin of the neck, a little swelling, and slight emphysema. The voice was subdued. In the evening there was some difficulty of breathing, and considerably distension and pain in the neck. Similar symptoms came on at intervals during the five days following the accident, and became at last so urgent that an incision was made in the median line of the neck. The finger was introduced into a mass of clotted blood, but the trachea could not be found. On subsequently turning out the blood, a bubble or two of air escaped from the lower part of the incision just above the sternum. On further examination, it was found that the trachea had been completely divided, and that the lower portion, from which the bubbles of air came, had been pushed on one side. There was an interval of an inch or more between the separated portions of the air tube. A long canula was introduced by Dr. Halford (then house surgeon,) and the blood which clogged the trachea was repeatedly sucked out. The patient became more and more relieved. The head was bent forward so as to diminish the extent of the gap. Nine days after the accident the tracheal tube was removed, and a double piece of gauze placed over the opening. The wound entirely closed in about a month. When Mr. Long examined the patient about six months after the accident, he observed a depression to exist, in the throat just above the sternum, capable of holding a walnut; this was increased doubly in length and in width during each inspiration. A fragment of trachea could be detected attached to the lower part of the larynx, below this nothing was felt like teacheal rings, but merely a fibrous tissue; his voice was hoarse, like that of a person suffering from the commencement of a cold; and when he breathed quickly and deeply, the sound produced was that of air passing through a narrow tube. I presume, therefore, says Mr. Long, "that a fibrous tube has been developed in the space existing between the upper and lower ends of the divided trachea." Such a fortunate termination must be extremely rare, as other cases, apparently more promising, do not survive the accident many days, or even hours.

HERNIA OF THE TRACHEA.

Hernia of the Trachea, or bronchial hernia, is a term given to a protrusion of the soft parts of the trachea between two of the rings, oftener seen in infants, but occasionally in adults. In the former instance it is due to an incomplete laceration of the trachea by rough extraction of the head in delivery; in the latter is supposed to be caused by forcible retention of the breath, or loud and habitual use of the voice. The tumor thus formed varies in size in expiration and inspiration, but is not productive of any inconvenience apart from the disfigurement it causes. The maximum size attained is about that of a pigeons egg. I do not know of a case having been cured, although some have known of the affection disappearing spontaneously; moderate and systematic pressure would seem to be the line of treatment indicated.

INJURIES OF THE LARYNX.

Injuries of the larynx are always of a serious character, inasmuch as it contains the organs of speech, and is the entrance of the air passages. Burns and scalds, wounds, fracture and concussion will claim some attention under this head, although some of them have already been considered under cut-throat and elsewhere.

BURNS AND SCALDS OF THE LARYNX.

The entrance of heated bodies into the larynx is productive of the most dangerous conditions, both as affecting life and the integrity of the parts. While perhaps it matters little, as far as the results are concerned, whether the heated material is solid, fluid, or gasseous, the symptoms vary greatly with referance to the extent of surface injured; death is a common termination of such injuries, under all circumstances, the case being sufficiently severe to call for medical care. In the few cases of recovery from severe burns or scalds, however, a consideration of the *manner* of burning will have an important influence on prognosis. I will speak, therefore, of burns from solid bodies, from heated fluids, from flame or gas, and from concentrated acids or alkalies.

Molten metal, or other heated solid bodies, inflict the first lesion on a somewhat restricted territory; the immediate effects of the burn extend but little beyond the point of contact. The primary effects, therefore, depend upon the point of contact; but from this process inflammation rapidly extends, until symptoms common to all forms of burning are produced. These symptoms are more or less aphonia, dyspnœa, pain on breathing, and bronchitis or broncho-pneumonia as a later state. The point of initial lesion is charred, forming an eschar, so that if the immediate inflammation resulting from the burn could be controlled, the presence of the eschar would re-excite it. If life is not lost from suffocation, or pneumonia, the contraction of the cicatrix after the sloughing of the eschar will have more or less influence on the voice or respiration. Notwithstanding the serious character of

burns from solid bodies, the fact that the body must be small is a circumstance in favor of the recovery of the patient.

Scalds or burning from heated fluids, are much more serious than those from solid bodies, chiefly because the immediate lesion is more extensive, and the tissues are affected to a greater depth. The accident usually occurs to children, oftener among the poorer classes, from the attempts to drink boiling water out of the spouts of tea-kettles and the like. In the case of adults, the pain instantly caused by a boiling fluid in the mouth, would prevent its being admitted to the glottis, as it would be thrown out at once. In the case of children, the pain in the mouth causes them to scream, which produces an involuntary inspiratory effort, drawing some of the fluid, at least, directly into the wind-pipe. The mucous surfaces are at once intensely congested and swollen, the glottis more or less closed, and the breathing instantly becomes greatly embarrassed. The respiration is croupy and labored, and inflammation of the bronchia or lungs, or both rapidly come on. Convulsions and vomiting commonly occur, and death is not long delayed, usually coming about the second day, sometimes not until the fifth.

Heated air or flame, produces extensive burning, similar to a scald. The accident is oftener met with in women, from the flame extending upward from burning clothing; it also occurs to firemen, who may become surrounded with flame, and on gasping for breath, draw in flame or heated air, which is drawn directly into the larynx. The tissues are probably not affected as deeply as in cases of scalds, but are so to an equal or greater superficial extent, sometimes extending even to the lungs.

Concentrated acid or alkalies, are sometimes swallowed with suicidal intent, the determination of the individual swallowing it overcoming the natural resistance to such irritating substances passing into the gullet. When introduced into the mouth accidentally there is spasmodic closure of the pharynx, shutting off the entrance of the œsophagus, and causing coughing. The commencement of a cough being a quick inspiration, may draw a few drops into the larynx. The symptoms are those of scalding and burning combined, the tissues being charred, and extensively burned superficially. There are cases in which Sulphuric acid has passed directly into the lungs, and produced very speedy death.

From the brief account of this accident given above, it will be seen that the injuries inflicted on the tissues are not in any sense unique; they derive their importance from the functions of the part. The loss of voice, when recovery is secured, may be of any degree, from slight hoarseness to complete aphonia; the impediment to breathing anything from slight asthmatic symptoms, to dangerous dyspnœa and frequent attacks of suffocation.

The *treatment* is as in the case of burns elsewhere, with the additional requirements to facilitate breathing while recovery from the imme-

diate effects of the burn are being attempted. This is to be secured by early tracheotomy, performed as low down as possible. If the burn extends below the opening in the trachea, this will do little good, perhaps, but this fact can scarcely be ascertained until an opening is made. *Urtica urens.*, *Canth.*, or some better indicated remedy, according to special symptoms must be given, and when the burnt surfaces are restored to something like their normal condition, the tracheal tube is removed.

It must be noted, before dismissing the subject, that the mouth and pharynx are always more or less injured, and the œsophagus may suffer by an extension of the inflammation from the contiguous air passages, or from contact with the heated material. Also, when recovery is secured, the glottis often loses some of its sensitiveness, so that food or drink may pass into the larynx. This may be corrected with *Gelsem.*, but great watchfulness of the patient, if too young to appreciate and guard against the danger, may prevent such accidents.

WOUNDS OF THE LARYNX.

These injuries have been partially considered already under cut-throat. The dangers are death from suffocation from the blood flowing into the wind-pipe, from hæmorrhage, and from paralysis of the glottis from nervous injury. The accident is consequently one of great peril, and must demand an enlightened view of the case, and a knowledge of the consequences of lesions of the sensitive air passages. Paralysis of the glottis, or vocal cords, while sufficiently important, may not be the most serious consequence. The well known tendency to deformity in healing of wounds of cartilages must not be lost sight of; there is also a possibility of necrosis, of these bodies. SIR CHAS. BELL relates the case of a man who "had cut his throat, suffered from repeated attacks of frightful dyspnœa, accompanied by a peculiar flapping sound in the top of the wind-pipe, for which no rational explanation could be afforded. He finally died in a fit of suffocation, when it was ascertained that one of the arytenoid cartilages had been divided, the fragment hanging by a piece of mucous membrane, so as to vibrate in the chink of the glottis, like a pea in a cat call." (GROSS *Surg.* II, 395.) Atrophy of different parts may occur, or almost any form of disorganization. And so with all the various parts entering into the composition of the organs of speech, the gravity of the symptoms depends upon the importance of the injured part to the function of speech or respiration.

Certain remote consequences are common to all the lesions, more particularly irritation or inflammation of the lungs and bronchia, either through extension of inflammation from the wound, the admission of foreign material, or injuries to the nerves. Also, probably from nervous injury alone, paresis of the glottis, impairing sensibility, will at once impair speech and respiration, and favor the admission of foreign material to the air passages.

Hæmorrhage, as an immediate consequence, has already received attention, and need not detain us at this time.

The *treatment* is to be conducted upon certain general principles, as laid down in an earlier paragraph, particular attention being had to keeping the severed parts in apposition, and at the same time not crowded together so closely that the mucus which collects in the air passages may not find a ready exit.

FRACTURE OF THE LAYRNX.

Fractures of the larynx are exceedingly dangerous and fatal accidents, perhaps oftener proving fatal than any other form of accident in this region. While fracture of any of the cartilages is a grave occurrence, statistics show that recovery is almost unknown in cases in which the cricoid is involved, either alone or in connection with others. MR. DURHAM (*loc. cit.*) gives a table of fifty-two cases collected by M. Henoque, with ten of his own added, in which this fact is conclusively shown:

CARTILAGES FRACTURED.	CASES.	DEATHS.	RECOVERIES.
Thyroid,	24	18	6
Cricoid,	11	11	
Thyroid and os Hyoides,	4	2	2
" " Cricoid,	9	9	
" Cricoid and Os Hyoides,	2	2	
" Cricoid and Trachea,	2	2	
Cricoid and Trachea,	2	2	
" Trachea and os Hyoides,	1	1	
"Fractures of Larynx,"	7	3	4
TOTAL, ...	62	50	12

The cause of such fractures is usually the application of some squeezing or compressing force to the larynx, as with the hand, or in hanging, particularly in those past middle life, or who from other causes, in early life, have osseous changes in the cartilages. The violence of the symptoms depends upon the degree of displacement of the fragments; in cases in which there is no displacement, the symptoms are insignificant, and indeed the true nature of the accident may never be suspected. When there has been displacement, the symptoms come on at once, and are quite violent from the commencement.

Pain and suffocation are the most frequent. The former may be continuous, or only felt when swallowing or speaking, or making some unusual effort to breathe. It is not violent, more of an aching than a positive pain, excepting when the fragments are sharp pointed, and irritate the sensitive mucous surfaces.

Suffocation is due either to the flow of blood into the air passages, to the swelling of the mucous lining, or to both combined. If seen early there will be a noticeable change in form in the neck, particularly when the compression has been made laterally, in which case the *pomum adami* will be more prominent. Manipulation will reveal undue mobility in the parts, and usually crepitation will be readily

detected. Later the neck will be found swollen, either with ecchymosis from effusion of blood, emphysema from a laceration of the lining membrane, or the usual serous swelling accompanying fractures in general. There will be cough, causing much pain, lowering of the temperature, and small pulse. In some cases these latter symptoms come on suddenly, late in the case, and are supposed to be due to a sudden displacement of some fractured cartilage. The *treatment* presents few indications, but they are exceedingly difficult to fulfil. The first, of course, is the reposition of such portions as are displaced. This is usually easily performed, providing the case is seen sufficiently early. Next is retention of the displaced portions. From the function of the part, and its constant motion, even if slight, this indication is very difficult to fulfill. Strips of adhesive plaster may be used, but they must be closely watched, as the subsidence or increase of the swelling constantly renders the dressings either too tight or too loose. Quietness, of the individual as well as the part, are essential.

Subjective symptoms must be met as they arise. It is impossible to notice them systematically in a brief essay like the present, but a fair knowledge of the materia medica will enable the average practitioner to meet all the necessities of the case. As a matter of fact when displacement occurs, it will matter little what is done, the result will be disastrous, in all probability, but duty to our patient, and the knowledge that an occasional case recovers, will give courage to continue treatment to the last. Perhaps *Acon.*, will be the most useful remedy, unless there is much ecchymosis, when *Arnica* should be preferred.

Tracheotomy must be employed when the respiration is much embarrassed, but should be delayed until it is evident that life cannot be preserved without it.

CONCUSSION OF THE LARYNX.

Blows upon the windpipe, not of sufficient violence to induce fracture, occasionally produces violent and even fatal symptoms, of great urgency and demanding prompt treatment. It has never been my fortune to see a case of this character, but from the descriptions I have read, and the account of cases related to me, I am of the opinion that the symptoms may be relieved easier than is generally supposed. The symptoms produced are not so much due to contusion as to shock and spasmodic closure of the glottis.

The symptoms are pain of a contractive character, in the throat, fauces, and extending up the neck to the ears; a gasping for breath, with feeling of suffocation. These symptoms may be constant or intermitting, but in fatal cases the intermissions gradually become shorter, and the suffocation correspondingly prolonged. The face has a startled expression, somewhat swollen, and dark, and the eyes protrude. The symptoms finally assume the type of apnœa, and death closes the scene.

The *treatment*, as universally given in works of surgery, is to perform tracheotomy at once "if life is still present." This I should pre-

fer to reserve for a last resort, and treat the case as one of reflex nervous irritation, as in the case of chloroform narcosis, or apnœa. Inhalations of *amyl nitrite* drawing the tongue forcibly forward, or passing the finger down to the glottis should each be attempted, in cases in which life seems to be extinct. When seen during the earlier stages, before complete suspension of respiration, it would seem that "moral treatment" would have a good effect. Thus much of the distress, I am informed, seems to be due to frantic efforts at respiration, which have the direct effect to increase the spasmodic contraction. Impressing this fact on the patient's mind, and counselling him to breathe slowly, and not lose his self-control, should have the effect to lessen the violence of the spasms. *Arnica*, either administered by olfaction, or dropped upon the tongue should aid reaction. All these measures failing, and the glottis becoming firmly closed, tracheotomy must at once be performed.

FRACTURE OF THE OS HYOIDES.

The hyoid bone is occasionally fractured usually by direct force, although some instances are recorded of fracture from muscular action. DR. GIBBS, of London has written a monograph on the subject, in which he gives the history of thirteen cases, of this number two died. The presumption is that the accident is quite infrequent.

The point of fracture is usually at or near the junction of the cornua; in one case only, mentioned by GIBBS did it occur in the body. A case is reported in the *Medical and Surgical Hist. of the War* (Part I, Surgical Volume p. 400), in which the body of a criminal who had been executed by hanging was examined, and the only lesion discoverable was a multiple fracture of this bone. There were six fractures, three on each side, in the cornua and processes, but none, I believe, in the body.

As a rule there is much displacement, the position of the bone with referance to the base of the tongue and the air passages making the symptoms somewhat peculiar and usually unmistakable, one case is mentioned by DURHAM, however, in which the accident was not detected until after death, although the symptoms were quite severe.

The *symptoms* are pain, more or less constant, but particularly on attempting to turn the head, swallow, or talk. Suffocation, particularly on protruding the tongue, is a quite constant symptom, on looking into the mouth, the parts will be seen swollen and ecchymosed, and if the fragments have perforated the mucous membrane the point may be seen; the hæmorrhage may be considerable. Manipulation externally will usually detect crepitus readily.

The *treatment* must include perfect rest, not only of the part, but the body. Reduction is quite readily effected by placing one finger in the mouth, and manipulating the parts externally with the other hand. No dressing can be applied to keep the parts in position, and as swallowing, speaking, or even respiration has a tendency to displace the

fragments, the utmost caution must be exercised to avoid any unnecessary disturbance of the parts. If it is particularly painful or difficult to swallow, an œsophageal tube had better be used to convey food to the stomach. Should dyspnœa become alarming, tracheotomy must be performed.

DISLOCATION OF THE OS HYOIDES.

Dislocation of the hyoid is even more rare than fracture. GIBBS (*op. cit.*) refers to five cases in his own knowledge, and others are found scattered through medical works, most of which, however, are not clearly made out. DURHAM quotes the following case from GIBBS work, which will serve the purpose of illustrating the condition as well as a detailed description. "The patient, a man aged forty-five, felt a sudden click in the *left* side of the neck, which produced a sensation as if something were sticking in his throat. On examination, this appeared to me to depend upon a displacement of the left horn of the hyoid bone, and was generally reduced by throwing the head backwards, towards the *right* side, so as to stretch the muscles of the neck, and then suddenly depressing the lower jaw, and so putting the depressors of the hyoid bone into operation. He died some years after of pulmonary consumption. On examining his throat after death, I found a sort of pouch, which answered the purpose of synovial capsule embracing the horns of the left thyro-hyoid articulation. It was filled with a clear fluid, had a comparatively large round sessamoid bone developed in its outer wall, and permitted an extraordinary amount of motion. This was the fourth case of the kind that had come under the notice of Gibb. All the patients were males. He subsequently met with a fifth case, in which the patient was a female.

Other cases are noted in the books, but as they are rarely if ever described as the result of accident, being chiefly due to constitutional peculiarities, it will not serve any useful purpose to refer to them at greater length. The method of reduction will in any case be as noted above, and the treatment does not present any peculiar features.

WOUNDS OF THE ŒSOPHAGUS.

Wounds of the œsophagus are rare, and can seldom be produced from accident without injury to near parts. Gun-shot wounds have been met with, and some few cases of stabs. Apart from associated injury to other parts, these lesions are not of particular interest, being treated as similar wounds elsewhere. The accident is readily recognized, when the wound is of any size, by the appearance of food or drink in the wound, if no lesion of the air passages is discovered. Injuries of the larynx or trachea that induce paralysis of the glottis, are frequently found to permit food or fluids to pass the epiglottis, and appear at the wound in the neck; due caution must therefore be exerted to avoid mistaking the nature of the accident. As regards the wound in the œsophagus, without any reference to other injured parts, there need be no great concern. The chief danger is in stric-

ture from cicatricial contraction, or the extension of inflammatory action to parts related by continuity of structure. Ordinary care should avoid the last of these, and electrolysis would seem to furnish an efficient remedy for the former.

Other paragraphs of this chapter, as well as that preceding, refer to lesions of this tube conjointly with other structures, and we can therefore dismiss the topic with this brief reference.

XXI. INJURIES OF THE SPINE.

Injuries of the spine are of interest, from the function of the cord enclosed therein, and the importance of the column to locomotion. A moments consideration of the various uses of this important part, some of them apparently antagonistic, will clearly show that serious injury must at all times be a matter demanding the solicitous care of the surgeon. It supports the head and superior parts of the body, resting upon the comparatively firm base of the pelvis. It gives at the same time flexibility to the trunk. It affords attachment and support to the ribs. Above all, it contains in its center the all-important medulla spinalis. With such important functions we would look for some unusual protection from injury, and are not disappointed. The first consideration would be protection of the cord from injury. This is secured both by location, and disposition of the spinal meninges. The vertebræl canal, in which the cord is contained, is situated nearly in the center of the column, the diameter of the bodies of the vertebræ little, if any, exceeding that of the lamellæ and spinous processes. In cases of extreme flexion, therefore, the cord is in that portion of the column that is least affected by motion. It is further protected from the fact that the cord does not fill the canal, being much smaller in calibre, and the dura mater is not attached to the walls of the canal as is the case in the skull, At the foramina for the passage of the spinal nerves processes are thrown off, which while investing the roots of the nerves, at the same time serve as suspensory ligaments to the cord itself. The arachnoid spaces are also filled with an abundant supply of cerebro-spinal fluid, a fact which materially protects from jars. The cord may be said, therefore, to float in a water packing, and suspended by the processes of the dura mater at the foramina.

The column is protected from fracture by a provision in obedience to a well known law of physics, touched upon when speaking of cranial fractures, viz.: that fracture, in case of extreme flexion occurs at the point of extension, in preferance to the point of compression. Should the flexion be posteriorly, the point of extension would be on the anterior face of the bodies of the vertebræ, which are not fixed, but yield considerably, through the medium of the intervertebral cartilages, which will give way before the bone itself yields. With the flexion in the opposite direction, or laterally, the freedom of motion in the articulations between the transverse processes, and extreme elas-

ticity of the ligaments, effectually protects the parts from injury. Joined to these elements of safety, we cannot fail to observe the number, size and strength of the muscles of the spine, filling the deep depression caused by the mode of attachment of the ribs, as well as the strength and density of the fascia. From this brief *resume* of the construction of the spinal column, it will be at once apparent that the protections from injury, by the exertion of any usual force, are ample and fracture must be, to a large degree at least, from direct causes.

The weakest regions in the spine, according to this process of reasoning, are those in which there is the least mobility, or mobility confined to or greater in one direction. Thus the sacro-lumbar, lumbo-dorsal, and the atlo-axial articulations. "It thence appears" says MR. SHAW (HOLMES, *Syst. Surg.* II, p. 357) that the portions most prone to injury are those situated where a flexible joins on to a comparatively inflexible division, and it might be expected that such should be the case. A force directed upon a pliant part of the column will cause it to bend, but on reaching a more rigid part, it will fail to do so; instead, therefore, of meeting with a gradually yielding, it will encounter a dead resistance; the force will be concentrated in place of divided, and it will overcome the strength of the material. Sir C. Bell illustrated the point by the breaking of a fishing rod. If the trout fisher in casting a long line snaps his rod in twain, the fracture will take place, not in the centre of one of the pieces, but near a joint, that is, at a part analogous to where the spine is most liable to be broken."

In considering the accident to which the spine is liable, I shall first take lesions of the bony structure, and finally those of the cord. The subject will therefore be, sprains, fracture, dislocation of the spine with contusion, puncture, division and concussion of the cord.

SPRAINS AND STRAINS.

It is utterly impossible to establish, with any degree of certainty, a differential diagnosis between strain and sprain; whether the condition is a subluxation, or a purely muscular lesion, will always be a matter of more or less doubt; not so much, however, from the similarity of the symptoms, as from the fact that the conditions usually co-exist. Every case of sprain will have some symptoms of strain because there are the *conditions* of strain; the reverse, however, does not necessarily hold good. As a matter of fact, concussion will oftener present a preponderance of the conditions of strain, while extreme and unlooked for flexion will give those of sprain; when the concussion is severe enough to cause symptoms of sufficient importance to demand medical aid, flexion also occurs, as will be shown later, and the etiology is correspondingly valueless. For this reason I shall speak of the conditions as identical, and include them both in the word sprain.

The causes of sprain are various, and the symptoms vary much with the region principally affected, and the degree of force applied. It

will be convenient, therefore, to divide the subject into sprains of the neck, and the lumbar spine, the dorsal region being practically exempt from such accidents.

(*a.*) *Cervical spine.*—The causes of sprain in this region, are usually sudden, unlooked for, or extreme flexion, or a severe jar. Under either circumstances the effects are the same. For instance: A man falls on the back, the neck striking on a curb-stone, stick of wood, or a stone. The momentum of falling being suddenly arrested by such an object as that referred to, the head and that portion of the spine above the point of contact, continue on, in the same direction, and with the same force and velocity, until arrested by the action of the muscles, involuntarily made tense, or by the head reaching the ground. The result is a sprain at the point first struck, caused by the concussion, the jar and the sudden forced flexion.

The *symptoms* of such an accident may simulate those of fracture or dislocation, but the matter can be readily determined, in most instances, particularly when the case is seen very soon after the accident, from the diffused character of the pain, and the absence of any irregularity of the spinal processes. The symptoms, again, vary somewhat with reference to the extent of the lesion, e. g., whether extending to the cord or not. At this time we are more particularly concerned with the conditions external to the spinal canal, which last will be reserved for a later paragraph. The most prominent symptoms are pain, immobility, and swelling. In the majority of instances the pain will be quite insignificant while the parts are at rest, but become very acute upon any attempt of motion. It may in the earliest stages be localized, but very soon becomes diffused, and extends along the muscles into the head, chest, and arm. In severe cases the patient will lie in the position that gives the most relief from pain, will be very averse to motion or any attempt thereto, and when necessary to change position will either do so by aiding the motion of the head with the hands, have it done by a bystander, or accomplish it very slowly and with complaint of suffering. Convalescence can be recognized by the greater freedom of motion.

Immobility of the neck is due to various causes; partly voluntarily, from the pain the least attempt at motion produces, and partly involuntary from the swelling of the parts, and the spasmodic tension of the muscles. Immobility being one of the chief diagnostic features of dislocation, it is essential that care be had to differentiate from sprain at this time it will be sufficient to observe that in dislocation, at least to a sufficient extent to produce the characteristic immobility, there will be more or less indication of spinal lesion, particularly paralytic symptoms.

Swelling is due to effusion, either serous or sanguineous, as occurs in the case of all contusions; when of blood the ecchymosis will be considerable and at once settle the question. If the blood remains fluid, and is poured out in considerable quantities, there is always danger

that some of it may find its way into the spinal canal, or becoming disorganized induce pyæmia. In the large majority of cases the swelling will be quite small; when the reverse greater care must be had in the examination, there being a reasonable presumption of graver lesion.

In rare cases there may be delirium, paraplegia, some paralytic conditions in some of the viscera, priapism, or convulsions, many of which, if not all, are producable by shock or concussion. While such symptoms are usually considered evidences of lesions of the cord, they may likewise be purely functional, and of a temporary character. With considerable effusion and swelling, it is often the case that one or more of the spinal roots are compressed, or they may have been squeezed at the time the neck was flexed. Such symptoms will, however, usually be onesided, and in the absence of any evidence of brain lesion, may be readily interpreted. Nevertheless there are exceptional instances, to which the surgeon must call to his aid his own common sense and powers of discrimination, which cannot be described with pen and ink.

The *pathology* does not differ from that of sprains in general, at least in any essential particular, excepting the liability of the roots of the nerves to injury as they pass out of the foramina. The muscles and ligaments are more or less lacerated, occasionally but a fibre or two, and again to some extent parts on the side of compression are contused; the venous sinuses are occasionally found ruptured, from being caught between the vertebræ, and as they are unprovided with valves the hæmorrhage is usually very profuse. In some instances, in which the exhibition of force has been extreme, there has been found evidences of partial dislocation, the parts slipping back into their position again, with slight fracture of the articulating surfaces.

The *treatment* depends upon the violence of the symptoms, and the extent of injury sustained by the parts. In ordinary cases, those in which the sufferer is not confined to his bed or house, *Rhus*, in any attenuation, given at intervals of an hour, will ordinarily produce perfect resolution in a day or two. In cases in which there is good reason to believe that there has been a slight dislocation, *Ruta g.*, has always done me good service. Much ecchymosis would call for *Arnica;* when the blood is fluid, however, forming a fluctuating swelling, *Hammamelis*, will have curative effects. Paraplegic symptoms, if due to shock, will be benefitted and often relieved by Faradaism of the affected parts. When shock alone seems to be the cause, *Arnica* will rarely fail to afford relief. So also when there is much ecchymosis, followed by more or less paralysis, there is a fair reason to suppose effusion into the vertebræl canal, and *Arnica* again will be the appropriate remedy.

In cases of greater severity, in which motion is excessively painful, and the constitutional symptoms severe, it will be necessary to have the head well supported by pillows, or even bags of sand, as long as

this sensitiveness continues; after this period, when motion can again be tolerated to some extent, caution must be exercised to avoid the continuance of this immobility, fearing future stiffness of the neck, and also to avoid too much or too violent motion, which might renew the active symptoms, or even establish inflammatory action.

(*b.*) *Lumbar Spine.*—Probably more sprains occur in this region of the spine than any other. The reason for this is thought to be the greater weight it is called upon to sustain, both in state of rest, and when the individual is engaged in any of the ordinary avocations of life; the position being between the fixed pelvis below, and the comparatively fixed dorsal spine above, and its greater exposure to accident from position and function.

The *causes* are similar to those observed in the case of the cervical spine, but in the majority of cases is a wrench or twist from attempts to save oneself from a fall or misstep. When occurring from a fall or jar, as has occurred in falls from a height on the nates, sudden arrest of momentum by the nates striking the ground, causes a very great weight, that of the thorax and head multiplied by the velocity of the fall, to fall upon this extremely flexible portion of the column. Indeed there are many cases on record in which both the neck and loins have equally suffered from such an accident. Accidents from machinery, such as being thrown over a shaft by belting, have caused many of the worst sprains; attempts to lift or carry heavy weights are also responsible for many accidents.

The *symptoms* vary greatly, as in the case of cervical sprains, but on the whole are more local in character, with less danger of lesions of the cord, and other nervous injuries, than obtains in other regions of the spine. The proximity of the kidneys, rectum and other abdominal and pelvic organs, predisposes to a group of symptoms peculiar to this region, and opens questions of deep interest to the medical jurist, which will be briefly discussed later. As far as pain, swelling and immobility are concerned, the symptoms are of similar character, and proceed from the same causes as when the neck is sprained. They may assume greater prominence, however, from the greater impediment to bodily movement. At times the pain and immobility will be so great, that suspicion of fracture or dislocation will be entertained. The fact that the pain extends through all the lumbar region on tactile examination or movement, and that the spinous processes can be traced in a direct line, will at once settle the question. Examination for purposes of differentiation will be very unsatisfactory unless made early before there has been time for much swelling. The pain in fracture, however, is localized, and attempts at motion, while causing some diffusion of the pain, will not remove or lessen that at the point of fracture; furthermore, the patient will *feel* a grating or slipping in the region, unless there should be impaction, which never occurs, or very rarely.

The *treatment* according to the prevailing authorities, contemplates

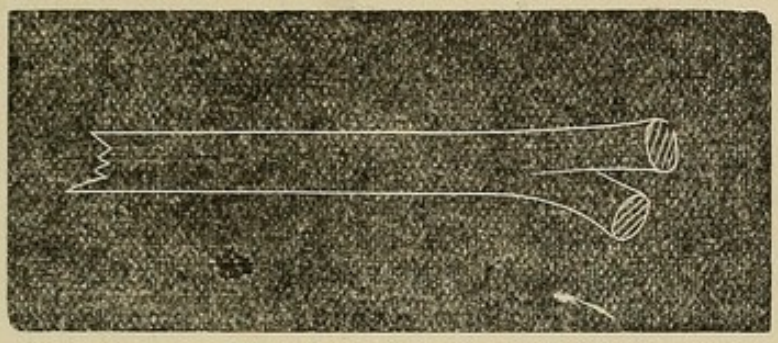
six or eight weeks in effecting a cure, even in the most favorable cases. My experience, whilst not large, has been respectable, teaches me that in nine out of ten cases, it need not consume as many days. *Rhus* is the most prominently indicated remedy, and has rarely, if ever, failed me, unless there was much ecchymosis, when *Arn.*, took the lead. Rest is an important aid, but it is perfectly competent to cure quite severe cases while the patient is moving about with the aid of a stick, attending to the ordinary affairs of life.

Some of the more frequent concomitants and sequelæ of sprains of the spine, particularly as they involve the spinal cord, remain to be considered; while our knowledge of these conditions is necessarily limited, any attempt at a systematic study of this common lesion would be incomplete without reference at least, to some of those more constant.

(*a.*) *Hæmaturia*, or bloody urine, is one of the more frequent concomitants of lumbar sprain. The situation of the kidneys with reference to the spine, and their somewhat fixed position, predisposes them to injury when the flexure of the spine has been extreme. That the blood so often observed in the urine is from a laceration of the kidney has been shown by the few autopsies that have been made; also that the laceration is in the pelvis of the organ. The amount of blood varies from a few drops sufficient to color the urine, to a positive hæmorrhage, which may and has been so profuse as to endanger life. In many instances it will cease in a day or two, and be reproduced a number of times, but in no well authenticated cases has the accident resulted in permanent disease of the kidney when no disorganization or predisposition thereto existed prior to the accident. In several instances, as appears in the various works on medical jurisprudence, suit has been brought against railway companies for damages resulting from accidents, when it was claimed that Bright's disease had been caused by the accident. In every instance, so far as my knowledge goes, it has been conclusively shown that the disease either existed prior to the accident, or what was supposed to be such a condition disappeared after a time, showing a purely traumatic condition. In several instances, however, juries have given plaintiff damages, when all the medical testimony was in favor of the defendant, probably from a well-known hostility to large corporations prevailing among the class from among whom juries are usually drawn.

The *treatment* of hæmaturia is not at all times easily determined, so much depending upon the extent of the lesion in the kidney. Although it will be reached again, when I come to speak of *Injuries to the Pelvis*, it may be noted here, that very frequently after a few discharges of blood from the urethra, there will be a suppression of urine, the cause for which may cause embarrassment unless prepared for it. On introducing a catheter it will be found that no urine flows upon withdrawing it the fenestra will be found filled with coagulated blood. The difficulty is now seen to be the lodgment of a clot of blood in the

neck of the bladder. This must be broken up with a catheter or sound; if the urine still flows with difficulty, injections of warm water may be practiced, through a double catheter like that exhibited in the



No. 31. Double Catheter.

accompanying cut. The double catheter is to be preferred to the ordinary form, inasmuch as the necessity for withdrawing and re-introducing the instrument is avoided. The urine will sometimes flow in a steady stream, with considerable force, when suddenly there will be a distinct shock felt by the hand holding the instrument, and the flow will be at once arrested. This is caused by a clot of blood falling into the fenestra of the catheter. Do not withdraw the instrument, if possible; it can usually be cleaned by applying suction with a syringe. There are cases noted, in which death has occurred, when the whole cavity of the bladder, greatly distended, has been found filled with coagulated blood, and the pelvis of the kidneys likewise engorged.

Arnica, or *Hamamelis* are the remedies most frequently called for in hæmaturia, the differential indications not being very exact or readily made out. As a rule it may be said that *Arnica* is indicated the greater the shock. When constitutional symptoms are absent or insignificant, *Ham.* would more properly be the remedy.

(*b.*) *Hæmorrhage into the canal* is an occasional concomitant of sprains, and one of an exceedingly grave character. Up to the present time it has been found almost impossible to determine with any degree of certainty the existence of this accident; it is always a mere conjecture. The symptoms are sufficiently pronounced, but resemble so closely concussion or compression of the cord that it defies modern science to differentiate the conditions. The accident is usually due to extreme flexure of the spine, more frequently laterally, by which the venous sinuses are torn or squeezed. When the blood is poured into the subcutaneous cellular tissue there is a reasonable certainty in attributing symptoms of spinal lesion to effusion of blood into the canal, if for no other reason, because there is evidence of considerable hæmorrhage. Under other circumstances, no blood appearing under the skin, there cannot fail to be much doubt.

The *symptoms* are generally paraplegic, but vary somewhat from those following destruction of the cord. When the cervical region is the seat of the injury, there is very frequently priapism, retention of urine, and constipation as primary symptoms. Later there will be

incontinence of urine, diarrhœa, occasionally with involuntary stools, and shriveling of the sexual organs. These symptoms are not so marked when the lumbar spine is affected. The paralytic symptoms are very irregular, and cannot at all times be readily accounted for. Thus cases have occurred in which the left arm and right leg lose both sensation and power of motion, with some lowering of the temperature. In others the symptoms will be choræic, sensation either unimpaired or exalted, but co-ordination disturbed, and the affected parts thrown about entirely beyond the control of the will. At other times the paralysis will be complete, both sides being affected alike. The symptoms are established very speedily after the accident, and slowly increase in intensity until the maximum is reached, when they may as slowly decline or remain permanent. It is only in exceptional cases, however, that perfect recovery takes place. The blood as it increases in amount, in the same proportion increases the intensity of the symptoms. The flow ceasing, the symptoms have reached their maximum, and commence to decline. Moreover, the lower portions of the canal being first filled with the blood, it is function derived from nerves supplied by that portion of the cord that first suffers. Should the extravasated blood be absorbed completely, perfect recovery may ensue, provided the compression to which the cord has been subjected has not continued so long that some lesion has been produced. Otherwise the symptoms may remain for an indefinite period, or morbid action once set up, some bodily vice may perpetuate or aggravate it. Complete resolution very rarely occurs. The commoner termination, it is thought, is a coagulation of the blood, partial absorption, and great injury done the cord by the contraction of the coagulum. In other instances, even when the greater portion of the blood is absorbed, small coagulæ remain attached to the walls of the canal or the dura mater, which at the best keep up more or less spinal irritation, and in some dyscrasic individuals even establish suppuration.

The *treatment* is as unsatisfactory as the diagnosis. This is unquestionably due to the obscurity surrounding the etiology. In ordinary practice, I do not question for a moment, etiology may be largely ignored, and the patient treated solely by indications purely subjective. But in conditions like the present, this method would signally fail. The symptoms, as has been shown may be of a character to indicate any supposable lesion of the cord, and any one out of a long list of remedies. Here we have but one solitary indication, *viz.:* the promotion of absorption of the extravasated blood. There is but one remedy, perhaps two, that is known to produce any such effect, at least as far as my knowledge extends. That remedy is *Arnica*. If any other has similar properties it would be *Conium*. Whilst *Rhus*, therefore, would be the remedy oftener indicated for a sprain, if effusion into the spinal canal can be made out *Arnica* must take precedence. From the difficulty met with in establishing this point, it seems to me, our treatment must always be purely expectant, and quite unsatisfactory.

(c.) *Inflammation and suppuration* are very remotely sequelæ to sprains of the spine, and in the absence of dyscrasia many authors deny the occurrence. On the other hand the relation of the dura mater to the vertebral canal would readily account for the latency of such conditions, or the failure to recognize them until well advanced. In the skull the intimate relation between the dura mater and bones, the former actually fulfilling the office of periosteum, morbid action in the bones is readily extended to the brain. In the spinal canal, on the other hand, there is a proper periosteum, and the dura mater, except at the point of exit for the spinal nerves, is far removed from the bones. Hence, inflammatory conditions may exist for a long time before the cord will be implicated, at least to a sufficient extent to attract attention. The earlier symptoms will invariably proceed from irritation at the roots of the nerves, and being one-sided, evidently not from cerebral irritation, attention will be directed to the point of injury. Another question then presents itself; is it a case of caries, and if so, what agency had the sprain in its production?

In caries the bodies of the vertebræ are chiefly attacked, and as they break down produce great deformity, projection of the spinous processes being the most marked. There are evident signs, also, of severe constitutional disturbance, symptoms that can hardly be misinterpreted. In the case of inflammation from sprain, the articulating surfaces of the lamellæ, and transverse processes suffer, and there can be great destruction of the parts with very little, if any, deformity. Abscesses forming in the region of the spine, evidently implicating the bones, can be distinguished from caries, therefore, by the absence of deformity, of cachexia, and of any history of constitutional trouble pre-existent to the accident. There can be no doubt, as every case of caries is referred by the sufferer to the reception of injury, that caries *may* succeed a sprain of the back; it can never be considered as more than an accidental exciting cause, the disease would be developed sooner or later, without any such accident.

It has been thought that the more frequent cause of inflammation of the spine, is a considerable displacement of the vertebræ, which slips back into position immediately, but only after severely contusing and squeezing the parts involved. Under all circumstances, however, the symptoms are slowly developed, and may pass away without suppuration ensuing.

The consequences, or results of inflammation, are various, apart from suppuration. Resolution is probably the more frequent, particularly where the diagnosis is made out early, judging from the infrequency with which we meet with reports of cases in the journals.

Erosion of the bone, and spontaneous fracture of some of the processes entering into the formation of the arch of the vertebræ, will be liable to occur when the inflammation is unchecked. It can hardly occur to any extent unless suppuration occurs. Such an occur-

rence will be nearly as serious as caries, portions of bone being detached, and abscesses form in the soft tissues, which have a tendency to reopen after being partially healed, which sooner or later exhausts the patient, inducing hectic, or pyæmia. The admission of pus into the vertebræl canal will set up some destructive affection of the cord, and the prognosis will be decidedly unfavorable.

The *treatment* depends upon the stage in which the condition is when recognized. In the earlier stages, when the integrity of the bone has not suffered, *Arnica* will be the remedy usually selected. Should suppuration have become established, and abscesses form, the pus must be freely evacuated. A failure to attend to this important matter, will precipitate that which every effort should be made to avoid, *viz.*, the admission of pus into the vertebræl canal. Should pyæmia threaten, it should be treated precisely as when originating elsewhere (*See Surgical Therapeutics*). When there is loss of osseous tissue some attention must be paid to splints, braces, position, or some measures taken to avert deformity, for recovery can then only occur with more or less anchylosis.

II. FRACTURES.

Fractures of the spine, are usually the result of the direct application of force; in very few instances are examples of indirect fracture observed. For convenience of description, as well because the division is logical and practical, I shall adopt the method of PROF. HAMILTON, and classify these lesions with reference to the different portions of a vertebræ, *i. e.*, first of the spinous processes, next of the transverse processes, then of the arches, closing with fractures of the body. Gun-shot fractures will require a few words in addition, and from the fact that they are always compound, whilst those from other causes are more frequently simple, it might be well, as some writers have already attempted, to treat the subject under these two heads. We cannot proceed far in our studies before the conviction is reached that the arrangement is purely artificial and impractical.

(*a.*) FRACTURE OF THE SPINOUS PROCESSES occurs in all regions of the spinal column, with less frequency in the lumbar spine on account of the projection backwards and upwards of the spine of the ilium on each side, as well as the greater strength of the processes themselves.

The *causes*, when direct, are blows upon the processes, either downward, or laterally. When applied directly on the extremity, tending to drive the process in upon the canal, the force will usually, or at least with great frequency, cause fracture of the arch. Indirectly the spines may be fractured by severe muscular effort, or sudden tension being placed on the ligaments; indeed a case was reported in a foreign journal some time since, the reference is unfortunately lost, in which on examining the body of a criminal who had been executed by hanging, two of the spinous processes in the cervical region, the sixth and the seventh, were completely fractured.

The *symptoms* are chiefly pain, mobility, frequently crepitus, and occasionally displacement. Pain is constant, and while quite severe at all times, is more particularly so when the trunk is bent forwards, thus putting the tissues of the back on the stretch.

Mobility is always marked, and while a certain indication may very well prove a deceptive one as to the exact nature of the injury. It may be fracture of the arches, in place of the spinous projection, the fact that there are no evidences of lesion of the cord, and the spinous process is not driven in, will ordinarily settle the question. Should the force producing the fracture be extreme, the concussion may cause paralytic symptoms, but as they are transient in character, a little delay in completing the diagnosis will enable the examiner to arrive at a correct opinion.

Displacement occasionally occurs, but rarely to such an extent, at least laterally, to produce much deformity. The record of nearly all the cases to which I have access, fail to note any marked displacement, and when we consider the strength and number of the ligaments and muscles attached to these processes, we cease to wonder that displacement so rarely occurs. Occasionally the fragment will be found forced downward, the appearance then resembling fracture of the arches or body that unusual care must be had in the examination. This is the more necessary as the force under those circumstances is usually so great that sufficient shock or concussion may be communicated to the cord and brain to produce paralytic symptoms of any degree of gravity. As said earlier, however, such symptoms are quite transient, and after a day or two, there should be no difficulty in arriving at a correct conclusion.

The *prognosis*, as to repair of the injury, is not good. It was stated by many of the older writers, notably HIPPOCRATES, that such fractures healed with as great readiness as in the case of other spongy bones. HAMILTON, together with all the more modern writers, arrive at an entirely different conclusion. In the vast majority of instances there is no appearance of union when an opportunity is presented years after such an accident, for examining the parts at post-mortems. In but one case, in fact, related by SIR ASTLEY COOPER, occurring in the practice of MR. KEY, has any kind of union been observed, and in this it was ligamentous and imperfect.

The *treatment* is purely expectant. In short there is nothing to be done. There always being room to doubt whether the arches are involved or not, no one would feel justified in applying retentive dressings, which would have a tendency to force the fragments in upon the cord, if the lamellæ were really fractured. Securing a comfortable position, and meeting febrile or inflammatory symptoms as they arise, with an occasional dose of *Symphytum* to hasten repair, will include all the indications. No great damage will result, if union *should* occur, with some displacement, which, however, is so seldom the case that it may safely be asserted the fragments are always found in position.

(*b.*) FRACTURE OF THE TRANSVERSE PROCESSES can scarcely occur except from direct violence, as a gun-shot, or some stabbing weapon. Very many cases have occurred, unquestionably, in which the accident was never recognized, the symptoms as related to the bone, at least, proving too insignificant to challenge attention. Such symptoms as are common to fractures of the various processes of the spine, such as mobility and severe deformity, will be found, but in the large majority of cases the symptoms of associated spinal lesion will entirely obscure those relating to the bones. In fact, should the accident occur in such a manner that the injury is confined to these processes, there is small chance that the true condition would ever be recognized. Such symptoms as pain and swelling would be attributed to contusion or sprain, and the fracture escape detection.

The force being always an extreme one, we will expect to find concussion of the cord, some wounding of the same, or effusion, either inflammatory or hæmorrhagic into the vertebral canal. For this reason, whilst the fracture itself is quite an insignificant affair, a prognosis is at all times unfavorable, the majority of such cases terminating fatally.

The *treatment*, as far as the fracture is concerned, is expectant; the patient is to be placed in the most comfortable position, and the various complications to be met as they arise. The few cases that have recovered, or at least in which death was delayed some months have on *post mortem* examination exhibited no signs of an attempt at repair. The broken extremities of the bone have been found rounded off, and either totally unconnected, or a false joint formed as was seen to be the case in fracture of the spinous processes.

(*c.*) FRACTURE OF THE VERTEBRAL ARCHES occurs, for the most part, when the blow is received directly on the spinous processes, driving them in on the cord, or laterally. The same force, in fact, that received not in the exact axis of the processes, will cause a fracture of the spinous proterberance which in the same axis will be communicated to the lamellar plates. As far as examination has been had both plates are broken, the pedicles rarely if ever being involved.

The *symptoms* vary materially from those indicative of either of the forms of fracture we have just considered. Displacement is the rule, and while a depression of the spinous process is usually observed, cases have occurred in which it was laterally. This last is produced by the fragments over-riding on one side. The nature of this fracture, and the direction of the force as usually applied, renders it almost impossible that the cord should escape injury. This will serve to assist in forming a diagnosis in doubtful cases, for, as has been shown, in fractures of the spinous processes, such symptoms are due to concussion or shock, and will soon pass away. Furthermore, in some instances, particularly when the case is seen sufficiently early, it may be possible to secure mobility of the fragments in such a manner that no doubt can be entertained as to the seat of fracture.

Cases occur, again, in which the symptoms of injury to to the cord are so extreme, and the sinking of the spinous processes so considerable, that fracture of the body will be suspected. Something may be predicated, as HAMILTON says, on a consideration of the "direction and manner of the blow which has produced the fracture. Thus a fall upon the top of the head would most often produce a comminution of the bodies by crushing them together; while a blow upon the back could scarcely break one of the vertebræ, without breaking the corresponding arch also. We might thus be led to infer in the first instance, that the arches were not broken; and, in the second instance if we could convince ourselves that the arches were not broken, we might rest pretty well assured that the bodies were not." Again, it must be borne in mind, a fracture of the arch may be clearly made out, and yet the observer still remain in doubt as to the condition of the bodies.

Symptoms of injury to the cord, which are of especial interest in this form of fracture, vary with the region injured. Following the arrangement of HAMILTON, in this respect, their consideration will be embraced under the head of fractures of the bodies of the vertebræ, which will save repetition.

The *treatment*, as is usual in spinal fractures, is altogether expectant. If there is no displacement, there is nothing to be done further than preserving quietude in some comfortable posture, and meeting concomitant conditions as they appear. The lesions to the cord are the chief interest, and in the absence of actual wounding will probably be due to effusion into the canal, or to shock or concussion. These have been partially referred to elsewhere, and will claim our attention more fully before the close of this chapter. *Arnica*, we may state in passing, will probable be the remedy in a majority of cases, as the frequency of effusion is greater than that of wounding.

With displacement the question naturally arises, whether attempts at reduction should be made, and if so what method shall be employed, HAMILTON (*Fractures* p. 148), discusses this question at considerable length, and in common with nearly all of the authorities of to-day, concludes that it is worse than useless. The patient will die if the fracture is unreduced, it is true; from a comparision of all the cases reported to which he had access, it appears that every one that was well authenticated, died after any operation. Surgeons of the first position, have repeatedly attempted operative measures, but invariably death has ensued. So uniformly has this been the case, that all reports to the contrary will be received with great suspicion, and it will require unusual evidence to alter the conviction of surgical practitioners that the case will do better if left to nature. If reduction should be effected, there is no possibility of securing retention. The accident is an eminently fatal one, death being due, as in the case of fracture of the transverse processes, to the associate injury to the cord. Recoveries have occurred, but in every instance it was where the officious practitioner would consider the "case had been shamefully eglected."

(*d.*) FRACTURE OF THE BODIES OF THE VERTEBRÆ are produced in various ways; either by blows directly on the spinous processes, in which case the arches are also broken; falls upon the head or nates; extreme flexion, as in the case of sprains; or from injury directly to the bone, as in the case of gun-shot accidents, or wounds from some stabbing weapon. It is impossible to state under which circumstances fracture oftener occurs; perhaps, all things considered, transmitted force is oftener the means. We have already seen, as MALGAIGNE has shown, that there are three points in the spinal column where motion is free, and that sprains occur, for the most part, at the point where an inflexible joins on to a flexible portion. In the case of fracture, and dislocation as well, the injury is sustained by the vertebræ forming the flexible part of the column. Thus we find the majority of the fractures, except those from direct violence, in either the region between the third and seventh cervical vertebræ, the eleventh dorsal and second lumbar, or the fourth lumbar and the sacrum. There are a few instances recorded of supposed fracture of the bodies of vertebræ by muscular action alone, or by transmitted force from the head striking the water when diving from a height. In both of them there are too many elements of doubt to permit us to include them in a list of probable causes.

The direction of the line of fracture, and its character, varies greatly. In some the bone is crushed into a great number of fragments; in others a small piece is chipped off; in still others the break is vertical or transverse; and in a large number of instances oblique, the line of fracture being from above downward, and from behind forward. In cases in which the force has been a crushing one, from above downward, the injury is rarely confined to the body of the bone, the spinous process, and arches usually partaking in the lesion.

Displacement is usually marked in these fractures, the upper fragment riding down over the lower. The deformity thus produced is extreme, throwing the spine out at a sharp angle, the point of the angle being formed by the spinous process next below the fractured vertebræ. It is this displacement, and consequent compression or laceration of the spinal cord, which causes so much interest to attach to this form of fracture.

Prognosis is always unfavorable, although there are many cases which escape with life; in these, however, there are functional troubles, of a paralytic character, that are never fully relieved.

The *symptoms* vary greatly with the region injured; certain symptoms, however, are common to all. Thus there is common pain, more particularly on contact or attempts at motion; swelling; ecchymosis; often crepitus; angular deformity, to some extent in all cases, but occasionally very slight; particularly, as symptoms of the first importance, paralysis of parts below the seat of fracture, due to lesions of the cord or spinal nerves. The bladder is paralyzed, in nearly all cases, and the urine is markedly alkaline; priapism is common, par-

ticularly in cervical fractures; at first retention of urine, followed by incontinence. So with the rectum, there is ordinarily first a spasmodic contraction of the sphincter, with retention of fæces, followed by diarrhœa with involuntary stools. Respiration, cardiac action, and other functional acts are more or less disturbed, depending upon location, and bed sores are frequent. To properly understand the significance of these symptoms, it will be necessary to take up each region of the spine separately.

HAMILTON (*op. cit.* 152), says: "Those who die immediately seem to be asphyxiated; while those who die later seem to wear out from general irritation, this condition being frequently accompanied with an obstinate diarrhœa and vomiting. A few become comatose before

Treatment will be taken up in connection with the consideration of fractures in the different regions.

(1.) *Lumbar vertebræ*.—The majority of fractures in this region are either from indirect causes, or gun-shot, the projection of the wings of the pelvis shielding them from ordinary injury from behind. The most dangerous fractures are those involving the first and second vertebræ, for the reason that the spinal cord does not extend much, if any, below the lower border of the first; the remainder of the canal is occupied by a bundle of large nevres, afterwards becoming an integral portion of the ilio-sacral plexus, collectively known as the "cauda equina." The nerves are so much firmer in texture than the spinal marrow, that they are enabled to withstand much greater compression. Furthermore, being loosely connected they slip easily among each other. The displacement must be considerable that will cause serious lesion to this portion of the cord. This constitutes one of the very few instances in the animal economy, when a part comparatively tolerant of injury is better protected from injury than one that needs such a safe-guard.

The nerves emerging from the lumbar and sacral foraminæ, supply most of the pelvic organs, the sphincter, genital apparatus, and perineum, as well as much of the lower extremities. It needs no further mention to show serious consequences may follow lesions of the cord in this locality. When the medulla is completely divided all functional life must at once cease in these important regions, and their complete and total loss is only a matter of time. When there is no positive laceration, but the cord is subjected to extreme compression, the paralytic condition may gradually improve, if life is preserved, but full restoration can never occur; in fact the improvement will always be very slight, but sufficient, perhaps, to admit of locomotion with the aid of some mechanical appliance, and to enable the sufferer to follow some kind of occupation.

In one case mentioned by HAMILTON, (*Ibid.* 154) the patient was confined to the bed seven months. "After eighteen months he began to use crutches. At the end of about three years all improvement ceased; at which time he could not quite stand alone. * * * * * This was also his condition one year later."

A case occurred in the practice of MR. KEY, as related by SIR ASTLEY COOPER, in which the cord was completely separated at the first lumbar vertebræ, and yet the patient survived the injury one year and two days. COOPER mentions another case, also, that survived a fracture of the first and second lumbar vertebræ, and "survived the accident a year lacking nine days. * * * After death it was ascertained that the fracture had united by bond, and that the spinal marrow was almost completely cut in two, the divided extremities being enlarged and separated nearly an inch from each other."

(2) *Dorsal Vertebræ.*—The symptoms of fracture of the dorsal spine are precisely the same as when occurring lower down, excepting that other organs and parts are paralyzed, higher topographically and in vital importance, and the fatality correspondingly increased. Respiratory, cardiac, and abdominal complications here arise; tympanitis, indigestion and labored respiration taking the lead. In the few cases recorded in which death occurred, the patients survived the accident from between six days and three months. One or two instances are mentioned of recovery, as far as preservation of life was concerned, when the injury to the cord was supposed to be very extensive.

The *causes* are either direct injury, extreme flexion, or transmitted force; when from gun-shot the nature of the lesion is so unique that an especial paragraph will be needed from its consideration. HAMILTON, (*Ibid.* p. 155) quotes a typical case, reported by LENTE in the *Amer. Jour. of Medical Science* for 1857, which is quoted here as being typical: "Barney McGuire having fallen a distance of twelve or fifteen feet on his back, was found with nearly complete paralysis of his lower extremities and his bladder. Swelling existed over the lower dorsal vertebræ, and this point was very tender. Subsequently, when the swelling subsided, the prominence of the spinous processes of the tenth and eleventh dorsal vertebræ put the question of a fracture beyond doubt. Gradually, under the use of cups, Strychnia, mineral acids, laxatives, buchu and electricity, his symptoms improved. In six months he was able to walk about the streets, and four years after the accident he was employed in a foundry under regular wages, being able to stand fifteen or twenty minutes at a time, and to walk half a mile without resting. At this time there remained no tenderness in the spine, but the projection of the process was the same as at first."

(3.) *Cervical Vertebræ.* Fracture of the lower five cervical vertebræ presents the same local symptoms observed in other regions of the spine, somewhat more prominent, in many particulars, owing to the more superficial position of the bones. The same paralytic conditions are observed, but we have as additions paralysis of the upper extremities, and greater embarrassment of respiration, with more speedy and certain death; owing to the imperfect respiration, the blood is not fully arrested, and the face is usually puffy and the eyes red and suffused. I am not aware of any instances of full recovery after this

accident, but one case is reported by HAMILTON, occurring in the practice of Mr. Hilton, which survived fourteen years, dying, however, from the effect of the fracture. The usual duration of life, estimating it from such records as are available, is from twelve hours, to three days. The following case from HAMILTON (p. 156,) will give a fair account of the typical conditions.

"On the 25th of July, 1857, a sailor fell backwards from the wharf, striking with the nape of his neck upon a bar of iron. I saw him on the following day, in consultation with his attending physician, Dr. Edwards. He was lying upon his back, breathing rapidly. His lower extremities were completely paralyzed; legs and feet swollen and purple; right arm completely paralyzed, and his left partially; from a point below the line of the second rib, there was no sensation whatever; his bowels had not moved, although he had already taken active cathartics; the urine had been drawn with a catheter; the pulse was slower than natural, and irregular. He was constantly vomiting. In reply to questions, he said that he felt well, articulating distinctly and with a good voice. His eyes and face were somewhat congested, but with this exception, his countenance did not betray the least physical disturbance. He lived in this condition about forty hours, only breathing shorter and shorter, and his consciousness remaining to the last moment."

"In proceeding to examine the spine a few hours after death, and before any incision was made, we were unable, upon the most minute examination, to detect any irregularity of the processes of the cervical vertebræ, or any crepitus; but on dissecting the neck, we found that the arches of the third and fourth vertebræ were broken, and the spinous processes slightly depressed upon the cord. The bodies of the corresponding vertebræ were comminuted, and the vertebræ above were driven down upon them, carrying the processes in the same direction. The theca and the spinal marrow were almost completely severed upon a level with the fourth vertebræ,"

(5.) *Of the Axis.*—From the fact that the phrenic nerve passes out from between the third and fourth cervical vertebræ, any fracture above or at this point, providing there is any displacement, or other lesion of the cord, must be fatal at once, at the best, death will be delayed but for a few moments. Without displacement the symptoms will be largely those of severe sprain, and the patient may survive, as occurred in one case, five months. Cases in which death has been delayed, are usually found to be those in which the fragments are not primarily displaced, but later, upon some unlucky movement of the head, they are thrown out of position, the cord is torn or compressed, and death ensues. In other instances, which, however, are quite few in number and somewhat problematical, a slight wound of the cord is made, the fractured bone unites, and cicatricial contraction of the cord produces progressive paralysis, with ultimate death. Sudden death, after a prolonged interval, from displacement of the

fragments, occurs with more frequency when the odontoid process is fractured. In these cases, the pain and feeling of insecurity in the head, obliges the patient to instinctly guard against rotation, at some unguarded moment a sudden turning of the head occurs, the atlas slips forward or laterally on the axis, and death ensues.

One case is reported, by DR. W. BAYARD of St. Johns, N. B., extracted by HAMILTON from the *Canada Med. Jour.*, Dec. 1869, which is thus reported: "In August, 1864, Charlotte Magee, of St. John, aged six years, previously in excellent health, fell five feet, striking on her head and neck, causing an immediate immobility of the head, which continued about two years and a half, when an abscess formed in the back of the pharynx, and the bone was spontaneously discharged. Since that she has been able to move the head freely, and her recovery may be said to be complete. The specimen was subsequently presented to the N. Y. Pathological Society, and no doubt remains that the entire process was thrown off."

(6.) *Of the Atlas.*—Fractures of the first cervical vertebræ are so rare, that Hamilton knows of but a single case in which that bone alone suffered. There are a number of instances of both the atlas and axis being fractured, the symptoms for the most part being similar to either one of the bones, depending upon which fragments sustain the greater displacement; ordinarily, it has been observed, the symptoms are more indicative of fracture of the axis than the atlas.

In the case of fractures of the atlas referred to by HAMILTON, occurring in the case of a boy who had been injured while carrying a heavy weight on the head, there did not seem to have been any displacement of the fragments. Indeed from a study of the anatomy of the parts, it would seem that displacement of a fragment inward upon the cord, must be a very infrequent occurrence, as the tendency must be to spreading outward. It is highly probable that cases have occurred other than that noticed by HAMILTON, the symptoms of fracture of that bone being quite obscure, particularly when they occur in the practice of those who have no especial aptitude for or practical knowledge of surgery. Death is inevitable, and if the cord escapes injury at the time of the accident, probably extravasation of blood, or inflammatory processes, are responsible for the fatal termination. In the case referred to, the boy held the chin in the hand, supporting the head very carefully, walking as if carrying an object on the head, to avoid jarring. If looking downward the chin was held in the hand; if looking upward the back of the head was similarly supported. If he was jarred, or in any way shaken, as in making a sudden movement, severe pain was felt, and he was obliged to sit down and hold the head firmly with his hands. On attempting to turn his head, the whole body was turned. He survived the injury about one year.

TREATMENT OF FRACTURES OF THE BODIES OF THE VERTEBRÆ.

The first question that would naturally arise is, shall any attempt be made to reduce the fracture. In the vast majority of instances the answer must be no! There are two excellent reasons, it appears to me, why reduction should be seldom attempted. In the first place, even in the most typical cases, there is always room for doubt as to the actual condition; fracture being made out, whether it is confined to the body or the arches, or both have suffered, cannot at all times be definitely ascertained. There is also, as will be shown later, much difficulty in differentiating between dislocation and fracture in a large proportion of cases. It must be apparent that the doubt hanging around the condition of the bones, must exist to an equal if not greater extent, with reference to the cord. What may be thought to indicate severe injury to the cord, may be simply due to shock, and *vice versa*. Realizing, therefore, the danger there must be to the integrity of the cord, in manipulating fragments of bone possibly in close relation to it, we can at once comprehend a potent objection to attempts at reduction indiscriminately. It is impossible to indicate the conditions that would render reduction of the fracture justifiable; each practitioner must be the judge as the case is presented to him. It must never be forgotten, however, that when a fragment of a vertebræ is pressed into the substance of the spinal cord, or lies in close apposition to it, if attempts at reduction are instituted, and successfully accomplished without aggravating the lesion to the cord, it does not evidence any unusual skill in the operator, the result being purely a matter of chance, as some one had said, due to "his good luck."

In the second place, supposing the fracture reduced, how is retention to be secured? It will be found in nearly every instance actually impossible. If the displaced fragments are angular, with sharp corners and edges, the ordinary motions of the part in respiration will displace them, and the latter condition probably be worse than the first. From every point of view, notwithstanding some good authorities advise to the contrary, I am decidedly of the opinion that unless there are unmistakable reasons for the contrary practice, the position of the fragments had much better be allowed to remain unchanged.

In cases in which it would appear that the displacement is slight, or that would in any way seem to demand an attempt at reduction, in preference to attempting this by manipulation, the weight and pulley method used in treating fractures of the long bones may be employed. Raise the foot of the bedstead by placing one or two bricks under each foot. Place the patient on the back, as gently as possible, so that there will be no danger of disarranging the fragments. Attach two broad bands of adhesive plaster, one on each side of the body, embracing the trunk from a level with the last rib, to the trochanter of the femur; each band will be about six inches in width, and about two feet in length. To the unattached portion below, affix strong bands of webbing or canvass. These are to be fastened to a stick, about two

feet and a half in length, to which is attached, by cord weights, varying from ten to twenty-five pounds, according to the necessities of the case, and hanging over the foot of the bed. In many instances the weight of the body will be sufficient for purposes of counter extension; when not so it may be secured by passing an axilary band on each side, attached to the head-board of the bed. The trunk may be further supported by bags of sand or bran properly bestowed.

In cases where extension does not seem desirable, as far as position is concerned, it must be determined with sole reference to comfort; which ever posture gives the most relief from pain, is the proper posture to be prescribed.

Attention must be paid to the bowels, bladder, and condition of the skin. The bladder must be emptied at once, and afterward as frequently as once in six or eight hours. The alkalinity of the urine will have a tendency to greatly excoriate and irritate the skin, and every precaution must be taken to prevent its being brought into contact with it, such as from wet cloths on which it is allowed to dribble. The contractility of the bladder being lost, the sphincters likewise suffer so that dribbling of urine does not indicate that the bladder in capable of discharging its contents, but that it is overflowing. Were it not for the irritation that a more frequent use of the catheter would cause, it would add to the comfort of the patient to empty the bladder oftener. How far it would be practicable to keep the instrument in the bladder, closing the opening with a plug, I am not prepared to state; my preferance would certainly be, as far as my knowledge goes, to adopt a different course.

The bowels must be emptied if possible, but it is useless to resort to purgative medicines for the purpose. To produce any result, under the altered condition of innervation, the doses must be excessive, and the drug very powerful and drastic in its character. Copious injections are to be preferred. If necessary they must be emptied by instrumental means, if they seem full and other methods fail.

Bed sores are quite certain to add to the complications of the case if life is continued any time, and under the peculiar condition of affairs little hope can be entertained of a cure. Recognizing the probability of such an event, it will be a wise precaution, when it can be done, to place the patient on an air or water bed immediately, or at all events so to protect prominent parts from pressure that the danger might be lessened for some time at least. All the essential elements of repair are necessarily lacking in a case of this character, and the prospect of a cure must be discouraging. (*Vide. Surg. Therap.*)

The remedies to be used will depend entirely upon the characters of the case. Under all circumstances the cord will demand the principal attention, the fractured bones being necessarily permitted to take care of themselves. In the absence of any special indications, *Arnica* should be used. When symptoms of some definite spinal lesion are developed, a remedy may be selected based on those symptoms. For this con-

sult a later paragraph, (on *Injuries of the Cord*) as well as the chapter on Diseases of the Spine in another volume of this series, (*Surgical Therapeutics.*)

(2.) GUN-SHOT FRACTURES.—The most elaborate essay on wounds of the spinal column from gun-shot, based upon actual clinical experience, is contained in the *Medical and Surgical History of the War of the Rebellion*, particularly in the first part of the surgical volume. In what remains to be said I shall draw liberally on these reports, particularly from the analysis of the various tables found on page 452 *et seq.* There can be no question that the reports there published do not approximate the total number of such lesions; many sufferers meeting their death in the field, dying from the lesion on the spot; the records, therefore, only include such cases as were subjects of treatment in the various hospitals. Whilst it is possible, that the actual mortality from the lesion of the spine and cord, was as high as 71 per centum, the table of results, as given below, exhibits a much smaller ratio from the fact that many trivial lesions of the spine resulted fatally from associate injury to other organs in the transit of the missile. The following includes all the cases brought into hospitals, and made matters of record:

REGION.	CASES.	DIED.	DISC'H.	DUTY.	UNK'N.	MORTALITY
Cervical,	91	63	19	8	1	70-0
Dorsal,	137	87	32	18		63-5
Lumbar,	149	66	51	28	4	45-5
Crevical and Dorsal,	2	1	1			50-0
Dorsal and Lumbar,	3	3				100-0
Not stated,	260	129	72	50	9	51-4
TOTALS,	642	349	175	104	14	55-5

Among seventy-three cases in which the ball had either lodged in one of the processes or body, and could not be extracted; or in which while possibly not impacted it could not be traced, the mortality was found to be very high. As occurs in all the tables, lesions of the lumbar spine were less fatal than the others, the dorsal being slightly more so than the cervical.

REGION.	CASES.	DIED.	DISC'H.	DUTY.	UNK'N.
Cervical,	12	8	1	2	1
Dorsal,	34	31	1	1	1
Lumbar,	21	16	5		
Not stated,	6	3	2	1	
TOTALS,	73	58	9	4	2

The fair presumption is, that all cases terminating fatally, in which visceral lesions were not severe enough to destroy life, (even when the injury to the spine was comparatively trivial,) did so from lesions to the cord, at all events, the few cases in which an examination into the

condition of the cord was made, but fifty-four in number, death was undoubtedly due to such lesions; in a few cases discharged the disability seems to have been permanent. Thus, they may be tabulated, out of fifty-four cases, forty-two died, and twelve were discharged. None are reported as having been returned to duty.

The operations in connection with fracture of the vertebræ, embracing removal of balls, and fragments of bone, give a somewhat different result from that which we would expect from a consideration of what I have previously written. It must be remembered, however, that the "operations," in very many instances, consisted in the removal of spiculæ, or necrosed portions; probably none, or but few of them, were formal operations, cutting down upon fragments through the unbroken tissues. The fractures being largely compound, the most that was done, probably, was to enlarge a wound. The results are thus stated:

OPERATION.	REGION.	CASES.	DIED.	DISC'H.	DUTY.	UNK'N.
Ball Removed.	Cervical.	1	1			
" "	Dorsal.	12	4	7	1	
" "	Lumbar.	16	5	7	3	1
" "	Not stated,	5	3	1		1
Bone Removed,	Cervical,	5	2	2	1	
" "	Dorsal,	6	2	1	3	
" "	Lumbar,	9	4	4	1	
" "	Not stated,	4	2		2	
Ligations,	. . .	4	4			
TOTALS, . .		62	27	22	11	2

Among the concomitant symptoms *noted*, the compiler states that "paralysis is mentioned as a prominent symptom in only one hundred and fifty-one of the six hundred and forty two cases enumerated in the table. Making every allowance for the considerable proportion of cases in which the lesions were confined to the apophyses, it must be regarded as probable that this complication was not always noticed when present. There were not a few instances in which paralysis was absent even when the cord was injured." Four such cases are given, all of the lumbar vertebræ, yet one of these had paralysis of the bladder.

Bed sores occurred in twenty-two cases, eleven terminating fatally.

Chest wounds occurred in fourteen cases, twelve terminating fatally.

Abdominal wounds were observed in fifteen cases; there was one partial recovery. The organs more frequently implicated were the lung, diaphram, liver, spleen, and kidney.

Tetanus supervened in seven cases, with the results not stated. *Pyæmia* is noted as occurring in eight. *Dyspnœa* and *Dysphagia* were frequently observed, the latter as often from injuries to the muscles of deglution as to lesions of the nerve trunks. *Costiveness*, as a primary symptom, followed by secondary involuntary diarrhœa, was quite common; as was also various *urinary* complications, in two cases

cystitis was given as the cause of death. This valuable report closes as follows:

"*Priapism* is reported in three cases only, all of the cervical region. It will be readily understood that the figures cited here and throughout this analysis of the table by no means furnish an exact estimate of the number of instances, in which a given rational symptom was present, but state simply how often it was *noted*. The reports were generally, of necessity, too brief to admit of a full review of the clinical phenomena."

III. DISLOCATIONS OF THE SPINE.

Dislocations of the Spine, with the exception of the cervical portion, are held by most authors to be impossible without fracture; some affirm that complete luxation in the lumbar region is possible without fracture. MR. SHAW (HOLMES, *Syst. of Surg.* II), treats both fracture and dislocation under the same head, refusing to recognize the existance of one without the other, except in exceptional cases in injuries of the cervical spine, stating that the lesion to the cord was the chief point of interest to the surgeon, which was identical in both conditions, and demanded practically the same treatment. Accepting the possibility of a pure dislocation, although acknowledged by all writers to be very rare, I prefer to adopt HAMILTONS method, and devote a separate article to the subject.

The *causes* of dislocation are similar to those of fracture, *viz.*, falls or blows on the head or nates; extreme flexion laterally and backwards. Cases are recorded of "spontaneous" dislocation, due to destructive processes in the vertebræ, but the conditions are rather those of fracture than dislocation.

The *symptoms* are likewise similar to fracture, with a single important differance, *viz.*, the rigidity is equally as marked as when luxation occurs in other joints. The parts are not immovable on account of the pain attending motion, a voluntary immobility, but involuntary, positive; the parts are rigidly fixed even when under the influence of an anæsthetic. There is pain upon attempt at motion, swelling, and discoloration, with a marked deformity in the spine, usually an angular projection. The particular spinous process affected, either flattened or prominent, being that belonging to the vertebræ displaced, which occurs also in the case of fracture, materially adds to the difficulty in making a diagnosis. Even crepitus is frequently wanting in fracture, and its absence is therefore far from being a reliable indication of dislocation; indeed a very slight fracture with dislocation may cause crepitus. From every point of view the differential diagnosis is extremely difficult, and cases not unfrequently occur in which the most experienced surgeon will be unable to pronounce a positive diagnosis. Dislocations occurring in the neck, particularly in spare subjects, or when the case is seen before swelling has occurred, or after it has subsided, from the readiness with which the transverse processes may be felt, are far more readily recognized than when occurring in other regions.

It will be impossible to establish a *prognosis* based upon general principles; each case must be studied without referance to similar ones. The whole matter rests upon the extent of the lesion to the cord. When a vertebræ is completely dislocated, even without fracture, the cord must be put upon the stretch, if not positively torn. Added to this, blood vessels are liable to be torn, particularly the venous sinuses opened, and extravasation into the vertebral canal will occur. There are cases in which the vertebra is rotated, and the continuity of the canal thereby unimpaired. Here the prognosis would be good, as a matter of course. In other cases, the displacement may be in such a direction, or to such an extent, that the cord is not compressed, simply brought into a state of tension. There are numerous instances in which the cord accommodates itself to this altered relation, and any impairment of function pass away. Unfortunately such cases are extremely rare. In general, therefore, the prognosis must be unfavorable; if death is escaped, the patient will have every reason to expect a permanent deformity, with a probable loss of health and vigor.

It will be more convenient, following HAMILTON's arrangement, to speak of dislocations in each of the spinal regions separately, quoting illustrative cases in each instance.

(1.) *Lumbar vertebræ.*—Many authors, notably COOPER and BOYER positively affirm that a dislocatiou in this region is impossible. HAMILTON whilst admitting that there are no instances, to his knowledge, of an uncomplicated dislocation, think it possible to conceive of such an accident. He quotes a case mentioned by CLOQUET, as follows: "A tiler fell from the roof of a house backwards, and dislocated one of the lumbar vertebræ. This patient lived many years after the accident, and at the autopsy it was found that the second lumbar vertebræ had been luxated to the right by a movement of rotation about the left articular process, the two oblique processes of the left side preserving their connection, while those of the right were separated quite half an inch. The right vertebral plate was broken, and the canal of the vertebræ was thus thrown open and widened."

A fatal case is thus described by DUPUYTREN, (*Inj. and Dis. of the Bones. Syd. Edi.* p. 340): "A man was crushed by the falling of a bank of earth upon his loins, when in the act of bending forward. On the third day he was brought to the Hotel Dieu, when it was observed that his lower extremities were completely paralyzed; and that there existed in the upper part of the lumbar region a hard tumor, by pressure upon which crepitus was manifested. A second tumor could be distinctly felt in front through the abdominal parieties, and the length of the spine was evidently diminished. This man died on the sixth day from a gradual asphyxia. When the body was examined it was found that the last dorsal and the first lumbar vertebræ had been pushed forward more than one inch, lacerating the spinal mar-

row, breaking the transverse and oblique processes of the last dorsal and first two lumbar vertebræ, and tearing off a small fragment of the body of one of the vertebræ when the intervetebral substance adhered to it." (HAMILTON.)

(2.) *Dorsal vertebræ.*—Among the many cases of luxation in this region, HAMILTON is able to find but three in which a simple dislocation was claimed to be found. They are of less value from the fact that no autopsy was made in two cases, and consequently are lacking in verification. As in the case of fracture, this accident is a much more serious one than the last. The anatomy of this portion of the spine would seem to forbid the occurrence of a simple luxation; the following case from HAMILTON (p. 511,) will serve to show how this may occur. The case was that of a mason who had fallen on the back upon the step of a ladder. He died on the following day. The autopsy was thus described by the surgeon (MELCHIORI): "On removing the soft parts it was found that the ligaments were extensively torn and detached, so as to permit the articulating apophyses of the tenth vertebræ to be carried into contact with the back of the ninth. The spinal marrow had undergone no visible alteration."

Quite a number of cases, acknowledged to be complicated with fracture, have recovered either with or without reduction. Among the former our author quotes a remarkable one occurring in the practice of DR. GRAVES, of New Hampshire. Paralysis and priapism followed a dislocation of the last dorsal upon the first lumbar vertebræ. Strong extension and counter extension were made, and the "restoration of the line of the vertebral column was found to be nearly but not quite perfect. On the sixteenth day he began to have slight sensation in his feet, and at the end of six or eight weeks he was able to control the evacuations from the bladder and rectum. Several months later he had recovered so completely as to walk with only the aid of a cane."

As an example of the effects of unreduced dislocation, the following case may be cited, reported by DR. SWAN, (*Boston Med. and Surg. Journal* xxii, p. 102), mentioned by HAMILTON: "Joseph Stocks, aged eleven, in the spring of 1826, was crushed under the body of an ox cart in such a manner as to produce dislocation of the last dorsal from the first lumbar vertebræ, causing immediately almost complete paralysis of all the parts below. This young man was seen by Dr. Swan, of Springfield, Mass. in the summer of 1834, at which time he was occupied as a portrait painter. His lower extremities remained paralyzed and of the same size as at the time of the receipt of the injury. He was unable to sit erect, owing to the mobility of the spine at the seat of dislocation, and he had therefore lain constantly on his side. The upper portion of his body was well developed, and his intellectual faculties were of a high order."

Treatment.—Whatever may be said as to the propriety or feasibility of reducing dislocations in the cervical region, and notwithstanding the excellent results obtained in the few cases in which reduction was

made in those of the dorsal and lumbar, there is much doubt whether it is safe or justifiable in the large majority of cases. It has been suggested that the danger to which the cord is subjected from contusion or stretching when forcible extension is made, particularly when combined with rotation, might expose the patient to greater injury and danger than if he was left alone. The majority of those sustaining such injuries die, it is true, and the condition could not be made much worse by attempts at reduction. A few, however, have recovered, even when the luxation remains unreduced, and hence I am of the opinion that it is a duty to attempt, at least, to replace the bones. The usual method is to fix the upper part of the body by strong bands under the arms, make forcible extension by the feet, or band surrounding the loins, making pressure at the same time on the projecting vertebræ, and adding a slightly rocking motion to the direct extension. *Arnica* must always be given after the operation, and quiet rigorously maintained. The bowels and bladder must be attended to, as in the case of fracture, and attention given to the prevention of bed sores.

3. *The Cervical Vertebræ.*—From the greater mobility of the neck, and nature of the articulation of the vertebræ, a simple dislocation is frequently met with. The causes are as in other regions, falls or blows on the head or neck, or extreme flexion or rotation. The latter frequently results in a displacement of one side of the articulating surfaces, the other remaining intact. The freedom of motion favors complete luxation, whereby the cord is subjected to dangerous pressure, or to laceration, at the same time admits of easy reduction. In most of the instances recorded, as far as the six lower vertebræ are concerned, the head is rigidly fixed in its abnormal position; after a time, should the accident be survived, there is unusual mobility. The dislocation of the atlas from the axis, being chiefly a laceration of the ligaments, particularly the odontoid, mobility is oftener observed than rigidity. The prominence of the spinous processes, and the comparatively superficial position of the vertebræ in this region, renders diagnosis from tactile examination a much easier and more satisfactory process than we have found heretofore. Irregularities in the spinous processes can nearly always be at once made out, and usually the transverse processes can also be traced.

The *prognosis* is probably better in these instances, than when other regions of the spine suffer, inasmuch as reduction is more readily accomplished. In the case of the atlas being dislocated from the axis, however, in which the odontoid ligament is ordinarily broken, retention will be exceedingly difficult, there being a natural tendency for the odontoid process of the axis to be carried backward against the cord. It is not uncommon to find such cases recover with anchylosis of this articulation, preventing rotation of the head. There are cases in which the transverse processes are so interlocked that no

justifiable exertion of force will release them. Failing in affecting reduction, therefore, in the manner hereafter to be described, our prognosis must at all times be very unfavorable.

A number of interesting cases are reported in the various text-books; a relation of many of them would not materially add to our knowledge of the subject, and I will quote a single one, the only one reported in our journals, so far as I am able to discover. DR. H. N. KEENER, of Springfield, Ill., reports as follows in the *Medical Investigator*, Vol. IX, p. 491, for November, 1872: "About 6 P. M., September 12, 1872, I was called to see 'a dead man across the street.' I went over and found the man being held up and some persons dashing water over him. Noticing that there was a preternatural mobility of the head, I told them to stop, and gathered that he had been drinking very heavily, and was endeavoring to ride a mule home, had got as far as my house when he suddenly pitched off."

"I had them lay him out straight, and noticing there was difficulty of the involuntary breathing, examined his neck and found quite a depression in the region of the second cervical vertebræ. Diagnosticated dislocation of that vertebræ forward; the respiration very difficult, every gasp portending his last; the pulse 48, slow and faintish; lips purplish, and, of course, completely unconscious, as he was dead drunk; temperature low, as he was on the cold pavement, had been douched, and nervous force partially gone. While lying upon his back, his head thrown back so that his head rested upon the pavement, the dislocation protruded forward so as to be distinctly felt."

"Dr. Lord, an Allopath, happened to pass that way, and came up and examined the man, when he suggested that some efforts be made to save the man's life. We drew his head up and forward, whereupon the respiration became more easy and natural, and the pulse 75, but when released it resumed its former position, and respiration again became difficult. Once Dr. L. thought that he had reduced the dislocation, but as the breathing and pulse was as formerly, I do not think the reduction was complete."

"After being removed to the police station, I had a white handkerchief placed on the back of his head, and the two ends brought forward over each ear front, and tied over a round of the head of a lounge he was on, and directed two men to take hold of his legs and pull him down toward the foot of the lounge, while I pressed down on his forehead to keep his head in the handkerchief, which they did, and gave him an awful pull, and again respiration became natural, and pulse full and 75, and continued so from that on without an interruption. There was no audible snap, but there was the unmerciful pull, and no more difficult respiration. About 10 P. M. he became conscious. Gave *Arn.* 30 in water, and left him, and he gradually improved until I gave the case to the family physician." The case did well up to the fourteenth, or the second day, when the doctor lost sight of it, the patient walking to the depot to return home.

The *treatment* is sufficiently indicated in the cases reported above. In addition it is only necessary to add that for some time after reduction, the head must be well supported, and particular care taken to avoid sudden movements of the neck.

IV. INJURIES TO BLOOD VESSELS.

The peculiar disposition of the arteries and veins in the spine and cord renders it almost impossible for a fracture or dislocation to occur, if any degree of displacement exists, without more or less injury to them and consequent hæmorrhage; excepting in the neck, however, the vessels are none of them of a size to furnish dangerous hæmorrhage, apart from the injury the cord is subjected to from extravasation into the vertebral canal. The vertebral artery is so disposed, running up through the foramina in the transverse processes of the cervical spine that it can endure much displacement of the vertebræ without lesion unless sharp fragments wound it. Below I give a brief sketch of the anatomy of the blood vessels of the spine, which will at once show that should a wound of any of the blood vessels be of sufficient magnitude to call attention to it, it would be next to an impossibility to determine the source of the bleeding, to say nothing of securing the vessel.

The blood supply is derived, for the most part, from the vertebral artery in the upper part of the spine, branches from which unite intimately with branches from a number of vessels. For instance, in the cervical region, the branches are from the vertebral and ascending cervical; in the dorsal, continuations of these and twigs derived from the intercostals; the lumbar region is supplied, in addition to prolongations of the above, from the lumbar, ilio-lumbar, and lateral sacral vessels. There are three branches of the seven main divisions of the vertebral artery, that are supplied to the spinal cord, meninges, and vertebræ, viz., lateral, anterior and posterior spinal.

The *lateral spinal* artery divides into two branches, one of them distributed to the posterior bodies of the vertebræ, and the other to the meninges of the cord. They enter the canal through the intervertebral foramina, communicating freely with those of the opposite side, and with other twigs finding their way into the canal, through the foramina, from other vessels.

The *anterior spinal* leaves the vertebral artery near its termination and passing downward, reinforced by twigs from the vessels entering the spinal foramina, anastamoses, by a very tortuous arrangement, with the vessels of the opposite side. It is situated in the anterior median fissure beneath the pia-mater.

The *posterior spinal* occupies a similar position on the posterior surface of the cord.

Arteries not in immediate relation to the spine are occasionally wounded, and have been ligated. A few instances occurred during our late war, some fourteen in number; the carotids, occipital, and

subclavian arteries, either wounded at the same time the spinal injury was received, or secondarily by spiculæ of bone, erosion on the sharp edges of the broken vertebræ, or by ulceration.

INJURIES TO THE CORD.

The point of greatest interest to the surgeon in all cases of spinal lesion, is the injury done to the cord. It is a matter of some importance to recognize early the actual condition, if not for therapeutic purposes, certainly for those of prognosis. Accurate diagnosis in cases not involving a lesion of the entire substance of the cord at a given point, can rarely be made; even those who have devoted much time to the study of nervous phenomena, are often at fault in determining the character and extent of the lesion. When the whole substance of the cord is included in the injury, complete paralysis existing of the parts below, we recognize the *extent* of the lesion, but it is not easy to ascertain whether the cord is divided, compressed, or suffering from concussion. Supposing the former, death is certain, if the lesion is higher than the last dorsal vertebræ; compression gives a slight hope of recovery, which will be much stronger should concussion be recognized. With the history of injury clearly related, the difficulties are greatly lessened, but not entirely removed. Thus a man has been stabbed in the back, complete paralysis of the parts below the seat of injury coming on at once. The natural presumption is that the cord has been divided; yet on examination we may find that the spinal canal has not been opened at all, the paraplegia being due to shock, and concussion of the cord.

I shall attempt to give the more constant features of the various forms of lesion to the cord, and it will be found convenient to take them up in some systematic manner. The natural division of the subject would be, concussion, compression, puncture, and section.

(*a.*) *Concussion of the Spine* is a term which Sir ASTLEY COOPER, I think, first introduced to the profession, and which has been sanctioned by long usage, although, as MR. SHAW says, it is not easy to discover the propriety of the term from a consideration of the supposed nature of the accident. Concussion of the brain is a term conveying some definite conception of the lesion; it is a jar of the brain substance, with loss or modification of function without structural lesion as far as can be discovered. MR. SHAW, (HOLMES, *Surg.* II, 370) admirably shows how the environment of the brain predisposes it to injury, that does not exist in the case of the cord. It is a soft mass, accurately filling the skull, unprovided with "dampers;" from a blow on the skull, insufficient to fracture the bone, the shock is communicated to the brain, which "is incapable of vibrating in harmony with the bony case surrounding it. Hence when the skull is set vibrating, it is obvious that the vibrations will inflict a succession of blows on the brain. These will vary in force in diffierent cases, but they will follow in rapid sequence; and the multiplication of them, even when

comparatively weak, will be injurious to the delicate textures of the brain." In the cord we have an entirely different state of facts. The cord is suspended in the canal, not in contact with the bony walls, the spinal fluid acting as a "damper" or buffer to protect it trom concussion. The term concussion indicating that the force of the injury is not transmitted from injury to parts immediately in relation with the cord, but is at once communicated to its inmost structure, it is impossible to conceive of a true concussion of the cord. However this may be, there are certain symptoms indicative of spinal lesion, that are frequently observed after severe concussion, more particularly in rail road accidents, that are yet attributed to concussion, and in the absence of more definite knowledge of the pathology the term will long continue to be used. The chief difficulty met with in exhaustively studying these lesions, is the lack of post mortem records. But one case is to be found in which post mortem dissection was made, the patient coming under the care of the surgeon one year after the receipt of the injury (*Vide* HOLMES *Surg.* II, p.). In this there was evident organic lesion, and could not properly be considered true concussion. One other case is mentioned, by the same author, in which a clot of blood was found in the centre of the cord, but it has not been claimed as an instance in point. From such material as is at hand, I am of the opinion that the condition is often one of laceration or contusion, with atrophic changes or fibrous degeneration of the cord.

The *symptoms* are usually observed in two well defined groups. Those which might properly be called *primary*, are paralytic, usually paraplegia, due in all probability to local contusion, or compression from extravasation of blood, and shock. These may be persistent, but are usually transitory, giving place to progressive symptoms, ultimately terminating in permanent paralysis. If the case was one of pure concussion, we would expect symptoms indicating lesion of the whole cord; this is not so. The cord will be injured in one or the other regions, from which extension is usually downward. In the large majority of instances the lumbar spine seems to be chiefly affected.

The *remote* or secondary symptoms are those of progressive paralysis, succeeding well marked irritation, resembling in many essential particulars, spinal sclerosis.

It is fair to suppose that what is called concussion of the spine is the effect of one or all of several conditions. Severe sprain, will cause contusion of the spinal nerves, which resulting in inflammation may extend to the cord or meninges, or both; effusion may be plastic, causing adhesion of the theca to the bone, which in flexible portions of the spine is a source of constant irritation to the cord.

At other times there will be more or less effusion into the vertebral canal, or extravasation of blood. In the former instance adhesions may form at a number of points, each point of attachment acting as a separate source of irritation. In the case of extravasation, as

already seen, small coagulæ may remain, and finding attachment to the dura mater or other structures within the canal, keep up a continual irritation, which will sooner or later impair the integrity of the cord.

Small lacerations also occur, at times, either at the origin of the spinal nerves, or in the substance of the cord, the wound healing by cicatrization, with all the evils attendant upon that process, such as contraction, which induces atrophy of the cord.

As MR. SHAW (*loc. cit.*) remarks, we will never know sufficiently the actual meaning of concussion, until our knowledge is derived more from the actual dissection than the verdict of ignorant or prejudiced juries.

The *treatment* is very difficult to lay down with any degree of assurance of success. Considering contusion and hæmorrhage to be the actual condition, we would expect rather better results from *Arnica* than any other single remedy; considered purely from the supposed pathology, there is no remedy that has such a close relation. In the absence of actual clinical experience, what I shall say about treatment is purely hypothetical. In Homœopathic practice, as has been amply proved on numberless occasions, our system of proving remedies furnishes most reliable data upon which to base prescriptions for conditions not seen. The term hypothetical is not exactly correct, therefore, yet there is no other word that can be used.

The remote consequences must be treated upon subjective phenomena, precisely as if the case was idiopathic, the list of remedies being as large as the varying expressions of the different cases. *Picric ac.*, *Sep.*, *Sil.*, *Plumb.* and other remedies having a marked relation to the spine, may be indicated, the chapter of *Diseases of the Spine*, (*Surg. Therap.*) giving full indications. In very many of these cases, however, *Arnica* will be found as potent as when the case is seen in the primary stages.

(*b.*) *Compression of the cord*, is a common accident in spinal lesions, produced either by the pressure of fragments of the vertebræ in cases of fracture; in dislocations from the displaced vertebræ; or in either accident from extravasation of blood into the vertebral canal. The growth of tumors in connection with the spine, tubercular conditions or constriction from cicatricial formations. It is evident that the symptoms will depend largely upon the nature of the case. When from traumatic causes, they come on at once, are connected with atrophy or wasting of the parts below the point of injury, and usually reach their maximum of intensity immediately. In the case of compression from slowly augmenting morbid action, they are equally slow, progressing, step by step, with the growth or increase of the morbid process responsible for the pressure, with wasting of the parts below.

The *symptoms* depend, as far as severity is concerned, upon the degree of compression. They are chiefly paralytic; in the case of

fracture or dislocation, with any degree of displacement, paralysis is pronounced. The growth of tumors, deposit of tubercles, or extravasations of blood, produces irritability of the spine, in the earlier stages, paralytic symptoms increasing or diminishing as the pressure is increased or diminished.

In the absence of a history of trauma there are few cases that can be at once made out; the symptoms must be obscure, and may be mistaken for atrophy of the cord, anæmia, or locomotor ataxia. As a matter of fact, the indications for remedies will be the same in one case as in the other, but prognosis must be impossible, at least with any degree of accuracy.

Diagnosis, as far as location of the lesion is concerned, is not usually difficult. Paraplegic symptoms, up to a certain level, will mark the extent and point of beginning of the lesion. It must be remembered, however, that spinal metamorphosis proceeds *downwards* from the injured point, at least primarily. There is usually some irritation or exaltation of sensibility above for some distance; after the morbid action has invaded all the tissues *below* it occasionally becomes developed above.

Prognosis, under all circumstances, whether acute or chronic, must be guarded, few cases recovering fully. As a rule, the more acute the condition the better the prognosis. in cases of fracture or dislocation, if reduction can be effected and the symptoms immediately improve, there is much hope that a cure will be effected. If reduction is impossible, or when successful, no improvement in the symptoms occurs, the prognosis is unfavorable. When the condition is chronic, due to the growth of tumors, or some other morbid process, it is impossible to prognosticate the result. In some instances, the parts accommodate themselves to the slowly increasing pressure; so that when it is removed, if there is no complete resolution, there is at least no increase of the paralysis. In others, the removal of the pressure seems to give impetus to the spinal disorganization, and the case rapidly assumes fatal characters.

Treatment presents two prominent indications to be fulfilled: first, remove the pressure, and second, attack the conditions of the cord, caused by the same. As said when speaking of injuries of the vertebra, attempts at reduction of displaced or broken bones must be governed by circumstances. It is unnecessary to return to that subject again. The other conditions may be met with greater readiness if they can be diagnosticated. Tumors must be removed if external to the vertebral canal, effusions discussed with proper remedies; tubercles probably will be unaffected by any treatment, chiefly on account of the obscurity of the condition, but the length of time elapsing before they can be recognized furnishes an opportunity for their increase far beyond any hope of cure.

The remedies must be selected by weighing well the indications

noted in preceeding paragraphs, and the chapter on spinal lesions in a previous volume (*Therap.*) *Arnica* must, however, be the remedy more frequently indicated.

(c.) *Puncture or partial division of the cord*, is a very serious accident, both in primary and remote consequences. It is usually the result of stabs with pointed weapons, injury from sharp spiculæ of bone, or laceration of the cord from extreme flexion of the spine, or concussion. The ill consequences are not alone due to the initial lesion, but to a very large extent to the hæmorrhagic effusion into the canal, and the associated injury to near parts. The symptoms may be studied in two groups, a primary and remote.

The primary symptoms depend largely upon the extent and character of the lesion. When a laceration occurs, or the cord is divided to some extent, paralysis, in some form, must ensue. The entrance of blood into the canal will add symptoms of compression, and the diagnosis must be very obscure. When made by stabbing instruments, a reasonable opinion may be formed of the nature of the accident; but, when the injury comes from within, as from injury to the bones, the symptoms are very perplexing. When a simple puncture is made, the symptoms are chorœic or ataxic in character. Usually there will be spasmodic conditions in particular sets of muscles, either tonic or clonic, developing in talipes of some form, or distortion of other joints, or some interferance with muscular co-ordination.

The *prognosis* is usually unfavorable, although it is better in proportion as irritation of the spine predominates over paralysis. This is from the fact, that paralysis indicates a lesion of the cord to such an extent that it can only be cured by cicatrization. The principle of contraction peculiar to this process has the effect to cause fatal compression of the cord, with resulting atrophy, or granular, fatty, fibrous, or some other form of degeneration. When simple irritation exists, if no cicatricial adhesions occur, a cure may be confidently expected.

The *treatment*, in the majority of instances of simple puncture, is quite successful. *Hypericum* will usually fulfil every indication. Symptoms of compression, will call for *Arnica*, the presumption being, when a wound of any size is made, that blood is poured into the vertebral canal. Should there be reason to suspect cicatricial adhesions, or contraction in cicatrices of the cord, my experience with *Silicea* for similar conditions elsewhere, would lead me to prescribe it in this instance, with some considerable degree of confidence.

(*d.*) *Complete division* of the cord is a condition utterly hopeless of cure. Union can never occur, and when the lesion is above the eleventh dorsal vertebræ, death is inevitable, sooner or later. The certainty of death is increased as we go higher up the spine, or rather it will follow the accident more speedily. The symptoms are those of complete paraplegia, with other functional derangements as laid down under fractures and dislocations.

XXII. INJURIES OF THE UPPER EXTREMITIES.

The hand and arm, from the multiplicity of uses to which it is applied, and its exposed position, is very frequently injured, perhaps more so than any other part of the body. Almost every conceivable form of injury has been noted in this region, which while rarely dangerous to life, are frequently causative of great future discomfort, from the crippling of a member essential to the proper performance of nearly every function of life. Following a systematic arrangement of the subject it will be more convenient to arrange it under the following heads: Wounds of soft parts; wounds of blood vessels; wounds of nerves; fractures, and dislocations. For this purpose it seems proper to include the scapula and clavicle as essential portions of the limb.

I. WOUNDS OF THE SOFT PARTS.

Wounds of the soft parts occur of all forms, and command attention from the frequency with which neglected cases recover with permanent crippling of the member. Apart from the injury sustained by the blood vessels, which will receive particular attention, that of the tendons is perhaps of the most interest and moment. Wounds of the large muscles, particularly those of extension and flexion, may seriously impair the usefulness of the limb, but generally union is secured so that little loss of power is perceptible. Division of the tendons, particularly of the wrist, is quite a different matter; the result is either in stiffness of the joint, or what is called a "dangling joint." In the first instance, the trouble will be found to be in cicatricial adhesions between the tendons and their sheaths, which last frequently become attached to near parts from inflammatory exudation; or a wide retraction of the cut ends, with adhesion of these extremities to the parts with which they are in contact. Should the injured part have been put up in a splint, and kept motionless for some time, there will be changes in the fascia and other tissues of the joint, due to inflammatory action chiefly, which alone will cause more or less permanent immobility.

The "dangling joint," is a term used to indicate a condition in which the tendons, particularly the flexors, are completely divided, and the wound has healed with such a slight inflammation that no plastic adhesions have occurred. In such cases the hand literally dangles from the arm, with no power of flexion in it or the fingers, the associate injury to the nerves and blood vessels being such that it is atrophied, and completely useless for all purposes of life.

Lacerated and punctured wounds are very prone to result in tetanus, perhaps the tendency is as great as from similar injuries in the foot. Slight wounds, as from tacks, needles, pins, broken glass, splinters of wood, and similar accidents, are exceedingly common, almost of daily occurrence in many occupations, but are rarely of any moment. In certain conditions of the body, even such slight lesions may be followed by very serious consequences; abscess, whitlow, tetanus, erysipelas and other conditions may be set up. In those suffering from any specific dyscrasia, whether active or latent, loss of a finger, hand or arm has followed a scratch with a pin. So also in the case of inebriates, serious consequences are quite frequently observed.

Needles are frequently thrust into the fingers and hands, particularly among washerwomen, often breaking off, so that no portion projects externally. Apart from the pain caused on attempting to use the hand, and the possibility of tetanus ensuing, the well known and remarkable tendency for such fragments to travel for long-distances through the tissues, even traversing the whole length of the limb, makes it a leading indication to remove them whenever it is possible to do so.

When the fragment is completely out of sight and cannot be felt through the skin, no attempt should be made to find and extract it, unless the pain on motion of the part can be accurately localized. An examination of the part is best made as follows: Placing the thumb of the right hand over the puncture of entrance, and the remaining fingers on the opposite side of the part or limb, pressure will reveal the foreign material if it is lying vertically to the surface. If not felt by these manipulations, pinching up a deep fold of the soft parts, including the puncture, may enable the fragment to be detected. Failing in these methods, and being unable to localize the pain, no attempt is to be made at extraction. When the fragment is detected, all attempts at extraction by the use of magnets will be futile, however excellent the idea may be in theory; nothing but radical measures will suffice. Take a small tenotome, and holding the fold of integument with the left hand, so that the extremity of the needle may be distinctly felt, insert the knife, flatwise, a little to one side of the end it is desired to reach, and cut down upon it. If successful in striking it, the grating of the knife upon it will announce the fact. Do not relax the grasp with the other hand. Introducing a pair of forceps into the wound, the fragment may be withdrawn, usually requiring some exertion of force to dislodge it. The incision must be a smooth one, made by a single decided motion, any picking of the parts asunder is not only bad surgery, but exposes the patient to abscess, or perhaps even greater trouble if at all predisposed to morbid action. The needle will usually be much discolored. The subsequent treatment will simply consist in covering the puncture with a piece of adhesive plaster or collodion.

Lacerated or contused wounds present no particular point of interest apart from what has already been said in a previous chapter The only question that might arise as related to this particular region would be that of amputation, with reference to the occupation or social position of the sufferer. In a laboring man, for instance, who has received a severe contusion of a finger, one that demanded amputation, as much of the member should be saved as possible. If the whole finger was condemned. it would be amputated by disarticulation at the phalangeo-metacarpal joint, thus preserving the transverse ligament and the natural breadth of the hand. In persons of higher social standing, or those in whom symmetry is more desirable than strength, amputation should, under similar circumstances, be performed below the head of the metacarpal bone, whereby a gap between the fingers is avoided.

Treatment of wounds, is conducted on the same principles laid down in an earlier chapter. The muscles and tendons of the arm are of such a size and character, that division will always be followed by extreme dispartition. Position and the proper use of sutures, must be considered to overcome this, at the same time avoiding, if at all possible to do so, any unnatural and strained position; if this should prove impossible or difficult, care must be taken not to retain the dressings so long that the arm will be injured by vicious attachments of the divided organs, or other causes. There are cases mentioned in which union has occurred under the most disadvantageous circumstances. One such is recorded in the *New England Med. Gazette*, (Oct. 1880, p. 320), which I quote entire: "On the 5th of February 1880, Dr. L. L. Stanton, of Tarborough, N. B., was called to see Mary S——, a girl of eleven years, quite anæmic and small for her age. While procuring firewood, she placed her hand in the way of an ax, when at one blow it was severed from the styloid process diagonally accross tho trapezium passing through the scaphoid bone and posterior anular ligament, dividing all the muscles, bones and blood vessels, and *completely separating the hand from the arm*, excepting a small portion of skin, below the articulation with the ulna; the hand was hanging at right angles to the arm when the physician arrived, half an hour after the accident."

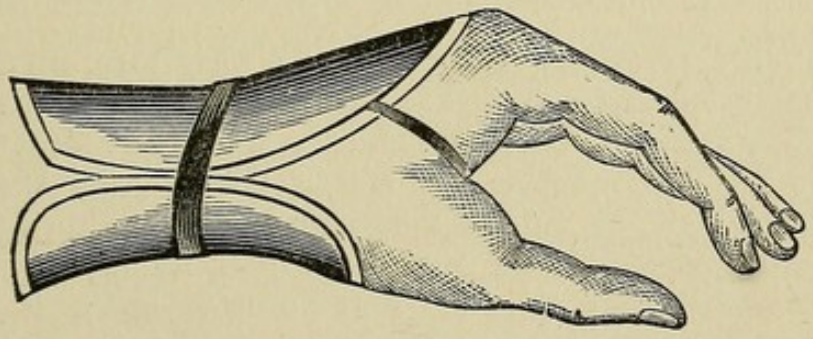
"Amputation at the joint above was at once decided upon, and Dr. Stanton returned to his office, a distance of half a mile, for the assistance of another physician; this being impracticable, he replaced the hand, holding it securely in position with silver wire sutures and adhesive plaster. During the process, the patient complained of pain in the arm, from the needle, but none when it was used on the hand.'

"The hand and arm were secured upon a broad splint, and kept warm by hot flannel cloths. Twelve hours later, the hand was much swollen, bnt there was no sensation or pulsation, nor had the patient complained of pain, but rested quietly. The next day there was a ittle pain, but no change in appearance. On the third day there was

pulsation in the hand and a different color; and from this time there was no suppuration, no secretion of any kind, and the wound entirely healed. The sutures were removed on the fourteenth day, and for a time the hand was carried in a sling. At present the patient is able to extend the fingers, and grasp with nearly her usual strength. There is no anchylosis of the wrist joint."

In case of stiffness of the joints from cicatricial contraction or adhesions, there are a number of methods promising more or less relief, already referred to in another place. Should *Silicea*, or electrolysis fail, the scar may be dissected out, or the adhesions divided subcutaneously and carbolized cat-gut crowded into the opening. It will only occur in extraordinarily severe cases that such measures will be demanded; in the majority of instances, as far as my own experience goes, *Sil.* or the galvanic currrent will prove all sufficient.

Dangling joints will prove incurable in the majority of instances; the most that can be done is to supply the lacking function by the employment of mechanical appliances. In the only case I have seen excellent results were obtained from the use of a glove with elastic bands; it is a better apparatus than that of HEYFELDER, (as in the cut,) but if economy and cheapness are essential, the latter may be used.



NO. 32. HEYFELDER'S SPLINT,

With referance to injuries to the blood vessels and nerves, a very important consideration in wounds of the arm, I shall consider them in separate sections, although the arrangement is somewhat artificial.

II. INJURIES OF THE BLOOD VESSELS.

Considering the superior extremity to include the clavicles and scapulæ, which in some respects is a perfectly natural arrangement, it would be proper to include in an account of injuries to the blood vessels of this member, those which supply or are in relation to these bones. This plan, however, will necessitate a recapitulation in another place, as many of the vessels are derived from the subclavian artery, and I will only adopt it in part; I will take up, at this time, therefore, such vessels as are derived from the axillary, or are continuations of it.

We find that the blood supply and circulation of the arm, may be condensed as follows :

1. The *auxillary artery* is the common source or origin, and will be remembered as a continuation of the subclavian, commencing at the border of the first rib, and terminating at the tuberosities of the humerus, at the point of attachment of the latissimus dorsi and teres major muscles. For surgical purposes the artery is divided into three portions, known respectively as the first, second, and third parts, an arrangement which in its main features should be borne in mind, the relations the different parts sustain to the nerves being important in operations for ligature. The pectoralis minor muscle marks the limits of each part. Thus, the *first portion* lies above that muscle; the *second* beneath it; and the third below it. At the commencement of its course it is very deeply situated, but in the third part becomes quite superficial, being covered by little more than integument and superficial fascia.

In the *first part* of its course, the brachial plexus of nerves will be found on the outer side, but not in close relation to it, being separated by an interval of cellular tissue. The cephalic vein will be found in front, and the axillary vein on the inner side.

In the *second part*, we find the axillary vein is still on the inner side, but the brachial plexus closely surrounds the vessel, separating it from the vein. The same arrangement continues into the third part.

To secure this vessel by ligature, it is a very rare, difficult, and dangerous operation to attempt it in either the first or second part of its course. The depth of the vessel and the important structures it is in relation with renders it a formidable undertaking that should never be attempted by an inexperienced person, in fact good anatomists and accomplished operators will avoid the attempt. unless the circumstances are such that no other course is possible. In the third or lowest portion of the vessel it may be readily tied, although skill and accurate anatomical knowledge will still be required. The line of the vessel may be indicated with sufficient accuracy, by extending the arm at right angles, or a little more, and marking it out in the centre of the axilla, inclining a little to the front. The incision is made by transfixion through the integument, the loose tissue carefully separated by the handle of the scalpel, and the fascia carefully divided. The median nerve and axillary vein will then be brought into view. Up to this time the arm has been held extended upwards, it is now brought down to a little less than a right angle, and with a spatula the assistant holds the nerve outwards, and the vein inwards; the ligature is to be introduced between the vein and artery, the needle carried down to the artery. When the branches of this vessel are wounded and the extremities cannot be found in the external wound, the main trunk is to be secured as above.

The branches should be remembered, if not with perfect accuracy, at least sufficiently so to enable the attendant to determine the

source of the bleeding. They are seven in number, three from the third part of the vessel, and two from each of the others. Commencing with the first part, these vessels are as follows: superior and acromial thoracic; thoracica longa, and thoracica alaris; subscapular; anterior circumflex and posterior circumflex. The first branch has nothing to do with the arm. The second, or acromial thoracic divides into a number of branches, some of them distributed to the chest, and some to the acromial region and muscles and other parts there. The two next are small branches, of little importance as to hæmorrhage, and are found in the axillary space, supplying the glands and integument. The subscapular, in close relation with the lower margin of the muscle of the same name, is the largest and most important of the branches of the axillary, dividing up into branches, and inosculating with branches from the subclavian, supplying the scapula. It is impossible to describe its course in a manner that would be of much value to the surgeon—further than to state that it follows a general course identical with the posterior border of the scapula, and in quite close relation to it. Its situation is so deep that it will rarely sustain injury that will call for its ligature. The other branches are distributed to the head of the humerus, and a portion of the superior border of the scapula.

2. The *Brachial artery* is a continuation of the axillary, commencing at the tuberosities, below the heads of the muscles inserted therein, and continuing down the front, and slightly to the inner surface of the humerus, for half of its course, when it is found directly in front. It extends to within a short distance of the bend of the elbow, where it divides into the radial and ulnar. The branches of interest to the surgeon are the superior profunda, nutrient, inferior profunda, and anastomotica magna, with a number of muscular branches.

The *superior profunda* is given off soon after the commencement of the brachial, and winding around the bone in the muscular spiral groove, supplies the back of the arm.

The *inferior profunda* is given off a little below the middle of the humerus, and also passes backwards, supplying the posterior part of the arm. These vessels anastomose with each other, as well as with the anastomotica magna, and branches from the ulnar and radial above.

The *nutrient* artery is given off at the centre of the humerus, passing down to about the insertion of the coraco brachialis it enters the bone through the nutrient foramen.

The *anastomotica magna* arises about two inches above the level of the elbow joint, and passing backwards, arching over the olecronon fossa, supplies the back of the arm by inosculating with the other vessels from the brachial, and ascending branches from the forearm.

The *muscular branches*, varying in number and distribution, are quite large vessels, and furnish important bleeding when wounded.

Whilst it is impossible to give their source and distribution with sufficient accuracy to be of value to the surgeon, hæmorrhage from that source may be recognized from the fact that the wound does not extend very deeply.

The course of the brachial may be quite accurately marked, by drawing a line from a point a little forward of the middle of the axillary space, directly to the centre of the bend of the elbow. A ligature applied in cases of wounds of the hand or forearm, or indeed under all circumstances when possible, had better be applied a little below the middle, between the nutrient artery and the inferior profunda. To apply one higher than this, may unnescessarily interfere with the nutrition of the bone; lower it would be ineffectual in arresting the bleeding, from the free communication between the profunda and the vessels supplying the lower arm.

The line will be found to fall along the inner edge of the biceps muscles, and the vessel will usually be found quite superficially situated, just beneath the border of this muscle, except near the elbow, where it dips down deeply, and is covered over by the bicipital fascia. In the first part of its course the median nerve will be found on the outside of the artery, but soon runs over it, and in the lower third will be found in the inner side. The basilic vein will be found on the inside, partially overlapping the artery. The parts being exposed, the biceps muscle and median nerve are to be drawn outward and vein inward.

It occasionally occurs that the brachial artery is double for a portion of its course, particularly the upper. In such an event, the surgeon must make pressure on each one, and thus determine, by its effect on the hæmorrhage, which one is to be taken up.

3. *Arteries of the Forearm.*—At the bend of the elbow, a little above, the brachial divides into two branches, the radial and ulnar, passing down the side of the forearm indicated by their name. The radial is the smaller of the two, but from its being in the same line of the brachial is generally considered to be an extension of that vessel. Each vessel will require separate consideration.

(*a.*) The *radial artery* runs along the radial side of the forearm, as far as the wrist, when it winds backward around the carpus, underneath the flexor tendons of the thumb, into the palm of the hand, crossing it to the ulnar side, forming the *deep palmar arch*, and terminating by inosculating with the deep branch of the ulnar artery. In its course it gives off a number of branches, but, with the exception of those in the hand, their description can be of no service to the surgeon, as it will be readily borne in mind that the distribution is chiefly on the radial side of the arm.

In the hand (and it is important to remember this), the thumb and index finger are supplied from the radial, the index finger, only on the radial side—the other fingers being supplied by the ulnar, or superficial palmar arch. The other branches of the deep arch, are given to the inter-osseous muscles largely.

The radial artery may require ligation for wounds in the hand, in parts supplied by it as above, in addition to wounds in its continuity. It will frequently occur that bleeding from the deep palmar arch cannot be controlled by ligation of the radial, owing to the free inosculation. For this reason, if pressure, and extreme flexion of the arm will not arrest the bleeding, the brachial must be taken up.

The course of the radial artery may be marked out by drawing a line along the inner border of the supinator longus muscle; in the lower part of its course it will be found between the tendon of that muscle and that of the flexor carpi radialis. The nerve will be found on the outer side of the artery, in the upper part of its course, and beneath it, slightly, below.

In wounds of the *deep palmar arch*, it is usually impossible to secure the vessel in the wound, and as said before, ligation of the radial is frequently useless; on account of the serious character of an operation on the brachial, it is best, as one of the few instances in surgery, to attempt milder measures at first. Pressure by a compress and bandage, with forced flexion of the arm, may be attempted; but if the force should be too great, or the part become cold and insensible, it must be discontinued, and the brachial secured. The ligature is to be applied below the inferior profunda, in the lower third of its course.

The *ulnar artery* occupies a position on the ulnar side of the arm, similar to that of the radial on the opposite. It is larger than the radial and gives off more important and larger vessels. On reaching the wrist it crosses the annular ligament; passing across the palm of the hand, it forms the superficial palmar arch, terminating by inosculating with the radial branches, particularly the superficialis volæ. At the commencement of the arch a branch is given off, the deep branch, which passing deeper, inosculates with the radial, completing the deep palmar arch. The palmar arch supplies digital branches to all the fingers not supplied from the deep arch, namely, the ulnar side of the index, and the second, third and fourth.

The most important branches of this vessel are the posterior interosseous, which divides to form the anterior vessel of the same name. The common trunk is given off soon after the commencement of the vessel. Various muscular and recurrent branches are given off, and as they are all found on the ulnar side of the arm do not need particularizing.

The line of the artery will be found between the flexor sublimis digitorum, and the flexor carpi ulnaris, situated somewhat more deeply than the radial; it is readily reached in the lower part of its course, when it lies between the tendons of the muscles given above. In the upper part it is covered by the muscles, and is more inaccessible. The ulnar nerve will be found on the outside.

Hæmorrhage from the *superficial palmar arch* may be controlled by

ligation of the ulnar, but the arch being more superficial, can oftener be reached directly. If ligation of the arch cannot be secured, and that of the ulnar proves ineffectual, the brachial must be taken up, as in the case of wounds of the deep arch.

III. INJURIES OF THE NERVES.

The nerves of the arm that are of particular surgical interest are the musculo cutaneous, internal cutaneous, lesser internal cutaneous, musculo-spinal, median, ulnar, and radial, which for surgical purposes may be considered the continuation of the musculo-spiral. They are all derived from the brachial plexus, and the name sufficiently indicates their location With the exception of some of the larger trunks there is much variation in their course; the distribution being quite uniform, a knowledge of the latter will always be sufficient to indicate the seat of the lesion, as injuries to the trunk find expression at the distribution. An observance of the parts paralyzed will always indicate the particular nerve injured, and it must be remembered that then peripheral symptoms are not permanent, in one sense, the paralytic condition extending upwards until the point of injury is reached, and quite frequently for some distance beyond. As in the case of lesions of the spine, the symptoms depend very largely upon the kind and degree of injury, complete division of a nerve producing total loss of function, while puncture, laceration, stretching or contusion will furnish symptoms of irritation (neuralgia) or inflammation (neuritis). I will first consider the more salient symptoms observed after injury to these nerves separately, and the constant symptoms, with reference to diagnosis, and treatment, collectively.

1. The *musculo cutaneous nerve* supplies the muscles (anterior) of the arm, and the integument of the forearm. The muscles particularly supplied are the coraco-brachialis, biceps, and brachialis anticus; the integument on the radial side of the forearm. Observing paresis in the integument in this region, or paralytic conditions of the muscles, if the lesion is high enough to affect them, it will be at once apparent which nerve is injured.

2. The *internal cutaneous* is supplied to the ulnar side of the arm, becoming cutaneous a little above the elbow. Above this point it is supplied chiefly to the fascia and sheath of the biceps. The symptoms are very obscure, and can scarcely be localized by others than experts.

3. The *lesser internal cutaneous*, is a very small branch, one of the smallest from the brachial plexus. It is distributed to the back part of the arm, reaching to the elbow or a little below.

The *median nerve* is the largest, and from purely surgical considerations, the most important nerve in the arm. It passes down the middle of the arm, in close relation to the brachial artery, giving off no branches in this part of its course. In the forearm a number of branches are given off, and terminates in the thumb, first, second, and

radial side of the third finger. The digital distribution renders a diagnosis quite easy, marked paralysis of these fingers being at once traceable to the median nerve.

5. The *ulnar nerve* is distributed to the ulnar side of the arm, forearm and the fourth finger, and the ulnar side of the third. The distribution, as in the last instance, renders diagnosis of injury quite easy.

6. The *musculo spiral* nerve, in the arm, is so deeply situated, being in close relation to the humerus, occupying the groove of the same name, that it is rarely injured in this part of its course, without great injury to most of the structures of the arm. In fracture of the humerus with much displacement, it is often torn to some extent, stretched, compressed or contused. It supplies the muscles of the arm, particularly the triceps, those of the forearm and hand, as well as the integument in those regions. Hence after fracture, or such injury as would include this nerve, when muscles of extension are paralyzed, there should be little danger of going wrong in the diagnosis.

7. The *radial nerve* is a large branch of the musculo-spiral, appearing as a continuation of the main trunk, on the radial side of the fore arm, and supplies, by numerous small branches, the integument of the radial side of the forearm, and the ball of the thumb, with one branch; and by the other the dorsal portions of the thumb, and index and middle fingers.

The *symptoms* of nerve lesions in the arm, depending upon the extent and character of the injury, should be carefully studied, as modern surgery furnishes means for the cure of such lesions that were unknown only a few years back. The injuries are usually from contusion, compression, particularly the inclusion in cicatrices, puncture, laceration, and division.

(*a.*) *Contusion* of a nerve, unless very severe, sufficient to induce laceration, rarely causes more than a temporary inconvenience, the parts supplied being the seat of a tingling and numbness, soon passing off on rubbing the parts. Should the numbness remain, gradually increasing, and the part feel cold, and look pale, the presumption will always be that there is some structural lesion, particularly laceration. The nerve may then become disorganized, and after a shorter or longer period of painfulness and irritability, the nerve action will become entirely lost.

The *prognosis* depends upon the character of the lesion. When plastic effusion can be made out, there will be some hope of effecting a cure by the methods referred to under the head of compression. Under other circumstances, *Arnica* may, and frequently has effected a cure, although it must be remembered that nerve lesions are slowly repaired.

(*b.*) *Compression* of nerves is an exceedingly interesting study. It may be due to many causes, viz., inclusion of the nerve in a cicatrix

growth of tumors; displacement of fragments in fracture, or a bone in dislocation; and the lodgment of a musket ball. The three last of these are eminently acute in character, the symptoms coming on immediately, and remaining as long as the condition exists, giving place, later, to complete paralysis from atrophy of the nerve. The first symptom will be numbness and impairment of voluntary mobility, soon succeeded by more or less violent pain, often with spasmodic muscular action; these symptoms, in turn, give place to atrophy of the parts supplied, lowering of temperature and sensibility, and ultimately complete paralysis.

The *prognosis* is good when the pressure is immediately relieved, and *Arnica* administered. When the second group of symptoms come on, the result is more a matter of doubt. In the majority of instances the symptoms will pass away as soon as the pressure is removed. If, however, the bodily condition of the patient is such that repair is slow or imperfect, the accident will be but the commencement of a disorganization that may proceed to complete destruction of the nerve.

In the case of the growth of tumors the symptoms are very obscure, being controlled by the character and rapidity of growth of the tumors. Thus a non-malignant growth, increasing slowly in size, may not cause any noteworthy symptoms, the nerve accommodating itself to the pressure, or the tumor growing around it. When the growth is malignant, or accompanied by inflammatory action, there will be associated neuritis, violent pain, and ultimate paralysis. So, also, when the increase in the tumor is rapid, as in some cyst formations, the stretching and compression of the nerves will cause more or less pain and inflammation, and atrophic changes are likely to occur.

The *prognosis*, as in the last instance, depends upon the bodily condition and habit of the patient. When circumstances are favorable, the release from pressure will at once put a stop to the symptoms, under other circumstances, retrogressive changes once established will go on until the destruction of the nerve is complete. Again *Arnica* will be the prominent remedy.

Cicatricial compression is the typical form, and its consideration opens up an immense field for study, data at present at our command being insufficient to determine at all times the result. The symptoms in a number of cases that have fallen under my notice have varied very greatly, so much so that in the absence of any history of injury I doubt if it would be readily conceived that the difficulty was due to the contraction of a cicatrix. It will serve a purpose to relate a case which will illustrate the character of the phenomena, and at the same time the treatment that has been found most effective.

A boy, L., aged sixteen, fell on a scythe, cutting the left wrist to the bone, on the palmer surface, dividing the communis tendon, but with no history of having wounded the artery on either side. This was one year before I saw the case, or in April, 1878. There had never been much pain in the hand or arm, but when the dressings

were finally removed, the hand was found of a mottled appearance, cold, the integument of the fingers smooth and shining, nails discolored and incurvated laterally, and loss of power to grasp any object, or even to fully extend or flex the fingers. There was tingling of the fingers, but sence of touch diminished. The back of the hand was still sensitive, but there was some loss in that region also. As time passed on the symptoms of paralysis gradually increased, until it was complete, the integument desquamating and peeling off in scales. The condition was at once recognized as compression of the median and ulnar nerve, possibly of the radial as well; from the fact that the paralytic symptoms came on gradually, it was evident that the nerves had not been divided at the time of the accident, or at the most might have been partially cut through. Operation May 1879. The ulnar and median nerves were found included in a dense cicatrix; the median evidently having sustained a partial division, the ulnar atrophied from the compression. The stretching was slight, the atrophy being so extensive that it was feared they could not bear the strain, and a flap slid over as in former instances. *Hypericum* tincture ten drops to the ounce of water, was kept constantly applied to the wound by cloths wrung out in the solution, and the same remedy given internally, in hourly doses, in the first dilution. After twenty-four hours the external application was suspended, the remedy being given, still in the first, once in two hours. *There was absolutely no pain*, except upon motion of the part. There was evident gain in the function of the hand after the first week, and improvement was constant, although slow, until, at the expiration of three months, the member had attained a moderate degree of usefulness. To-day, nearly two years after the operation, there is perfect motion, both in flexion and extension of the fingers, some hyperæsthesia of the extremities of the fingers, but considerable lack of muscular power. The length of time in which he has remained in this condition, precludes, it seems to me, any hope of *full* recovery, but he is in much better condition than would have seemed possible ten or even five years ago.

(*c.*) *Puncture of nerves* often results in tetanus. Under all circumstances there will be great pain, as far as my experience goes, and stiffness of the part, with a tendency to muscular spasm. The injury being inflicted with a sharp, polished, *clean* instrument, such as a needle, or the point of the surgeon's knife, the symptoms will usually soon pass away. Under other circumstances, the instrument being rusty, rough, or carrying some foreign material with it, the prognosis is not so favorable. The chapter on *Injury of the Nerves* will give all the information necessary on this subject, the purely local symptoms being readily interpreted when the general effects are borne in mind.

(*d.*) *Laceration of the Nerves* will give symptoms similar to compressions, which will either pass away as repair is perfected, or become aggravated if morbid action takes the place of repair.

(*l.*) *Division*, when complete, will necessarily result in complete paralysis of the parts supplied. Should the lesion happily be subcutaneous, there is a strong probability that union will occur, or the gap between the cut ends fill up by a prolongation of nerve tissue, as shown in a former chapter.

The divisions being partial, the symptoms and prognosis will be the same as in the case of laceration, the condition being slightly more favorable than in that case.

IV. FRACTURES.

A discussion of fractures of the upper extremity will include fracture of the clavicle, scapula, humerus, ulna, radius, carpus, metcarpus, and phalanges. Messrs. FLOWER and HULKE (HOLMES *Syst. of Surg.*, 11. p. 764), present a table giving the seat of fracture of these bones, as occurring in 2705 cases received and treated at the Middlesex Hospital during a period of sixteen years, ending on June 30, 1867. From this table, which forms an exceedingly appropriate preface to our topic, it will be seen that during the period of life in which, as far as occupation and nature of amusement are concerned, that girls and boys are exposed to the same accidents, the number of fractures is remarkably even in the two sexes. Later, when the boy comes to be a man, and enters upon the more active duties of life, being thus exposed to greater liability to accident, fractures among men are more numerous than among women. Later in life, say between the ages of forty-five and sixty, man's active life having, to some extent, ceased, the proportion between the sexes is about even. In advanced age, however, from some cause not yet determined, women sustain more fractures than men, more particularly of the lower end of the radius. The table, which is reproduced below, will sufficiently explain itself, and needs no extended comment; it will furnish a useful study for those who are desirous of acquiring knowledge in this direction, more particularly as it is related to medical jurisprudence.

BONE.	AGE 0-5		AGE 5-15		AGE 15-30		AGE 30-45		AGE 45-60		AGE 60		TOTAL.		TOTAL.
	SEX.		SEX.		SEX.		SEX.		SEX.		SEX.		SEX.		BOTH SEXES.
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F	M.	F.	
Scapula,	5	3	3	0	1	1	11	6	7	0	1	1	28	11	39
Clavicle,	176	171	84	47	56	26	67	33	51	33	18	10	452	320	772
Humerus, Upper,	1	4	7	2		0	11	45	8	4	5	8	37	23	60
Humerus, Middle,	39	22	42	17	27	18	25	16	11	16	6	15	150	104	254
Humerus, Lower,	8	4	46	3	14	2	2	2	5	1	1	1	76	13	89
Olecronon,	1	0	7	2	23	3	14	5	8	4	4	5	57	19	76
Ulna	8	7	19	1	7	6	19	10	13	10	2	5	68	39	107
Radius	62	64	92	19	78	45	75	57	45	123	21	87	373	395	768
Both Bones,	20	17	71	11	15	7	8	9	9	12	4	8	127	64	191
Carpus,	0	0	0	0	0	0	1	0	0	0	0	0	1	0	1
Metacarpus,	1	1	10	1	62	9	50	13	15	3	3	0	141	27	168
Phalanges,	3	2	44	7	46	8	32	13	24	5	4	1	144	36	180
TOTALS.	324	295	425	110	335	125	315	169	196	211	69	141	1654	1051	2705

1 FRACTURE OF THE SCAPULA.—From the above table, as well as such other records as have been kept, it is apparent that this bone is very rarely fractured. The immunity is secured partly by its position, protected by muscles of much strength and size, its great mobility, and its peculiar functional use. Fracture has occurred in the body, the corocoid and acromion processes, and the neck.

(*a.*) *Fracture of the body of the scapula* is considered one of the most infrequent of fractures of this bone, but from the difficulty experienced in making a diagnosis when there is no displacement of the fragments, or the line of fracture does not extend beyond one of the borders, or involve the spine, it is fair to presume that there are many cases that are never recognized. The fracture usually is situated in that portion of the bone immediately below the spine, running transversely or obliquely across. In some instances, as discovered by autopsy, the thin portion of bone beneath the spine was found fissured, starred, or a small portion beaten in. Such a fracture, in the case of a person of ordinary development, must be utterly unrecognizable. Should the line of fracture extend through one of the borders, and include more than one-half the bone, there will be some displacement that will be readily made out by external manipulation. Complete separation of the fragment, unless the patient is very fleshy or muscular, is easily made out. The portion of bone above the spine has never been fractured, without involving the rest of the body, at least has never been recognized, I believe, during life.

The *cause* of such fractures may be direct or indirect, oftimes the former. When from indirect force, it is usually from a severe squeeze of the trunk, the ribs, or other parts, suffering with the scapula. Direct injury, such as a severe blow, or compression, is oftener the cause. Many cases are recorded as caused by being run over by wagons or loaded carts.

The *diagnosis*, in case of a fracture of sufficient magnitude to call for surgical aid, need not be a difficult matter under ordinary circumstances, exercising due caution against drawing erroneous conclusions, as may occur if an important consideration is lost sight of. This is the faint crackling sound elicited in the shoulder by the slipping of the tendons. The chief diagnostic symptoms will be mobility, crepitus, and deformity. In spare subjects the bone can be readily outlined, if the case is seen very early, and the examination is quite simple. Inasmuch as the injury must be quite severe to produce a fracture of a bone protected as this one is, there will be great swelling rapidly established if too much time elapses before examination. In muscular or fleshy subjects the difficulties would be correspondingly greater. The hand may be firmly pressed, flatwise, upon the scapula, and the arm moved by the other hand in various directions; if this fails to give mobility of a supposed fragment, grasp the acromion process firmly, and manipulate the body of the bone. MALGAIGNE recommends, for the purpose of making the borders of the bone more

prominent, that the arm of the injured side be drawn behind the back, carrying the hand as high towards the opposite shoulder as possible.

Treatment.—Having diagnosed the fracture, if there is displacement, the fragment must be reduced by moulding the parts with the fingers, the arm on that side being kept close to the side. If there is no displacement, dressings are still needed to keep the parts quiet until union has been secured.

The dressings are simple, the more so the better. Some recommend a shield of gutta-percha, or some similar plastic material, confined to the part by a body bandage. I have had the privilege of seeing two cases, and in each the following method has proved perfectly satisfactory: Place a thin compress over the bone, and keep up pressure by a broad adhesive strip passed around the chest. Better than this, had I another opportunity, would be a simple body bandage in lieu of the plaster. The swelling of the parts will soon make the plaster too tight for comfort; it is only to be loosened with difficulty, and the secondary shrinking will, by making it too loose, defeat the object for which it was applied. With much displacement, it is said, this difficulty in keeping the fragments in position is almost insurmountable, we must expect deformity, and possibly some impairment of motion in the arm. Union is rapid, seldom occupying more than three or four weeks. During the treatment the arm must be kept more or less constantly confined to the side, at least for the first ten days or fortnight.

(*b.*) *Fracture of the acromion process*, at least with any considerable displacement, is not a common accident. The causes are usually a fall on the point of the shoulder, blows downward on the process, or falls on the elbow or hand, thus driving the humerus upward.

The *symptoms* are pain at the point of fracture, and inability to raise the arm; usually, when seen standing, the patient will support the elbow by the hand of the opposite side. There will be some loss of prominence in the point of the shoulder, when there is any displacement, the fragment being drawn downward chiefly from the weight of the arm. Raising the arm, pushing the humerus towards the process, will restore the contour of the shoulder, and obtain crepitus. Passing the finger along the spine of the scapula, and alternately pulling down and pushing up the humerus, will ordinarily at once give the seat of fracture. Cases undoubtedly occur, however, in which the periosteum is unbroken, or the fragments are held in place by some other means, and failing to elicit mobility or crepitus, no suspicion of fracture would be entertained.

The indications for *treatment* are quite simple and easily fulfilled. The arm is to be raised, carried slightly backwards, and not too close to the side. This keeps the fractured extremity in connection with the bone, or prevents its displacement, if none has already occurred. A sling is to be used to support the arm, not extending on the forearm more than is absolutely necessary, sufficiently raised to keep the head of the humerus well up against the acromion. A pad of raw

cotton is to be placed between the arm and side, sufficient in thickness to direct the elbow slightly outward, and a body bandage applied over all. A separate sling will then be needed to support the hand. It will require fully four weeks for union to become sufficiently advanced to warrant the final removal of the dressings.

The *coracoid process* is very rarely fractured; in the few cases in which it has occurred, it has either been due to direct violence, or a complete dislocation of the shoulder. It will require extreme violence to rupture the sterno-clavicular ligaments, which while they remain entire, will effectually oppose the downward traction of the strong muscles attached to this part, and thus prevent deformity. These ligaments being torn, the altered shape of the shoulder will be at once apparent. Mobility and crepitus are the principal signs, quite readily detected in complete fracture; displacement is too infrequent to enter into the catalogue.

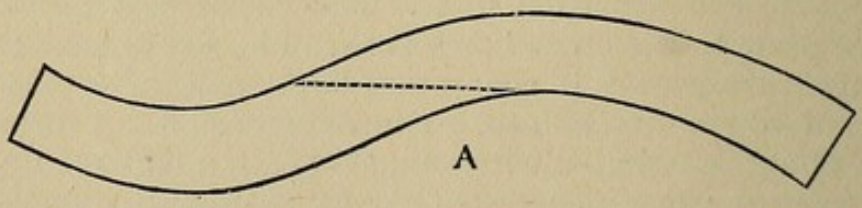
The *treatment* is the same as in the case of fracture of the acromion process, with the exception that the arm is to be carried *forward*, to release the muscles attached to the process.

(*d.*) *Fracture of the neck of the scapula*, using the term in an anatomical rather than a surgical sense, is asserted to be impossible by all modern writers, or at least, if not impossible, there are no cases recorded which establish the fact. It is true that Cooper and others speak of such cases, but in every instance the diagnosis was not confirmed by *post mortem* examination, the patients passing out of sight of the surgeon. MALGAIGNE alludes to a somewhat frequent complication of fracture of the margin of the glenoid fossa in dislocations resulting from extreme violence, and finding the symptoms so similar to those attributed to fracture of the anatomical neck, that the older records are justly regarded with much suspicion. The glenoid cavity itself is not infrequently fractured, but apart from the difficulty experienced in retaining the head of the bone in place after reducing a dislocation of the shoulder, there are no symptoms to call attention to it. The constricted portion of the bone posterior to the notch in the superior border is sometimes fractured, always, however, in connection with fracture of the coronoid process, of which it is, indeed, a simple extension. A direct injury, such as would be inflicted with a musket ball, might readily produce such a fracture; but a somewhat careful examination of the records in the *Medical and Surgical History of the War* fails to discover a single instance, at least one in which there was not extensive comminution of the bone, and great injury to near parts.

2. FRACTURE OF THE CLAVICLE.—Fractures of this bone are exceedingly common, particularly in children before the fifth year; in fact, with the single exception of the radius, more fractures occur of this bone than of any other in the body. The *cause* may be direct or indirect, as far as my experience goes, oftener the latter. When from direct causes, the force applied must be extreme, inasmuch as

the elasticity of the bone (supported only at each extremity), and the degree of mobility in the acromial extremity, protects it from slight degree of force by diffusion and the yielding of the bone. Indirect causes are falls upon the shoulder, elbow or hand, crushing force applied to the chest and shoulders, and muscular action. In the two former instances the ends of the bone are crowded together, and the shaft being bent, will give way at the weakest point, which is about the middle. Muscular action, according to reliable reports, has occurred in twenty-six well authenticated cases; and intra-uterine fractures in quite a number. The bone will usually be found to have given way at one of three points, the shaft, acromial extremity, or sternal extremity, in order of frequency. We will find it convenient to take up each form separately, in the order named, giving treatment at the close, as it is pretty much the same in either instance.

(*a.*) *Fracture of the Shaft*, usually occurs in that portion of the bone between the two curves, as it is the weakest part. The usual direction is transverse, although a number of instances are mentioned in which it has been oblique. Were it not that our text-books assert positively that the transverse fracture usually occurs I should unquestionably have asserted the contrary, inasmuch as all the cases I have seen, perhaps ten or a dozen, were unquestionably oblique. This fact simply goes to show the folly of constructing theories from the experience of a single practitioner. A consideration of the form of the bone would give color to the statement that obliquity was the rule. The weakest portion of the bone is between the curves. In all the cases of oblique fracture found in museums, the break commences at the deepest portion of one concavity and terminates at the other. The figure shown below is a diagramatic representation of the bone, with the ordinary line of fracture. It will thus be seen that a compressing force at one extremity and a solid resistance at the

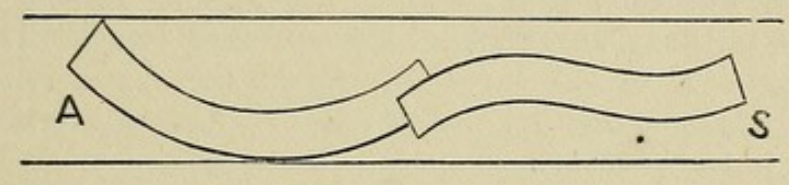


No. 33. Line of Fracture of the Clavicle.

other, the point of extension will be at A, which gives way in obedience to the law frequently alluded to. Whether the fracture is transverse or oblique, there is always more or less displacement, providing it is complete, the inner fragment draws upwards, and the outer in an opposite direction. When the displacement is complete, in transverse fractures, or the line is oblique, the outer fragment is drawn inwards, beneath the inner. The extent to which the frag-

ments are drawn upwards or downwards, depends much upon circumstances that cannot at all times be estimated. In some instances there is a barely perceptible inequality on tracing the bone with the fingers, in others the inner fragment will be tilted up at an angle of forty-five degrees. Probably the cause of this variation will be found to be the violence of the injury, the direction, and the strength of the muscles attached to the different fragments.

Another peculiarity in the direction of the displacement, quite uniformly observed, as far as my experience goes, although it is not alluded to in some of our text-books, is an angular, backward displacement, diagramatically shown in the annexed cut. The peculiar-



No. 34.

ity should not be lost sight of, one of the indications in the treatment having direct reference to it.

The *symptoms* of fracture of the shaft are, pain at the point of fracture, not always felt except upon motion of the arm, or on pressure being made with the finger upon it. A sinking of the shoulder on the injured side, with an inclination of the head to the same side; the pain and feeling of weakness this causes, prompts the sufferer to support the arm in the hand of the opposite side. More or less perceptible deformity in the bone, if not visible to the eye, readily made out on tracing it with the fingers. Crepitation is quite easily obtained, and mobility of the fragment in complete fracture, renders the diagnosis accurate. Should any doubt exist, which in the case of very fleshy persons is not impossible, drawing the shoulders back, and elevating that on the injured side, by at once reducing deformity, will effectually set the matter at rest.

(*b.*) *Fracture of the acromial extremity* occasionally occurs, and in very many instances, particularly when it occurs outside of the coraco-clavicular ligament, is not easily recognized, and is readily mistaken for acromial fracture. When the fracture occurs within the corcoid and acromial ligaments, the displacement is usually considerable, the trapezius muscle drawing the inner fragment up, and the weight of the arm carrying the outer downwards. Under other circumstances, the displacement is very inconsiderable, and may not be observed at all.

The *symptoms* are similar to fracture of the body or shaft, the shoulder drooping, the elbow carried in the hand, and the head inclined to the injured side.

(*c.*) *Fractures of the sternal extremity* are very rare, very few instances being found in the text-books. The symptoms are somewhat similar to fracture in other regions, displacement being very slight. The slight displacement, and the comparatively trivial nature of the symptoms, will probably account for the few reports of such cases: many such fractures doubtless occur which are never recognized in life. The injury is usually direct, and the degree of displacement is somewhat proportionate to the amount of force.

(*d.*) *Incomplete fractures* are frequently met with among children. I have had the privilege of seeing two cases very recently, in which all the symptoms of fracture were well marked, except mobility and crepitus. The results, as to symmetry, are not as encouraging in these instances as in the case of complete fracture.

Comminuted and compound fractures are almost unknown in civil practice. In military surgery they are doubtless frequently observed, but the proximity to the large vessels of the neck, renders them exceedingly fatal accidents, and few are brought to the attention of the surgeon in the hospital.

Treatment.—The indications to be fulfilled are three fold: Keep the shoulder up; keep it back; and draw the outer fragment outward. The different methods prescribed for this purpose are all more or less useful and successful, yet none of the permanent and mechanical appliances can excel, in the results obtained, an improvised dressing I have long employed, being a homely imitation of the apparatus of Fox. Take an ordinary long stocking, cut off the toe part, leaving as much of the foot as possible. Cut off enough of the leg to leave it the length, from the heel, of the forearm from the elbow to the tips of the fingers. Split it up with scissors along tho front part of the foot and leg, making a sling which will be found to nicely accommodate the arm in a flexed position. Attach tapes to each of the corners, long enough to tie around the neck when applied. Next construct an axillary pad, as large as the clenched fist, of raw cotton wrapped in an old handkerchief, a few stitches being taken here and there to keep it from becoming disarranged. This should be rolled up quite hard. Fold a piece of soft muslin, about eighteen inches long and twelve in width, into a number of folds, say two inches wide, stitching the edge of the folds together, when completed, to prevent its becoming disarranged. Lap the ends over, making a ring large enough to fit loosely over the shoulder, and sew them securely together. Place the ring over the sound shoulder. Place the arm of the injured side into the sling, first putting a little raw cotton into the angle in which the elbow will rest. The two tapes at the extremity of the sling at the hand, will then be securely knotted to the ring over the opposite shoulder, drawing the hand as high as the breast. The outside tape on the upper corner is carried over the front of the chest and likewise knotted to the ring. The axillary pad is now to be placed in position, high up, and the remaining tape carried across the back, drawn quite

tightly and fastened to the ring. In the majority of instances this will complete the dressing, care being taken to protect the parts over which the tapes pass by small compresses of cotton. Should the reposition of the fragments not prove satisfactory, or from any cause seem insecure, there are two methods of reinforcing the dressing, one of which will rarely fail to afford perfect satisfaction. The *first* is to knot a handkerchief in a figure of eight, around the shoulders, to draw them farther back. The *second* to pass a long body bandage around the chest and arm of the injured side, taking an occasional turn upward around the elbow over the opposite shoulder.

I wish to be understood that *all* the different methods taught are, as far as I know, perfectly satisfactory; none of them, however, possessing any material advantage over the improvised dressing I have described. They all possess the disadvantage, of being not only somewhat expensive, but of not being at hand, at all times, when wanted.

3. FRACTURE OF THE HUMERUS.—It has long been the custom, and even such late works as HOLMES and BRYANT adhere to the arrangement, to treat of fractures of the humerus as occurring at one of three points, viz., the shaft and either extremity. It is possible that for purely practical purposes, this arrangement might be sufficiently precise, but it would seem that greater precision, both in treatment and prognosis, would be obtained, if the plan were much extended, and a distinction made at least between extra and intra-capsular fracture, as well as one or the other condyle. HAMILTON (*Fract. and Disl.* p. 214,) has classified fractures in, what seems to me, a rational manner. He finds eleven points at which fracture is observed, in the following order:

(*a.*) Head and neck; intra-capsular, both impacted and otherwise.

(*b.*) Through the tubercles; extra capsular, both impacted and otherwise.

(*c.*) Longitudinal, through the head and neck, both external and internal.

(*d.*) At the surgical neck, below the tubercles.

(*e.*) The shaft, any point below the surgical neck; or separation of the upper epiphysis.

(*f.*) At the base of the condyles; separation of the lower epiphysis.

(*g.*) At the base, extending into the joint, between the condyles.

(*h.*) Separation of the internal epicondyle.

(*i.*) Separation of the external epicondyle.

(*k*). Separation of the internal condyle.

(*l.*) Separation of the external condyle.

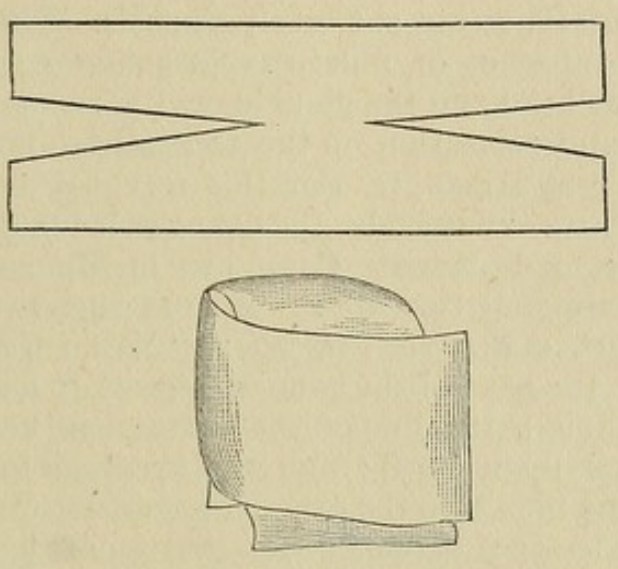
There appears to be some diversity of opinion as to the portion most frequently broken, each author finding much to confirm him in the opinion that his own experience is that of a sufficient number of others to make it a rule. Yet it is apparent that the majority of practitioners meet more cases of fracture at the middle third. HAMILTON's experience was that the majority occurred at the lower third.

My own experience, necessarily insignificant as compared to HAMILTON, would select the upper third. From a comparison of what has been written on the subject, it may be safely asserted, that such lesions are more common at the middle third. This is the more reasonable supposition, inasmuch as the causes of fracture in the shaft are usually indirect, and the middle portion would naturally be the weakest.

(*a.*) *Fracture of the Head and anatomical neck of the Humerus*, is nearly always the result of direct injury. Exceptionally the head of the bone may be broken into fragments by a severe blow upon the shoulder, or a fall, without any penetration of the joint. In the larger number of instances, however, the fracture is caused by gun-shot, or some body entering the joint, coming into immediate contact with it. The bone is usually found broken into a number of fragments, which rarely if ever unite, becoming foreign bodies, exciting suppuration, and calling for removal sooner or later. The constitutional disturbance is usually quite extreme, and death is not an infrequent termination. From the fact that such fractures are generally compound, there can be little difficulty in establishing a diagnosis; even when simple, the symptoms are manifestly unmistakable, and it seems impossible to draw eroneous conclusions. The arm will be shortened; there is a considerable depression in the shoulder, below the acromion; the arm is usually dangling; crepitus is very distinct, and the fragments can be felt slipping among each other. The only accident that a superficial examination could confound it with, would be some form of dislocation of the shoulder. The latter producing extreme immobility of the part, there does not seem any room for a mistake.

The *treatment* depends upon the character of the fracture, whether simple or compound. When the former, whilst the probabilities are altogether in favor of the fragments dying and setting up a dangerous irritation in the joint, it is undoubtedly proper to make an attempt to save the part. The diagnosis made out, no further manipulation must be tolerated, as the fragments are greatly disarranged by so doing, and an unlucky movement may derange a position of the fragments that was the most favorable for reunion. Flex the arm, carrying the forearm across the chest, the hand being midway between pronation and supination. Cover the shoulder with raw cotton, and fit a card board splint as follows: Take a piece of binders board, about eight inches long by four wide, in the case of an adult, and divide it, longitudinally, (*a*) to within an inch of the centre from both ends. Soak it in hot water until it becomes perfectly pliable, and mould it to the shoulder, by placing the centre, or uncut portion, over the top of the acromion, and folding the two inner parts downward, one over the joint and the other behind, smooth them into shape with the hand, (*b.*) The outside portion is now to be turned down, over the deltoid, and the two ends carried over the other, at right angles, and carefully moulded to the parts. It will now be necessary, in some instances at

least, to apply an inner splint, made of the same material, reaching from the axilla to the middle of the arm. This splint must not be pushed up hard into the axilla, as it would interfere with the circula-



No. 35. Splint for Shoulder.

tion and cause sloughing, and the end must be broken across, in preference to cutting, as it will thereby be safer and present no sharp edge. The whole is now to be secured by a bandage, one extending from the fingers to the shoulder, a few turns, if possible being carried from around the elbow to the shoulder of the opposite side. The forearm and hand are to be carried in a sling.

Fractures of the anatomical neck, as would be expected, are exceedingly rare. In the presence of some degree of confusion in our text-books on this point, it will be well to state, that the anatomical neck is the groove immediately surrounding the head, into which the capsular ligament is inserted. The surgical neck, is the slightly constricted portion immediately below the tuberosities. When the term "neck" is used without any prefix, it is meant the whole of the upper epiphysis.

The *cause* is usually direct, and it is thought by many experienced surgeons, that such a fracture is usually secondary upon some disease of the bones. In experiments I have made with recent specimens, it has proved almost impossible to produce this fracture. In one case, a violent blow on the lower extremity of the humerus detached the head at this point; in another, a blow obliquely downwards, on the tuberosities, succeeded, in each case by driving the head of the bone against the margins of the glenoid cavity.

It has been found that the line of fracture is quite accurately in the line of insertion of the capsular ligament, but to a considerable extent extra-capsular. Opportunities for post-mortem examination have been infrequent, yet such as have been made seem to confirm

this conclusion, particularly when it is noted that union occurs in the majority of such cases, which would not be the case were it intra-capsular.

Displacement of the fragments vary in extent and direction, a fact which greatly controls treatment and prognosis. The globular form of the head, the absence of muscular attachment, and the smooth surface of both the head and the glenoid cavity, renders displacement easily produced, and reposition of the fragments almost impossible except by the merest accident. For this reason it is undesirable to manipulate the parts extensively, the chances being that a bad position will only be made worse. Cases are mentioned in which the head has been completely turned around; one such is thus related by HAMILTON, (*Fract. and Disloc.*, p, 217): "When the capsular ligament was opened, the head of the bone was found to have been broken from the shaft though the line of the anatomical neck, and to have completely turned upon itself; and the cartilaginous surface was actually driven one inch into the cancellated structure of the shaft, so as to split off the lesser tubercle, with a portion of the greater. Only one-half of the upper fragment was thus impacted, the other half projecting beyond the margin of the lower fragment. Between the cartilaginous surface and the shaft no union had occurred; but there was complete bony union between the upper and lower fragments, beyond the limits of the cartilage." This case was observed by MR. ROBERT SMITH, being that of a woman who had sustained the fracture many years before the examination noted above.

The impaction noted above is quite frequent, particularly when the force is indirect, and from a blow on the elbow, with or without a rotation of the capsular fragment. The symptoms of fracture in such instances, are somewhat obscured as a natural consequence.

Union occasionally occurs perfectly; particularly when the fragments are not displaced, and the surgeon has not disturbed the position in which the accident left them. At other times union cannot be secured, the head either acting as a foreign body, as in the case of comminuted fracture, setting up suppuration, and calling for extraction, or else it gradually atrophies, and remains, like a floating cartilage, without producing any untoward symptoms. At other times a false joint forms, by ligamentous union. It would seem, however, that in the greater number of instances, as the reparative material comes from the lower fragment entirely, repair is effected as in the case of extra-capsular fracture of the femur, viz., by the growth of the ensheathing callus, like osteophytes, upwards, surrounding the fragment, which it holds in position without any union having taken place.

The *symptoms* are similar to those of fracture of the head, excepting that there is not as marked crepitus or shortening, and the fragments are not felt to slip among themselves. It will require accurate anatomical knowledge to determine whether the separation is within

or without the capsule, and in many instances the fact, probably, can never be determined during life.

The *treatment* is the same as in the case of fracture of the head.

(*b.*) *Fractures through the tubercles*, according to HAMILTON'S classification, are those in which the line of separation is through the tubercles, between the anatomical neck and the surgical neck. The line of fracture may be either transverse or oblique, oftener, judging from the very few specimens seen, in a transverse direction. The fracture is entirely extra-capsular, but its close relationship to the joint assures more or less loss of function.

The *causes* are necessarily direct; indirect force, especially when muscular. cannot produce this fracture, inasmuch as a simple separation of the tubercles is excluded from this category.

There is little if any displacement, partly from the opposing action of the various muscles inserted into the part, and partly from the frequency with which impaction occurs. For this reason the symptoms are somewhat obscure, so much so that when the fragments are impacted, it would seem almost hopeless to make a diagnosis.

Union is readily secured, and is osseous in character. The arm, nevertheless, is more or less permanently crippled, from the changes produced by the inflammation, and the irregular deposits of callus so near the articulating extremity.

Treatment as already given, under fracture of the head and anatomical neck.

(*c.*) *Longitudinal fracture of the head and neck* is an exceedingly rare accident, and characterized by such obscure symptoms that unless an opinion can be based upon *post mortem* examination, diagnosis will always remain a matter of mere conjecture. There are but six or eight cases occurring in the text-books, and in each of them there was dispute as to the actual condition, unless the joint was examined after death. The cause must always be direct violence.

The line of fracture may be entirely extra-articular, when one or the other tubercle is broken off; or partly within and partly without the capsular ligament, when it follows the bicipital groove. It is possible that in very young subjects the tubercles may be broken off by muscular action alone; there are so many other points, however, at which fracture would be likely to occur, that it is doubtful if such an accident has been encountered.

There is little if any crepitus, and no unusual mobility of the arm, the fragments rarely being completely separated. The most pathognomonic symptom would be a widening of the shoulder, either laterally or antero-posteriorly, due to the separation of the fragments at the point of detachment. The repair is osseous and firm, but, as in the last instance, the amount of callus and the inflammation, very seriously impairs the freedom of motion of the joint, the part, when completely repaired, resembling, on ordinary inspection, a tumor of the bone.

Treatment must be negative in results, no matter how carefully conducted. When separation is complete, an apparatus similar to that already described, will be all that is needed; when the bone is simply split, and the fragments not detached, if moderate pressure will not retain them in close apposition, I know of nothing that can be prefer to leaving the case to nature.

(*d.*) *Fracture of the surgical neck* is a far more frequent occurrence than of other portions of the bone in this region, and yet not so much so as the exposed position would seem to promise. What in the young subject would be a separation of the upper epiphysis, in the adult is a fracture of the surgical neck. The results, under ordinary methods of treatment, are strikingly dissimilar; union is the rule in fracture, whilst non-union is more frequent in separation of the epiphysis.

The *causes* may be either direct, as a blow on that portion of the arm, or indirect, as from a fall on the hand or elbow, or sudden contraction of the deltoid or latissimus dorsi. There may be displacement or not, usually the former, the action of the muscles being such that it is the merest accident whether it occurs or not. When it does occur, the latissimus dorsi draws the lower fragment inward to a considerable extent, the deltoid being inserted sufficiently below this attachment, although on the opposite side of the arm, to greatly assist in displacing the fragment. When the original injury fails to produce primary displacement, it is not likely to occur later, if the surgeon avoids rough manipulations, the muscles then opposing each other in such a manner as to prevent this occurrence.

The *signs* of fracture are ordinarily quite pronounced. Mobility, crepitus, pain, and deformity being quite constant. With displacement we will have shortening, but both may be much reduced, if not entirely overcome, by carrying the forearm across the chest.

The *treatment* includes the same general principles already laid down, the splints being required of greater length so as to extend as low as the middle of the arm. In the case of separation of the epiphysis, union will rarely occur unaided by art. It may be secured by the administration of *Calc. phos.* in about the 12th to the 30th attenuation, four doses a day for one week. Something might be expected from *Symphytum*, after this, and in the two cases which I have seen the presumption was in favor of the supposition that it confirmed repair Nothing can be predicated, however, on such insignificant experience Supposing the failure to be due to an interruption in the process of development, and knowing something of the value of *Calc. phos.* in analogous conditions, I feel warranted in claiming for that remedy the power to accelerate and probably insure repair.

(*e.*) *Fractures of the shaft of the humerus* occur from both direct or indirect injury, when from the former at the point of bone injured, from the latter usually near the middle. The chief point of interest attaching to the location of the break is the proximity to the nutrient foramen, the facility of repair being dependent upon the integrity of the vessel it accommodates.

The direction of the fracture is either transverse or oblique, many authors conceiving the matter to be one of chance, or dependent upon the degree and kind of violence. It will be remembered that in an earlier chapter (*Fractures in General*), it was stated that the line of fracture depended more upon the age of the bone than any other consideration. Thus in infancy and childhood, incomplete or "radish-like" fractures were the rule. In adolescence and middle life, oblique was more probable; whilst in old age they were literally transverse, "pipe-stem," or comminuted. I cannot conceive how the kind or degree of injury, or the direction from which the force comes, can in any material way influence the line of fracture; the whole question must turn upon the age of the bone, not in years, but in development. Since having my attention directed to this important fact, I have seen too few cases to permit me to use them as conclusive evidence; those occurring earlier were not recorded in a manner to enable me to recall the circumstances invariably. From what I am able to learn in my own experience, therefore, the fact as related seems to be undisputed.

Displacement, which is at once proportionate to the amount of violence, and the direction of the line of fracture, will be greater in oblique fracture, or transverse fracture from severe injury. Shortening will be in relation to these circumstances; greater in oblique fractures. As an additional factor, the insertion of the various muscles of the arm must be borne in mind. Thus a fracture above the insertion of the deltoid or the latissimus dorsi will have a tendency to draw the lower fragment inwards or outwards, according to circumstances.

Non-union occurs more frequently in fractures of the shaft of the humerus than any of the long bones. HAMILTON inclines to the opinion that it is due to the habit of dressing such fractures with the forearm flexed, and thus rendering it impossible to secure perfect immobility of the fractured bone. Such, I believe, is not the belief at present, and my own experience would seem to contradict it also. As far as statistics are available, it appears that the majority of non-united fractures occur at the middle of the arm, in the immediate neighborhood of the nutrient vessel. It is true that the larger the lower fragment, the larger the line on which the forearm will act, and the greater the certainty of motion at the seat of fracture. This, therefore, should increase the percentage of non-union the higher the fracture, but statistics do not so teach. We are fully justified, in view of all the facts, in considering the failure to unite due to deficient or interrupted nutrition. More particularly is this the case when we remember the results following operations for such conditions, either by resection or otherwise, but particularly when our remedies have been given to arouse the dormant natural forces. The ends of the fragments, in these cases, have been rounded off, smooth, and lost all the essentials to union, yet an operation is

ordinarily successful, because the nutrient vessels have recovered from the injury they had sustained, and are in a condition to furnish the material needed to repair the break. It will not be forgotten that the dressings after such operations are precisely the same as in the original accident, and yet union is the rule. It seems to me, therefore, that HAMILTON must be in error.

In considerable displacements, the musculo-spiral nerve is peculiarly exposed to injury, and it is not uncommon to find evidences of contusion, compression, or laceration, as shown in an earlier paragraph.

The *treatment* must be considered under two heads, for the ordinary form, and for ununited fracture. The arm must be placed in a position, if necssary, to relax the action of any muscle that may have a tendency to draw the fragments asunder. This will often necessitate a complete change in the system of dressing after the first two or three days have passed. Thus in one case the deltoid continually drew the lower fragment outward, almost as fast as it was reduced. The arm was then extended at right angles, properly supported on a pillow, and a long straight splint applied, from the fingers to the shoulder. After the fifth day the arm was brought gradually closer to the body, and finally dressed in the usual way, with the forearm at right angles to the arm, and supported in a sling. In the absense of any indication, such as that above, the best dressing I have been able to find, is a moulded binders-board splint, like that illustrated in a previous paragraph. The splint may be made to fit over the shoulder or not, which is rather to be preferred, and should reach to the elbow; an interior splint, from the axilla to the elbow is also needed. A bandage should then be applied over all, commencing at the fingers, and covering the shoulder. The dressings should be worn for four weeks, not changed as long as they fulfill the indications, or unless they become soiled. The hand must be examined frequently to see that the circulation is not impeded by tightness of the bandage, and the splints that they are not too loosely held. With the bandage too tight gangrene of the arm is to be feared; with the dressings too loose, the fracture is not properly supported, and a false joint may ensue. After the third week passive motion must be commenced in the elbow, otherwise it will become somewhat crippled for a long time, perhaps permanently. The dressings may be partially removed after the fourth week, but the arm must be supported for two or three weeks longer before it can be considered sufficiently restored to risk its use.

Ununited fracture has been discussed in a previous chapter, and little need be added at this place. It was then stated that the best treatment was to commence with the most radical measures, in preferance to temporizing with mere methods of expediency, which, I fear, are oftener evidences of timidity than conservatism. In recent cases, those in which from six to twelve weeks have elapsed with no attempt at union, *Calc. phos.* should be given, I think not lower than the 30th;

the results have been good in the few cases of which I have knowledge. In one case of my own union seemed to commence at once, and in six weeks seemed to be complete. During this time, however, the arm should be put into a straight splint, reaching from the tips of the fingers to the shoulder, and unusual care taken to keep the fragments immovable.

(*f.*] *Fracture at the base of the condyles* is a not uncommon fracture, and while presenting peculiar and striking symptoms, the diagnosis is often very difficult, the most experienced being frequently led into error. The symptoms closely resemble dislocation backward of the ulna, and fracture is frequently mistaken for dislocation in consequence, although HAMILTON has found an error more frequent in the opposite direction "namely, a dislocation of both bones backward has been supposed to be a fracture."

There are a few symptoms, however, of this fracture that it seems to me, if properly understood, cannot admit of an error in diagnosis, if there is the least displacement of the lower fragment. The displacement is almost invariably backwards, which is the chief point of resemblance to a dislocation. The differences are notable, and will be better understood, probably, if placed side by side, in the form of a table:

FRACTURE.	DISLOCATION.
1. Mobility of the joint.	1. Fixidity of the joint.
2. Crepitus.	2. No crepitus unless olecronon or the coracoid process are broken; the former readily detected.
3. Deformity easily reduced, but at once reproduced.	3. Deformity can only be reduced with great exertion of form.
4. Olecronon process and condyles in perfect relation.	4. Olecronon process and condyles much out of relation.
5. Measurement from acromion to condyles shows shortening.	5. Measurement shows no shortening.

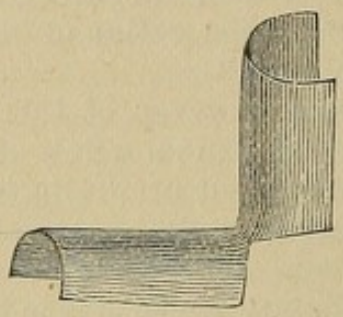
HAMILTON gives a much larger table of comparison, but those mentioned above are far more constant and reliable.

The *result* is usually firm bony union, but with some shortening, when there has been much displacement, and more or less pain from pressure on or contusion of the musculo-spiral nerve. In the latter event, the usefulness of the arm will be much impaired, and the hand and forearm will ultimately suffer from innervation.

The *treatment* will include reduction, retention, and relief of nervous symptoms. The first indication is usually easily fulfilled. The arm should be extended, to fully relax the triceps extensor, and fixing the arm with the left hand placed upon the seat of fracture, draw down the forearm, making flexion, at the same time pronating the hand and carrying it across the chest.

Retention is made by a selection from a large number of splints, each surgeon having his own preference, too frequently, as regards

the simplicity of our literature, one of his own design, space forbidding a description of them. I beg permission to profit by the general custom, and describe the dressing I have always used, not claiming, however, the least originality, the methods being in common use. Place a soft compress over the lower fragment on the *back* of the arm; a similar compress over the upper fragment, anteriorly. Measure the circumference of the arm, at the condyles, and cut two pieces of binders, board a little more than half of the circumference in width, and long enough to reach from the middle of the arm, or the shoulder, to the wrist. Cut them as shown in the



No. 36. Splint for Elbow.

figure, half through from each side, soak them in hot water, and mould them to the arm, one splint posteriorly, and the other in front. Any inequalities in the neighborhood of the joint are to be filled with cotton, and a bandage smoothly applied from the fingers to the shoulder. The hand to be supported in a sling. The posterior splint to be considered the permanent one, and should never be removed, for at least a fortnight. The anterior splint overlaps the other, and can be removed at every dressing to inspect the arm.

Compression or contusion of the nerve is to be treated precisely as if arising from other causes. It may be exposed by a carefully planned incision (that is, one that will not endanger the blood-vessel), and stretched. The earlier this operation is performed after the condition has been positively recognized, the greater the promise of success. Nothing can be gained by delay, as each day increases the injury to the nerve.

(*g.*) *Fractures at the base and between the condyles* is a rare form of fracture, in all cases found to be the result of a severe blow upon the back of the elbow or the olecronon. Dr. Willard Parker conceived that he had a case of this kind, in which the patient had fallen on the hand; the doubt, however, that the fracture was of this character, was admitted, and Hamilton believes such a fracture from such a cause, practically impossible. The symptoms are exceedingly obscure, and the rapid swelling and inflammation of the joint makes it almost impossible to arrive at a correct opinion.

The condyles are separated by a longitudinal fissure, and may be completely detached; this gives increased width of the lower extrem-

ity of the humerus, and apparent shortening of the arm from drawing up of the ulna. Measurements of the condyles will show that there is no shortening, but to the lecronon will give a different result. The indications, therefore, are those of dislocation, with two important exceptions, *viz.*, there is no immobility, and, an absence of fullness in the bend in the elbow. Moreover, on making slight extension of the forearm, and pressing the condyles together, crepitus can usually be detected.

The *results* are quite unfortunate as a rule; bony anchylosis and complete loss of function in the elbow nearly always occurs. The proximity to the joint, in fact the *implication* of the joint — makes inflammation almost a sure promise of its destruction. In some rare instances a cure has been secured, with useful motion of the elbow, but such an event must be very exceptional.

Treatment is mainly directed to the condition of inflammation, although efforts to approximate the fragments must not be overlooked. This may be secured by appropriate bandages, or small angular splints, but must always give place to the indication of greater importance, that of subduing the inflammation. Probably *Acon.*, *Arn.* or *Bell.* will oftener be indicated for this purpose. When the inflammation has subsided somewhat, passive motion must be carefully instituted, in the hope that a stiff joint may be prevented.

(*h.*) *Separation of the internal epicondyle* is included by HAMITON in the list of fractures of the arm, from the fact that it, with the external projection of the same name, represent separate centres of ossification, and are frequently found separated from the condyles prior to the age of complete ossification, viz , the eighteenth year. The internal epicondyle is occasionally separated by muscular action, most of the pronators and flexors having their origin at, or passing over this process; at other times, and it is thought with more frequency, the injury is direct, as a fall upon the elbow.

The *symptoms* are pain; some degree of ecchymosis, depending upon the violence of the injury; usually some evidences of injury to the ulnar nerve; and marked deformity from displacement of the fragment. There are some instances recorded of complete fracture without displacement, but there seems to be some doubt about the authenticity. The displacement is usually downward, toward the hand, in one case to the extent of an inch and a half; in one case it was upward and backward, towards the olecronon. The swelling is usually extensive, and rapid, inflammation being quite violent. The proximity of the process to the joint attaches a value to this form of fracture which would not otherwise obtain. The result is often in partial anchylosis, in all cases, it is affirmed, there is considerable stiffness for a long time, with perfect pronation and supination, but difficult extension and flexion.

Treatment, as in the last instance is very unsatisfactory, the inflammation materially complicating the result. It is often found impossi-

ble to replace the fragment, or in the event of succeeding to retain it, flexion or extension displacing it again. If replacement is secured, a compress and bandage may retain it there, if it is not found necessary to apply the former so tightly that the circulation of the arm is impeded, or the inflammation materially aggravated. In the case of children an angular splint will be required; but, says HAMILTON, "in no case, however, are more than seven or fourteen days to elapse before all bandaging and splinting should be abandoned, and careful but frequent flexion and extension substituted."

(*i.*) *Separation of external epicondyle* is considered by HAMILTON, as never having occurred, it seeming impossible to produce such a fracture without the condyle being implicated, and extension into the joint.

(*k.*) *Separation of the external condyle* is usually, indeed always, the result of direct injury, as a fall on the elbow. The direction of the fracture is oblique, either extending through the olecronon fossa, or simply including the "lesser head" with which the radius articulates. The symptoms are few and characteristic when the case is seen so arly that the swelling does not mask them. There is usually displacement, upward or downward, the latter with greater frequency; in some cases the lower part of the fragment was pushed back by the radius, and the upper correspondingly forward. With this displacement there will be some deflection of the arm to the radial side, and a notable increase in width in the elbow. As in all fractures about the joint there will be much inflammation, and swelling, which claim first attention, even at the expense of some deformity.

Crepitus can usually be distinctly felt, either by grasping the condyle with the finger and thumb, or moving it in various directions. If the swelling is already too great to accomplish this, grasping the elbow with the left hand, and rotating the forearm will succeed.

Treatment, as in the case of separation of the epicondyle, must be chiefly directed to the inflammation, subordinating retention thereto. Union is bony, in most instances, and if there should be moderate displacement of the fragment, with care the motion and usefulness of the arm should be little impaired. As straightening the arm will develop a tendency to tilt up the fragment on its upper border, the arm must be dressed flexed.

(*l.*) *Separation of the internal condyle*, resembles in all essential particulars a similar accident to the external. The symptoms are the same, somewhat more pronounced, on account of its greater size, and the indications for treatment are exactly similar in all essential particulars.

4. FRACTURE OF THE ULNA.—The ulna is broken at one of three points, either the olecronon, coronoid process, or the shaft, separation of the portion articulating with the radius, in the wrist, being properly included in fractures of the shaft.

(*a.*) The *olecronon process* is oftener broken by direct violence,

although some instances have occurred as a result of muscular action. Falls upon the process directly, or a blow immediately below it on the shaft of the bone are noticed as the cause in the large majority of instances.

The point of fracture may be at the apex or base, or a point midway between the two; in the two former, the line being transverse, in the latter quite oblique, the posterior face of the shaft of the ulna suffering extensively. When the apex is broken, or the fracture occurs from muscular action, the portion of bone detached will be that to which the tendon of the triceps extensor is directly attached.

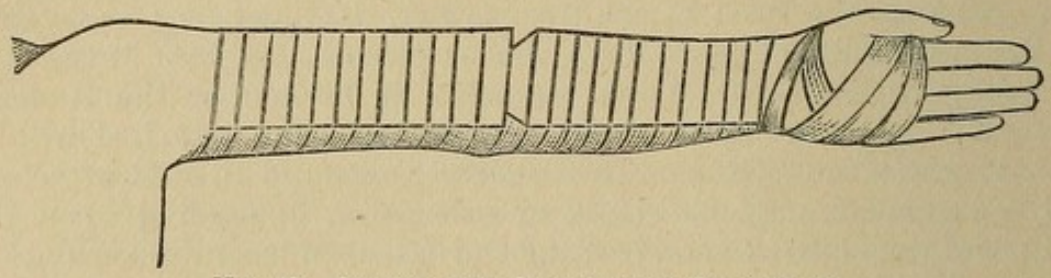
Displacement may be slight or otherwise, depending upon the degree of the violence received, and the extent of laceration sustained by the ligaments of the joint. It will always be in the direction of the action of the triceps, directly upwards. There are cases reported in which crepitus was distinctly felt at once, on making an examination, justifyiug the presumption that there was no displacement.

The *symptoms* are distinct when the case is seen before swelling is extensive. There will be more or less of a depression between the fragments, depending upon the extent of the displacement, and a notable alteration in the shape of the elbow, viewed posteriorly. Crepitus can be elicited by forcing the fragments together, and rubbing the upper on the lower; it the displacement is too slight to suggest this, or the swelling so extensive that the fragments cannot be clearly felt, extending the arm, grasping the elbow with the hand, and moving the joint in various directions, may elicit it. The swelling is usually so rapid and so great that an examination, if attempted after its establishment, must always be very unsatisfactory; so marked is this that when called to a case which has received an injury known to produce fracture of the olecronon, it is safe to suspend judgment until opportunity has been had for a number of examinations.

Union seems to be ligamentous, oftener than bony, particularly when there has been any displacement. When the displacement is slight, retention perfect, and no untoward circumstances occur, bony union may be secured, and no loss of function occur. As in all fractures about the joint, anchylosis is probable, less so, perhaps, in this instance than others, and the joint must be frequently inspected, to enable us to take measures to prevent it, or at least to place the arm in the most useful position.

The *treatment* has for many years been a question of animated discussion. Without taking space to rehearse the arguments *pro* and *con*, with reference to extension or flexion, I am compelled to bear witness to the satisfactory results obtained from the dressing advised by HAMILTON, adding a word of caution: *viz.*, if anchylosis seems to be inevitable, the dressings must be removed, and the arm fixed at nearly a right angle, the hand being midway between proation and supination. HAMILTON (ibid., p. 316), describes his dressing as fol-

lows: "The surgeon will prepare, extemporaneously always, for no single pattern will fit two arms, a splint from a long and sound wooden shingle, or from any piece of thin light board. This must be long enough to reach from near the wrist joint, to within three or



No. 37. Splint for Olecronon Fracture.

four inches of the shoulder, and of a width equal to the widest part of the limb. Its width must be uniform throughout, except that, at a point corresponding to a point three inches, or thereabouts, below the top of the olecronon process, there shall be a notch on each side, or a slight narrowing of the splint. One surface of the splint is now to be thickly padded with hair or cotton batting, so as to fit all the inequalities of the arm, forearm and elbow, and the whole covered neatly with a piece of cotton cloth, stitched together upon the back of the splint. Thus prepared, it is to be laid upon the palmar surface of the limb, and a roller is to be applied, commencing at the hand and covering the splint, by successive circular turns, until the notch is reached, from which point the roller is to pass upwards, and backwards, behind the olecronon process, and down again to the same point on the opposite side of the splint; after making a second oblique turn upon the olecronon, to render it more secure, the roller may begin gradually to descend, each time being less oblique, and passing through the same notch, until the whole of the back of the elbow joint is covered. This completes the adjustment of the fragments, and it only remains to carry the roller again upward, by circular turns, uutil the whole arm is covered as high as the top of the splint. * * * * * * * Before the bandage is applied about the elbow-joint, the olecronon must be drawn down, as well as it can be, by pressure with the fingers, and a compress of folded linen, wetted to prevent its sliding, must be placed partly above and partly upon the process; at the same time, also, care must be taken that the skin is not folded in between the fragments." In the absence of untoward symptoms, the dressings should be worn at least twenty days.

(*b.*) The *coracoid process* has been found fractured, on dissection, very frequently, but there are no instances recorded in which the accident was definitely recognized during life. It is usually broken, judging from what has been learned previously of the history of the case, by the same force which would produce a dislocation backwards of the elbow. In fact it is supposed by many to be a concomitant of such dislocation, and not a fracture pure and simple.

The *symptoms* are those of dislocation, to be entered upon later, with crepitation on manipulation. If it is ever essential to detect the fracture apart from the displacement of the joint, the accident may be predicated upon the fact that redisplacement is constant. Reduction of a dislocated elbow, in the absence of fracture of the coracoid process, is easy, and retention readily secured; in this case, however, it will be next to impossible to keep the bones in place, the ulna slipping backward on the slightest provocation. The mere fact of this easy reluxation is almost sufficient to base a diagnosis upon; when we have crepitus added thereto, there can be no question as to the existance of fracture.

The *prognosis*, as to union, is that when the separation occurs at the base it will be bony and firm; when occurring above this line, it will either fail entirely, or be simply ligamentous. If the patient escapes anchylosis, which is somewhat more rare than in the case of other fractures about the joint, ligamentous union will not materially cripple the arm. There is more danger of anchylosis, in proportion as the union is bony; when no attempt at repair is made inflammation is either moderate or absent entirely, and there is no deposit of callus, two essential conditions to stiff joint.

The *treatment* will be as in the case of dislocation of the elbow backward; the arm to be flexed, midway between pronation and supination, and confined in an angular splint, with the hand suspended in a proper sling.

(c.) The *shaft of the ulna*, as compared to accidents by which both bones of the forearm are broken, is fractured infrequently. Its position does not expose it to direct injury, and indirect force can scarcely affect it without corresponding lesion of the radius. The injury is, therefore, usually direct, as in warding a blow with the arm. It seems to have been fractured with equal frequency in all parts of its length, the portion sustaining the blow being that which gives way. The line of fracture is usually oblique, at least in the middle third; more or less transverse at either extremity. Displacement is not always considerable, frequently it will be imperceptible. The upper fragment, from its firm and broad articulation with the humerus, is rarely deflected to any extent; the lower, however, chiefly through the action of the pronator quadratus, will often be found drawn inward toward the radius. From the fixed position of the extremities of the bone, overlapping cannot occur without fracture of the radius, or such an extensive injury that the ligaments in the wrist are torn up. For this reason the deformity will never be extreme, and even with considerable displacement of the lower fragment, will be too slight to attract attention on superficial examination. If the case is not seen until swelling has occurred, it will require close inspection to establish a diagnosis, even when the displacement is great. There are many cases in which the fragments remain undisturbed; others in which the displacement is in the direction of the force producing the

fracture, and to an extent commensurate to the degree of violence. In the majority, however, the lower fragment will be found more or less drawn towards the radius.

The experience of most surgeons is, that in civil practice there is no form of fracture oftener complicated than that of the ulna. HAMILTON, in nearly all of his cases, had comminution, extensive injury to the soft parts, or dislocation, others speak in the same terms. My experience, necessarily limited, would fully bear out this statement, all my cases having been compound. Nevertheless the prognosis may be set down as good, both as to preservation of fracture, and to bony union. The displacement being so slight, as a rule, and the absence of overlapping, will ensure speedy union, should the fracture be simple. Supination is generally perfect, but pronation may be impeded.

Treatment presents but few indications, and these readily fulfilled. The hand may be pronated, in dressing, to relax the pronator quadratus, but care must be taken to keep the lower fragment drawn away from the radius, otherwise the callus may bridge over and prevent rotation of the arm. An ordinary angular splint, flexed arm, and a sling for the hand are the rules of dressing. In compound fractures the case is to be treated in accordance with the principles already laid down.

5. FRACTURES OF THE RADIUS.—The radius is found fractured at either extremity, or the shaft. Fractures of the lower extremity are generally confined to one point, although Dr. J. RHEA BARTON described a variety not hitherto recognized, but which HAMILTON and other equally good authorities, consider to be of doubtful occurrence, there not being a specimen in any of the museums, or a well authenticated case reported in current literature. I feel justified, therefore, in dividing our subject into fractures of the neck or head, of the shaft, and COLLES fracture in the wrist.

(*a.*) *Fracture of the head* is an exceedingly obscure accident, inasmuch as swelling is early and extreme, and many of the usual signs of fracture are either obscured or wanting. When the head of the bone can be *felt*, rotation of the arm would settle the question, for or against fracture; but when we are compelled to wait for the subsidence of the swelling, it is too late, from the degree of union established, to remedy mal-position of the fragments. Crepitus may be elicited without difficulty, but in the absence of other signs it simply proves the existence of fracture in the joint; it does not affirm that the head of the radius has suffered. It is important to establish the diagnosis early, as the result of the treatment is much affected by our comprehension of the case. Thus, the biceps muscle is a strong supinator. A fracture occurring below the insertion of this muscle, will allow the fragment to which it is attached to become completely supinated. If now, the arm is dressed in a position of pronation, and union occurs, supination is forever lost, and even pronation is more or less defective. The arm is, therefore, permanently crippled. For this reason

the arm must be dressed in a position of complete supination, as much flexed as possible (to relax the biceps), and maintained so until the subsidence of swelling affords us an opportunity to verify our diagnosis by careful examination. Should the accident prove to be a fracture of the head, by fully relaxing the biceps, which occurs when the arm is flexed, the fragment may be rotated into a position of pronation, pronating the arm at the same time, and retained there without much trouble, the union already affected much assisting the retentive apparatus.

The *treatment*, therefore, is to dress the arm primarily, in a nearly straight position, strongly supinated. After the seventh day, attempt pronation and flexion, as indicated above.

(*b.*) *Fracture of the shaft* occurs at any point, between the extremities, when from direct injury. When the injury is indirect, it seems to occur with greater frequency at the lower third. The deformity is generally quite marked, the upper fragment drawn upward and away from the ulna, the lower drawn more or less strongly towards that bone. The displacement of the upper fragment has some relation to the direction of the force producing the fracture; but more to the action of the biceps and the pronator radii teres, which tilts it up in the direction of their action. The lower fragment is likewise drawn towards the ulna by the action of the pronator quadratus on the upper end, the supinator longus assisting by traction made on the lower extremity. Reduction is not difficult if the arm be pronated and partially flexed, which also elicits crepitus.

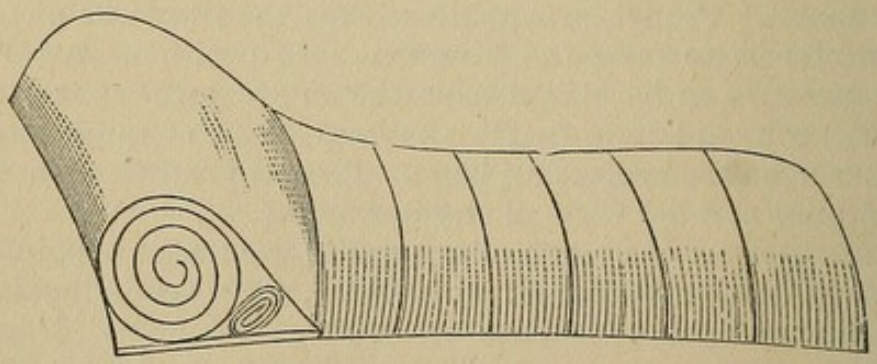
The *treatment* consists in placing the arm in the position which will relax the muscles that have a tendency to keep the parts asunder. Thus flexure will relax those acting upon the upper fragment, as well as the supinator longus which makes traction on the lower end of the lower fragment. Pronation equally relaxes the pronator quadratus, which permits us to raise the fragment into position. A soft graduated compress is to be placed over the interosseous space, on both sides of the arm, and an ordinary compress over the upper fragment, not directly upon the projecting bone. The arm is then to be dressed in the ordinary manner with an angular splint.

(*c.*) *Fracture of the lower extremity*, usually occurs at a point rarely more than an inch from the end of the bone, notwithstanding it would seem that it would be difficult to break it at that point. Prof. Ab. Colles was the first to accurately describe this fracture, and it was not until the publication of his *Lectures on Surgery* that the accident was well understood. Previous to his time it was quite commonly the case that dislocation or sprain was mistaken for fracture, or the reverse. In the edition of his lectures compiled by Mr. Simon McCoy, (1845,) the professor speaks as follows: (page 324.) "When you look at the carpal end of the radius, you would suppose that a fracture near it must be very uncommon, yet it is really the most frequent seat of such accident in that bone, but why I cannot say; it is not easily dis-

covered on account of the swelling which rapidly supervenes here as in other injuries about the wrist and elbow. This fracture takes place about an inch and a half above the carpal end of the bone; the deformity produced, precisely resembles what Dessault calls a dislocation of the carpal end of the radius, and I am very much disposed to think he sometimes mistook one case for the other." The close resemblance to dislocations of the wrist must at times cause embarrassment to the most experienced; at all times the student will find a mighty problem to solve. It must be borne in mind that there is a want of immobility, that would attach to dislocation, and the presence of crepitus, which must constitute proof of fracture. The variety of fracture is now known as Colles fracture of the wrist.

The cause is usually indirect injury, as falls upon the hand in such a way that it is extended. There is considerable pain at once, much swelling, and a unique deformity. There will be observed a firm swelling on the palmar side of the wrist, with a depression, or a sharply defined swelling on the opposite side. The hand will be directed upwards, at a more or less acute angle, the fingers partly flexed, and only moved with some degree of pain. The end of the ulna is apt to be unusually prominent, and the hand carried slightly to the radial side. On grasping the hand, palm to palm, with the fingers disposed around the wrist, and making traction, the deformity is reduced, particularly if the line of traction is slightly towards the ulnar side, and combined with a rocking or rotary motion. At the same time crepitus can be produced.

The *treatment* is variously prescribed by different writers. My own experience leads me to prefer that of Dr. HOYNE, who introduced it in the *American Journal of Medical Science*, April 1852. The splint is



No. 38

made as seen in the cut, to be thickly padded, aud applied to the palmar surface, the fingers grasping the pad shown in the distal end. It may be necessary to place a compress between the wrist and the splint, to keep the fragment in place, but ordinarily it will not be called for. The swelling lasts a long time, many weeks, and the

limbs remain stiff indefinitely. Usually the dressings may be allowed to remain for four weeks, when passive motion of the wrists and fingers, and friction must be instituted.

6. Fracture of Both Bones of the Forearm.—This form of fracture has always been one of unusual interest to surgeons, partly from the unusual predisposition to gangrene, observed in a large number of instances, and partly from the many opposing views of eminent men as to the indications for treatment—of late years the question of treatment has been quite generally decided upon, and the usual practice is as will be found below.

The *causes* of these fractures are either direct or indirect; when from the former causes, any part of the bones may suffer; when from the latter, usually the lower third. In the majority of instances the deformity will be considerable, the mobility so great that no embarrassment need be felt to determine the nature of the accident Owing to the superficial character of the blood vessels, and the freedom of motion in the fragments, disturbances in circulation are easily produced, and gangrene has often destroyed an arm that had suffered only a simple fracture from a comparatively insignificant injury. Unquestionably the practice that formerly obtained, of bandaging the member before applying the splints was often responsible for this condition, but it must not be lost sight of that the severity of the accident, carelessness of the patient or nurses, and some constitutional defect may be as often responsible as the surgeon. There are too many cases in which the instructions of the surgeon have been defied, or his dressings tampered with by amateurs, to warrant us in attaching blame to the medical attendant upon a simple statement of the patient or his friends.

The *treatment* includes attention to the following points—to avoid pressure on or interference with the blood vessels, to keep the bones separated, and to preserve the symmetry of the arm. The old practice of placing a compress on the arm to keep the bones apart, was responsible for many accidents, I have no doubt. We now know that with the arm placed in a position of supination, the interosseous space is fully preserved, and no mere muscular action can draw the bones together, unless the break is so low down that the pronator quadratus exerts much influence on the lower fragments. By using two broad splints, anterior and posterior, so wide that the bandage cannot press the bones together, and carefully preserving the supine position, there need be no apprehension felt, in ordinary cases, of an untoward result. Usually in twenty days the bones will be found sufficiently united to dispense with the splints, although they frequently unite unequally; that is, the ulna or radius has been found firmly united, whilst the other bone has failed entirely. In one case mentioned by Hamilton, the radius was not united two years after the ulna was firm. Under good treatment, *Calc. phos.*, or *Symphyt.*, we can scarcely conceive of such a result to-day, unless some foreign material is interposed between the ends.

7. FRACTURES OF THE CARPUS.—The carpal bones are rarely the subject of simple fracture. Compound fractures from gun-shot injuries, or other species of extreme violence, are not uncommon, but are of such a character that the joint, if not the hand, is at once destroyed. In the event of a simple fracture, particularly from indirect violence, there is little if any displacement, and union is speedily effected. No splints or dressings are needed, as deformity need not be feared. The only danger is that the joint may be permanently destroyed by inflammatory action, In cases of compound injury the probabilities are that the hand will be lost if the fractured bones are allowed to remain. The practice is to remove the fragments at once, and treat the case as one of exsection. With much associated injury to the soft parts the hand may be considered lost whether or no, but it is well to remove the fragments of bone, and leave amputation until it is demonstrated that the hand cannot be saved.

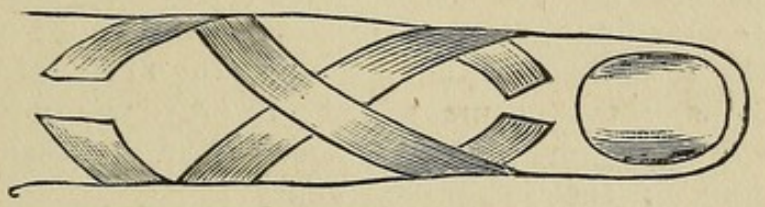
8. FRACTURES OF THE METACARPUS.—The metacarpal bones are fractured oftener, it would seem, from blows made with the clenched fist, or from the hand being caught and crushed between two solid substances. When from the latter causes, the fracture is usually compound; when from the former, simple. The fracture oftener occurs in the middle third of the shaft of the bone, and the distal fragment is found displaced downwards into the palm. This displacement is variously accounted for by the shape of the bone, and the action of the interosseous muscles. Probably both conditions will be found to influence it. In compound injuries, all parts of the bone will be found to suffer alike, depending, as a matter of course, upon the point receiving the injury, and the displacement of the fragments will be determined by the direction of the force. The results are usually speedy bony union, without deformity or functional loss, if reduction has been secured early.

The *treatment* presents few indications. Extension will usually bring the fragments easily into line, and a very simple dressing will suffice to keep them there. Have the fingers easily flexed, fill up the hollow of the palm of the hand with cotton, and apply a splint that will reach from the base of the fingers half up the forearm. Over the back of the hand a pasteboard splint may be moulded, and the whole retained in place with a few turns of a roller, the hand to be supported in a sling.

9. FRACTURE OF THE PHALANGEAL BONES.—The bones of the fingers are frequently broken by direct violence, or from being caught in machinery, or struck by balls and other missiles and implements used in games. From the fact that the injury is received at the point of fracture the swelling is extreme, and comes on at once, whereby many of the ordinary signs of fracture are obscured. Displacement, however, is the exception, unless the injury is compound, from extreme violence. In the latter instance, particularly when occurring to the distal phalanges, the part may be condemned at once.

I have yet to see a case in which the last phalanx was broken, and the soft parts wounded to an extent to permit the extrusion of the bone, which recovered; union has never taken place, and the tip of the fingers has only been saved when the fragments of bone that were loose were removed at the first dressing. The fracture being simple, repair is generally speedy and perfect. The part must be inspected daily, to discover if there is any displacement.

I have never found it necessary to use any apparatus in dressing these fractures, than a peculiar application of adhesive strap, as



No. 39.

indicated in the accompanying cut. The parts are held sufficiently firm, and at the same time are easily inspected, when occasion demands, without disarranging the dressings. Four strips are required, two of which are crossed, as in the figure, both on the palmar and dorsal surface of the finger, crossing each other a little below the line of fracture. On account of the swelling of the part, the strip should not be applied until it has been subdued by *Arn.*, or other indicated remedies, the finger, meanwhile, being supported by a light wooden splint.

V DISLOCATIONS.

From the tables published by Messrs. FLOWER & HULKE (HOLMES II, p. 764), it appears that dislocations of the upper extremity occur with less frequency than fracture. At the same time that dislocation is of less frequency, it is generally conceded by surgeons, I believe, that the accident is one of greater importance, both with reference to immediate and remote consequences; the injury done to soft parts, and the lesion being confined to the joint, it must be apparent that loss of function is more imminent than would be the case in simple fractures. The table is as follows:

REGION.	AGE 0-5		AGE 5-15		AGE 15-30		AGE 30-45		AGE 45-60		AGE 60		TOTALS.		
	SEX.		SEX.		SEX.		SEX.		SEX.		SEX.		SEX.		BOTH
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	SEXES.
Clavicle,	1		2	1	4		2	1	2	1	2	1	13	3	16
Acromion,			1		3		3	1	3	1			10	2	12
Humerus,	1	2	1	1	24	9	63	21	42	34	36	28	167	95	262
Elbow,		1	43	5	8	3	8	3	2				61	12	73
Thumb,		1	11	3	18	3	23	11	15	10	3	1	70	29	99
Fingers,			6	2	11	3	6	11	7	7	3	3	33	26	59
TOTALS.....	2	4	64	12	68	18	105	48	71	53	44	32	354	167	521

This is a record of cases occurring in sixteen years, ending June 30th, 1867, at the Middls-ex Hospital, and is a valuable analysis. It will be observed that the joint of the shoulder has been oftener dislocated, and that the ages from thirty to forty-five present the greater number of dislocations of all kinds. This will show that the more movable, or the greater the variety of motion in a joint, the greater the liability to dislocation ; and that the completion of ossification, as occcurs between the ages specified, predisposes to displacement of joints, perhaps to a greater degree than to fracture. However this last may be, from one point of view, it is generally admitted that it will require greater exertion of force to produce a dislocation than a fracture; the force being expended upon the articulating extremity of a bone, a dislocation occurs, whilst a fracture would take place if a less degree of force were applied to the shaft of the bone.

Dislocations of the upper extremity are classified by different authors according to their conception of the meaning of the word. Thus considering the word to indicate a separation of the bone from one nearer the trunk, or one more fixed it its position, English authors quite generally speak of dislocations of the scapula (acromial dislocations,) rather than of the acromial end of the clavicle. I shall adopt that classification as far as this joint is concerned; in other instances I prefer to consider both bones as implicated in the accident, and refer to luxations of the shoulder, elbow and wrist, in preferance to humerus, forearm, and carpus. In all cases the distal bone will be understood as being particularly displaced; thus, "backward dislocation of the elbow," will be understood as dislocation backwards of the ulna and radius.

This gives us the following classification: Dislocations of the scapula, clavicle, shoulder, elbow, wrist, carpus, and fingers.

1. Dislocation of the Scapula (Acromial extremity of Clavicle.) The cause of this dislocation is direct violence on the scapula, as a fall on some hard substance. The displacement occurs in one of three directions, by which the end of the clavicle is carried above or below the acromian process of the scapula, or in extreme cases, both the acromion and coracoid processes are carried above the bone. The symptoms are common to injuries about a joint, viz., pain and swelling, with some modification of motion. The arm seems lengthened, the shoulder broader, and carried in towards the sternum. The end of the clavicle can be plainly felt in its new position; by tracing the bone with the fingers, outward from the sternum, it can scarcely be mistaken for one of the scapular processes. The hand will support the elbow, and the body be inclined to the injured side as in the case of fracture. On drawing the shoulder backward all deformity will at once disappear, thus completing the diagnosis.

The *treatment* may require variation in exceptional cases, but that which seems to give the best results is as follows: Keeping the shoulder well drawn back, place a compress over the end of the clavi-

cle; pass a broad band, either in the form of a bandage or a strap with buckles, over the shoulder and around the elbow, or a Petit tourniquent may be used for that purpose. The hand is to be carried in a sling. Union should not be considered good under three weeks.

2. DISLOCATION OF THE CLAVICLE.—Pursuing the classification adopted, this accident represents a separation of the clavicle from the sternum. Whilst an accident rather frequently occurring, as compared to fracture it is not as common; inspection of the tables published in this chapter, will show that as compared to fracture, it occurs about in the proportion of 3-10 per centum. This difference is accounted for from the fact that there is little if any mobility in the joint, and the whole bone being quite firmly bound down there is a greater liability of a compressing force breaking the bone than of disturbing the relations of the joint. The *cause* of the dislocation is usually indirect, from forcing the shoulders together or backwards; direct injury can rarely be inflicted of a character to cause a dislocation. The displacement is in one of three directions, viz., upward, forward (or downward,) and backward.

(*a.*) *Upward dislocation of the Clavicle*, is a comparatively rare form of luxation, produced by some force which carries the shoulders downward and inward, as falls or blows on the top of the shoulder. The shoulder will seem depressed, the elbow supported in the hand, and displacement will be at once seen on comparison with the bone of the opposite side. The head of the bone, moreover, will be felt on the upper border of the sternum, carried slightly forward.

Reduction is effected by carrying the shoulders upward and outward, at the same time pushing the head of the bone downward. The dressing for fracture of the clavicle, will answer a good purpose, and placing a compress over the head of the bone, with a body bandage to hold it in position. It is almost impossible to secure union without deformity, but even when allowed to go unreduced, but little inconvenience will be felt, except in lifting weights above the head.

(*b.*) *Forward dislocation of the Clavicle* is a somewhat common form of the accident, produced by force acting upon the front of the shoulder. The head of the bone is carried forward and a little downward, being easily felt, in most instances, in its new position. In very fleshy subjects, or when there is much swelling, it may be difficult to feel the bone, but as little, if any, inconvenience results when allowed to remain unreduced, it is of less importance than if the conditions were otherwise. The alteration in the line of the clavicle, as compared with the bone on the opposite side, the pain at the point of injury, the necessity the patient feels to support the elbow in the hand, and the nature of the accident, will usually prevent any opportunity for a mistaken diagnosis.

Reduction is sufficiently easy. Place the knee between the shoulders, and draw them backward and outward, whilst an assistant presses the head of the bone into its proper place. A figure of eight bandage

around the shoulders, posteriorly and a compress over the head of the bone, held in place by a proper bandage, will be all the dressing usually required. Some surgeons have succeeded in keeping the head of the bone in place with an ordinary hernia truss, with a soft pad. It will be found very difficult to prevent some deformity.

(c.) *Backward dislocation of the Clavicle*, a somewhat rare occurrence, is produced by crowding the shoulders together, or pressure forward and inward. The deformity is peculiar, and can scarcely be mistaken. The head of the bone is carried behind the sternum, where it may sometimes be felt; the shoulder is carried forward; the clavicle appears shortened, and, in extreme cases, dyspnœa or dysphagia will be complained of from the pressure of the head of the bone on the trachea or œsophagus. MR. DAVIE, of Bungay, as related by COOPER, found it necessary to saw off the head of the bone in a case in which reduction could not be effected.

Reduction is usually easily produced, by drawing the shoulders back, and securing them by a figure of eight bandage. In some extreme cases, a strong straight splint has been placed across the shoulders, which are drawn back by a firm bandage. Any mal-position of the head of the bone may be corrected by compress and bandage as in other varieties of dislocation of this bone. When the head of the bone has been pressed against the trachea or œsophagus with sufficient force or for a sufficient length of time to cause some interference with their function, *Arn.* must be given for twenty-four hours or longer.

3. DISLOCATION OF THE SHOULDER.—The freedom of motion in the shoulder joint, greater than in the case of any other joint in the body, renders it much more liable to dislocatiou than other joints in the upper extremity, if not to any other joint in the body. Its importance, from the variety of motion, in all the avocations of life, renders its integrity of paramount importance, so that from every point of view, dislocations of the shoulder have at all times engaged the attention of surgeons. Referance to the tables quoted in this chapter, will show that out of a total of 521 dislocations of all kinds, 262 occurred at the shoulder. Also, that out of a total of 2705 fractures of the upper extremity only sixty occurred in the upper part of the humerus, an exceedingly small number of these being fractures of the head or neck of the bone.

The literature of this subject is very involved, as regards classification, etiology and treatment, unnecessarily so, it seems to me. Nearly every writer of note has added to the embarrassment by attempting something new and original, and late writers have greatly increased it by quoting all they can find access to, besides proposing additional methods of their own. As to classification, a moments consideration of the anatomy of the joint should, it seems to me, cause all to adopt the simple and rational classification of SIR ASTLEY COOPER. The head of the humerus can only leave the glenoid cavity in one of three directions, downward, forward and backward; this reduces our varie-

ties of the accident to three in number, all others representing simple modifications of these, either in extent or direction. Thus "sub-coracoid" simply represents a minor form of "sub-clavicular," either of them being simply "inward," of different degree. So, also, most of them being secondary upon a downward dislocation, it is proper to consider this form first, as being typical of the other two, and including the same considerations of etiology, symptoms, and treatment.

(*a.*) *Downward dislocation of the humerus* (*subglenoid, into the axilla.*) is the commoner form of shoulder dislocation, and one which very frequently is antecedent to other displacements. The causes are various, and yet similar to a certain extent. Thus there must be a laceration of the capsular ligament, and the application of some force that will force the head of the bone out of the glenoid cavity, and downward. Among the more common causes, are blows upon the head of the humerus, received on the outer and upper surface; falls on the hand or elbow carrying the arm out from the body; extreme tension on the arms whilst held vertically above the head, as when catching at a rope when falling through a hatchway, or drawn by the reins attached to a run away horse. These accidents disunite the bones, and on attempting to rise from the ground when fallen, or change the postion in any way, the head of the bone slips through the torn capsule, and the dislocation is produced, the head generally resting on the smooth triangular space on the anterior border of the scapula, immediately below the glenoid fossa, or imbeded in the subscapular or infra spinatus muscle. All the muscles of the part are somewhat torn, stretched, or separated from there attachments, and it is not uncommon to find the greater tuberosity detached. The circumflex nerve is bruised, torn, or compressed, and the axillary vessels and nerves are more or less injured when the dislocation is complete.

The *symptoms* are unique, and unmistakable, although it is related that good surgeons have accasionally overlooked or misinterpreted them. While not having had the misfortune to make a mistake in the diagnosis of the few cases that I have been privileged to see, it must be admitted that after the lapse of a sufficient time to permit the swelling to form, some embarrassment might arise, particularly in the case of a fleshy person. The tip of the shoulder will appear very prominent; a marked depression will exist below the acromion, and an unnatural fullness in the axilla. The elbow will be carried out from the body, often as far as three or four inches; the arm will be lengthened from a half of an inch to an inch, measured from the acromion to the condyles, and it will be impossible to place the hand on the opposite shoulder. The body will be inclined to the injured side, and the elbow supported in the hand, as in the case of clavicular fracture. The elbow cannot be approximated to the side, without causing great pain, and there is the characteristic immobility. When a day or more has elapsed before attempting reduction, motion of the joint will give a friction or chafing sound, which must not be mis-

taken for fracture; separation of the tuberosity, however, would give true crepitus, but usually only after much manipulation, as the broken surfaces are widely separated.

The *results* of such accidents depend upon the extent of injury done to the associated parts, and the length of time elapsing before reduction. When reduced early, perfect motion is at once restored, but it will require weeks or months to fully regain the strength of the joint. Compression or other injury to the nerves of the axilla, may cause more or less paralysis and atrophy of the arm, in the majority of instances ultimately passing away. In ancient cases reduction is not only always difficult, but may be even impossible. As shown in an earlier chapter (*Injuries to Joints*), the glenoid cavity sometimes fills up, and a new one forms, even in the body of a muscle, the head of the bone being retained therein as perfectly as in the original one In such cases, (ancient dislocations), a caution previously (*ibid*) given must be remembered; the length of time the joint has been misplaced may cause such shortening of nerves, arteries and veins, not to mention the muscles, that they are in emminent danger of being torn on attempting reduction. One of the most frequent and embarrassing sequelæ to this accident, particularly as being a pretext for suits at law for malpractice, is a fullness on the anterior surface of the shoulder, as if the reduction had not been complete. This is explained by HAMILTON, as probably due to a rupture of the tendon of the supra-spinatus, or the long head of the biceps, (perhaps both), whereby the head of the bone is drawn forward by the muscles which have lost the antagonism of the former, or *falls* forward from the removal of the compression exerted by the tendon of the latter.

The *treatment* includes reduction and the application of dressings to keep the bones in place. Reduction may be effected in two ways, either mechanical extension or manipulation; the latter to be preferred. As is usual in these operations, first slightly increase the deformity; then placing the knee in the axilla, the patient being seated, make pressure with one hand downward on the acromion, and keeping the arm a little back, to relieve muscular tension, use it as a lever to lift the bone into its position. Failing in this, have the patient lie down. Sitting on the edge of the bed, place the heel in the axilla, and make traction on the arm in the direction in which it leads, an assistant pressing down on the shoulder. In simpler cases, one hand may be placed in the axilla, as a fulcrum, the arm to be manipulated as a lever at the same time. The arm is then to be brought to the side, the forearm flexed across the chest, and suspended in a sling, while the shoulder will be securely bandaged for at least a week.

In cases of greater difficulty, particularly when ancient, apparatus for extension may be needed. The best that I have seen is that devised by PROF. N. R. SMITH, which may be simplified as follows:

The patient is seated in an ordinary wooden chair; a broad, firm band is placed over the injured shoulder, and secured around the seat

of the chair, one end passing down the back and one in front. Another band is passed around the chest, close up into the axilla, the two ends being fastened at some convenient point, or drawn upon by assistants. Extension is then made by assistants on the arm, the surgeon manipulating the parts with his hands free. I doubt not there are cases that will resist all these methods of reduction. If so, and there is any useful motion of the shoulder at all, I would prefer to leave the case alone, rather than subject the parts to greater force, which could readily add greatly to the injury.

(*b.*) *Forward dislocation* (*sub-corocoid*, *sub-clavicular*), is produced by the same causes as in the case of a downward displacement, perhaps the arm may be carried a little behind the body, or directly backward. In a great many instances this displacement is secondary upon a downward dislocation, attempting to rise from the ground, or some other motion throwing the head of the bone upwards, under the pectoralis minor. This is particularly the case when the luxation is not complete, the head of the bone having passed downwards until more than one-half of its diameter has passed the edge of the glenoid depression. The deltoid and scapular muscles will be much stretched or torn, frequently the lesser tuberosity will also be detached.

The *symptoms* in addition to those common to all dislocations of the shoulder, will be as follows: The head of the bone can be seen or felt in its new position; the arm is carried out from the body, and cannot be moved backward or forward; the shoulder is very prominent, the depression under the acronion being very marked, particularly posteriorly; the elbow may be very slightly directed backwards, and the arm somewhat rotated outward, from the tension to which the abductors are subjected.

The axillary vessels and nerves are less exposed to injury in this form of dislocation than any other, but sufficiently so to demand caution in attempts at reduction in all cases.

The *treatment* is conducted upon the same general principles already laid down. In some instances, when unusual difficulty has been experienced, the following method has been successful: Lay the patient on the back, and extend the arm upwards by first bringing it in across the body; then rotating upwards. Extension is made directly upward, fixing the shoulder with the foot; as the head becomes disengaged, carry the arm outward, until it is at a little less than right angles, then carrying it downwards across the chest to the opposite side, finally bringing it into the side. The additional strain brought upon the abductors by this method, renders it necessary to reserve it for the last resort.

(*c.*) *Backward dislocation* (*sub-spinous*) is a rare form of the accident, and sufficiently unique in character to render it at once distinguishable. The causes are the same as already given, the hand being carried forward, so that the force pushes the head of the bone back-

wards. Blows near the head of the bone, directed downwards and backwards, on the anterior surface, may also produce the displacement. I am of the opinion, however, based upon the cases of dislocations of all kinds that I have seen, that direct injury very rarely operates to produce a dislocation; it is oftener the case that the head of the bone is *lifted* out of its socket by the shaft operating as a lever.

The *symptoms* differ somewhat from those already noticed. The arm is short, the shoulder is prominent, and there is a depression under the acromion. The elbow is also carried away from the body. In addition the arm is carried forwards, a little on the chest for its upper two thirds, and, unless the subscapularis is torn, also somewhat rotated inwards. The head of the bone can be felt under the spine of the scapula, and rotation can be felt on rotating the arm. The shoulder is also notably elevated. Reduction is not difficult, and repair is speedy.

The *treatment* may be conducted on the ordinary principles, or extension made in the direction in which the arm points. In recent cases, before there has been time for shortening of the parts in relation to the joint, SIR ASTLEY COOPER reduced several cases, by raising the arm perpendicularly and carrying it around back of the head.

With *partial dislocations*, so-called, we shall have nothing to do. There is much doubt whether such an accident ever occurred, considered solely with reference to the shoulder. It is impossible to have the shoulder dislocated without more than one-half the diameter of the head of the humerus passing over the margin of the glenoid cavity. A displacement less than that would be spontaneously reduced. In the cases described as partial luxations, in which there was no laceration of the capsular ligament, the presumption is that the head of the bone was thrust forward from the rupture or dislocation of the long head of the biceps, or some similar accident to the subscapularis or infra spinatus.

4. DISLOCATIONS OF THE ELBOW.—In the tables already quoted, it will be seen that whilst out of a totality of 2705 fractures, of all kinds, of the upper extremity, but 107 occurred in the elbow joint, there were seventy-three dislocations out of a total of 521. Injuries to the elbow, therefore, are far more frequently causative of luxation than fracture, notwithstanding there are such exposed points as the olecronon and humeral condyles.

In the prevailing classification of these lesions, a distinction is made between dislocation of the ulna alone, and one which includes the radius also. While it is possible that some good reason exists for this custom, I am unable to discover it, as it is difficult to see how the radius can be separated from the movements of the ulna. The difference is only in degree; when the dislocation is complete, then it is spoken of as "dislocation of both bones." In this instance, therefore, I shall take the liberty of ignoring the ancient classification, and consider dislocations of the elbow as affecting both bones. It is

obvious that the radius may be dislocated without the ulna being in any sense implicated; hence we find a true elbow dislocation, and another of bones in the neighborhood of that joint. We will consider elbow dislocations, therefore, as including dislocations backwards forwards, and lateral of the ulna, and forward and backward of the radius.

(*a.*) *Dislocation of the ulna backwards*, in which the coronoid process is thrown on or beyond the trochlear surface of the humerus, is the ordinary and typical form of dislocation. It is produced in various ways, as by forced flexion, falls on the hand bending the arm backwards, twisting in marching, or exceptionally by blows received on the back of the humerus, or front or upper part of the forearm. When complete, the forearm is carried directly backwards, the action of the triceps tending to draw the bones upwards, until the coronoid process rests in the olecronon fossa, or even higher. In the minor degrees, constituting what are called dislocations of the ulna alone, the coronoid rests on the trochlea. The ligaments are all more or less torn, particularly the lateral; the brachialis anticus either torn or very much stretched; the biceps in a more moderate state of tension, although cases have occurred in which the tendon was torn from the tubercle of the radius, or the tubercle itself fractured and detached. The coronoid process is occasionally broken off, which, as has been said earlier, will render retention of the parts difficult, and reluxation easy. The median and ulnar nerves are painfully stretched, sometimes torn or contused, and the musculo-spiral is equally exposed to injury.

The *symptoms* are quite characteristic, and can only very rarely mislead. The arm is usually slightly flexed, at an angle of about one hundred and twenty degrees, in some rare instances this is increased to almost a right angle. Hand is usually pronated, with the fingers somewhat flexed. There is preternatural lateral mobility, but no flexion or extension without great pain at least. The tip of the elbow is very prominent, and the flexure of the same is filled up. On flexing the arm the olecronon becomes more prominent, which would not be the case in fracture near the joint, and it will be found materially above the internal condyle. On measuring the arm from the acromion to the condyle, there will be no shortening, but if it is extended to the styloid process of the ulna, shortening will be pronounced, varying from half an inch to one inch and a half. Reduction is usually readily effected in recent cases, but in ancient ones it will not only be very difficult, but even impossible.

Treatment.—The method of Sir Astley Cooper is that most frequently employed. The patient is seated in a chair, the surgeon resting one foot on the seat of the chair, in front of the patient, places the knee in the elbow, making forcible flexion of the forearm. This lifts the coronoid process out of the olecronon fossa, separates the bones sufficientiy to allow it to pass the articulating surface of

the humerus, and draws the forearm forward. When reduced, as a test of success, flex the arm fully; if it cannot be done, reduction has not been accomplished. Should there be a tendency to redisplacement, and some crepitus, fracture of the coronoid process is probable, and retentive dressing must be employed. For this purpose, treat the case as one of fracture, using an angular splint.

(*b.*) *Dislocation of the ulna outwards*, or towards the radial side, is usually incomplete, and is rather a rare form of the accident. The causes are usually a fall on the hand, which is thrown inwards, blows on the outer side of the lower end of the humerus, or the inner side of the forearm, or any force which presses the bones asunder in this direction. There are a number of instances in which attempts to reduce a backward dislocation has resulted in throwing the bones into this position; as a rule, however, the displacement is primary. The olecronon will be found resting on the outer condyle, or even the epicondyle; the brachialis anticus and anconeus torn or much stretched, and the internal lateral ligament ruptured. The nerves and arteries suffer but little, and yet the radial and musculo-spiral nerves have been found badly injured.

Symptoms.— The forearm is usually in a moderate state of flexion, about as in backward dislocation, or 120 degrees. The hand is pronated; elbow immovable; internal condyle of the humerus very prominent, with a deep depression below it; the arm more or less inclined outwards; the head of the radius easily recognized by its cup-shaped depression, is felt outside of the joint, and can be made to rotate on turning the forearm. The olecronon is very prominent, made more so by flexion, as was shown to be the case in backward dislocation. Reduction is generally easy, if the attempt is not too long delayed.

Treatment.— The head of the radius must be found, as it sometimes occurs that it is dislocated from the ulna. When it is found in front of the joint, it is dislocated separately, and the hand must be strongly supinated, to replace the radius, and as a preliminary to reduction of the ulna. The method of COOPER, given above, is to be pursued, with extension combined with lateral pressure.

(*c.*) *Dislocation of the Ulna inward*, or to the ulnar side, is exceedingly rare, and HAMILTON is unable to find an instance in which it was complete. This is unquestionably owing to the greater size of the inner condyle, and the difficulty that would be experienced in forcing the ulna over such an obstruction. The causes are similar, but partly reversed, to those responsible for outward dislocations, viz., blows on the inner side of the lower end of the humerus, or the upper and outer part of the forearm; falls on the hand, which is forced outward; or from the action of machinery. The head of the radius will be found occupying nearly the position of the coronoid process when the arm is moderately flexed; the olecronon will be upon the inner condyle. The ulnar nerve is very frequently crushed between the olecro-

non and epitrochlear, the blood vessels usually escaping injury. The external lateral ligaments are very tense, rarely torn, and the brachialis anticus, anconeus, and biceps more or less tense. Occasionally there is a backward displacement, so that the head of the radius is found in the olecronon fossa.

Symptoms.—The olecronon is prominent, and seen on the inner condyle; the radius is felt in the bend of the arm; external condyle is very prominent; the forearm is flexed, and the hand strongly pronated, unless the head of the radius is behind the joint, when it will be supinated. The arm is often inclined slightly inward, or in straight line from the humerus in place of the usual deflection outward. Reduction is very difficult, often impossible. Anchylosis, when it results from non-reduction, does not affect pronation or supination, which is usually perfect.

The *treatment* is precisely the same as when the displacement is in the opposite direction, making lateral pressure inward on the lower end of the humerus, and outward on the forearm.

(*d.*) *Dislocation of the Ulna forward*, is an exceedingly rare form of the accident, the result of extreme violence, and complicated by fracture of the olecronon. Extreme flexion, or extension by machinery, are the commoner causes, if any cause can be "common" in such a rare accident. The ligaments are much stretched, and the end of the olecronon rests in the coronoid fossa.

Symptoms.—The arm is usually strongly flexed; hand in extreme supination; point of the elbow is lost, and the condyles of the humerus are felt in its place. The deformity is very marked and peculiar, but from the fact that force has been extreme, there will be great and early swelling of the parts, so that a critical examination will be impossible. The fact of the strong flexion not being accompanied by contraction of the biceps, seems to me a valuable diagnostic symptom.

Treatment.—The flexure must be somewhat increased, then making counter extension backward on the lower part of the humerus, extend the forearm, making extension at the same time. In complete dislocations of this variety, moderate flexion alone, if not made too abruptly, will usually replace the parts.

(*e.*) *Dislocation of the Head of the Radius forward*, as far as my experience goes, is oftener overlooked, than any other form of dislocation. I have seen a number of cases that were never recognized by the attending physician; in fact I do not recall a case in which the attendant had made a correct diagnosis, or even suspected any serious lesion of the joint. The usual causes are falls on the arm, striking the head of the bone on its posterior or inner surface; falls on the hand while in a state of pronation, or in such a manner that the hand is forced into a state of extreme pronation; twisting the hand into extreme pronation by machinery; or lifting children by the hands, particularly when done suddenly. The ligaments, particularly the annular, are more or less torn; and the head of the bone thrown on the humerus, a little outwardly.

Symptoms.—The arm is flexed, not to any extent, however; the hand pronated; the forearm inclines unnaturally outward; the head of the bone is felt in its new position, and on rotating the hand is felt to follow the same motion. The forearm cannot be flexed beyond a right angle, but later is capable of putrenatural extension, in one case as far as 120°. Cannot place the hand on the head, particularly on the occiput. Reduction is easy, as a rule, but retention almost impossible. Indeed some surgeons declare the accident is irremediable, and beyond confining the arm for a few days, to permit some degree of union in the torn ligaments, make no attempt to treat it.

Treatment.—Notwithstanding a too common practice, an attempt at reduction and retention should be made, particularly as more than one perfect cure has occured. To reduce the displacement, make extension in the direction in which the arm is found. Not relaxing the extending force, next flex the arm fully, pressing down the head of the bone with the thumbs. A right angled splint is now to be applied, the hand placed midway between pronation and supination, and a compress secured over the head of the bone with a roller. Great care must be taken not to permit or attempt extension of the arm for some weeks; and under no circumstances must forcible extension be attempted, as the dislocation is exceedingly liable to be reproduced.

(*f.*) *Dislocation of the Head of the Radius backwards*, is caused by forces acting in the opposite direction to those mentioned in the preceeding instance. For example, blows received on the front of the arm, on the radial head; extreme supination; falls on the supinated hand; and violent attempts to supinate, while the arm is held firmly pronated. The ligaments are more or less torn, as in the preceeding instance, the head of the bone being thrown upward aud behind the condyle of the humerus.

Symptoms.—The head of the bone is felt, and seen to rotate, behind the external condyle; the forearm is flexed, *slightly* pronated, and directed outward at quite an angle. Flexion and extension are difficult, and while pronation may be very slightly increased, supination is impossible. Perhaps flexion cannot be made to the same extent as in forward dislocations, as a rule, but cases do occur in which a right angled position *can* be secured. Reduction is not ordinarily difficult, but the results are even less satisfactory than in the case of forward luxation.

Treatment.—Extension is to be made, as in the former instance, in the direction in which the arm points, making counter extension from the humerus. Next forcibly supinate the hand, drawing the forearm to the ulnar side, press the head of the bone into place, and flex the arm. The dislocation is now reduced, and up to this time no difficulty will have been experienced. The trouble is, that a forward dislocation is easily produced, on very slight provocation, and the case can now be treated precisely as if that were the case.

Some authors speak of an *outward dislocation* of the radius, but as it

is always secondary upon the other, and calls for no treatment, from the impossibility of a cure, it is dismissed here with a brief statement of its possibility.

5. DISLOCATION OF THE WRIST.—Under this head is included dislocations of the carpus from the radius, both backward and forward, dislocations of the lower extremity of the ulna, and dislocations of the carpal bones among themselves. A comparison of the statistics attainable, as well as the experience of surgical practitioners with whom I have an acquaintance, establishes the fact that these accidents are all exceedingly rare, so much so that there are not a few who emphatically deny their occurrence, deeming most of the reported cases to be fracture. There is no doubt that there is ample ground for this statement, very many supposed dislocation having been found to be fracture on subsequent examination. Nevertheless, accompanying the fracture there is often a displacement of the bones of the joint, and as compared to extent of the lesion, dislocation may properly claim preceedance.

(*a.*) *Dislocation of Carpus backward* is declared by DUPUYTREN to be almost impossible, and in support of his assertion it is notorious that in every case in which post-mortem examination was had a fracture was discovered. The displacement is generally so much greater than the fracture, both in importance and extent, that the accident may well be considered one of complicatad luxation. The displacemen, backward, or on the dorsum of the radius, is caused by falls on the back of the hand, or pressure causing extreme carpal flexion. The carpus is thrown up on the dorsum of the radius, tearing up the extensor tendons, and lacerating the ligaments, anterior and posterior particularly. The styloid process of the ulna, or the apophysis of the radius is usually fractured, and the radial and ulnar arteries are occasionally torn, at all times somewhat compressed and put upon the stretch.

Symptoms.—The appearance very closely resemble Colles fracture, so much so that a mistake in diagnosing is frequent. The hand is usually in a straight line with the forearm, whilst in fracture it is inclined to the radial side. There is an abrupt angle on both the palmar and dorsal surface of the wrist, the former produced by the ends of the bones in the forearm, the latter by the carpus. The hand is flexed, also the fingers slightly.

In simple dislocations, or when complicated if the associate lesion is not too extensive, the prognosis is good, and recovery will be complete and satisfactory. In compound cases the prognosis is always bad; a question of amputation or resection will always arise, and radical treatment must not be too long delayed.

Treatment.—Generally making traction in the direction in which the hand is found pointing, with counter extension from the wrist, will readily reduce the displacement. Failing in this, bending the hand backwards, until it approximates a right angle with the arm,

and pushing the carpus down, will succeed. In other cases, increasing the flexion, and making traction, conjoined with pressure, on the carpus, will be the best. As a rule, no difficulty will be experienced in reducing the dislocation, but the usual associated fracture renders retention difficult. Nevertheless, if it can possibly be avoided, do not use splints of any kind, as they increase the dangers of anchylosis. Rest the hand on a pillow, well supported, and administer remedies to combat the inflammation, as Aconite or Arsenic.

(*b.*) *Dislocation of the carpus forwards* is produced by falls on the palm of the hand, or forces causing extreme carpal extension, and give the same symptoms, with obvious modifications, as the backward luxation, calling for precisely the same treatment in every particular.

(*c.*) *Dislocation of the carpal end of the ulna backwards* occasionally occurs without associated fracture, produced by extension with forced pronation; as a rule, however, there is fracture of the radius to some extent. The injury to ligaments and near parts is comparatively unimportant, and no permanent loss of function need be feared if reduction is early. The end of the bone will be found on the front of the radius.

The *symptoms* are often very insignificant, and unless care be had in the examination a partial luxation will entirely escape detection. The hand will be slightly pronated, the hand and forearm a little flexed, and the end of the bone can be felt in the back of the wrist, quite movable.

The *treatment* will consist in strongly supinating the hand, extension, and pressing the bone into its place. If possible, splints, and retentive apparatus generally are to be avoided.

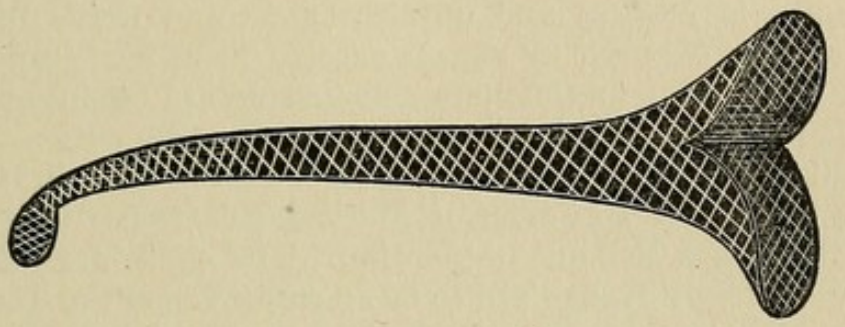
(*d.*) *Dislocation of the carpal end of the ulna forward* is more rare than the preceding. It is produced by violent supination, or a forcible attempt at supination while the hand is held in a position of pronation. The hand is supinated, and the end of the bone is felt on the front of the wrist.

Reduction is effected by increasing the supination somewhat, flexing the hand, and pressing the head of the bone into position. Mr. PARKER, of Liverpool, England, reports a case in which the hand had to be pronated before reduction could be effected.

(*e.*) *Dislocation of the carpal bones among themselves* occasionally occurs, but fracture is much more common. The swelling is usually considerable, and is established early, so that if examination is delayed, it may be impossible to recognize the accident until it is too late to reduce it. The bone is usually forced directly backward, toward the palm, forming a swelling on that side, with a corresponding depression on the opposite side. Care must be taken to differentiate from ganglions, which is easy, inasmuch as the displacement is rarely complete.

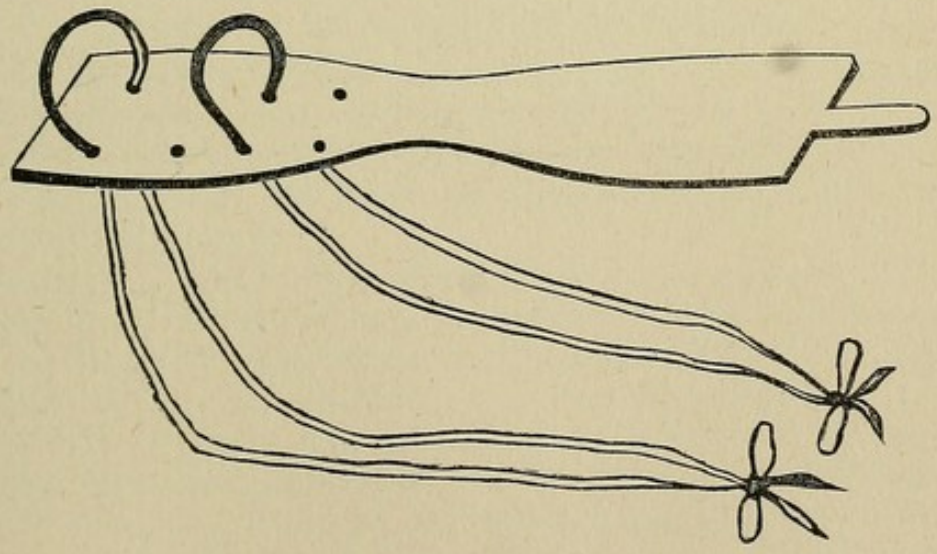
Reduction is to be effected by fixing the carpus above the point of dislocation, making extension on the fingers which have the most direct relation to the bone, and pressing it into position.

6. Dislocations of the Hand.—With the exception of the thumb, the metacarpal bones are very rarely dislocated. They have been thrown out of place by blows received on the back of the hand, particularly when some hard substance is struck with the fist. The carpal end of the bone is usually thrown inwards, toward the palm, and in the few instances on record the displacement has been complete.



No. 40. Indian Puzzle.

When the metacarpus of the thumb is dislocated, it is rarely complete. It is produced by falls on this member, the bone being displaced in any direction; depending upon whether the force is applied at either side, or forcing the thumb into extreme flexion or extreme extension. In either case the deformity is too pronounced and unique to permit of mistake, if the surgeon is at all familiar with the anatomy of the parts.



No. 41. Levi's Adjuster.

Reduction is usually best secured by slightly increasing the deformity, making extension, and pressing the bone into place. On account of the shortness of the member, it is often impossible to make the requisite degree of tension, from the difficulty of securing a hold This may be aided by making a "close hitch" with a handkerchief,

or strips of bandaging, (17) or applying the "Indian puzzle," (40) as shown in the cut. In this way a secure hold can be had, and extension properly and effectually made.

The same methods are employed in dislocations of the other metacarpal bones.

7. DISLOCATIONS OF THE FINGERS.—The phalangeal bones are frequeutly dislocated, either from extreme flexion or extension. The deformity is marked and unmistakable, and needs little mention. Reduction is secured by simple extension, which is much facilitated by the application of the ingenious instrument devised by Dr. LEVIS, or either of the methods shown in the preceding cut.

In dislocations of the first phalanx or the thumb, it occasionally seems impossible to reduce it, and many cases have been abandoned with the bones still out of position. The cause for this difficulty is now universally recognized to be an eatanglement of the head of the bone under one or more of the ligaments, or "button holed" in the fascia. It is proper to divide these impediments subcutaneously, if faithful effort fails to reduce the luxation. In one case in which two physicians had spent much time, and subjected the patient to severe pain by prolonged traction, I succeeded finally by dividing the external lateral ligament, under which the head of the bone was engaged.

XXIII. INJURIES OF THE CHEST.

The fact that the chest contains many of the organs most essential to life, renders accidents in this region peculiarly interesting, so much so that even when appearing quite trivial to the uninformed the experienced surgeon will view them with concern. The relation which the scapula and clavicle sustain to the chest, not less intimate than that sustained to the upper extremity, somewhat complicates attempts to systematize a study of the region, with reference to surgical considerations, more particularly as to injuries purely external, and not involving penetration of the walls, or injury to the visceral contents. At this time our arrangement must include contusions of the chest wall and mammæ; wounds, non-penetrating and penetrating; wounds of the lungs, heart, and diaphgram, with hernia of the lung, or pneumonocele; wounds of the blood vessels, both internal and external; closing with notice of fracture and dislocation of the sternum, ribs and cartilages.

1. CONTUSION OF THE WALLS OF THE CHEST.

In many particulars, contusions of this region do not present any peculiar characters, unless of sufficient extent, or produced with a degree of violence that either lacerates muscles and blood vessels, fractures or dislocates the bones, or implicates the viscera either by contusion or concussion.

The *pectoral muscles*, more particularly, occasionally the latissimus dorsi, and intercostals, are torn, in whole or in part, and from the known characters of such lesions, as discussed elsewhere, the accident will be of a very serious character. The loss of power thus entailed may seriously and permanently cripple the usefulness of the arm, embarrass respiration, or from the loss of an important barrier a portion of the lung may be forced out between the ribs, and a hernia of this organ occur. Under all circumstances, and in all regions, as has been frequently alluded to in previous pages, a ruptured muscle is a serious accident, both from the greater or lesser loss of usefulness and power involved, and the difficulty of keeping the torn extremities in opposition until union can be effected. In the chest, from the constant and partially involuntary motion of the parts in respiration, and the danger that might exist in attempting to keep the side of the chest injured motionless, the gravity of the accident is much

increased, and none can avoid feeling solicitude. Subcutaneous sutures must be employed, as noted in the chapter on injuries of the muscles, and an effort made to keep the torn ends in contact, and restrain motion of the part as far as possible, for at least two months. Instances are mentioned in the text-books of quite perfect recovery by the employment of deep sutures and appropriate bandages, which should give courage to attempt the cure of even the most unpromising cases.

The *blood vessels* of the chest walls are unusually large, for superficial vessels, and their relation to the bony parieties are of such a character that they are not unfrequently torn in severe contusions, and pour out immense quantities of blood into the cellular tissue, forming swellings that might well give rise to a suspicion of acute suppuration. The fact that the swelling is immediate upon the reception of injury, and the abscence of heat or other symptoms of inflammation, will serve to readily differentiate between ordinary ecchymosis, acute abscess, and extravasation of blood. The most extensive extravasations are usually readily absorbed in this region, but the wounded vessel must be secured, or if this is impracticable cold applications or compression must be applied to arrest the hæmorrhage *Arn.* or *Ham.* as laid down in another place, (*Contusions*) will be indicated to hasten the resorption of the blood.

Fractures or *dislocations* of the bones of the chest, ribs or sternum, may occur when the compression is severe, and will receive attention later, in a more appropriate place.

The *viscera* may also be contused, by transmission of the force of the blow, or from compression. The symptoms of such lesions are exceedingly obscure, and are of a purely negative character. Having determined that there is no penetrating wound, and some disturbance in the function of the heart or lungs continuing longer than would obtain if due to simple shock, the presumption is that they have sustained some injury.

Laceration is not impossible, of either the heart or lungs, and there are a number of such instances referred to in works on general surgery and medical jurisprudence. In the case of the heart death is usually instantaneous, or nearly so, although in a few instances it was delayed several hours. The lungs have been ruptured more frequently, and whilst not as rapidly fatal as the former, I believe, there are no verified instances of recovery after such an accident. There may be no rational signs of the accident whatever, further than the dyspnœa or disturbance of the circulation, although in some cases there is a discharge of blood from the mouth or nose. The heart, as is well known, is not infrequently ruptured without external violence, from *sudden* over action due to mental emotions; I know of nothing of that kind occurring in the lung.

Other visceral lesions, more remote in character, are pneumonia, pleuritis, suppuration in the mediastinum, or even empyema, or pus

in the pleural cavity. Latent pectoral disease is often set up, or becomes active by contusion of the chest. The possibility of such grave consequences will prompt the surgeon to institute the most careful examination in such cases, and guard his prognosis with care.

The *treatment* will necessarily be conducted on the general principles of treating contusions, probably *Arnica* always being indicated for the primary conditions. The resistancy and elasticity of the ribs and sternum renders them tolerant of over extreme pressure, and there is a possibility of the most extensive injury to the contents of the thorax without any fracture or dislocation of the bony walls.

II. WOUNDS OF THE CHEST.

Wounds of the chest are usually either incised or punctured, the symptoms, prognosis and termination being very materially dependent upon the fact whether the walls of the chest or the cavity of the pleura are opened. In this country, apart from wounds encountered on the field of battle, such injuries are very uncommon. In dueling countries, particularly France and Spain, when the small sword is a common weapon, such injuries are frequent, and the study of their nature and characters has been quite thoroughly pursued. It will present the question more completely, to consider it under two heads, *viz.*, *non-penetrating* and *penetrating*.

(*a.*) *Non-penetrating wounds* are chiefly made with pointed weapons, as swords or knives, and musket-shot. As the term implies, they are wounds which do not extend through the chest walls. It is a matter of the first importance to determine the question of penetration in the outset, a matter not at all times as readily determined as would at first sight appear. As will be seen later, the occurrence of emphysema, which would seem to be only producible by exit of air from the lungs, is not confined to penetrating wounds. The symptoms in favor of non-penetration, therefore, will be of a purely negative character, *i. e.*, simply the absence, in many cases, of any indications of penetration beyond a doubt. A long incised wound may sink so deeply at the middle of its course, that a small puncture may occur in an intercostal space; or a stab wound may produce a similar opening at the commencement, becoming quite superficial at the termination. Under such circumstances, it is evident, it will require careful probing of the whole extent of the wound to determine whether the weapon has at any point entered the cavity of the chest. Even without penetration there is sufficient gravity in these injuries, the weapon gliding along the ribs for long distances, in many cases forming suppurating sinuses, besides injuring blood vessels, which produce many of the unfavorable symptoms under contusions. Besides this, there is danger, more particularly in the case of incised wounds, of such injury to the large muscles as will cripple the arm; or to the intercostal muscles, so that the lung will protrude, constituting hernia of the wound, or pneumonocele.

Besides these more patent sequelæ, VIDAL (HOLMES II, p. 576,) refers to another that will seldom occur in this or other non-dueling countries:

"Punctured wounds, even of the slightest character, may be attended with symptoms simulating those of lesion of some internal organs, or internal hæmorrhage, such as coldness of the skin, feeble circulation, a sense of suffocation, syncope and cough. These phenomena, he states, are chiefly observed in wounds received in duels. Whatever may be the courage of the champion, at the moment of combat the blood does not circulate normally, and the innervation is not regular, and he is not without emotion; if to this moral state there is superadded a wound of the chest, the wounded person regards it with most vivid uneasiness, and if fear has not already set in, it will soon take place. Thus is readily explained the occurrence of the above phenomenon, and the salutary effect of removing these impressions by moral agencies of a reassuring kind."

It has been laid down as a cardinal principle, in wounds of this character, to search thoroughly for fragments of the weapon in the wound, unless the weapon itself can be found and no portion of it missing. The tendency to suppuration is so great, and the length of the sinus such that disastrous consequences are easily induced, a neglect to remove all foreign material is much more important than in the case of wounds elsewhere, if such a thing is possible.

As in the case of contusions, the extravasation by blood is very extensive, and whilst coagulation is the rule, with rapid absorption, it occasionally occurs that it remains fluid a long time, and undergoes degeneration. Furthermore, the coagulation of the blood will often cause an arrest of bleeding. If this does not occur, and the hæmorrhage is excessive, an attempt must be made to secure the vessels. It will be necessary to carry in mind a rough idea of the circulation of the region, and this will be given in a later paragraph.

Emphysema does not infrequently occur, and may mislead the attendant into the supposition that he has a penetrating wound to deal with. It is produced by drawing in of the air from without, when the wound is long and deep, such as would be made by a pointed weapon passing under the skin for a long distance. Carefully watching the accession of the swelling, it will be observed that there is an increase in size, in waves, with each inspiratory effort, the motion of the chest walls, in some conditions of the wound of location and direction, acting as a piston, to draw the air in from without. I have had the rare fortune to witness an occurrence of this kind, but at the time did not appreciate either its rarity or significance. Hence it can be readily seen that a diagnosis of penetrating wound must not be hastily made, based upon this simple symptom.

The record of our late war (*Med. or Surg. Hist. of the War, Surg., Vol.* I, p. 466) gives the following resume of injuries to the chest:

WOUNDS OTHER THAN GUN-SHOT.

CHARACTER.	CASES.	DIED.	DISC'H.	DUTY.	UNK'N.
Sabre,	9	1	4	4	
Bayonet,	29	9	6	12	2
Incis d—Various Weapons	27	8	5	14	
Punctured—Various Weapons,	6	4	1	1	
TOTALS	71	22	16	31	2

Added to this we have a record of two hundred and ninety-six contusions, of which five died, fifteen discharged, two hundred and five returned to duty, two results unknown. The case of sabre wound that died, was tuberculous, and some of those dying from bayonet wounds, suffered penetration of the chest, and should be removed from this list. In the larger number, however, death was due to hæmorrhage, therefore primary. Considering those who were discharged as added to the list of deaths, inasmuch as the fighting force of the army was that much reduced, out of a total of two hundred and ninety-six non-penetrating wounds of the chest, to the exclusion of gun-shot wounds, fifty-eight were lost to the service, in two the result was not known, and two hundred and thirty-six were returned to duty. Contusions being excluded from the list, of seventy-one cases, thirty-eight, or more than one-half, either died or were discharged the service in consequence of their injuries.

The results of GUN SHOT wounds is thus given, exclusively those of the back.

CASES.	DIED.	DISC'H.	DUTY.	UNK'N.
11 549	113	1 790	8 980	658

Out of this number but fifty-two met their death directly from the wound in the chest. Many died from associated injuries, or those sustained by other parts simultaneously, or from morbid action secondary upon the wound, or that was roused into activity thereby.

Treatment.—These injuries are to be treated on the same principles already laid down in speaking of wounds in general. When long tracks are made, thorough cleansing, and maintaining moderate pressure to keep the sides in contact has given good results. Under no circumstances, I think, should the external wound be closed or sealed up; the discharges must have free exit. Hæmorrhage must be arrested by pressure or cold applications, or better by hot water, if circumstances forbid attempt at ligation; whenever practicable ligature is the proper treatment. If the hæmorrhage cannot be checked, and is sufficiently profuse to cause alarm, unless the internal thoracic vessels are wounded the bleeding artery *must* be secured.

(*b.*) *Penetrating wounds* of the chest, may be complicated with wounding of the pleura, heart, lungs, or great blood vessels, or consist of a simple penetration without such injury. It is a natural arrangement of the subject, as well as eminently practical to consider wounds of the viscera apart from a mere penetrating wound, as the heart and lungs may be injured to an extent sufficient to destroy life without an external wound, or even by causes acting altogether internally. For this reason a separate section will be devoted to injuries of the viscera.

A penetrating wound, even without associate injury to the contents of the thorax, may result fatally from the admission of air external to the pleura, the exposure to irritation that the lungs are thus subjected to, and the evil results attending the admission of blood or other fluids to this cavity. To as great an extent, perhaps, hernia of the lung, either as a primary or secondary condition, may be enumerated as among the possibilities. From this it is evident that it is of the first importance to determine whether perforation exists, or there is a simple flesh wound. As MR. POLAND, (HOLMES II) remarks, it is far easier to determine the necessity than to accomplish an accurate diagnosis in this respect. There are many cases of wounds with swords, bayonets, and gun-shot, in which the weapon or missile has been deflected by a rib, so that the wound of exit will be nearly opposite that of entrance, giving every appearance of the chest having been completely traversed, and yet subsequent examination has shown that the whole track of the wound is superficial. The probe in small wounds, or the finger when it can be used, must be relied upon to settle vexed questions, but either will frequently fail, and must be cautiously employed at all times. We are to consider in all cases of doubt, the nature of the weapon; the direction from which the wound was made; the position of the injured party at the time of the accident or assault; if by a blow from a knife, or similar weapon, whether self inflicted, by a second party, or in either case, by a right or left handed person; consider the marks of blood on the weapon, when it can be obtained, and all circumstances that might in any manner aid in determining the force, nature, and direction of the wound, weapon, and method of infliction.

The *nature of the weapon*, whether pointed or with cutting edge, flat or triangular, flexible or stiff; or if a gun-shot injury, whether a rifle, pistol, or smooth-bore gun, are manifestly questions that must weigh very much in determining the probability of penetration, but it often occurs that the weapon cannot be found. So, indeed, there is so much unintentional error and mis-statement in the relation of eye witnesses, that it seems impossible to secure accuracy even in matters about which there would seem to be no dispute. As questions of interest to medical jurists, these points are of paramount importance, as the direction and character of the wound would often determine the nature of the weapon, with which hand a stab-wound was

infiicted, and the relative positions of the assailed and the assailant. In determining the question of penetration, for purely diagnostic purposes, the same considerations are of value, to a somewhat minor extent. Thus a point blank blow, with a non-flexible weapon, or a musket-shot, received perpendicularly to the surface, in an intercostal space, and probing shows no deflection from the original direction for some distance, the presumption is altogether in favor of penetration, provided there is evidence of sufficient depth, or force sufficient to accomplish that purpose.

The consequences of such perforation are to be considered as occurring in two general groups, the immediate and remote. Under the first head, acute pleuritis, pneumonia, or other inflammatory conditions are perhaps the more common. The characters do not differ from the same conditions occurring idiopathically, and need not detain us at this place, particularly as the treatment does not differ from that pursued in ordinary cases.

A somewhat rare result, in the immediate group, is *hernia of the lung*, or pneumonocele. This, as the name implies, is a protrusion of lung tissue through the wound, invested in its pleura as a sac. The causes for this protrusion are two-fold: a wound in the chest, and the operation of some force within to force the viscus out. At the time of reception of a penetrating wound of the chest, there is an involuntary deep inspiration, with a closure of the glottis, which so increases the size of the lung beyond its normal dimensions that it seeks relief from the pressure at any point which will give way, usually the diaphragm, but in this case a ready relief is effected by the wound. The protrusion appears as a more or less globular swelling, varying in size from a cherry to an ordinary egg, of a bright pink color, soon becoming a deep red, and afterwards gradually growing darker until it becomes almost black. At first it increases and diminishes in size, during respiration, but as the engorgement becomes more complete, remains stationary in this respect. To the touch it seems soft, crepitating and elastic, and not notably painful, except at the point of constriction. Respiration is little, if any, embarrassed, apart from the pain felt at the constriction on inspiration, which increases in severity for some time, and then, after full congestion, gradually lessens until it entirely disappears. In some cases, pleuritis is set up from this point, and extends rapidly, and in others, pneumonia. In the large majority of instances, however, the difficulty will be purely local, and a spontaneous cure is the rule. The practitioner must not suppose pneumonocele to be of frequent occurrence; the fact is that it is exceedingly rare, so much so that a man with the wide experience of SAMUEL COOPER saw but one case, and that accidentally, during his visit to Belgium after the battle of Waterloo. The case is supposed to have proved fatal, but more from associate injury than the accident to the lung.

Treatment in uncomplicated cases, is simple, presenting but few indications.

Reduction must only be attempted when the constriction is slight, or can be easily divided. When extreme, and the hernial protrusion is of some size, it is proper to extend the wound, if it can be done without implicating the intercostal vessels. When slight, taxis may be employed, if too much violence is not required, the delicate texture of the lung forbidding rough usage. Reduction being impossible or unadvisable, from gangrene of the protrusion, the pedicle may be ligated, allowing the part to slough off, or it may be excised with or without ligature. Nature will accomplish the same result in a short time, and such cases have done well.

The *remote consequences* of perforating wounds are pneumonia, suppuration or pneumonocele, as before. The latency of the processes materially adds to their gravity, but there are no special indications for treatment in addition to what has already been said.

III. INJURIES TO THORACIC VISCERA.

To the exclusion, for the present, of injuries to the great blood-vessels of the chest, the lungs, heart and diaphragm may be injured, either by external or internal agencies, each of which will require separate consideration.

(*a.*) WOUNDS OF THE LUNGS, at all times of extreme gravity, depend as to results, on the nature of the lesion, with reference to the weapon or instrument inflicting the same, and whether the force be external or internal. The lesions may be considered as mainly caused by cutting or stabbing weapons, the sharp extremity of a broken rib, gun-shot missiles, arrows, and the effects of severe contusions or concussions. Under all circumstances the consequent complications, either immediate or remote, will be emphysema, hæmo-thorax, empyema, hæmorrhage, pleuritis, pneumonia, or circumscribed abscess. Whilst the rate of mortality is always very large, it appears the weapon used, in military practice very materially influences the result, with especial reference to the character of the wound, whether incised or more or less contused, and the fate of the missile, whether extracted or not. Thus in *Circular* No. 3, from the Surgeon Generals office, it appears that between 1865 and 1871, there were noted as occurring, chiefly in garrison, and as typical cases, excluding much larger material obtainable from reports of Indian battles, thirty-five cases of gun-shot injury of the chest, the ball penetrating, and supposed to wound the lung; of this number twenty-three died, leaving but twelve recoveries in some of which it was never determined positively as to the lesion of the lung. In six of these cases both lungs were injured, and all terminated fatally, the compiler stating that there are no records of recovery when both lungs are wounded.

Incised wounds, in the same circular, are noted as uniformly doing well, in the absence of severe hæmorrhage, some of a very extensive character healing promptly without unpleasant sequelæ.

Arrow wounds (*loc. cit.*) on the contrary, as uniformly proved fatal, seven cases furnishing six deaths. In these there was a complication

of punctured wound, and retention of the head of the arrow in all, and in one or two of them, whilst death was directly due to other and graver injuries, the arrow wound alone would have been sufficient.

While on this subject let me refer to a table of results in 8715 cases of gun-shot injury of the chest, found in the *Med. and Surg. Hist. of the War*, (*Surgical Vol.* part I, p. 606.) The wounds are not at all times of the lung alone, the heart and large blood vessels frequently being involved, but the resume will be valuable as furnishing information on points already touched upon, or yet remaining for consideration, which can be done as well, at this time, as by separating the complete table.

CHARACTER OF WOUND.	CASES.	DEATHS	DICH'D	DUTY.	UNK'N.	RATIO OF MORTALITY
Missile traversing chest.....	2 782	1 011	1 352	403	16	36-5
" believed to have lodged..	484	243	189	48	4	50-6
" penetrated without detail	1 780	1 348	65	299	68	78-7
" wounded lung, " "...	1 683	1 192	110	266	115	76 0
Simple penetrating, " "...	1 304	1 214			90	100 0
Missile external, to pleura.....	1	1				100-0
" " fractured ribs...	446	68	176	186	16	15 8
" both lungs	58	47	7	2	2	83-9
" wounding diaphragm.....	8	8				100 0
" both chest and abdomen..	121	89	31		1	74 2
Would of Intercostal and Mammary arteries.	21	17	4			80-9
" Pericardium	10	6	4			60-0
" Heart	12	11	1			91 6
" Innominate artery.....	3	3				100-
" Œsophagus.....	1	1				100-
AGGREGATE.....	8 715	5 260	1 939	1 204	312	62-6

This table furnishes a statement that 83.9 was the ratio of deaths to wounds of both lungs, which weakens the statement made by the compiler of *Circular* No. 3, to which reference was made. The presumption is a fair one, that the latter statement is the more accurate, inasmuch as there was more leisure to investigate accidents in garrisons, than when a large number of wounded are brought in from the field of battle. This is the more probable, when we consult the following table, compiled by Surg. J. T. WOODS, ninety-ninth Ohio volunteers, in which fifty-five cases of perforating wounds of the chest were carefully studied.

REGION.		CASES.	DEATHS.
Right	Upper Lobe	6	4
	Middle "	5	
	Lower "	3	
	Not known.....	5	5
Left	Upper Lobe	12	3
	Middle "	9	4
	Lower "	7	3
	Not known.....	6	5
Both Lungs		2	2
		55	26

Whatever the cause may be, certain symptoms are usually present in wounds of the lung, when made by external force with a wound in the chest walls, which while quite pathognomonic when present, their absence does not agree the other way. They are as follows, differing somewhat in degree and kind with the character of the wound: Hæmorrhage, pneumothorax, emphysema, hæmothorax, and what might be called hæmoptysis.

(*a.*) *Hæmorrhage* is much greater usually in cases of incised wound, and may be external or internal. The quantity of blood lost depends upon the extent of the wound, and the nature of the blood vessels wounded. Thus it may be chiefly external from the intercostal vessels; internal from wounds of small vessels in the lungs, or the larger thoracic trunks. When the incision is free, and the wound in the lung corresponds with the wound in the parieties, the bleeding will be mainly external, although some portion of it must fall within the chest. Under other circumstances, as when the stab is made obliquely or in such a manner that the wounds do not correspond, the hæmorrhage will be chiefly internal. The symptoms in this latter event will be, as stated in an earlier chapter, dyspnœa, coldness of the extremities, thirst, a sensation of bleeding internally, and collapse or syncope. This is natures method of meeting this emergency, by arresting the hæmorrhage by coagulation of the blood. So potent is this as an element of treatment, that McCleod and other military surgeons strenuously warn surgeons against probing such wounds, either with the finger or a probe, which would have a tendency to break up or disturb clots already formed, and thus re-establish hæmorrhage. They also state that collapse must not only be interfered with, but even artificially excited by copious venesection. In short, it may be stated in the most emphatic terms, that in severe hæmorrhages from chest wounds the patients safety is in direct proportion to its amount. When found in a state of syncope, the head must be lowered, and under no circumstances should the patient be moved or disturbed, unless the conditions are unfavorable to life, as from very severe weather. When reaction comes on, if the bleeding returns, the prognosis is decidedly unfavorable; if it does not, and it is necessary to carry the sufferer into shelter, handle him with the greatest care, and for some days caution him against sudden movements, or indeed any attempt to help himself, in the most trivial affairs.

In other cases blood will find its way into the bronchia and windpipe, causing constant cough, with more or less coughing up of blood, which may be fluid or frothy, in proportion as it is mixed with air. In extreme cases, when the vessel wounded is of the first magnitude, the hæmorrhage may be in a continual stream until life is extinct, or syncope occurs, or after reaction there may be a gush of blood from the mouth and nose, deluging the person and surroundings, with immediate death.

The *treatment* is sufficiently indicated by what has been written

above; it is to be purely expectant and negative. Never probe the wound; never inject fluids, for hæmostatic purposes or otherwise; and never disturb the sufferer in any way. Trust to syncope to coagulate the blood, and then close the external wound.

(*b.*) *Pneumothorax*, or entrance of air into the pleural cavity, is a somewhat common occurrence from wounds of the lungs. It is related closely to emphysema, but will be separately treated, as the symptoms are somewhat unique. The conditions under which it is produced are two-fold either a want of correspondence between the wounds in the lung and parieties, or with such a correspondence, entrance of air from without. Usually, however, when the wounds are in relation to each other, the air will escape externally, although it is not uncommon that it finds entrance from without. Air appearing at the wound will be indicated by the frothy fluid blood. In pneumo-thorax, there may be no emphysema, yet the other symptoms are so peculiar that a diagnosis should not be difficult. There is great dyspnœa, so that the recumbent posture is impossible. Auscultation gives amphoric respiration, "and a kind of ringing metalic resonance" if the lung is not too much compressed. Percussion shows tympanic resonance, gradually extending from the immediate region of the injury over the wounded lung, and even to the other side. Pleuritic adhesions are barriers to its extension, very frequently, and may cause it to force its way out of the wound. It is a very difficult matter to differentiate between inter-lobular emphysema and pneumothorax, but its discussion enters more properly into a future paragraph.

The *prognosis* is usually good, unless the wound is very large, and the infiltration to such an extent that the lungs cannot perform their functions. In such cases the countenance assumes the livid hue due to apnœa, from imperfect aeration of the blood; dyspnœa increases; the hearts action becomes more and more feeble; and the extremities cold, the patient dying from suffocation.

Treatment is chiefly, if not altogether mechanical; nothing can be done but to relieve the lungs from compression by furnishing an outlet for the imprisoned air. Enlarging the incision, with the hope that the external and internal wound may be brought into the same line, must be attempted, providing the intercostal vessels are not endangered. Failing in this, aspiration is the only resort. In fact I think this would have the first choice with me, should opportunity offer. The effect of compression of the chest, by bandages or the like, must be determined by experiment; if pressure with the hands gives some relief, by all means apply bandages leaving directions that they are to be removed if dangerous symptoms arise.

(c.) *Emphysema* is a term used to indicate an infiltration of air into the cellular tissue, either from within or without, and occurs in two forms, the intra-lobular, and the external or general.

The former, or *inter lobular* form, is from a rupture of some air cells, either from the effects of contusion of the chest, excessive straining,

as in child birth, or puncture, as from a broken rib, although it may and has occurred in connection with an external wound as well. The symptoms closely resemble pneumothorax, somewhat aggravated in degree, and the prognosis is much more unfavorable. The rupture, in what might be called idiopathic cases, occurring for the most part in the centre of the lung, the peculiar symptoms are not at once established. After it has made some progress, tympanic resonance, amphoric respiration, and the metalic tinkling before alluded to, come on, and the case resembles so closely pneumothorax, that, although it has a different pathology, it may be considered identical, for all practical purposes, and so treated.

General or external emphysema, as already remarked, may occur from air drawn in through the external wound, or forced out from the lungs, particularly when the wound is oblique, or the wound in the lung is not in line with that in the integument. It may be limited to a puffiness in the immediate neighborhood of the wound, or extend all over the body, producing such an enormous swelling that all the features may be obliterated, the eyes closed, and the lips so swollen that the mouth cannot be opened. The skin retains its natural color, and might give rise to a suspicion of anasarca, but that no pitting follows pressure with the finger, and the surface is elastic and crepitating, instead of the doughy, boggy feeling characteristic of dropsy. On making pressure with the hand, the air may be forced from one point to the other, being filled up again by a wave-like motion as new air takes the place of that displaced. As the case progresses, the respiration becomes embarrassed, both from admission of air into the pleural cavity, and swelling of the throat and glottis, the heart's action becomes enfeebled, and some danger to life may exist. As a rule, however, the prognosis is good, and the majority of cases recover spontaneously.

The *treatment* is to be conducted upon the same general principle already laid down, *viz.*, give free exit to the air, or adopt some methods for its expulsion. The steps to be taken depend upon the cause. Thus, when the wounds in the lung and integument do not correspond, enlarge the external wound if practicable. Failing this, bandaging may be used if it does not cause the patient any distress. Small punctures may be made in the distended integument, or an aspirator may be employed. Should the air enter through the external wound, it must be forced out, and the wound carefully closed to prevent its readmission. No medicinal treatment will be required, as the lesion is readily repaired when the air is finally expelled.

(*d.*) *Hœmothorax* is an effusion of blood into the pleural cavity, or the cavity of the chest in general, from injuries promoting similar conditions to those producing emphysema, *viz.*, want of correspondence between the wound in the chest and that in the lung. The symptoms are largely dependent upon the source of the blood, whether from vessels of the first magnitude, or smaller branches in the lungs,

and the rapidity with which the blood flows. It is manifest that a wound of the aorta or vena-cava, with a gush of blood in large quantities, would produce more rapid collapse than if the wound opened smaller vessels, with a more gradual loss of blood; in either case the accident might be fatal, but the result would be more speedy in the former, and accompanied by more startling symptoms.

Immediately upon the receipt of an injury opening blood vessels in the chest, there will be more or less shock, not as profound as in the case of abdominal wounds, but marked and decided. There will be a feeling of weight in the chest; dyspnœa increasing more or less rapidly as the effusion compresses the lungs, or fills the air-cells or bronchia; constant inclination to cough, in many cases blood being thrown out from the larynx, fluid or frothy in proportion as it is mixed with air or not. There may be a visible change in the form of the chest, the side in which the hæmorrhage occurs being fuller; the intercostal spaces pushed out, and less motion on respiration than on the opposite side. Auscultation gives symptoms that might be rationally expected, such as faintness and ultimate loss of respiratory murmur, with a bubbling sound from blood in the bronchioles; percussion gives increasing dullness, gradually rising as the blood accumulates, changing the area as the position of the patient is changed. Thus on lying down the blood will gravitate to the back part of the thorax; on rising again it settles down on the diaphragm, finding its level in obedience to natural law. Pleuritic adhesions have an effect to limit the extravasation, and anomalous physical signs may thus occasionally be explained.

Joined to these symptoms we will find those common to hæmorrhages already alluded to, such as coldness, failure of the heart, intense thirst, and restlessness, joined to the distressing dyspnœa from compression of the lungs. The sitting posture is preferred, notwithstanding the weakness, as the descent of the blood in the chest affords more room for the expansion of the lung.

It was formerly considered an infallible sign, and one necessary to complete a diagnosis, the appearance of ecchymosis on the back at the junction of the lumbar and dorsal spine, from the infiltration of blood. Indeed, in one or two pronounced cases, the surgeon has refused to operate to evacuate the chest, because this rare symptom was not present, the subsequent autopsy showing the chest full of blood.

The *prognosis* depends largely upon the vessels wounded, the amount of the effusion, and the bodily condition of the patient. A vessel the size of the pulmonary artery or vein, or the aorta or vena cava, cannot be seriously injured without producing death. The question as to which vessel has been wounded must always be a matter of mere conjecture, particularly as in some instances the shock is so extreme that the symptoms may readily be mistaken for hæmorrhage.

The *amount* of the effusion is a potent factor in prognosis. When the amount is small or moderate, confined to one side, particularly the right, and not extending higher than one-third of the pleural space, absorption frequently occurs, and no further trouble will occur. When in larger amount, the absorbents are not adequate to the task of removing it, and if death is averted, the hæmorrhage being controlled, the blood will either degenerate and form empyema, with danger of pyæmic or septic complications, permanently ruin the lung by compression, or at least greatly circumscribe its usefulness.

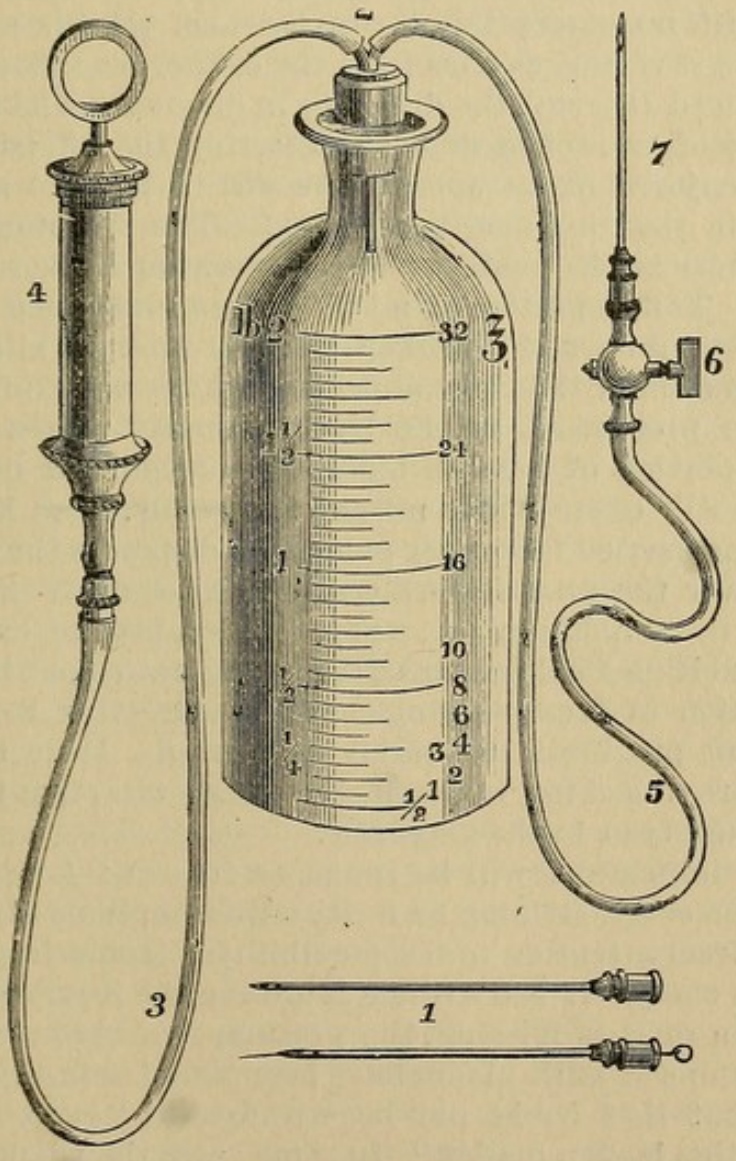
Treatment.—The first indication would be to arrest the hæmorrhage, if the amount is not so excessive that it is evident one of the large vessels is wounded. This point, however, is an exceedingly difficult one to determine, for reasons already given. The hæmorrhage still continuing, the only method to cause an arrest is to favor or hasten coagulation, and thus dam the vessels. Shall this be attempted by closing the wound in the chest walls, or keeping it open, that the blood may be discharged as fast as possible? Either way cannot be laid down as an unvarying line of procedure. Many authorities tell us to place the patient in such a position that the blood may run out freely, even enlarging the wound, if necessary to this end. This practice has certainly succeeded very often, syncope coming on, and coagulation then effected. Others tell us to close the wound, and the effused blood will rapidly coagulate. This practice, also, has given good results. In a grave case I much doubt if either practice can be arbitrarily adopted; the only safe method will be to discover the effects by experiments. Thus, close the wound at once; if unfavorable or alarming symptoms ensue, then open it again, and even enlarge it.

The hæmorrhage being arrested, the next step is to dispose of the effused blood. When small in amount, let it alone as far as instrumental treatment is concerned; *Arn.* or *Ham.*, as the blood is fluid or coagulated, will materially assist in promoting absorption, which, however, will usually be sufficiently prompt by the unaided natural forces. When the amount is larger, it must be evacuated artificially, or by aspiration, trocar or incision. The two former are the only safe procedures, as one of the indications is to give the greatest freedom of exit, with the least possibility of the entrance of air.

Paracentesis Thoracis.—The operation for this purpose is performed as follows: When there is no notable bulging of the intercostal spans, with pronounced fluctuation indicating the point at which the instrument is to be entered, the chest must be carefully explored, with a delicate exploring canula (*vide* fig. 4, *Minor Surgery*) which at once determines the character of the effusion, the extent of the cavity in which it is contained, and prevent the admission of air. The intercostal vessels must be avoided in the selection of a spot for the perforation, and to avoid other important structures the following rules are laid down by MALAIGNE, POLAND, COCK and others. Quoting from the first author (*Operat. Surg.*):

"To avoid the arteries, the middle third of the contour of the chest, midway between two ribs, is to be selected, and in order to avoid the diaphragm, the third or fourth intercostal space, counting from below upwards, should be preferred. In France it is usual to select the third space on the left side, and the fourth one on the right, in consequence of the liver."

The spot having been selected, enter the trocar with a steady pressure, as soon as the point is felt to be free, withdrawing it, leaving the canula in place. Hold the finger over the opening in the canula until an expiratory effort is made, to avoid the entrance of air. Having satisfied ourselves of the character of the effusion, and the like, the canula may be withdrawn, and a larger trocar inserted, or an aspirator may be used for both purposes.



No. 42. The Aspirator.

If an ordinary trocar is used, it should be of small size, and the surgeon must give his unremitting attention to the stream flowing from it, as any arrest of it during respiration might cause air to be

drawn into the chest. The cavity being emptied, withdraw the canula with the opening closed with the forefinger, *immediately* closing the wound in the skin, and covering it with plaster or collodion.

There are some considerations with reference to wounds of the lungs that yet remain, which may not properly be included under either of the preceding paragraphs.

(*e.*) *Foreign bodies in the chest*, either without or within the pleura, is of frequent occurrence, more particularly from gun-shot injury. The records attainable show that pieces of knife blades, either imbedded in the rib or sternum, or perfectly free, particles of bone broken off by a passing bullet, or gun-shot missiles, are the articles more commonly met with in this connection. Whilst many remarkable cases have occurred, in which large foreign bodies have remained in the chest for years with no perceptible inconvenience, yet the accident is an exceedingly grave one, at once from the dangerous inflammatory conditions induced thereby, the difficulty in diagnosis, and the frequent impossibility of extracting or even detecting the offending body; in fact in the majority of instances there will be more of a suspicion of the condition than a demonstrable fact. The symptoms vary much with the nature of the missile, and the extent and other characters of the wound. Thus a portion of a knife blade embedded in the bone, or the sharp extremity of a broken rib, will produce either irritation and inflammation of the pleura, or hæmorrhage with inflammation of the lung, in proportion as the free extremity passes through the pleura. A portion of a knife blade, or a spicula of bone perfectly unattached, will cause wider mischief, possibly, from its freedom of motion, being carried for longer or shorter distances through the lung tissue, or over the pleural surfaces. A gun-shot, if large, may fall down upon the diaphragm, or, when smaller, become encysted in the tissues, or exciting local circumscribed suppuration or abscess. From a consideration of these varying conditions, it must be evident that an intelligent prognosis can rarely be formed. More than this, the symptoms are so lacking in distinctive characters, that there must be equal uncertainty as to the diagnosis.

The chief indications will be found as follows: A non-penetrating wound of the chest, striking on a rib, with symptoms of lesion of the lung, will direct attention to the possibility of some foreign material being in the chest. If the weapon inflicting the injury can be found, and a portion of it is missing, the presumption becomes a certainty. In fact, portions of knife blades have been found so firmly imbedded in the bone that they could not be withdrawn, "even could not be loosened with a leaden mallet." In some cases the rib or sternum has been trephined or resected before the fragment could be dislodged. In other cases the weapon is found and is entire. The presumption here is three fold: either a portion of bone has been driven before the weapon, and detached from the parent bone, a fracture has occurred

with one of the fragments displaced inward; or some foreign substance, as a portion of clothing, a button, hook, eye, etc., is driven in at the wound. There will also be a possibility of a rupture of some of the air cells from concussion, but the almost certain emphysema, and abscence of signs of hæmorrhage or inflammation, would aid in differentiating. Finally gun-shot injuries, with a single wound, of entrance only, with no trace of extraction of the missile, must be reasonable evidence that some foreign material is in the wound, or when there are two wounds, one of entrance and one of exit, if the position of the individual when receiving the shot, and the direction from which the shot came can be positively ascertained, and any object in range with the line of fire capable of receiving an impression shows no mark of the bullet, there is again a presumption that *some* foreign material is in the wound, which might become a certainty if some fracture of the bones at the wound of entrance exists, and the wound of exit is not sufficiently ragged to indicate that it passed out with the missile.

Other questions might arise, but enough has been said to indicate the difficulties hanging around a diagnosis, and the care and methods that should prevail in making an examination.

The *treatment* is purely expectant. There must positively be no probing of the chest cavity to search for the foreign body; the evidence must always be of a purely negative or subjective character. When the body can be located, if it is causing mischief, it must be extracted, provided no danger to life accompanies the effort; when the irritation is slight, or not alarming, and the situation of the body such that some danger would be incurred in extracting it, far better let it alone. It may become encysted, or an abscess may form which when finally evacuated will either bring the foreign body with it, or facilitate its extraction.

(*b.*) WOUNDS OF THE HEART.—Wounds of the heart include also the consideration of lesions of the *pericardium*, which are usually associated therewith. As a matter of fact it is often, if not always, an utter impossibility to distinguish a pericardial wound from one of the heart, the sole guide being the region and direction of the lesion, and the doubtful interpretation of purely subjective symptoms.

(*c.*) *Wounds of the Pericardium*, may be of any character, although gun-shot, punctured, or lacerated are more common. They are usually associated with similar lesion of the heart, and hence, for practical purposes it is not necessary to consider them at any length. Such injuries, *per se*, are not necessarily fatal, although few cases recover. POLAND (HOLMES II, 601,) quotes a table prepared by FISCHER, of four hundred and fifty-two cases of wounds of the heart and pericardium, from which it appears that in fifty-one cases of wounds of the pericardium alone, the results were as follows:

Wound.	Death.		Recovery.		Time of Death Uncertain.
	Immediate.	Remote.	Proved by Inspection	Supposed from Symptoms	
Punctured		3			
Incised		15	2	11	4
Gun-shot		1	1	4	1
Lacerated	1	1		4	3
Totals	1	20	3	19	8

We here find twenty-nine deaths from pericardial wounds, and of the twenty-two recoveries only three, it can be possitively asserted, sustained the lesion, as was shown by actual inspection; the nineteen remaining cases were diagnosticated simply by the symptoms of the patient, and the location of the external wound. It is perfectly fair to suppose that at least one-third of them may not have sustained any lesion of the pericardium; pericarditis may be set up without that. This would add materially to the ratio of deaths.

The symptoms are of two characters, either of which is valueless taken alone, unless the external wound is of such character that the pericardium can be inspected; even when taken together, there must always be much uncertainty in a diagnosis. The situation of the wound in the chest, the direction it assumes, the supposed depth, from the character of the weapon, and the immediate symptoms, are all elements in the diagnosis. Symptoms of pericarditis and effusion, coming on later, add to the probabilities, but unless the membrane itself can be *seen*, there are few cases in which there can be absolutely no doubt of the nature of the accident.

The symptoms of pericarditis, and the prognosis are to be found in all the text-books on general medicine, and have nothing of a surgical character apart from the traumatic origin. Death is unquestionably due, in uncomplicated cases, to consecutive carditis, or disturbance of the hearts action from the compression exercised by the effusion. In many cases, again, the internal mammary artery, large blood vessels of the chest, œsophagus, or the important nerves found in this region, will be injured conjointly with the pericardium, and the graver lesion thus obscure the lesser.

(*b.*) *Wounds of the Heart* are necessarily of an exceedingly grave character, whether penetrating the organ or merely superficial, death resulting, in nearly every case, sooner or later, either directly from the injury, or from the resulting carditis much more severe than in an idiopathic case. The table of Fisher's above referred to, including wounds of the pericardium, is as follows:

Location of Wound.	Punctured.				Incised.				Gun Shot.				Lacerated.				Time of Death Uncertain.				
	Deaths.		Recov'd.		Deaths.		Recov'd		Deaths.		Recov'd		Deaths.		Recov'd						
	Primary.	Remote.	Inspection.	Symptoms.	Primary.	Remote.	Inspection.	Symptoms.	Primary.	Remote.	Inspection.	Symptoms.	Primary.	Remote.	Inspection.	Symptoms.	Punctured.	Incised.	Gun-Shot.	Lacerated.	Totals.
Right Vent..	2	6	2		19	54	5	4	4	10	5		2	1				3	3	3	123
Left "		10	4		17	36	1	1	3	9			5	5			1	3	4	2	101
Bath "		4			7	5	2		1	1			1	1				2	2		26
Right Auric.....	1	1				10			1				5	3			1	1	1		28
Left "					1	4			1				3	2						2	13
Septum.....			1			2				1				2						1	7
Apex.....						7	3	1		2				2				1		1	17
Base							1										1				2
Whole Heart.....						2			2				8			1			3		16
Right "					3							1									4
Left "						1			3										1		5
Coron' Artery....		1					1														2
Uncertain	1	1	1	2	6	13	6	5	4	2		1	3	1	1	1	1	1		7	57
Pericardium.....		3				15	2	11		1	1	4	1	1		4		4	1	3	51
Immediate.....	4				53				19				28								452
Not Immediate...		26				149				26				18							
Recovery..... ..			8	2			21	22			6	6			1	6					
Uncertain																	4	15	15	23	

Thus out of four hundred and fifty-two cases, there are but seventy-two known recoveries, and fifty-seven in which the result is uncertain. We find, in comparison from the table, that thirty-six of the cases were diagnosticated by "conjecture by symptoms," leaving but thirty-six cases out of four hundred and fifty-two wounds of the heart that are known to have recovered.

With reference to the region wounded, we find that wounds of the ventricles are the most serious, and result fatally with greater frequency, with the single exception of wounds of the "whole heart," probably what are known as "crushed heart," in which fifteen of the sixteen cases perished; as the case noted as "recovery," was diagnosticated on symptoms alone, it is fair to presume that such lesions are uniformly fatal.

The rapidity of death, as shown from the same table, is as one hundred and four, occurring immediately, to two hundred and nineteen, occurring more remotely, the period of death varying from half an hour to nine months. The causes of death, in the delayed cases, are largely inflammatory condition, and secondary hæmorrhages.

The comparative fatality may be stated as follows:

	CASES.	DEATHS.	RECOVERY.	RATIO OF MORTAL'Y.
Gun Shot	56	44	12	78.5
Punctured	40	30	10	75.0
Incised	241	198	43	82.1
Lacerated	53	46	7	86.7

It thus appears that lacerated wounds of the heart, including rupture, furnishes the largest ratio of mortality, the causes of death being shock, hæmorrhage, and, if death is not immediate, acute carditis. Gun-shot wounds induce death by similar processes; punctured mainly from carditis and shock; and incised wounds, proves fatal oftener from hæmorrhage. In the latter case, or in punctured wounds with cutting weapons, the direction of the incision with reference to the direction of the muscular fibres, will much influence the result, at least as to immediate consequences. When the fibres are simply seperated, or the incision is parallel to their general direction, the wound will not gape much, and the bleeding will be less than when it is transverse, with necessarily greater gaping. The records we have, even whilst furnishing many instances of recovery, or at least long delayed death, do not enable us to prognosticate with any certainty, no matter what part of the heart is wounded, its extent, or the character of the lesion. One will succumb to a lesion, that even when more severe will not destroy life in another, and we can give no adequate reason for the escape of one, while reasons are plenty to account for the death of the other. With our present knowledge of the sources of life, it is impossible to approach certainty in these questions, and we are justi-

fied in estimating heart wounds as fatal, an opposite result almost seeming to depend upon the merest chance, so impossible is it to account for the exceptions.

In many cases, those in which the symptoms, both objective and subjective, are of an ordinary and uncomplicated character, there can be no doubt of the nature of the accident. Very frequently however, the indications are not so well marked, and there will always be doubt as to the exact nature of the accident. The location of the external lesion, will be a leading symptom, if made with a weapon propelled with sufficient force to penetrate to the heart, that is capable of piercing the tissues, and the direction and depth of the wound such as would reach the organ. There will usually be more of shock and collapse, particularly when the injury has been expected. The wound being of sufficient size, there will be symptoms of concealed bleeding, so often referred to, which may be so profuse that life is at once destroyed, or shortly arrested by the pericardium or mediastinum becoming filled with blood, which coagulates and thus stops the bleeding. There will be more or less dyspnœa, in most cases, from the impediment to the lungs action from the compression of the blood, or injury sustained by the nerves. DUPUYTREN speaks of a peculiar tremor about the heart, with weakened arterial pulsations, and a peculiar *bruit*, which he calls an "undulous crepitation." The pulse is small, weak, and intermitting. There is often an acute pain under the sternum, very severe, referred to by many authors as of constant occurrence, and quite a conclusive symptom. The general teaching of the day is, however, that this pain is only exceptional, and far from being conclusive even when present. It requires little argument to show that in spite of the gravity of the accident, there are many occasions in which it can only be suspected, and "recovery from a heart wound" be open to grave suspicion of the accuracy of a diagnosis, unless the wounded organ has been *seen*, or the symptoms noted of the most pronounced and unmistakable character.

The *treatment* is purely negative and expectant. Bodily and mental quietude must be obtained, and such general treatment pursued as will at once tend to arrest hæmorrhage, and lessen shock. Inflammatory symptoms that may appear secondarily must be met as they arise, chiefly with *Acon.* or *Arn.* and if the pericardium is filled with blood, the question of aspiration must receive attention. The nature of the accident is such, that if death does not immediately occur, the delay is due to almost purely accidental circumstances, which makes it a question how far the surgeon should interfere in the treatment, there being some danger that his attentions may prove more mischievous than beneficial.

(c.) WOUNDS OF THE MEDIASTINA.—The middle and posterior mediastina being filled with many of the organs most essential to life, as the heart, large blood vessels nerves, thoracic duct and œsophagus can scarcely be opened to an extent sufficient to call for surgical atten-

tion without such injury to the contents of the cavity, that the mere opening thereof is of no interest or significance whatever. In the anterior mediastinum the contents are few and unimportant, as relates to vessels and nerves, it being mainly filled with loose connective tissue, which readily breaks down under inflammatory action, and forms an abscess. The symptoms of this sequelæ are quite obscure when taken apart from the history of trauma. Unquestionably when pus is evidently present it must be evacuated.

IV. WOUNDS OF BLOOD VESSELS.

Above almost any other region in the body, the vessels of the thorax furnish by far the most dangerous hæmorrhage, both as to quantity of blood lost, and the difficulty in reaching and securing the vessels from which it springs; furthermore the size of the trunks, and their importance to the continuance of life, would forbid their ligation even if perfectly accessible. Whilst this is true, to some extent, of all the vessels of the thorax, whether external or internal, it is eminently so as applied to those within the cavity of the chest. For convenience of description, as well as in obedience to a perfectly natural arrangement, we will consider our subject under these two heads, viz., vessels external, and those internal to the thorax.

1. EXTERNAL VESSELS.—The vessels supplying the outer surface of the chest, that are of sufficient magnitude to call for ligation when wounded, are as follows: Posterior scapular, superior thoracic, subscapular.

(*a*) The *posterior scapular artery*, is a branch of the transverse cervical, which in turn is derived from the thyroid axis of the subclavian. It descends along the base of the scapula, underneath the rhomboid muscle, supplying this muscle together with the serratus magnus, and latissimus dorsi. The point to be selected for its exposure in the neck has already been given when speaking of the superior thyroid artery. The transversalis colli, of which it is the second branch, is the middle branch of the three coming from the thyroid axis. It is only exceptionally that the posterior scapular will need ligation, or, if so, that it cannot be readily reached. If completely divided, however, and the cut end cannot be reached, the transverse cervical had better be taken up.

(*b.*) The *superior thoracic* artery is a small branch of the axillary, given off at a point corresponding to the inner or upper border of the insertion of the pectoralis minor, between that muscle and the subclavius. It is small and short, but bleeds enormously when cut, so much so that ligation is imperative.

(c.) The *acromial thoracic* is a larger branch of the axillary, given off immediately below the former, dividing into two branches immediately, one passing to the shoulder, and the other distributed to the muscles of the upper part of the chest. A second branch is given off from the thoracic twig, which passes upward in close relation to

the superior thoracic, and confusion may arise as to which branch is injured. The vessel requiring ligation, and not readily acessible in the wound, a ligature should be passed close to the point of division of the acrominal branch. The fibres of the pectoralis major must be separated to a sufficient extent to expose the outer portion of the pectoralis minor, the vessel being found close to the inner border of the latter muscle.

(*d.*) The *long thoracic* is a large and important branch, given off next below the last, at a point corresponding to the lower edge of the pectoralis minor, being covered by the pectoralis major, but not to an extent sufficient to require division of the latter to fully expose it. Throughout its whole course it follows the line of the large pectoral, at its lower border, just within its margin. It is readily found and taken up.

(*e.*) The *subscapular* artery is a deep vessel, given off from the axillary just below the long thoracic, distributed to the lateral regions of the chest, the latissimus dorsi, and the subscapularis muscles. It may be exposed, near its root, by drawing the arm outward, backward, and upward, putting the latissimus dorsi, and pectoralis major on the stretch. It will be found lying between the latissimus dorsi and subscapularis, crossed near its origin by the ulnar nerve, which must be held outward to expose the vessel.

Other vessels that may be wounded in the anterior portions of the chest, are either so small that they will not call for ligation when wounded, or proceed from perforating branches derived from vessels within the chest.

2. INTERNAL VESSELS.—The vessels within the chest are rarely accessible to ligature, or if so too important to life to tie. Among the former, are the internal mammary, the aortic intercostals, and the superior intercostal; the latter, are the aorta, innominate, subclavian, and pulmonary arteries, as well as the corresponding veins which may even furnish hæmorrhage more fatal than arterial.

(*a.*) The *internal mammary* artery, is given off from the subclavian immediately opposite the thyroid axis, descending behind the clavicle, close to the sternum, resting on the costal cartilages, in front, and pleura behind, accompanied by venæ comites. The vessel itself cannot be ligated if wounded, at any point below its origin or the first three intercostal spaces, and then only by a deep and dangerous dissection. The operation is one eminently major in character, and it does not enter into our plan at present, particularly as it is impractical under circumstances of accidental hæmorrhage. Various methods have been proposed to arrest bleeding below the third intercostal space, where it can be reached with comparative ease. The operation is thus described by POLAND (HOLMES II, p. 611): "It is performed by making an incision for two inches along the side of the sternum, in an oblique direction from above downward, and without inward, forming with the axis of the body an angle of forty-five degrees; the

centre of the incision to be three or four lines from the border of the sternum. Having divided the skin, cellular tissue, and origin of the pectoralis major muscle the intercostal space is brought into view; the intercostal muscle is now to be carefully divided upon a director, and the edges drawn apart by retractors, when the artery becomes exposed."

The branches of the internal mammary that are exposed to injury, or that when injured can be differentiated from other vessels, are the perforating, and anterior intercostal. The former pierce the tissues in the five or six upper intercostal spaces, supplying the pectoralis muscle, and integument. The latter are distributed on the borders of the ribs in the same spaces, and inosculate with the aortic intercostals, as well as supplying the muscles in these regions, and the mammary gland. The remainder of the intercostal vessels are from the superior intercostal, which is derived from the subclavian.

Occasionally a wounded intercostal can be secured in the wound, but the spaces are so small, and the vessels so deep, that, it is almost impossible to secure them. It is useless to attempt ligation of the main trunk, as the intimate connection between the subclavian, the internal mammary, and the aortic intercostals, prevents the ligation of any single trunk being effectual, unless by the merest accident. PARÉ, and others, recommend a complete division of the vessel, where only nicked with the hope that the cut ends will retract into the tissues. Others that a piece of sponge, attached to a string, be pushed within the chest, and compression made by keeping traction on the string until hæmorrhage ceases. Some have succeeded in passing a silver wire, with a curved needle, around the rib, including a vessel, twisting the wire over a small roll of linen externally. In one or two instances relays of assistants kept up pressure with the finger, inserted in the wound, until the hæmorrhage was arrested. In short, the surgeon will often be driven to exercise his ingenuity in these accidents, and will soon learn, that in spite of the small size of the vessels, the hæmorrhage from them is eminently dangerous and intractable.

The large vessels of the thorax cannot be wounded without destroying life, either immediately or in a short time. There are some cases reported in which life was preserved for a few days, none longer than ten days, I believe. The symptoms are those ordinarily observed in internal hæmorrhages, and the treatment precisely as is already laid down under wounds of the heart, and lungs.

V. FRACTURES.

Fractures in this region include the ribs, sternum, and costal cartilages. These will be taken up in order.

1. FRACTURE OF THE RIBS.—WALES (*Surg. appliances*), states that the elasticity of the ribs is such that fracture is comparatively rare. He gives no statistics to sustain this assertion, and the experience of most hospital surgeons does not seem to agree with his. Thus

POLAND, MALGAIGNE and others consider them of frequent occurrence, whilst HAMILTON, agrees with WALES to a certain extent. Thus POLAND (HOLMES II, 554), finds out of two thousand two hundred and seventy-five fractures of all kinds admitted into Guy's Hospital in a given time, two hundred and twenty-two were of the ribs. Again, in the "Hotel Dieu at Paris, there were two hundred and sixty-three fractures of the ribs," out of two thousand three hundred and fifty-eight fractures of all kinds. Women seem to suffer from such accidents less frequently than men, in the proportion of one to five, not from any anatomical peculiarity, but from the sex not being exposed to the same influences as men. Age as would be expected, exercises a very marked influence upon the facility of fracture; thus of one hundred and sixty-one cases admitted into Guy's Hospital, thirty-five cases occurred under thirty years of age, while one hundred and twenty-six occurred at the ages between this and seventy. The immunity in young persons is entirely due to the extreme elasticity of the ribs, which later in life is lost, as the earthly constituents predominate, and the cartilages become more brittle.

The *form* of fracture will depend upon the cause, and age. Thus when from gun-shot injury, or injuries from cutting or pointed weapons, they are necessarily compound, more or less comminuted, usually complete, and of any direction, transverse, oblique, or longitudinal. When produced by ordinary causes, as contusion or compression, they are either transverse, oblique, or incomplete. Age influences the direction of the line of fracture; youth furnishing more cases of incomplete fracture, and old age transverse and comminuted. Diagnosis, symptoms, and prognosis, all depend largely upon cause, as the displacement and form of the fracture will very materially influence local symptoms and visceral lesions.

The *causes* are as usual, either direct or indirect, the former preponderating in cases of compound fracture, the latter in the simple forms. Direct injury, such as gun-shot wounds, or those made with penetrating weapons, will displace the fragments, if any occurs, in the direction of the force, usually inward. The fracture will be at the point of injury, and from its necessarily compound character, inspection is facilitated, and the probability and extent of visceral lesions capable of solution. Such fractures being produced by extreme violence, are mostly complete.

Indirect injury, such as severe compression, produces fractures very greatly differing from those just considered. They will rarely be compound, and such visceral lesions as may occur are due to contusion, compression, or concussion, not from impaction of a fragment of the bone in the lungs, heart, or pleura. The fracture will usually be incomplete, with an angular projection *outward*, which will at once dissipate any fears of visceral lesion from the broken fragments. The point at which fracture occurs, will be midway between the point of compression and that of resistance. Thus when a weight, as the

wheel of a wagon, passes over the chest, the fracture will occur at the sides of the chest, the point of greatest extension. When compression occurs, laterally, the bone will give way either at the line of junction with the cartilages, or the neck of the bone near the spinal articulation, oftener the former. In cases of incomplete fracture, unless extreme violence is inflicted, the sharp points of bone will be directed outward and the viscera thus escape injury.

Fracture of the ribs has occurred, according to MALGAIGNE, from simple muscular effort, but the presumption is there was already some weakening of the bone from necrosis, caries, or absorption. Also cases are noted in which violent attempts at inspiration, or the sudden expansion of the chest, as in the pains of child birth, have resulted in fracture; the bones were probably also weakened by morbid action, in this instance. Such cases are extremely rare, and are referred to at this place solely to call attention to the possibility of such an occurrence.

Displacement, as a rule, will be dependent upon the character of the injury, whether direct or indirect, and whether the fracture is complete or partial. When from indirect causes, both fragments project outwardly, when the bone has given way in the shaft near the centre particularly. When the causes are direct, the displacement may be internal, if that was the direction of the force. Displacement can only occur in one of these two directions, the intercostal muscles effectually preventing it either upward or downward.

Symptoms.—The symptoms of fracture of the ribs depends largely upon the condition of the viscera as affected by the injury. There will be a knowledge of the fracture by the patient, usually, who will feel the snap at the time of the accident. There will be difficulty and pain on breathing, at the point of fracture, so much that every effort will be made by the patient to restrain the motion of the chest, carrying on respiration with the diaphragm and abdominal muscles, almost entirely. The seat of pain will point at once to the location of the fracture. On inspection, if there is an angular elevation or depression, all doubt is removed. In the rare instances in which there is no displacement, further examination is required. Crepitation and mobility can be detected when the fracture is complete, perhaps to a slight degree when not so. Auscultation may detect crepitus when mobility is small, but precaution must be had to differentiate from pleuritis. All this applies to uncomplicated fracture.

The viscera may be variously injured, from rupture or concussion, or by puncture by the fragments of bones, laceration from the weapon inflicting the injury, or the impaction of fragments of bone completely detached and driven deeply into the parts before the missile in gunshot injuries. The symptoms of such lesions may in various ways complicate the diagnosis, as the swelling of emphysema or from extravasation of blood. There will be the usual symptoms of visceral

lesion alluded to in former paragraphs, the lesion varying from irritation of the pleura, to the most severe injury to the lungs, heart, or large vessels.

The *prognosis* will have direct relation to visceral complications, as apart from that consideration fractures of the ribs are readily repaired, and no future trouble need be apprehended. Repair will occupy from twenty to thirty days, the close relation the ribs bear to each other rendering it very common to have the callus bridging over the interosseous spaces, and in this manner somewhat abridging the mobility of the parts. In some rare instances union never occurs, the provisional callus becoming definitive, and ensheathing the broken extremities like a ferrule.

The *treatment*, in uncomplicated cases, presents few indications, and these readily fulfilled. Thus, the small degree of displacement possible, will not call for any particular skill in reduction, the chief indication is to keep the parts quiet until union is secured. For this purpose we have a choice between bandaging or adhesive plasters, with a decided preference for the latter. Should the surgeon prefer it, or circumstances seem to demand a bandage, one may be selected from the various body bandages described in the first volume in this series, (*Surg. Principles*). Such a necessity must very seldom arise, however, and the adhesive strips are almost universally used.

The question then arises, shall both sides of the chest be confined, or only one. My experience leads me to prefer the latter decidedly, To apply the dressing proceed as follows: Cut a number of strips of ordinary plaster, depending upon the extent of the injury (whether one or more ribs), about two inches in width, and in length equal to rather more than one-half the circumference of the chest. Seizing the moment when the chest is partially inflated, apply the first strip around the chest, on the injured side, the space of two ribs below the seat of fracture. With the chest in the same state of inflation, apply the other strips, going upward, each strip overlapping the one below one-third of its width, until sufficient have been applied to reach a corresponding distance above the broken rib. If two or more ribs are broken, the whole chest had better be covered in. When both sides of the chest are to be included in the dressing, the strips must be cut of lengths equal to the circumferance of ths chest, with one-third added. In either case allow the strips to be retained for thirty days, unless they become loosened, soiled, or in any way become offensive, or lose their efficacy. In the event of a compound fracture, the wound must be left uncovered, by cutting out the centre of a sufficient number of strips, to permit of daily inspection, and the application of such special articles of dressing as may be deemed advisable.

In fractures complicated by visceral lesions, other indications arise, many of which cannot be provided for in a treatise general in character. The surgeon must determine in each case which condition takes precedence, and govern himself accordingly. Thus with serious

laceration of the heart or large blood vessels, a fatal termination is inevitable, and all that can be done is to make the sufferer as comfortable as possible.

2. Fracture of the Costal Cartilages.—From the extreme elasticity of the cartilages, when in a normal condition, and from the fact that when partially ossified by morbid changes the ribs and sternum undergo corresponding changes in composition, the cartilages alone are rarely broken, at least without associate injury to their bony connections. The same causes operate to produce this accident as in the case of fracture of the ribs, but the results are somewhat different. Thus the line of fracture is smoothly transverse, and there is usually considerable displacement of the outer fragment. The costal fragment is usually found overriding the sternal, and projecting to such a degree that the deformity is at once noticed. It is supposed that the degree of force used to produce a fracture of these structures, is so much greater than is necessary to break a rib, that much injury must be communicated to the viscera, but I am not familiar with any reports that would establish the fact. Certainly the anterior mediastinum does not contain organs or parts as vital as is found elsewhere in the chest, and unless the fracture were made with a perforating or cutting weapon, I can conceive of no graver lesion than the formation of a deep abscess.

Repair is by bony union, requiring about the same time to secure union in the ribs, but the parts are left in a more favorable state for future fracture, as far as structure is concerned, although I am not aware that refracture has been frequently observed.

Treatment is conducted upon the same principles laid down for fractured ribs, excepting that the displacement can rarely be completely reduced. A compress may be needed over the prominent extremity, which would render a bandage more useful than the adhesive strips.

3. Fracture of the Sternum.—Fracture of the sternum, without spinal lesion or associated fracture of the ribs, is an exceedingly rare occurrence. Perforating fracture, from gun-shot injuries, are undoubtedly frequent in military practice. In connection with other fracture or visceral lesions, there is no doubt that a number of cases have occurred, as evidences of such lesions are not uncommon during post mortem examinations, or in the dissecting room. The causes are nearly always direct violence, although there are cases mentioned as occurring from forcibly bending the body backward, as when falling across some object, as a fence, from a height; or bending forward to the same degree. Fracture of the sternum has occurred in child birth, the pains being somewhat of a spasmodic nature, the patient throwing the head and trunk violently. One case is noted in which a gymnast sustained such a fracture, while attempting to lift a heavy weight with the teeth whilst bending backward. The line of fracture is generally transvere, not exactly so, at the point of union between the manubrium and gladiolus, a fragment being detached from one or the other, sufficient in extent to destroy the transverse direction.

The *symptoms* are pain, mobility, and crepitus, at the point of fracture, with more or less evidence of deeper lesion to the viscera, either from the force of the blow, or the penetration of the cavity of the chest. The lower fragment, when there is any displacement, will be found riding over the upper, thus preventing respiration. Unless the swelling is extreme, the individual is very fleshy, or there is no displacement, the symptoms are very plain, and a diagnosis very easy.

Treatment is the same as for fracture of the costal cartilages, and in the abscence of visceral lesions the prognosis is good.

VI. DISLOCATIONS.

There has always, it has seemed to me, but much unnecessary confusion existing in the literature of dislocations of the bones of the thorax. The standard text-books, much more the systematic works, speak of dislocations of the costo-vertebral articulation of the ribs from the cartilages, and of the cartilages among themselves. The fact is that the only *joints*, having relations to the chest, are those between the ribs and spinal column; furthermore, separation of the cartilages from the ribs would bear the same relation to a dislocation that separation of the epiphyses of the femur would, yet the latter is always included in the list of fractures. For these reasons, as well as the more potent one that fractures of the cartilages have already been considered, I shall consider the costo-vertebral dislocation to be the only accident of that nature to which the thoracic region is exposed.

A glance at the anatomy of the articulation of the ribs with the vertebræ, considering the depth below the surface of the body, the practical increase in this depth by the backward curve of the ribs at that point, the strength of the ligaments, the protection afforded by the projecting processes of the vertebræ, and the dense character of the fascia in the region, would surely convince any observer, that not only would it be extremely difficult to produce a dislocation of the joint, but that accompanying fracture, and great injury to near parts from the extreme violence required, was almost unavoidable. In a tabulated statement of nine cases, by MR. POLAND, (*loc. cit.*) it appears that in all cases in which an opportunity for inspection occurred, through the death of the patient, fractures of the vertebræ, or some equally severe lesion existed.

Where actual inspection cannot be made, as for instance, when the patient recovers, it is impossible for any to be certain in their diagnosis. The symptoms of sprain, or other spinal lesion are so pronounced, that it can only be very exceptionally that a dislocation of a rib is even suspected. It can only be made out by carefully studying all the conditions as they are met with, and by a system of exclusion determining that as no other lesion is probable, it must be a dislocation of the ribs.

The *treatment* will be sufficiently indicated by what has gone before. If spinal lesions predominate, they must receive first attention. Should the *suspicion* of dislocation be entertained, nothing can be done further than to keep the parts quiet by appropriate bandaging or strapping, to prevent any further displacement.

XXIV. INJURIES OF THE ABDOMEN.

Injuries of the abdomen. both of the parieties and the contents, have within the past ten or fifteen years occupied the attention of surgical practitioners to an extent unknown to an earlier period. The result of this study, prompted by fatal results in one or two exceptionally notorious cases, has confirmed many theories of long standing relating to the gravity of abdominal injuries, rejected some, and brought to light many new facts, some of which are probably but dimly recognized even to-day. To properly present this topic as its importance demands, I shall take up the following arrangement:

Contusions, whether complicated by deep seated lesions or not; wounds, both penetrating and superficial; injuries to the blood vessels, both external and internal; and foreign bodies within the cavity, both intra and extra-visceral.

I. CONTUSIONS.

Contusions of the abdomen, at all times recognized by the accomplished surgeon as capable of producing grave visceral and nervous lesions, even when far from being severe in appearance, are of more particular interest as it is borne in mind the number and importance of associated injuries that may be sustained by near and remote parts. The list includes suppuration within the parieties; rupture of muscles; contusion of the peritoneum and abdominal organs; laceration or rupture of the same; or speedy death from shock, or disturbances in the cardiac plexus. Questions of legal interest are also associated with these accidents, and as MR. POLLOCK (HOLMES II,) tells us, a case must always be looked upon with a vivid recollection of the most extreme danger that may attend upon an apparently insignificant blow.

A contusion of the abdominal parieties, without a wound in the integument, and without manifest symptoms of deeper injury, may terminate in morbid action of a kind partly determined by the region, partly by the state of the contents of the cavity (whether filled with food, or empty,) and partly by the condition of the walls themselves, whether thick or thin, muscular or fatty, flacid or tense. In the right hypochondria we might expect lesions of the liver or gall bladder; in the left, of the stomach or spleen; a blow in the hypogastric region, might develop some injury to the colon or cæcum, or kidneys; in the

umbilical to the ileum. The walls being fatty, we would expect the effects of the injury to be confined to the parieties; if muscular, the rectus or oblique muscles might be ruptured. The walls being tense, the injury would oftener be limited to their tissue, as when lax and retracted the viscera would be more likely to receive injury from proximity to the surface. So with the hollow organs, as the stomach and intestines, there would be much greater danger of rupture from contusion when they were distended, as during the process of digestion, than when empty and flacid. Knowing, as all accomplished surgeons do, that life may be destroyed at once by serious injury to the viscera, without the least evidence of grave accident externally, every case of contusion of the abdomen of sufficient importance to be brought to the attention of the surgeon, must be carefully examined, and its full importance realized.

Notwithstanding the fatal or dangerous results often succeeding apparently uncomplicated contusion of the abdomen, the large majority are found to be simple, and recovery is prompt. The most that is to be apprehended is the formation of an abscess within the walls, which if extensive, may weaken them by destroying their muscularity, and thus afford opportunity for ventral hernia.

The *symptoms* are in two groups, the primary and the remote; the former largely subjective, the latter objective. At the time of the accident there will be more or less pain, at times of the most agonizing character, with arrest of breathing, from paralysis of the diaphragm, if the blow is received in the epigastrium. The pain and dyspnœa soon pass away however, and the ordinary symptoms of contusion elsewhere then come on, such as swelling and ecchymosis. If a vessel of any size, as the superior epigastric, is torn, as may occur in exceptional instances, there will be profuse extravasation of blood into the cellular tissue, usually soon ceasing as coagulation occurs. The effusion will either be absorbed or degenerate into an abscess.

The *viscera* may be contused, without rupture or serious lesion, by transmission of force (*contra coup*,) or from receiving the force of the blow from lying close against the parieties. The primary symptoms developed will be pain, distinctly located in the organ injured, later by swelling and a feeling of weight, with disturbance of function, either exageration or depression. The rule is, as far as my own experience goes, that function is at first exagerated, after the primary suspension passes away, and is followed by suppression or decline later. In some instances, for reasons as yet not understood, in rare instances the injured part will atrophy, and either become completely lost, or destroy life when the organ is single, or one very essential to the continuance of life.

A question of much interest to medical jurists now arises, and one that has excited an animated controversy in legal circles, can life be destroyed by a blow on the epigastrium, particularly, without visible lesion of the viscera. Works on medical jurisprudence debate this

question at great length, citing many judicial opinions in support of the affirmative declaration. Sir ASTLEY COOPER, MR POLAND, and many other eminent authorities held to the same opinion, and refer to cases in support, yet in every instance, except one, when a *post mortem* examination was had, there were lesions found sufficient to account for death other than a mere concussion of the cardiac plexus. MR. POLLOCK (*l. c.*) asserts the possibility of such an occurrence, but thinks that they are too infrequent to warrant the conviction of one accused of manslaughter unless fortified by incontestable evidence furnished by a competant autopsy.

The *treatment* of simple contusions, is conducted on plain indications, *Arnica*, with rest for a time, being sufficient in the majority of cases. If symptoms of inflammation of the peritoneum, or viscera, come on later, the treatment will not vary from that pursued in the same conditions not traumatic in character. *Arnica* will, however, very often avert such later manifestations, if given early. The occurrence of free hæmorrhage from a ruptured artery, calls for other considerations. If coagulation soon occurs, the case had better be left to nature, freeing the effusion by an incision if it becomes degenerated. Should it continue, however, to an extent sufficient to endanger life, means must be taken to arrest it, if possible, by exposure of the vessel and ligating it securely. The steps to be taken will be given in a later paragraph.

Abscess within the tunics of the parieties must be opened early, as soon as the presence of pus is certain, for the purpose of lessening the extent of the destruction of tissue, and thus avert danger of hernia later.

Contusions, as said earlier, may not be limited to the integument or even to superficial structures or organs. Hence we must consider in what manner deeper parts become implicated, the symptoms and prognosis of such complications, and the means to be employed for their relief.

(*a.*) *Rupture of the Abdominal muscles*, is a not uncommon result of severe contusion. The conditions favoring it are either something unusual in the force or character of the blow, or some predisposing condition of the muscle. The mere *force* of the blow causing muscular rupture, would also produce great injury to both superincumbent and deeper structures. In such cases, whilst the muscular lesion would not be lost sight of, yet the visceral injury would demand greater attention. It is the *kind* of blow, and the state of the muscle as to contraction or extension that would prove the most essential factors. Thus a comparatively light blow received from a dull instrument, as a cavalry sabre, upon a muscle in a state of tension, would produce rupture very readily, while a blow of far greater violence if made when the muscle is relaxed, would not lacerate it without inflicting equal or greater injury upon the other tissues. The predisposing causes therefore, lie more in the state of the muscle than the character of the blow or the weapon inflicting it.

The *symptoms* depend upon the degree of violence used, the injury done to the tissues, and the extent of the rupture of the muscle, whether confined to a few fibres, or extending entirely through its substance. They have already been fully given in a previous chapter (*Inj. to Muscles*), and need but brief mention at this time. When the division is partial, there will be a swelling at the point of injury, from the rolling up of the torn fibres, and the swelling from the contusion. There will be pain upon any attempt to use the muscle, or when the body is in such a position that the fibres are put upon the stretch. When the division is complete, if seen early, the edges can be felt more or less widely retracted, with a noticable gap between them, and a feeling of utter powerlessness to cause contraction. Later the gap will be filled up, by the effusions, and the appearance will be more of a welt or boggy swelling than a depression. Deep pressure will detect the fluid character of the swelling, and the utter loss of power in the muscle will assist to complete a diagnosis.

The *treatment* is to be conducted upon the same principles already laid down for ruptured muscles. The body must be inclined in a direction that will relax the muscle injured, and suitable bandages or splints applied to preserve it. If the torn edges are not too ragged, they must be drawn together by subcutaneous sutures, but it is very doubtful if they will hold in the crushed state of the tissues. The conditions are somewhat different than when a muscle is torn by sudden extension, conditions very unfavorable to subsequent union. Failure to secure union, permanent loss of the muscle, and ventral hernia as a result, are among the consequences of these lesions oftener observed.

(*b.*) *Rupture of the Peritoneum* is an exceedingly rare accident considered as occurring apart from injury to the viscera or abdominal parieties. That it has occurred there can be no question, both from the evidence of autopsies, and the unmistakable character of the symptoms in the few instances of recovery. To a certain extent the symptoms and results are the same, whether the lesion be of the parietal or visceral layer, differing only in degree. The structure of the membrane is such thas it is very difficult to conceive what the kind of injury would be that would cause rupture alone; in the few cases in which it has been observed there was no history of similarity of violence; in one case a blow on the abdomen tore loose an old parietal adhesion, and lacerated the peritoneum at that point. In another a kick was received on an old hernia, rupturing the intestine in the sac, but lacerating the peritoneum at a distance from the intestinal lesion. Other cases have been observed in cases of acute intersusception, in which the intestine has become suddenly inflated. It will be impossible, therefore, to designate the *cause* for this accident, beyond the reception of injury, that for some reason not known, expends its force on this membrane.

The *symptoms* vary somewhat with the extent and location of the

lesion, chiefly in degrees of hæmorrhage and pain. Thus the detachment of an old parietal adhesion, will not furnish hæmorrhage of a character, or in amount, to cause as much concern as when the membrane associated with the mesentery, or a gravid uterus is torn. In the latter case the hæmorrhage will be abundant, perhaps sufficient to destroy life, or at least very greatly jeopardize it; in the former it would be insignificant, as a rule, and might never be even suspected. While circumstances may render a small rent equally dangerous with a large one, it is obvious that the latter must furnish the most severe and pronounced symptoms. Mr. POLLOCK (HOLMES II, 634), gives a detailed account of a typical case, one, it is true, in which no actual inspection was made of the peritoneum, but the experience of the distinguished observer, and the marked character of the symptoms, hardly permit of a doubt as to the nature of the accident. The case occurred in the practice of SIR R. MARTIN, who states it as follows: "Two men were run away with in a gig, and one of them healthy and about twenty years of age, was thrown out with great violence, and fell from a height of many feet on a quarter staff, which he had retained in his grasp, one end of the staff becoming fixed in the ground, while the other received the falling man upon his epigastric region. It was represented that the man was at once rendered insensible, and remained so for about an hour; soon after which he was seen in bed by Sir R. Martin. The countenance and general appearance had all the characters of the most fatal collapse of remittent fever, with the addition of urgent terror. There was the concentrated epigastric anguish, and the body was fixed and immovable; the abdomen being enormously tumid, and as hard as a barrel, the epigastric region intolerant of the weight even of the sheet. The pulse was not to be counted, and the skin was cold and damp. I considered the symptoms referable to both epigastric shock and hæmorrhage. The man was ordered diffusible stimuli, with small doses of Calomel and Opium, which were continued until the system was brought gently under Mercurial influence. The case recovered steadily and without accident. Sir R. Martin's remarks at the conclusion of the case are worthy of notice: 'We can but conjecture' he says, 'at the nature and extent of the injury in this case. My own view at the time was, that rupture of the peritoneum, with hæmorrhage had occurred; certainly I have seen men killed by blows on the abdomen of less violence than took place here. The anguish of both mind and body was greater than I remember ever to have seen, either in the collapse of remittent fever, or from wounds or accidents.'" It will be at once observed, from the symptoms so graphically given above, that it is a matter of extreme difficulty to differentiate between laceration of the viscera with peritoneal laceration, and the latter uncomplicated by the former. It is the utter abscence of symptoms of visceral complication that must settle the point, and it is manifest that such clear cut cases can rarely occur in actual practice. Mr. POLLOCK in summing up says:

"It is the extent of extravasation, rather than the extent of laceration, which settles the rapidity of the case; it is *that* alone, we may almost say, if the viscera be not ruptured, which calls for our utmost care, and aggravates our anxiety. Short of hæmorrhage, and short of ruptured intestine, a laceration of the peritoneum *need* not alone be fatal, probably *will* not be fatal."

The *treatment* should be as for ordinary peritonitis, without reference to any condition of hæmorrhage, unless the latter is so severe as to claim particular attention. *Arnica* will probably do more to subdue inflammatory symptoms, followed, perhaps, by *Acon.* or *Bell.* than any other single remedy. Moist heat applied to the tumid abdomen will aid somewhat in hastening resolution, but should not be persevered in if provocative of pain or increased discomfort.

(c.) *Rupture of the Diaphragm*, a very infrequent accident, is one rarely accomplished without much injury to other parts associated with it, if not a visceral lesion, of some kind, a severe contusion of the abdomen or lower part of the thorax. For some reason, for which no satisfactory reason can as yet be found, the rent will oftener occur on the left side. The passage of a cart wheel across the chest, a violent effort to preserve the balance when a false step is made, or a sharp blow in either hypochondria or the epigastrium, have produced the lesion. The effects are to destroy life, either immediately or remotely from consective difficulties, although it has been preserved for as long as eleven months. In the very few cases in which recovery was noted, the diagnosis was made solely from the symptoms, the observer admitting the possibility of error, but the strong probability that the true condition was recognized. The only value of a diagnosis is for purposes of prognosis, as the accident is in every sense utterly irremediable, and death, sooner or later, directly due thereto, may be asserted with positive assurance.

Death occurring immediately, or within a few hours or days, in the absence of visceral lesion, will very frequently be due to hæmorrhage, which must at all times be quite free. In some cases the shock to the cardiac plexus will be the direct cause, but in most instances the causes of death are prominently revealed at *post mortem*.

Death being delayed, there will usually be found a protrusion of the stomach, spleen, omentum, or even portions of the mesentery through the rent into the thoracic cavity, constituting what is known as *phrenic or diaphragmatic hernia*. In the large majority of cases this result may be confidently expected, unless the rent is so small that none of the viscera can find an entrance. As a study of a phase of traumatism this topic is at all times one of interest, but the surgeon can offer absolutely nothing, in the way of mechanical or medicinal therapeutics, which holds out the least promise of success, in reducing the dislocated organs. Apart from the increased difficulty in respiration, and some slight disturbance of function of the part displaced, there will be little to attract the attention of the surgeon to

the true state of the case in the beginning, particularly if the organ is a solid one, as the spleen. Later, however, strangulation occurs, and the case terminates fatally.

The *symptoms* are not at all constant as a whole; there are very few that could properly be considered pathognomonic. There is usually a sensation of a snap or giving way in the region of the diaphragm, with instant pain, usually very severe and sharp. Respiration at once becomes painful, possibly dyspnœa to some extent. If vessels of magnitude are ruptured, there will be the ordinary symptoms of hæmorrhage, with increasing embarrassment in breathing. It is very rarely the case that hernia of the diaphragm occurs primarily. Ordinarily, within a day or two, there will be complained of a sudden "feeling of slipping," with momentary pain, nausea or faintness, and increased difficulty of breathing. The pulse will be disturbed, and the feeling of weight in the chest will prompt a physical examination. If the organ is a hollow one, as the stomach, it is possible that the area of resonance will not be decreased; if solid, on the other hand, we will find dullness on percussion extending to some distance beyond the margin of the displaced organ. In either case, the vesicular murmur will not be heard in the lower part of the chest, on the affected side, and the heart will be pushed up and to the right side, the rent usually taking place on the left. There will also, according to the observations of most authors, be a notable enlargement of the portion of chest covering the viscera, and examination will show a loss of prominence in the region which it normally occupies. Vomiting is likely to be severe and persistent.

Death may be due to either shock, hæmorrhage, pleuritis, or strangulation of the escaped viscera.

(*d.*) *Rupture of the Liver*, more frequently occurring than either of the preceding, is also far less fatal, as ordinarily occurring, there being many cases of undoubted rupture from which recovery has been perfect. The prognosis may be said to depend entirely upon the extent of the lesion, the injury being confined to the substance of the gland, not implicating the peritoneum, gall bladder, or the common duct. In many cases recorded, examination after death revealed cicatrices, of a size to indicate extensive lesion, which were evidently of long standing, death being due to other causes.

The *causes* are usually contusion, or some crushing accident, such as the passage of a cart wheel across the abdomen, being grazed by a cannon shot, or, as has occurred in at least one instance, an explosion of gas.

The *symptoms* are not at all times of a character to call attention directly to the liver, inasmuch as the force producing the lesion is often wide spread, involving the large portion of the abdomen and thorax. The size of the laceration, and the fact of peritoneal rupture or not will very materially modify the symptoms. In nearly all cases, there will be quite severe shock; pain in hepatic region, more or less

acute, and if the peritoneum is implicated, we may expect to have very intense pain, localized in the region of the laceration, but extending to a greater or less extent throughout the abdomen. There will also be more or less tympanitis, and often mental disturbance, but whether the latter is due to shock or to other causes, we have, at present, no means for forming an opinion. If the rent is of some size there will be violent hæmorrhage, and it may be safely aserted, that without extensive peritoneal lesion, or serious injury to other parts, the prognosis depends entirely upon the extent of the laceration in the liver, hæmorrhage being the chief danger. The symptoms of hæmorrhage are as usual, but owing to the profound shock nearly always existing, it may not be easy to differentiate one from the other.

The *prognosis* is good, as said above, just in proportion as the rent is small, the peritoneum uninjured, and other parts and tissues are not extensively implicated. The great danger being hæmorrhage, the prognosis must in all cases be very guarded until the laceration has entirely healed, as many cases are on record, in which everything did well until an unlucky movement of the patient tore asunder the new and weak adhesions, fatal hæmorrhage at once occurring.

Treatment is negative and expectant, in this case the terms being synonymous. We can offer nothing that promises the least success in arresting the bleeding, except perfect quietness, and cold applications. The question rests entirely upon the limit of the extravasation. If the blood is poured out into the peritoneal cavity in any amount, or even between the parietal peritoneum and the abdominal walls, it may be said to at once forbid any hope of the recovery of the patient. When it is poured out into a sac formed by peritoneal adhesions to the liver, as soon as the sac is filled, bleeding will probably cease. Hence the prime indication being the arrest of hæmorrhage, it can be at once conceived, that the surgeon can do little to influence the result. If signs of hæmorrhage abate, reaction comes on, and the patient survives several hours, the presumption is either that the lesion was very small, or that the blood has ceased to flow if a rent of magnitude was made. The indication of the first importance now is, to prevent the patient, even to the slightest degree, making the least attempt to move himself, even the most trivial movement being fraught with imminent danger. An unguarded movement may tear asunder a partly healed laceration, or disturb a coagulum, and sudden profuse hæmorrhage be established, which in a short time produces death. The patient must be constantly reminded of the danger, and must submit to have all his wants supplied by nurses, even to feeding, and slight changes of posture. The surgeon will do well to guard against a future loss of reputation by impressing these facts firmly on the attention of the patient and his friends, from the very beginning.

Rupture of the Gall Bladder, or of the common bile duct, may occur without laceration of the liver, or in connection therewith. In either case, it is doubtful if the accident can be distinguished from a lacera-

tion of the liver, and in view of the fact that it is certainly fatal, perhaps not so speedy as in some other forms of visceral lesion, it is not necessary to make an accurate diagnosis. The immediate cause of death is severe peritonitis, from extravasation of bile into the peritoneal sac.

(*e.*) *Rupture of the Stomach*, as compared to rupture of the solid organs, or even of the small intestines, may be considered a somewhat rare accident. While it has been considered that small rents may occur, in an empty stomach, and life not destroyed, there are no cases on record to substantiate the assertion; every case of undoubted laceration, whether large or small, made in a full or empty stomach, has hitherto proved fatal, and speedily so. The causes are as usual in visceral laceration.

The *symptoms* are, profound shock, agonizing pain, vomiting of blood, and every symptom of approaching death. There is an expression of terror on the face, the extremities are cold, the pulse falls, and death very rapidly ensues. The causes of death are many, and not at all times distinguishable prior to *post mortem* examination. In many cases it is undoubtedly due to the escape of the contents of the stomach into the peritoneal cavity, particularly as the accident usually occurs when the stomach is full, probably from the difficulty with which a rent could be produced in the empty flacid organ. Nothing need be said of the treatment, as there is absolutely nothing to be done, the case being surely fatal. It may be enquired why perforations of the stomach, whether by ulceration or from gun-shot wounds, may occur without necessary fatal results, and yet an opposite state of fact exist in laceration from contusion. The question will be more fully discussed elsewhere, and it will be sufficient to call attention to the fact, at this place, that in one case the perforation is due to slowly-acting chronic conditions, which afford ample time for adhesions to near parts, thus preventing as serious an injury to the peritoneum; and in the other case, the external wound affords a ready exit for material that would otherwise find its way into the peritoneal sac.

(*f.*) *Rupture of the Spleen*, produced by causes similar to those operating in other visceral lesions, produces symptoms, both immediate and remote, so similar to laceration of the liver, that apart from a study of the particular accident, it is often impossible to decide which organ has been injured. Thus in contusions which implicate a large part of the surface of the abdomen, as the passage of a cart-wheel, or a gaseous explosion, the symptoms are very confusing, and hardly capable of differentiation. Blows received in the immediate neighborhood of the spleen, however, afford a ready clew, and the accident is easily recognized. The immediate cause of death is hæmorrhage, or extravasation of blood into the peritoneum. The symptoms, pathology, and indications for treatment being precisely as in the case of ruptured liver, there is no necessity for simply repeating what has been already said.

(*g.*) *Rupture of the Kidneys*, whilst not so fatal an injury as some forms of visceral rupture, is an exceedingly grave accident, and one furnishing a very high ratio of mortality. The causes are usually direct injury, although strains or sudden and extreme flexion of the lumbar spine have more than once produced laceration of the organ.

The *symptoms* and prognosis are entirely dependent upon the extent of the lesion, to some degree they may be modified by the portion of the kidney involved, whether the posterior or anterior. When death results immediately, it is usually due to hæmorrhage; when remotely, to abscess or peritonitis from urinary extravasation. There are as initial symptoms, vomiting, extreme shock and collapse, local pains, bloody urine, pain in the course of the ureters, in the testicle, and in the head of the penis, with a retraction of the testicle on the affected side. There will be more or less ecchymosis over the seat of injury, sometimes extending up over the region of the liver. The lesion being extensive, death will rapidly ensue, as a rule, in the manner noted under other grave lacerations of the abdominal viscera, although there are cases in which life has been prolonged for a year, or, perhaps, even longer, death being due, in such cases, directly to the injury of the kidney.

In cases in which death is delayed, the remote symptoms are various, and many of them indicate conditions not included in the catalogue of surgical affections. Marasmic affections occasionally occur, but the majority suffer from abscess of the kidney, pelvic cellulitis, with diffused suppuration, or pyæmia, septic in character. In some rare instances, renal fistulas will form, affording an external exit for the pus, and life may be prolonged, or even preserved by this fortuitous occurrence.

The *prognosis*, I think, will depend largely upon the urgency of the symptoms. Thus when the hæmorrhage is excessive, indicating extreme laceration, notwithstanding a case now and then, at long intervals, recovers, the prognosis is always bad; death is the rule, almost inevitable. The acute stage having passed, however, recent experiments in operative surgery seem to warrant the belief that life may be preserved in nearly every instance.

The *treatment* in the acute stages, as is common in visceral lesions, is very largely expectant. Rest, and the placing the parts in a position to favor coagulation being the only indications. If the case passes into a chronic state, with the formation of abscess, the indications are to evacuate the cyst by lumbar incision, or drain with an aspirator, with the hope that the walls may be brought into contact, and the sac, which the kidney has now become, may thus be obliterated. Failing in this, extirpation of the organ is to be performed. Although the operation is too recent, and has been performed too seldom to warrant a decided opinion as to its results, yet the few instances in which it has been performed have proved so successful, and without the attempt it is certain that the case will

terminate fatally, it would be utterly unjustifiable if it were omitted. It has not been my fortune to perform this operation, or see it performed, nor has it occurred to me to have a case, for some years, at least, requiring it. My friend, DR. MCCLELLAND, of Pittsburgh, Pa., has been more fortunate, however, and recently (Aug. 19, 1880,) he removed the left kidney in a young woman who had suffered from chronic abscess of the same from childhood. The extreme exhaustion subsequent to the operation was removed under *Ars.*, 6, in hourly doses, and recovery was complete, as far as the record goes, *i. e.*, to the twentieth day. This achievement (*Hahn. Month.* xv. 1880, p. 665,) is a noteworthy one in the history of Homœopathy, and DR. MCCLELLAND has gained universal reputation from his brilliant success.*

Rupture of the Ureter is a very rare occurrence, and cannot be determined, except negatively. The occurrence of symptoms indicating urinary infiltration, without any discoverable lesion of the kidney or bladder, would direct attention to the possibility of such an accident. The condition is even more hopeless than kidney rupture, both from its concealed character and the quantity of urine continually poured out from the probably uninjured kidney.

(*h.*) *Rupture of the Intestines* is by far the most frequent accident, in the nature of laceration of the abdominal viscera from contusions, that the surgeon is called upon to treat. The most frequent cause, both in civil and military practice, seems to be kicks in the abdomen by horses, although they have been observed from all kinds of contusions and crushing injuries. The rupture may occur at any part of the intestinal tract, from the stomach to the rectum, and be of any magnitude, from a pin-like perforation to a long, longitudinal rent, or complete transverse separation of the part. The usual location, however, is in the jejunum, partly from its thinness, and partly from its more fixed position. The direction of the rupture is more frequently observed, I think, as longitudinal in least muscular parts, and transverse when muscularity is greater.

With the intestines empty, it can only be possible to cause a laceration by the exertion of extreme force, a force that would inflict great injury on other parts, perhaps sufficient to cause death without reference to the intestinal lesion. There is a possibility, from conditions to be referred to shortly, that some mild cases escape detection from the little disturbance they cause; but the observation of the profession has been, that in uncomplicated intestinal rupture, from contusion of the abdomen, the intestines are either filled with the injecta, or distended by gas. It is manifest, however, that the parts are exposed to greater injury under the latter circumstances than when they are empty and flaccid.

The consequences of such an injury are of the gravest character, so much so that it may be stated that there is no opportunity for recovery if the laceration is actually produced. There may be severe contu-

*Since this was written the operation has been made by DR. J. E. JAMES, of Philadelphia, and others.

sion, with bruising of the intestines, in which many of the symptoms of laceration occur, without any such condition existing, and the observer be misled in estimating the *status præsens*. Where there has been no mistake of this kind, where the evidence of laceration is conclusive and positive, I am not aware of a single report of recovery.

The *symptoms* vary in degree, somewhat, with the extent of the lesion, and the complications that may exist. Although it is not as unfailing and uniform as has been represented, yet the sudden inflation of the abdomen, and the establishment of meteorismus may be considered, when it occurs, a certain sign of intestinal laceration. This is due to the entrance of intestinal flatus into the peritoneal sac, from the rent in the gut. This sudden distension may also produce rupture of the peritoneum itself, and thus hasten the establishment of somewhat later group of symptoms. The abscence of this metorismus does not contraindicate laceration, whilst its presence proves conclusively the fact. In addition to the escape of air, there is an escape of the contents of the bowel, which is a far more serious occurrence, and at once puts the case beyond hope of relief from the very intractable and violent form of peritonitis thus established. There will always be extreme shock, the patient passing immediately into a state of collapse, with all the symptoms of near death. Vomiting and hiccough next appear, the matter first vomited is of the ingesta, more or less tinged with blood, soon becoming stercoraceous, if the rent is in the ileum, or lower, of an undeniably fæcal odor and appearance. Tympanitis, under any circumstances, will soon come on, the distension being so extreme that the parieties feel like a board, or a solid bony wall, with such exquisite sensitiveness that no examination can be made, even the weight of the sheet being insupportable. The pain is very acute also, apart from sensitiveness to touch, and the bowels are immovably constipated On the whole, as LARREY has affirmed, and subsequent observers have fully sustained him, ruptures of the hollow viscera are much more serious and uniformly fatal, than similar lesions of the solid organs.

Ruptures of the Omentum are not as serious in the results as of the intestines, but may furnish more hæmorrhage and thus endanger life. There are instances of a rent having embraced knuckles of intestine, which become strangulated, and death induced.

Ruptures of the Mesentery are equal in gravity to intestinal rupture, from the resulting peritonitis as well as hæmorrhage. To sum up the results of visceral lesion without external wound of the abdomen, the following table is quoted (M. and S. *Hist. of War*, p. 26, *Surg. Vol.* pt II):

RUPTURE.	CASES.	LIVER.	SPLEEN	KIDNEY.	INTESTINE.	UNK'N.	Result:	
							RECOV.	DEATH.
From shot.....	41	1	1	3	5	31	21	20
Other violence...	11	4	2	1	4		1	10
TOTALS.....	52	5	3	4	9	31	22	30

II. WOUNDS OF THE ABDOMEN.

Wounds of the Abdomen are uniformly divided into two grand classes, penetrating and non-penetrating, important considerations attending each form. External, or non-penetrating wounds will be considered first, in this instance, which may serve to represent a logical proposition, proceeding from the minor to the major.

1. NON-PENETRATING *abdominal wounds* are common, and occur of all varieties, incised, punctured, lacerated, and contused. There is nothing peculiar in the character of the injury, nor in the method of infliction, all the interest in the subject attaching to the complications and results. These may be stated to be, the formation of ventral hernia, injuries to the muscles affecting the integrity of the parts, hæmorrhage, and lesions communicated to the viscera.

The first consideration, to some extent, is the *character* of the wound, whether punctured, incised, lacerated or contused. In many respects nothing of interest would attach to the character of the lesion, above what is observed in such lesions generally, were it not for the fact that the broad layers of muscles, consequent quantities of connective tissues, and the close proximity of important organs in the abdominal cavity, renders lesions of the walls at all times of interest to surgeons.

As was said of contusions, the surgeon must approach the examination of every wound of the abdomen, no matter how trivial it may be in appearance, with a remembrance of the most disastrous consequences that may attend visceral lesion, and the difficulty, so often experienced, of determining whether it be penetrating or superficial. In the case of incised wounds, the fact is easily determined, as to penetration, as a rule, although cases continually occur in which the point of entrance of the knife, particularly when introduced by a stabbing motion, is much deeper than the rest of the incision. Punctured wounds, when made with small pointed weapons, will often prove deceptive, in this respect, from the closing up of the bottom of the wound by a particle of fat from the omentum, or other source, thus preventing the admission of a probe, if it is thought best to employ one. The character of the wound will often indicate the character of connective or associate lesion to anticipate. Thus a contused wound would render possible contusion or laceration of the viscera receiving the blow. An incised wound would render hæmorrhage the chief characteristic, with penetration of the walls, and muscular lesion as secondary conditions requiring careful investigation. Punctured wounds will first raise the question of penetration, and next of extensive suppuration of the walls in the track of the wound. Gun-shot injury will partake of the character of both contused and incised wounds.

(*a.*) The question of *penetration* is the first question to be decided. Under all circumstances, abdominal lesions will be accompanied by

shock, greater, very often, than the degree of injury would seem to warrant. This is greater in the case of penetrating wounds, other conditions being equal.

The symptoms of penetration will be given in a later paragraph, but it may be remarked here that they may be classed as physical and rational. The former will be prominent in cases of large wounds, in which inspection can be freely had, and the perforation positively determined. The rational signs would be such as a consideration of the weapon employed, the marks upon it indicative of the extent of penetration, the direction of the wound, or the existence of symptoms indicating peritoneal lesion. It would be very unwise to leave a case without determining the question of penetration, and equally unwise to persist in exploration to an extent that would add to the peritoneal lesion, if perforation had occurred, or to establish suppuration, if otherwise.

There is a well-founded prejudice to the use of the probe in abdominal wounds, which is perfectly proper if it is employed for the purpose of determining the fate of missiles that may be supposed to have entered that cavity. But for the purpose of determining the question of penetration of the parieties, if used with due caution, care is taken to use a probe of large size, and the examination is not too prolonged, I cannot avoid considering it an inexcusable error to omit a thorough examination, with the probe or finger.

(*b.*) *Hæmorrhage*, which in obedience to a standing rule in surgical practice should be considered first, is a question of unusual importance, unusual as applying to superficial wounds. The vessels of the abdominal parieties, particularly the epigastrics, are large in size, and so situated that on section they are permitted to retract deeply into the tissues; the loose connective tissue in which they are suspended being bounded in front by the sheath of the rectus abdominalis, behind by the spinal muscles. above by the ribs, and below by the pelvis and Pouparts ligament, affords space for the most profuse bleeding, sufficient to destroy life without opening the cavity of the abdomen, or a single drop appearing externally. It is an imperative obligation resting upon every surgeon, to secure wounded vessels of any magnitude whenever they can be reached, in any region of the body; in this case the obligation, if possible, is increased, there being little hope of spontaneous arrest by coagulation, the opportunity for extensive extravasation being greater than usual. A later paragraph will be devoted to a consideration of wounds of the blood-vessels, so that at this time it is only necessary to remark that all bleeding vessels must be secured by ligature, or something equivalent, even if the wound requires to be greatly enlarged.

(*c.*) *Suppuration* is frequently observed as a concomitant of punctured wounds, more particularly if made with a blunt-pointed weapon, as a nail, or fencing foil. The occurrence may not be any

more common than in the case of punctured wounds in general, but the location gives it some peculiar interest in the present instance. The same characters that render hæmorrhage exceptionally dangerous, renders suppuration important, prominently the loose connection between broad flat layers of muscles, which permit extensive burrowing, and more or less destruction of muscular tissue, thereby weakening the walls of the abdomen, and favoring subsequent intestinal protrusion.

(*d.*) *Wounds of Muscles* are among the commoner accidents from superficial wounds, and derive their interest or value from a consideration of the direction of the incision, whether transverse or parallel to the course of the fibres, and to the extent of the injury, whether involving only a few fibres, or the whole substance. When the wound is longitudinal, or parallel to the course of the fibres, the function of the muscle will be little if any impaired, and if suppuration does not ensue there will be little if any fear of ventral hernia as a later result. Under other circumstances, the wound being transverse, there will be a permanent loss of function, with great probability of subsequent hernia, proportionate to the extent of the injury. Of course in longitudinal wounds, the probability of separation will bear a certain relation to the extent.

(*e.*) *Wounds of the Viscera*, particularly laceration and contusion, may readily occur without penetration of the parieties, precisely as in the case of contusions of the abdomen, noticed in a previous section of this chapter. Such lesions are far less common than in the case of contusions, yet the possibility of the occurrence must be constantly before the mind, when approaching a case of abdominal wound, and care taken not to hastily diagnosticate penetration of the parieties because there is evidence of visceral lesion.

(*f.*) *Ventral Hernia* is a very common result of wounds of the abdomen (non-penetrating,) the liability increasing, as would be supposed, in direct proportion as the loss of muscularity in the parieties, or the size of the wound as affecting muscular tissues. Nothing can be said of ventral hernia as to chosen site, further than the majority of cases seem to be in front, in the neighborhood of the recti muscles, or the linea alba. Proper inguinal and femoral hernia have unqestionably been caused by severe contusions or concussions of the abdomen, and hence should not enter into this catalogue. The records of the Pension Bureau of the United States in 1871, showed three thousand seven hundred and thirty-five pensioners drawing pension from abdominal injuries, of whom three thousand two hundred and eighty-three had hernia, as was alleged, due to injuries received in the line of military duty. Of these, we may note in passing, that two thousand seven hundred and forty were cases of single hernia, and five hundred and forty-three double. It is notorious that fraud is not a rare element in application for pension. The records in the surgeon generals office,

show that there were returned during the late war reports of injuries to the abdomen as follows:

	NUMBER.	DEATHS.
Non penetrating wounds....	4 821	266
Penetrating "	3 717	3 031
	8 538	3 297

This shows that five thousand two hundred and forty-one of the total number of wounded recovered, as far as life was concerned, but of this number, the ultimate termination of the case was unknown in two thousand two hundred and ninety, reducing the number to two thousand nine hundred and fifty-one of which some record was made. Of this number, again, we find that five hundred and seventy-four were discharged. Those returned to duty reaching the large number of two thousand three hundred and seventy-seven out of two thousand nine hundred and fifty-one known to have recovered without loss of life, leaves the impression that many of those subsequently returned to duty had late development of hernia, or the number was swelled by recruits from the great army of "unknown" to the formidable proportions noted in the pension office records. The presumption to be drawn from these records is, therefore, making due allowance for intentional and unintentional fraud, that ventral hernia is only exceptionally immediately produced when following the form of injury under consideration, unless the wound is of such size that the viscera are at once protruded, and not from tenuity of the cicatrix as oftener occurs. The result might be tabulated as follows:

CASES.	DEATHS.	UNK'N.	DUTY.	DISC'H.	TOTAL RECOV.	CASES OF HERNIA.
8 538	3 297	2 290	2 377	274	5 221	3 283

Thus more than one-half of those sustaining abdominal injury, had at some time hernia presumably due thereto.

Hernia of this character are met with of all sizes, from a mass no larger than an ordinary cherry, to one that includes almost the entire enteric tract. I have a case on hand now, in which the rent extends from the umbilicus to the pubis, in the linea alba, requiring constant support to keep the whole of the abdominal contents, apparently, from falling into the opening. The integumentary covering, in most instances, is extremely thin, so much so, in cases in which the cavity of the abdomen has been opened, that it feels as if the slightest violence would cause it to give way.

Apart from the inconvenience resulting from a large hernia, the necessity for wearing support constantly, and the dragging to which the mesentery is subjected, the larger the opening the greater the

security to life, and consequently they are far more desirable than small protrusions. Small hernia indicate a small outlet, and there is constant danger of strangulation, and a constant menace to life.

This includes a hasty survey, necessarily more brief than the important character of the subject demands, of the nature and consequences of non-penetrating abdominal wounds. Enough has been said, however, to make good the statement with which we started out, that unimportant as they might appear on first examination, their importance must not be undervalued.

Treatment.—Wounds of the parieties must demand the same methods of treatment as wounds in general, modified by such indications as may arise from injury to the viscera. Thus hæmorrhage must be arrested, foreign material removed, and the wound closed. If the viscera have been contused, *Arn.* will be needed, or cold applications if any symptoms of hæmorrhage are observed. Wounded muscles must be drawn together and a free exit afforded to pus if it collects Peritonitis will call for *Acon.*, *Bell.* etc., precisely as if it were due to non-traumatic agencies; and in every respect the treatment will be as has already been laid down in many places in the course of these pages.

The therapeutic question of greater interest is what can be done for ventral hernia, also is there any efficient prophylaxis. It is impossible for a single practitioner, no matter what the extent of his practice, to have brought under his immediate attention any considerable number of cases. Even those in large hospital practice may never see a case. We are thus dependent upon reports compiled from a large number of individual experiences, in estimating the value of different methods of treatment. Judging from these, as well as my own experience, limited to four cases, nothing is to be expected from prophylactic attempts. All methods have either utterly failed, or at best simply delayed the development of hernia. To attempt this by wearing a truss, will simply hasten the attenuation of the cicatrix; to wear a broad supporter to the whole abdomen, will weaken the walls of the abdomen to an extent that will forbid ever throwing it aside. The hernia being produced, the question of cure can be answered only in a doubtful affirmative, at the best only a slight modification can be promised.

There are reports of a cure, very few in number, yet still enough to hang a hope upon, particularly when the case has been seen very early. To attempt the cure of an *old* ventral hernia of any size, is to attempt to make the abdomen hold a larger bulk than it has capacity for. The tension on the mesentery has really increased the bulk of the mass considerably above the normal standard, and the absence of viscera from their proper position has produced a literal contraction of the abdominal parieties almost to a corresponding extent. In old cases, therefore, do nothing beyond attending to the comfort of the patient by furnishing proper support. In recent cases, an attempt may be made to cure, by freshening the edges of the fissure, *removing*

every particle of cicatricial tissue, and close it by numerous points of suture of silver wire. An elastic bandage must now be worn continually, and if a year elapses without the reproduction of the tumor, the case may be considered cured.

2. PENETRATING *Abdominal Wounds.*—A wound that pentrates the walls of the abdomen, whether the peritoneum is involved or not, is an injury of the most serious character, not much if any, slighter in importance than penetrating wounds of the chest. The accident is too infrequently observed in civil practice, even large hospitals presenting comparatively few examples, to base an opinion upon as to ratio of mortality. We are compelled to resort to military records for this purpose, and must admit that there are too many unfavorable conditions surrounding wounded soldiers, in an active campaign, to present a perfectly truthful picture. We find, on consulting the records in the offlce of the surgeon general, (*Med. and Surg. Hist. of the War*, pt. II, *Surg. Vol.* p. 202), the following table of results :

WOUNDS.	CASES.	DIED.	RECOV'E.	UNK'N.	RATIO OF MORTALI'Y
Without known visceral lesion :					
Punctured and Incised..	13	4	9		30.7
Gun shot.....	19	7	12		36 8
With known lesion of viscera, punctured, etc.:	14	12	2		85.7
Shot — Stomach.....	79	60	19		75.9
Shot — Intestine.....	653	484	118	51	80.3
Shot — Liver.....	173	108	62	3	63.5
Shot — Spleen.....	29	27	2		93.1
Shot — Pancreas.....	5	4	1		80.0
Shot — Kidney.....	78	51	26	1	66.2
Shot — Blood vessel, omen' and mesent	54	47	7		87.0
Shot — S. R. capsule.....	1	1	7		100.0
Visceral lesions not exactly described.....	2 599	2 226	186	187	92.2
AGGREGATE.....	3 717	3 031	444	242	87.2

Large as this percentage is, it has been greatly exceeded in Europe, as shown by tables printed in the volume from which I have just quoted. From this it appears that race and climate must exercise a very important influence on the mortality, the greatest loss occurring when hostilities were conducted in regions far removed from hospital facilities, or where the climate was unusually cold or hot. Thus the French in Algiers showed a death rate of 100.0; similar injuries during the Parisian revolutions (1830 and 1848) shows 66.6, and 77.7 respectively. So, also, with the British in the New Zealand war, when the ratio was 93.3, whilst in India, it was but 84.2. In the Crimea, when the weather was very severe, and the British were notoriously deficient in hospital supplies and conveniences, their loss was 92.5, against a French loss of 91.7. It would thus appear that there can be no question, that whilst the death rate from penetrating

abdominal wounds must at all times be large, yet the exigencies and deprivations of military life fails to furnish perfectly trustworthy data to the civil surgeon. I am unable to find any statistics of the results in civil practice, at least in tabulated form, but from the few records available it is certainly safe to put the death rate as high as 85.0 when the viscera, taken generally, are injured, and not lower than 40.0 when no visceral lesion is prominent.

The consideration of this subject embraces a variety of topics, something as follows, with or without visceral protrusion; and with or without visceral lesion.

(*a.*) *Penetrating wounds without protrusion of the viscera* may be at once apparent from the size of the opening, but not infrequently the peritoneal wound will be the merest puncture, while the integumental lesion may be of almost any extent. As already said the fact of penetration must be definitely settled, as prognosis cannot be intelligently made until the fact is established.

There being penetration, no matter to how slight an extent, the case immediately becomes one of the utmost gravity. We have seen how the smallest puncture of an intestine filled with the ingesta or fecal matter, will almost certainly induce fatal peritonitis from escape of the contents. This danger, strange as it may appear at first sight, increases as the wound is smaller, as the chances for an escape of the intestinal contents through the external wound diminishes as the wound is smaller. This, however, will receive attention in a later paragraph. There will always be shock, in abdominal wounds, greater when penetration occurs, but the evidences of shock vary so in different individuals, that as a diagnostic symptom it has little value. The only certain sign will be the passage of a probe into the cavity. This is the only use to which a probe must be put; the fact being established it must be thrown aside. No attempt must be made to search for missiles that have entered, to determine the neighborhood of different viscera, or to determine the depth or direction of the wound. A contrary course might disturb coagulæ that had formed, or even set up peritoneal inflammation. Having determined the fact of penetration, the next step will be to determine visceral lesion, which will receive attention later.

The consequences of such a wound depend very greatly upon the extent. Under all circumstances, however, there is a probability that ventral hernia will appear sooner or later, the probability increasing with the size of the wound. In muscular subjects, where the wound is of the punctured variety, or the incision is in a line parallel to the fibres of the muscles chiefly involved, there is a possibility that hernia may be averted.

The *treatment*, however, no matter what these circumstances may be, must always be conducted with a view to guard against visceral protrusion later, and to facilitate speedy and firm union.

The *treatment* to this end is as follows: The parts being thoroughly

cleansed, the edges are approximated, and held by deep quilled sutures, the stitches being through the muscles as well as the integument. The patient must be placed in a position that will relax the injured muscles; inclined forward, when the recti are involved, sideways when the oblique, slightly forward or backward, as the external or internal oblique are chiefly injured. The practice is a good one to aid in maintaining close apposition of the severed parts throughout their whole extent, as well as to relax the muscles, to reinforce the sutures by long adhesive strips, passing over the quills, and appropriate bandaging over all. Remedies will be used as in the treatment of wounds in general, particular care being taken to disturb the dressings as little as possible. In the few cases I have seen, I have made it a practice to allow the sutures to cut their own way out.

(*b.*) *Penetrating wounds with Visceral protrusion* present indications, and are followed by consequences depending upon the fact of injury to the viscera or not. We will first consider protrusions without lesion of the viscera. In large incised wounds, more particularly, the viscera are liable to be protruded, in some cases of very extensive wound almost all the contents of the abdomen, not firmly fixed in position, have been found outside of the cavity. The protruded viscera, as a matter of course, depend upon the region of the wound, and the extent of the protrusion usually is proportionate to the extent of the wound. All things being equal, and the wound a simple incision, the small intestines and omentum are oftener displaced; next in frequency is the large intestine and stomach. In severe lacerated wounds, as occasionally occurs from machinery accidents, or the claws of wild animals, the fixed viscera, as the liver, spleen, or kidneys are displaced. The extent of the wound, also, will have an important influence on the extent of the protrusion. Thus a portion of the liver or spleen, may be exposed, yes, even pushed out through the wound; a single loop of intestine, or a knuckle of omentum, may appear through a moderate wound. Further than this, reposition of the viscera depends upon the size of the wound; in small wounds enough of the intestines may be protruded to become strangulated, and even to effectually forbid reduction without enlarging the external wound. All these varied conditions will, it will be at once perceived, very materially modify treatment as well as prognosis. In such cases, as far as my experience goes, the shock is very great, which together with the hæmorrhage, which is usually quite profuse, puts the case in a very unfavorable condition from the very start.

The *treatment* and examination of this variety of abdominal wound, demands consideration simultaneously. The first thing to be done is necessarily to arrest hæmorrhage, no matter how trivial. Next examine the protruded parts with great minuteness, to determine the existence of injury to the viscera. None being found, steps must be taken to replace the parts within the cavity. If omentum alone is protruded, it must be carefully raised, and the portion

engaged in the wound examined to discover if any portion of the intestines is protruding. If such is the case, it must be reduced before the omentum. If the protrusion has continued some time, it must be carefully inspected as to its vitality. The diagnosis having been made, all hæmorrhage arrested, and the parts carefully cleansed of all foreign material with warm water, reduction is proceded with as follows:

Supposing *omentum* alone to be presenting, if it is found discolored, or giving other unmistakable symptoms of devitalization, a question will arise as to the propriety of returning it within the abdomen. It is impossible to give the indications forbidding reduction, each surgeon being compelled to exercise his own judgment. It can only be said that a degree of devitalization that forbids hope of restoration will be conclusive reasons for deciding against reduc-

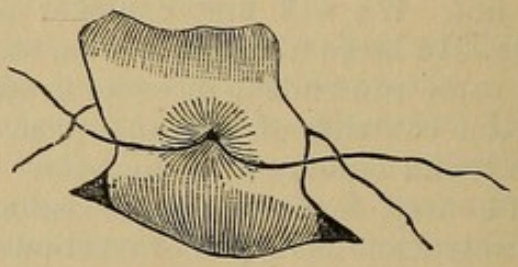


FIG. 42. LIGATURE OF OMENTUM.

tion. Under these circumstances, arm a stout needle with a double ligature, and pass it through the omentum, close to the point of constriction. Cut the loop in the eye of the needle, separate the ligatures, and tie each one separately on different sides. (Fig. 42, Ligature of Omentum.) With a scalpel then separate all the tissue external to the ligature, and return the stump within the abdomen. Care must be taken to retain control of the ligatures until it is seen whether hæmorrhage occurs or not. If it should, the ligatures must be drawn tighter; if not, the free ends may be secured to the integument by an adhesive strip, and the wound closed as usual.

Should it be decided to return the organ within the abdomen, make steady pressure with the tips of the fingers on the neck of the mass, that portion held in the wound. If it is held so tightly that reduction seems impossible, the wound must be carefully enlarged, in the direction which exposes the vessels to the least injury.

After it has passed through the integumentary wound, the wound in the peritoneum must be sought for, and care taken that the protrusion has passed within it. There are instances in which the peritoneal wound has been so much smaller than that in the integument that the protrusion has been found between the abdominal parieties and the peritoneum, leaving the sufferer in as bad or even a worse condition than he was before. To avoid this, when it is at all

practicable, the peritoneal wound should be sought for and enlarged carefully to the same extent as the wound in the integument, and held up by the finger of one hand, whilst reduction is effected.

When the *intestine* is prolapsed, with or without omentum, reduction is to be effected by pursuing the same course already laid down, providing that when both appear externally, the intestine must be first reduced.

There are many cases on record in which intestines almost on the verge of gangrene, if not quite so, have recovered vitality after release from constriction. For this reason, less care is required in inspection with a view to devitalization than in the case of the omentum, and yet no risk should be run unnecessarily. Positive gangrene, or suspicious softening of the intestine, must forbid reduction, although the constriction must be relieved, and the parts kept external to the abdomen for a time, to see if the parts recover vitality. If so, they are to be returned. If not, an artificial anus must be formed, as described in "*Surgical Operations*" of this series. We may state at this time, however, that the course of procedure could be briefly described as follows: Draw down the upper portion of the intestine until sound tissue is reached. Pierce this part with a needle armed with a silver wire, and sever the intestine within half an inch outside of it. The upper portion is to be firmly stitched to the margin of the wound, in such a manner that it may be kept open. The procedure is repeated with the lower portion. The anus thus manufactured, being unprovided with a sphincter, must be kept covered by a compress and bandage, for purposes of cleanliness. The operation to close this opening, when the necessity for its continuance has passed, will be fully considered in a future volume, as it has none of the elements of emergency about it, and may be considered a major operation.

(*c.*) *Wounds of the Viscera*, whether with protrusion or otherwise, greatly adds to the gravity of the accident, and materially changes the indications for treatment. The symptoms are similar to visceral lesions already considered in earlier paragraphs, with the advantage that in very many instances the wound is open to inspection, thus removing any doubt as to the nature of the injury.

Prognosis and treatment both depend upon the character of the organ injured. Thus in the case of solid organs, it becomes a question of the extent, hæmorrhage being the greatest element of danger. Perhaps wounds of solid organs of slight extent, if made by a contusion, will prove more dangerous than an incised or punctured wound of far greater extent, owing to the liability to gangrene. However, all things being equal, it may be safely asserted that the extent of the lesion, in the case of solid organs, will determine the result. The treatment is to be conducted upon the same indications already laid down when speaking of visceral lesions from contusion, so far as the visceral lesion is concerned. The external wound will be treated precisely as if no visceral wound existed.

Wounds of *hollow organs*, at all times more serious than in the last instance, are more or less ominous in proportion as they communicate freely with the external wound, and there is absence of passage of their contents into the peritoneal cavity.

The hollow viscera being wounded and protruding through the parietal wound, there is little danger of peritoneal irritation, from foreign material, and the prognosis is vastly improved. With escape of the contents into the peritoneal sac, treatment of any kind is useless; death must ensue sooner or later.

The consequences of such lesions are to be predicated upon the character of the organ, and the opportunity afforded for treatment. Thus a wound of the gall bladder or the common biliary duct, is an irremediable accident; if the escape of the bile into the peritoneal cavity can be avoided, its diversion externally may not preserve life. In the case of wounds of the stomach or the intestines, without entrance of their contents into the peritoneal sac, if the wound can be reached, there is a strong possibility that it can be closed, and life preserved. If the circumstances are such that the wound cannot be closed, we may succeed in the formation of a permanent fistula, as in the case of an artificial anus, or as occurred in the celebrated case of Alexis St. Martin.

In the case of double organs, as the kidneys, or ureter, more properly belonging, perhaps, to the pelvic region, severe injury may be sustained by one, and life maintained. Thus a ureter being severed, and the kidney being uninjured, we may construct a urinary fistula, by bringing the divided extremity of the ureter into the external wound, or, if this is impracticable, even remove the kidney.

In the case of hollow organs, therefore, the course to be pursued is as follows:

Should circumstances, (which cannot be foretold,) seem to forbid the attempt to close the wound and return the part within the abbomen, with a tenaculum draw the edge of the wound to the external wound, and stitch them together with silk or carbolized catgut, hoping to secure union and the establishment of a fistula which may be allowed to remain permanently, or closed by a secondary operation after a time.

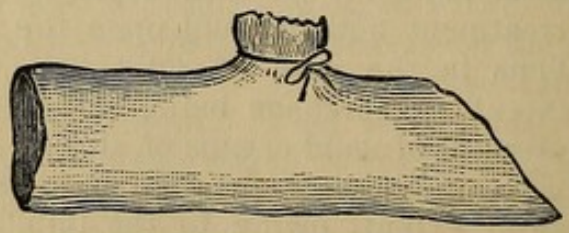


Fig. 43. LIGATURE OF INTESTINE.

The wound being of a character that will permit closure, which will in nearly every instance be the case, the method will depend upon the character of the wound. Thus a small perforation, such as would be made with an awl, or a small pistol ball, the edges may be seized with

a pair of forceps, and the whole extent surrounded with a silk thread, as a bag of meal is tied. (Fig. 43, Ligature of Intestine.) A larger perforation, as by a musket ball, or grape shot, will be more effectively closed by running a continuous suture around the rent, and tying

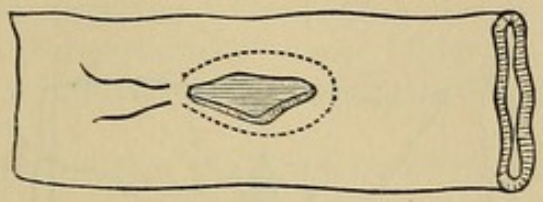


Fig. 44. LIGATURE OF INTESTINE.

the ends firmly, which acts as a purse or "puckering" string. (Fig. 44, Ligature of Intestine.) The suture may be of cat-gut, the ends cut off, and the whole left in the abdomen, the external wound being closed as if there were no visceral lesion.

A longitudinal wound, of an intestine particularly, may be closed as follows:

The operation is made differently by different practitioners, the object being to somewhat invert the edges, so that fæcal effusion may be the more effectually prevented. The ordinary continued suture will fulfill nearly all the requirements of the case, and is to be preferred, I think, to some of the more complicated methods. The free ends are to be firmly tied to the last stitch, the ends cut off, and the intestine dropped back into the abdomen, the external wound to be finally closed. (Fig. 45, Suture for Intestine.)

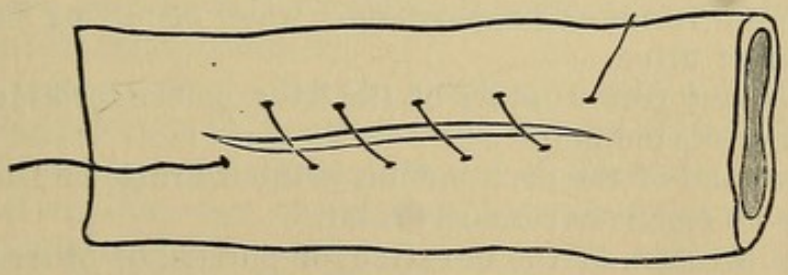


Fig. 45. SUTURE OF INTESTINE.

In transverse wounds, the suture of LEMBERT has many advantages. It is thus described by GROSS (*Surg.* II, p. 666): "A short stitch, including only the peritoneal and muscular coats, is taken on one side of the wound, about two lines and a half from its edge; the needle is then carried across the gap, and a similar stitch is taken on the opposite side. In this way one thread after another is deposited, the intervals between them not exceeding the sixth of an inch; and when they are all arranged, they are drawn firmly together, and tied with a double knot, the ends being cut off as in the ordinary operation. By this procedure the wound is closed in every portion of its extent, its lips being inverted so as to approximate their serous surfaces, at the same time that they form within the tube a ridge, upward of a line in

length." (Fig. 46, Lembert's Suture.) Any material may be used for these sutures; if metalic they will remain indefinitely without producing any irritation; if cat-gut, or any animal fibre, they will become dissolved; if of ordinary silk, they will ultimately fall within the intestine and be carried away with the dejections.

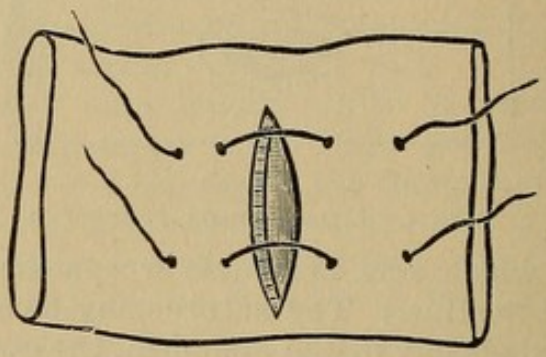


Fig. 46. LEMBERT'S SUTURE.

In closing this portion of our subject, I will quote a summary written by Mr. POLLOCK (HOLMES II, 679,) which will serve as a "kind of index of results attendant upon these injuries."

He says: "1. That a rupture of stomach or intestine, *without external wound*, is a fatal lesion: more fatal than when lesion of either viscera occurs with *external wound*.

2. That when rupture of liver or spleen is fatal, death is generally the result of hæmorrhage. Rupture of the gall bladder is always fatal.

3. That when rupture of the kidney proves fatal, death, when occurring early, is the result of hæmorrhage; when occurring later, is the extravasation of urine.

4. That recovery from rupture of the liver, spleen, or kidney, is not improbable nor uncommon.

5. That a wound of the peritoneum, without bruise or laceration of tissues, is by no means necessarily fatal.

6. That a protrusion of the intestine, or portion of other viscera, if the protruded part be not bruised, nor long exposed, need not necessarily prove fatal.

7. That a wound of protruded intestine or stomach, if small, should be secured by a ligature, if large, by suture; and the protruded viscus returned into the abdomen. The former lesion may terminate in recovery, but wounds amounting to direct division of the canal are irreparable, unless artificial anus be established.

8. That punctured wound of the viscera is more dangerous, than wound with protrusion, less dangerous than rupture without external wound; that the danger is in proportion to the size of the internal wound; and that an artificial anus affords the best prospect of recovery when the wound is extensive."

III. WOUNDS OF BLOOD VESSELS.

As in the case of injuries of the chest, it will be necessary to speak of wounds of the arteries of the abdominal parieties, separately from the vessels of the cavity. It should be unnecessary to repeat a remark already made with some emphasis in various places, in reference to the importance of securing vessels that are wounded by radical measures. In the *Medical and Surgical History of the War*, (Surgical Vol. pt. II, p. 9.) the industrious compiler uses the following emphatic language:

"It must be confessed that the histories of the examples of hæmorrhage, in wounds of the abdominal walls, that appear upon the reports, do not impress the investigator with a favorable estimate of the manner in which this complication appears to have been dealt with by our army surgeons. Here, as in the management of bleeding from the wounded internal mammary and intercostal arteries, timid, inefficient, temporizing treatment appears to have been followed by lamentable loss of life. The instances to be cited teach emphatically that wounds of the epigastric, circumflex, mammary, and lumbar arteries are not to be regarded as trivial, but demand the rigorous application of the rules for the management of wounded arteries, the exposure of the bleeding point, and a proximal and distal ligature." In obedience to this maxim, I have long made it a rule to ligate, secure by torsion, or by acupressure, every vessel that springs, in which there is not a marked tendency to spontaneous arrest of bleeding upon exposure to the air.

The vessels in the abdominal walls that are of sufficient magnitude to demand ligation under all circumstances of hæmorrhage, or degrees of injury, are as follows: Lumbar, epigastric, circumflex iliac, ilio lumbar, and internal mammary.

(*a.*) The *Lumbar arteries*, four in number on each side, are branches of the aorta analogous to the intercostal arteries above. Immediately upon reaching the transverse processes of the vertebræ, each vessel divides into two branches, one of them ascending the spine, to supply it and and the spinal muscles, and the other passing between the transversalis and internal oblique muscles, supplies the abdominal parieties, inosculating freely with other arteries in the region.

(*b.*) The *Epigastric* artery arises from the external iliac artery. In the abdomen it is first found at the lower margin of the sheath of the rectus muscle, having pierced the transversalis fascia, and entering the sheath it ascends behind the rectus, inosculating with the internal mammary, or superior epigastric as some prefer to call it in this region. In the lower part of the abdomen the vessel will be found internal to the internal abdominal ring, below the spermatic cord, and above the femoral ring.

(c.) The *Circumflex iliac* artery is also a branch of the external iliac, a little below the origin of the epigastric. It passes around the crest of the ilium backward, inosculating with the ilio lumbar. Near the

anterior spine of the ilium an ascending branch is given off, which ascends between the internal oblique and transversalis muscles, furnishing numerous branches, which in common with similar branches from the epigastric supply the muscular parieties.

(*d.*) The *Ilio-lumbar* arises deep in the pelvis, from the posterior branch of the internal iliac. It ascends beneath the psoas muscle to the upper part of the iliæ fossa, whence the abdominal branch originates, being the main trunk continued upwards. It supplies the psoas and quadratus lumborum muscles, inosculating freely with muscular branches.

(*e.*) The *Internal mammary* is a branch of the subclavian already outlined in the upper part of its course when speaking of injuries of the chest. It descends within the sheath of the rectus, furnishing many muscular branches, and inosculating with the epigastric.

It can be seen from this brief review of the anatomy of the blood supply of the part that it may not be at all times easy or even possible, chiefly through the free inosculations between the various muscular branches, to determine the source of hæmorrhage as far as the main trunk of the bleeding vessel is concerned. Hence the importance of heeding the injunction quoted recently, to expose bleeding vessels, and tie both distal and proximal ends.

2. The *Internal or Visceral Vessels* can rarely be ligated when wounded, both from the difficulty experienced in reaching some of them, and the rapidity of death from hæmorrhage from such large trunks. Of course wounds of the aorta, hepatic and iliac arteries, must result in death, as far as facility or time for ligating them are concerned. Should a clot form and the bleeding be temporarily arrested, no man would feel justified in running the risk of interfering with it, by attempts to reach the vessel. So also, although perhaps to a somewhat less extent, with wounds of the splenic, suprarenal, renal, or mesenteric vessels. Other visceral branches, as the gastro-epiploica, phrenic, spermatic, and other smaller vessels, have been tied when they could be reached through the external wound; one such case is referred to in an earlier chapter. Under all circumstances, however, wounds of the visceral vessels must be considered very alarming accidents, inasmuch as if the patient escapes death directly from the hæmorrhage, almost equal, if not greater danger is run from the escape of blood into the peritoneal sac.

IV. FOREIGN BODIES IN THE ABDOMEN.

Foreign bodies within the abdominal cavity are far from being uncommon, and are oftener introduced in one of three ways: either through the alimentary canal, lodging at some point between the œsophagus and rectum; by entrance through the mucous outlets, anus, vagina, or urethra; or by perforation of the parieties.

However entered it is always desirable to extract them as speedily as possible, the degree of danger to life, as well as liability to reten-

tion, varying somewhat with the nature of the foreign material. We find it easy to class these objects under one of three heads, the first class being the least dangerous to life, even if of a size or other charters that makes expulsion or extraction difficult.

1. Smooth, spherical, or small flat bodies, swallowed through the mouth, as coins, seeds and stones of fruit, etc.

2. Accumulations of articles taken with the food, such as hair, the chaff of different kinds of meal, and the like.

3. Irregular, sharp, or long bodies, such as needles, pins, knives, pencils, artificial teeth, and a host of other objects, including almost everything that can by any possibility be taken into the mouth, thrust through the walls, or pushed up any of the canals or outlets.

Before considering the methods of treatment of foreign bodies found in the alimentary canal, which constitutes by far the largest proportion of cases,some attention must be paid to other methods of, entrance, as they are quickly disposed of, chiefly from their exceedingly unpromising character.

(*a.*) Foreign bodies entering the abdominal cavity by perforation of the parieties, are chiefly missile weapons, as musket or pistol shot, or, exceptionally fragments of cutting or stabbing weapons. Falls on stakes, iron pickets, and various other accidents may force foreign material through the parieties, which may break off and be retained. Notwithstanding there are a few instances of recovery from the most formidable accidents of this character, recoveries in which the foreign body has never been removed, or at least remained undisturbed for long periods of time, it may be put down as an axiom that such injuries are of a mortal character. It is almost impossible for the viscera, blood vessels, or peritoneum to escape such lesion that the most serious consequences are certain to ensue, so that if death is not immediate it will come on remotely from secondary morbid action. Musket balls have penetrated the intestines, and afterwards been discharged from the rectum with the stool, but such instances are too few and far between to warrant our building any hopes of a favorable issue.

If life is not immediately destroyed, and the foreign body can be *felt* through the parieties, a question will arise as to the advisability of attempting its extraction by operative measures. The foreign substance *must never be sought for by the probe*, or any other method of internal examination; if it cannot be distinctly felt through the walls, and near the surface at that, it is the part of wisdom to let it alone, and trust entirely to expectant measures. Taking such steps as are feasible to arrest hæmorrhage if it occurs, to combat inflammation, whether of the peritoneum or other parts, and should the patient survive the immediate effects of the accident, open any abscesses that may form.

Under other circumstances, the foreign body being near the surface, and plainly discernable, we must first consider what additional

visceral lesion will be inflicted if it is cut down upon, and if such an operation would in any way place the sufferer in additional danger. When we remember that the accident itself is almost certain to cause death, we may feel justified in attempting operative measures under circumstances peculiarly favorable. What these circumstances are cannot be foretold or anticipated in a hypothetical case. Each case will be one for special study, and the surgeon must decide the question on his own responsibility, or by calling in competant counsel and advice.

(*b.*) Foreign bodies entered through the various outlets, are essentially of the same character and same significance, as when entering through the parieties. Inasmuch as the objects found in these situations are oftener used for erotic purposes by masturbators, or instruments for catheterism, or for purposes of procuring abortion, they are usually long and somewhat slender, embracing such objects as knitting needles, pencils, pieces of catheter, uterine sounds, and other articles, which have oftener pierced the parts, as the uterus, bladder, or urethra, and inflict very serious injury. The prognosis is based upon the extent of peritoneal lesion, and the injury done to the organs through which it has passed, with more particular reference to hæmorrhage. In other respects the condition may be considered analogous to that last considered.

(*c.*) Foreign bodies in the intestinal canal, must be studied more with reference to their characters than to location. Smooth, oval, spherical, or regular bodies, regular in outline, will usually pass through the canal in from twelve to thirty-six hours, unless too small, as cherry stones or some kinds of seeds, which are very apt to be arrested in some of the rugosities of the canal, at the ileo-cœcal valve, in the vermiform appendix, or the sigmoid flexure of the colon. Smaller bodies are often retained in the folds of the rectum or anus, and are very often provocative of inflammation, followed by abscess and perforation of the intestine. In the colon, either near the origin, or at the sigmoid flexure, if the inflammation is at all chronic in character, cases have occurred in which the intestine has contracted adhesions to the parieties, the abscess has opened externally, and a fistula formed. Rectal fistulæ are also frequently produced by similar processes in the anus or rectum. If adhesion fails to occur, the sufferer is in great danger of perforation of the intestine, with escape of the contents into the peritoneal cavity, and certain death. In some instances the suppuration is very chronic in character, the foreign body becoming ultimately loosened and carried away, recovery then ensuing unless some dyscrasia operates to keep up the morbid action.

The most dangerous consequences, at least to immediate loss of life, is when pointed, or irregularly shaped bodies are engaged in the canal, such as needles, knife blades, false teeth, etc. They produce serious lesions as soon as lodged, rapid ulceration, or even positive laceration of the parts, and rapid death from escape of the intestinal contents.

Equally dangerous, although operating more slowly, is the accumulation of indigestible substances, either in the stomach or other portions of the canal. Probably one prominent element of danger is the slow chronic nature of the difficulty, the symptoms closely resembling ordinary indigestion, and not attracting attention until they become so violent that there can be no doubt that serious mischief has been inflicted.

The *symptoms* depend entirely upon the nature of the foreign material. When acute in character, that is immediately succeeding lodgment, there is usually pain, more or less severe, distinctly located at the seat of lodgment. In spare persons, and when the foreign body is of some size, it is sometimes possible to feel it from the outside, or it may be recognized by sight alone from the pushing out of the parieties. The body being pointed, sharp, or of irregular shape, particularly when metalic, the pain will be very severe, and definitely located. When the accumulation is slow, if lodged in the stomach, the symptoms will be those of indigestion, gradually increasing in severity, and usually for a long time will baffle the diagnostic skill of the surgeon. The symptoms will finally simulate carcinoma, or some tumor formation, and I know of no method of examination that promises accuracy in the conclusions reached. It would seem that the history of the case is the only guide to a correct understanding.

The *prognosis* depends upon the time elapsing since the admission of the foreign body, its nature, and the point of lodgment. In recent cases, where a surgeon is called in at once, if the body is not too large to pass the ilio-cœcal valve, is not sharp pointed, or very irregular in shape, the prognosis is good. It is less so, under different circumstances, as where it has become engaged at one point, been in position for some hours or days, is too large to pass the ileo-cœcal opening, or sharp pointed, or irregular in shape. When it is the result of slow accumulations in the stomach, cœcum, sigmoid flexure, or near the termination of the ileum, particularly where inflammation, suppuration, or ulceration has commenced, the prognosis is not only bad, but a recovery may properly be considered impossible, unless under very exceptional circumstances. True, musket balls, or other foreign material of even more unfavorable composition, have become encysted, or induced the formation of fistulæ, even passed out with the stool, and life has been preserved, the injured person dying years afterward from other conditions unconnected, apparently with the foreign body. Such occurrences are exceedingly rare, however, and are the result of causes originating in accident or vital processes beyond the control of art, and should have little if any weight in establishing prognosis.

Treatment is largely expectant. As a rule when a child swallows some foreign body, says MR. POLLOCK (HOLMES *Surg.*) the mother gives a dose of castor oil, or some other cathartic, and *then* sends for the surgeon. This is the very worst practice possible. The indication, particularly in the case of material that is capable of passing

through and out of the intestines, is to promote solidity of the fæces, that the foreign body may become imbedded in it, possibly, and thus carried out with the stool. The violent peristalsis caused by cathartics, must at once have a tendency to fix the body, particularly if sharp pointed, in some part of the mucous surface, and the fluid character of the dejections will fail to dislodge it, except under somewhat peculiar and perhaps accidental circumstances.

In the case of large bodies engaged in the canal, a question of extraction by abdominal incision may be entertained. Such cases are hopelessly fatal, as a rule; very rarely adhesions may form to the parieties, and a fistula be established. The operation, on the other hand, is one of the most formidable character, and hardly less fatal than the accident itself. The surgeon is thus placed in a highly embarrassing position. It might be said that when the foreign body can be felt or seen through the walls of the abdomen, or its location accurately pointed out by the subjective symptoms, if it can be easily reached, without going through a very prolonged search, the case may be fairly presented to the parties intrusted, the patient and friends, and the operation be performed or declined on their decision. If attempted, every precaution must be taken to have it at once understood that the operator assumes no responsibility, and it is only attempted as a last resort.

Full details will be given in a later work in this series (*Surgical Operations*,) at this time it is only necessary to give a few general hints. The great danger is in effusion of the contents of the intestine into the peritoneum, and injury done this membrane by the manipulations necessitated by the operation. The preliminary incision should be in the direction that exposes the muscles and blood vessels to the least injury, and as deep as possible without opening the peritoneum. The remaining layers are to be carefully opened on a director, to the full extent of the integumentary wound. The viscus containing the foreign body is to be drawn out through the wound, if possibly entirely outside of the abdomen to a convenient extent, and cautiously opened. The impaction being complete, there is manifestly a damming up of the contents on the proximal side of the foreign body, which might escape into the peritoneal cavity if the part were opened inside the abdomen. The foreign body being extracted, treat the case as an ordinary wound of the viscus, either closing it, or forming an artificial anus as the circumstances may seem to require.

After treatment must be conducted with a view to prevent peritonitis, or modify it if occurring, which will often be secured by the aid of *Acon.* or *Arnica.*

XXV. INJURIES OF THE PELVIS.

A systematic treatise on the accidents to which the pelvis and its contents are liable, must necessarily include much that, under other circumstances, would be more appropriately referred to in other chapters. Properly speaking, lesions of the uterus, ovaries, vagina, urethra, rectum, bladder, ureters, muscles, both external and internal to the pelvis, with the blood vessels, and other contiguous structures, should be considered in a systematic treatise. In the present instance, however, in view of the fact that other chapters considered traumatic conditions affecting the intestines, and in those to come the genitalia, and muscles associated with the pelvis and lower extremities will receive full attention, at this time I will take up lesions of the bladder and ureters, and fractures and dislocations of the pelvic bones.

I. INJURIES OF THE BLADDER AND URETERS.

The injuries of the urinary organs contained within the pelvic cavity, are lacerations, wounds, and the entrance of foreign bodies.

1. The BLADDER, perhaps with greater frequency among men, is exposed to many forms of injury, resulting for the most part in laceration, or some perforating lesion, constituting an accident of the most extreme gravity.

(*a.*) *Contusion and Concussion* of the bladder, produced by blows in that region, particularly when the bladder is only partly distended with urine, is an accident of infrequent occurrence. The bladder being quite movable, to a certain extent, it is quite effectually protected from the consequence of ordinary jars and contusion, so much so that a lesion from such a cause must be an exceedingly exceptional occurrence. It would be much easier to produce laceration than simple contusion, whilst concussion, to a limited extent, might be far more certain. The two conditions are mentioned together, in this place, from the fact that the symptoms are very similar, so much so that it is a matter of exceeding difficulty to differentiate, in a large majority of instances, notwithstanding the remote consequences may be quite dissimilar.

A sudden, sharp blow, or a fall from a considerable height, would be more likely to produce a concussion than a bruise, although both conditions may exist. A severe compressing injury, as a heavy blow

in the pelvic region, particularly if there is a resisting body applied to the back, as when the wheel of a wagon passes over the body, will produce contusion or laceration. A reference to causation may thus enable the surgeon to distinguish between concussion or contusion; at all events to estimate the probabilities.

Under either circumstances, the *symptoms* will be as follows: retention of urine, and pain in the region of the bladder. In the case of concussion, the pain will not be quite so prominent or continuous as when contusion has occurred. In concussion, also, there will be little if any desire to evacuate the bladder, and the surgeon may not suspect retention until his attention is called to the pelvic swelling and a catheter is introduced. There is a paralytic condition, which is usually of short duration, if the urine is not allowed to accumulate in great quantities.

In *contusion* there may be a paralytic state of the bladder, but it is not usual or very marked. The contractility remains, but the pain produced by attempting to expel the urine, obliges the sufferer to desist, the urine accumulates, and the bladder becoming over-distended, there may be an atonic condition induced thereby. Moreover, in cases of contusion, there is often some ecchymosis of the parts over the bladder, or other evidences of mechanical injury.

The *prognosis*, in cases of contusion, depends entirely upon the nature and extent of the lesion. In the large majority of instances, a perfect cure may be confidently predicted. When, however, the contusion is severe, and a fold or small portion of the bladder has been severely squeezed, it may become devitalized, the part slough, and the patient exposed to urinary extravasation and consequent death. In some rare instances it is possible that adhesions may form between the parieties and the bladder, and effusion prevented. The fact that the pain gradually subsides, the contractility of the bladder becomes restored, and the urinary excretion is free, and copious, must be interpreted as favorable indications, and recovery is quite certain. On the other hand, the subsidence of pain, with continued atony, and scanty excretion, with symptoms of uræmic poisoning, will be indicative of perforation of the bladder, or progressing disintegration, and renders the prognosis consequently grave.

Whilst perforation, and consequent urinary infiltration is generally a fatal occurrence, yet it is not uniformly so, as circumstances may favor a circumscribed abscess, which may discharge externally, and form a fistula. This will be returned to, in a later paragraph, but at this time the fact may be noticed, and encouragement given to practitioners to continue to treat the case to the end, a fortunate conclusion being possible now and then.

Concussion of the bladder may usually be pronounced curable, unless the sufferer is of advanced age, or one of dissipated habits. The most frequent of the unfortunate results is in more or less per-

manent paralysis, partly from atony, the result depending, to some considerable extent, upon the promptitude with which a diagnosis is made, and the bladder emptied. In subjects predisposed, either by age or habit, to visceral lesions, the neglect to empty the bladder within the first forty-eight hours after the accident, may result in permanent impairment of the function of the organ.

Treatment, in both contusion and concussion, is practically the same. As a preliminary, the bladder must be emptied at once, and either kept empty by retaining a catheter, or drawing the urine as often as once in four hours. This will avert the danger of atony, in cases of concussion, and lessen the danger of perforation, in cases of contusion, by relieving the tension, and consequent disposition to devitalization.

Arnica, is the remedy first indicated, in both conditions, which should be persevered in until all danger of paralysis or perforation has passed. After a reasonable time, varying with the violence of the accident from twenty-four to forty-eight hours, if no manifest improvement occurs, the treatment must be changed with reference to the nature of the accident. Thus in cases of contusion, perforation being the most prominent danger, *Arsen.*, *Lach.* or *Calc.* must be used, as the symptoms indicate, the first named usually taking the lead. In cases of concussion, *Nux vom.* or *Sulph.* will be more or less prominently indicated, paralysis being the probable danger.

Perforation and extravasation having occurred, the case must be treated on different principles, which will be considered in a later paragraph.

(*b.*) *Rupture of the Bladder*, is one of the most alarming accidents to which man is exposed, next in fatality, probably, to rupture of the intestines. Out of fifty examples collected by Mr. BIRKETT, only three were known to have recovered, and in one of these the diagnosis was not by any means conclusively established.

The causes are always, in the absence of lesions extending from near parts, severe concussion or contusion, when the bladder is overdistended, in most of the instances recorded the patient being intoxicated at the time of the accident. Post mortem examinations have shown that the rent is usually on the posterior surface, extending from the urachus downwards, and not infrequently involving the peritoneum. In some rare cases, it has occurred anteriorily, but the recti muscles, and the strong fascia on the front of the abdomen, protects the viscus from the effects of direct injury to a very considerable extent.

The *symptoms* are sudden pain in the region of the bladder, with constant and distressing desire to urinate, the urine being scanty, and bloody. There is extreme collapse, the surface being cold and clammy, the mouth dry, tormenting thirst, and a burning pungent heat in the pelvis, gradually extending throughout the abdomen. In a short space of time, peritonitis will become general, the abdomen distended

and hard, and exquisitely sensitive to touch and pressure. The symptoms are so pronounced in character, that when taken in connection with the nature of the accident, there can be little doubt in the diagnosis.

The *prognosis* is at all times very unfavorable, as has already been intimated. With rupture of the posterior wall of the bladder, I consider hope of recovery to be utterly vain, although one such case is mentioned. Of the three instances of recovery noted above, two of them suffered anterior laceration thereby avoiding peritonitis. Where life is spared we must expect pelvic cellulitis, abscess in some portion of the region, with fistulæ at a point only to be determined by the circumstances of the case.

Treatment must be prompt, the almost certainty of death should not induce us to relax our efforts. The indications are first to prevent urinary extravasation continuing, next to combat and anticipate the almost certain advent of peritonitis, finally, if suppuration ensues, to promote its early evacuation.

Peritonitis cannot be avoided if there is escape of urine into the cavity of that sac. Until symptoms of this complication arise, it will be impossible to determine whether the laceration is posterior or anterior. Fortunately, as far as diagnosis is concerned, peritoneal inflammation will not be long delayed; in the majority of instances it will be fully established by the time the surgeon reaches the scene of the accident. To meet the condition, I know of no remedy that promises more than *Aconite* or *Rhus*, the indications being quite similar in general. The remedy should be given in repeated doses, say once in fifteen or twenty minutes, until some effect is produced, when the intervals may be lengthened. Warm application to the abdomen should not be omitted, and in spite of the well founded objection entertained to topical medication, I feel warranted in urging the employment of irritating applications. A little mustard, or even salt, may answer every purpose. The etiology of the case, however, does not warrant the expectation, or even hope, that treatment will influence the progress of the inflammation, the urinary secretion having particularly unfavorable effects on the peritoneal membrane, perhaps in excess of anything else in the way of normal secretions, to all of which this sensitive tissue very quickly responds. Nevertheless it would be utterly unpardonable to omit any means that might, by even the most remote possibility, promise some success.

Urinary extravasation occurs at once, as a matter of course, and whatever damage results from contact of urine with tissues intolerant of it, is at once accomplished. There is a hope, in the early moments of the accident, that it may be extravasated into the pelvic cavity, external to the peritoneum; but even if the reverse proves to be the case, there is an imperative necessity for preventing any further extravasation. The means by which this may be attained are many and various. The first indication is to keep the bladder con-

tracted and empty, thus keeping the edges of the rent in something approaching apposition, placing the parts in a position conducive to repair. The reaccumulation of urine is to be combatted by attention to the food, and frequent evacuations of the bladder. Under no circumstances must the patient be allowed to attempt micturition; as the danger is great that the edges of the rent may be partially torn asunder, if some attempt at repair is made, or, in any case, there is far greater probability that the urine will escape by the rent than the urethra. Feed sparingly; in fact deny all food, until twenty-four hours has passed, and then administer it in quantities just sufficient to maintain life, which will have the effect to lessen the formation of urine. The tormenting thirst, however, may be allayed by administering ice, broken into small fragments. There will naturally be a small amount of urine, due to the shock, collapse, and local disturbance, and there need not be much fear of a great accumulation,

The question will arise, shall the urine be evacuated by frequent catheterization, or shall an attempt be made to keep the catheter in the bladder. The answer must be left for each practitioner to decide for himself as occasion arises, as there are many cases in which the instrument is passed through the rent into the peritoneal cavity, and more danger results, or quite as much, as if the urine were allowed to collect. If it appears that the instrument can be made to remain just within the neck of the bladder, and is not in danger of going through the laceration, it will be proper to retain a catheter; under other circumstances, the urine had better be withdrawn once in four hours, at least. Some surgeons have proposed, in all cases of laceration, whether pelvic or peritoneal, to open the bladder by perineal section, as for lithotomy, keeping the wound open. I am not aware what degree of success attends the operation, knowing of no reports of cases in which it has been tried; it appears to be a recommendation not based on clinical experience. Should the case survive the primary conditions, the patient must be unremittingly watched for at least fourteen days, after which time there will be a fair presumption that the rent has healed, and the patient be allowed to empty the bladder naturally.

Suppuration may occur in any case that survives the primary conditions, more particularly when the extravasation has been pelvic. It will be announced by the customary signs, rigors, throbbing pains, etc., and it will at once demand a careful and minute search for the point of collection, and immediate evacuation. The perineum, the rectum, and in the case of women, the vagina, must be thoroughly explored, and suspiciously fluctuating points be examined with the exploring needle, trocar, or aspirator. Pus being found, it must be completely evacuated. If the sac fills up again, shortly, it must be again emptied. Should there be no indications of an attempt at immediate closure, the wound may be kept open, a fistula established, and *Calc. phos.* 6x, given four times a day, until some signs of

a subsidence of the process appears. The fistula is then to be closed, by proper methods, often by an operation of a major character, which will receive attention at the proper time. There being evidences of an attempt at repair after one or two emptyings of the pyogenic sac, the process may be hastened by injecting a weak solution of *Iodine*, about in the proportion of one to ten, as in the case of the old operations for hydrocele.

During all these procedures, whilst it is imperative that the diet must be carefully regulated so that it is just sufficient to sustain life, it is equally essential that the vital powers are not allowed to fail from too little nourishment. It is a nice question to solve, and one that must engage the serious attention of the surgeon.

(c.) *Wounds of the Bladder*, whilst sufficiently fatal, are less so than lacerations, notwithstanding there is usually much associated injury, as wounds of the parieties, fracture of the pelvis, and frequently opening of blood vessels of size. In the records of the war department, we find one hundred and eighty-three cases of shot wound of the bladder, with only a loss of ninety-six, or a ratio of 52.5. It is true in very few was recovery perfect, some functional difficulty remaining; in some cases life was ultimately lost, after years of suffering. The fatal results, in all cases of which we have reports in detail, was due to peritoneal lesions, chiefly from the extravasation of urine. In many that recovered, the urine had been extravasated into the pelvic cavity, with consequent diffuse suppuration, and ultimate fistulæ. The remarkable results, however, are not to be attributed to greater skill of army surgeons; it is shown by the records, as in the case of intestinal lesion, that the existence of an external wound was of benefit to the patient, as its situation was such that the urine flowed freely out, thus avoiding collections of this fluid within the cavity of the peritoneum. A single drop of urine in the peritoneal sac, would undoubtedly cause a more or less violent peritonitis, but not as dangerous as when a large quantity was extravasated, incapable of being removed, and constantly receiving fresh additions.

The symptoms, prognosis, and treatment, are to be conducted upon the same general principles laid down for the treatment of visceral lesions of the abdomen in general. There is a single item of interest, peculiar to wounds of this viscus, that must be adverted to in addition.

A urinary fistulæ may form, at the wound, *either of entrance or of exit*, and which will occasionally remain open indefinitely, in some cases most of the urine passing by this unnatural channel. The impossibility of controlling the urinary discharge, from the absence of detrusor muscles, permits a constant dribbling of urine, which not only keeps the parts with which it comes into contact excoriated, and sore, but imparts a urinous odor to the whole person. From every point of view it is essential that this opening should be closed, provided there is no impediment to the passage of urine by the natural channels. The urethra being closed, or the natural flow of urine

obstructed by other means, the restoration of the natural channel wil usually cause fistula to close, or at all events is an essential preliminary step. This will require consideration by works on operative surgery, being decidedly an operation of the first magnitude in some instances. The passage to the bladder being open, the patient must be compelled to attempt voiding urine by it constantly; the fistula must be covered with a pad, and the flow of urine through it arrested. The cessation of the passage of urine through the fistula will usually leave it in a condition favorable to a cure; if it does *not* close, after the urine has become diverted into its proper channel, it must be closed by an operation. The sides of the fissure may be destroyed by caustic applications, or scarified with a fine tenotome, and dressed with a compress and firm bandage.

(*d.*) *Foreign bodies in the Bladder* are not uncommon, and are of very great variety, both with reference to their character, and their mode of entrance. They may consist of pieces of bone, driven in by gunshot lesions of the pelvis; of shreds of clothing, pieces of buttons, etc., from the same cause; bullets, or pieces of other weapons; pieces of catheters broken off in the bladder; articles of various kinds introduced for many questionable purposes. The mode of entrance may be through the urethra, through the rectum or vagina, through the parieties of the abdomen, or by ulcerative absorption when lying in contact with the bladder for some time.

The *symptoms* produced, depend very largely upon the nature of the foreign material. When long and pointed, there will be local pain, pain at once referred to the introduction of some foreign body. When smaller, the symptoms will be very similar to those of stone in the bladder, *viz.*, weight in the perineum, rolling in the bladder, more or less pain in the tip of the glans, or in the testes; bloody urine, and frequent micturition.

The *prognosis* depends upon the nature of the body. When sharp and pointed, the bladder may be wounded, urine extravasated, and fatal peritonitis ensue. When soluble, it may be dissolved, and expelled in the urine, or when partially dissolved it may become encrusted with phosphates or other urinary salts, and become a veritable vesical calculus. Musket balls, fragments of shell, pieces of bone, or other solid substances have often become encrusted by urinary salts, and assume all the characters, and cause all the symptoms of urinary stone from other causes.

The *treatment* is precisely as if we had a case of stone to deal with. Extracted by the urethra when small enough to pass that canal; when of different characters, it must be removed by perineal or hypogastric incision, according to circumstances; taking the same steps, and practicing the same precautions as in an operation for stone. For this reason, the reader is referred to works on operative surgery.

II. INJURIES OF THE URETERS.

As a result of severe concussion, occasionally from direct injury, the ureters may be torn, or they may become wounded in various

ways. The accident is one quite rare, fortunately, and is so similar in symptoms and results that it is almost impossible to distinguish it from laceration of the bladder. As compared to vesical lesions, the indications are purely negative. Thus there will be all the signs of urinary extravasation, but there are no symptoms of rupture of the bladder. The absence of blood in the urine, unless the bladder partakes in the injury, and freedom of micturition, will usually serve to make out a diagnosis.

Beyond recognition of the accident, there is little of interest attached to it, the result being almost certainly in death. There have been recoveries, by suppuration and fistulæ, but the continued peritoneal activity of the kidney prevents the arrest of the extravasation by any means short of nephrectomy, an operation of too much magnitude to be lightly undertaken. If life is not immediately imperilled, from severe peritonitis, it might be proper to consider the propriety of such an operation. No advice can be given on this point; each surgeon must be the judge of the indications, the circumstances as they are presented controlling his judgment.

III. FRACTURES OF THE PELVIS.

The bones of the pelvis, for surgical purposes, are the innominate, the sacrum, and the cocyx. Anatomically, up to the period of consolidation, we might consider the ileum, ischium, and pubis, separate bones; but as there is practical utility in considering fractures in one or the other portion of what is essentially a single bone (as in fact the lesion will rarely be confined to a single portion), it seems more rational to adopt a classification like that above.

The pelvis, at once from the strength of the bones entering its composition, and their protection by thick layers of large muscles, can only be injured by the exertion of extreme force, which operates to make fracture rather an infrequent occurrence. For the same reason, when injury is inflicted on the bones, the accident is a grave one, the force with which it is accomplished communicating almost certain injury to the organs contained within the cavity. This is particularly true of simple fractures as they occur in civil practice. In military practice, shot perforation forms by far the largest proportion of fractures, and we find the results are remarkably favorable. Thus in TABLE IX, (*Med. and Surg. Hist. of the War*, Pt. 2, *Surg. Vol.* p. 423) the results are given as follows:

INJURY,	CASES.	RECOV'D.	DIED.	UNKNOWN
Shot Fractures	1494	918	544	32
Punctured and Incised Wounds	15	12	3	
Penetration, but no known Visceral lesion.	38	25	13	
Shot Wounds of Bladder	185	89	96	
" " Prostate	8	4	4	
" " Rectum	103	59	44	
Wounds Nerves and Vessels	179	94	85	
AGGREGATE	2022	1201	789	32

From this somewhat imperfect analysis, it can be inferred that the mortality was in direct proportion to visceral injury. Thus there were reported of cases in which no visceral lesion is mentioned, 1547 cases, furnishing 560 deaths, or more than one third. Of cases in which such lesions were recognized, there were 495, with a mortality of 229, or nearly half. This, however, does not include the serious disability often surrounding pelvic fractures, from injury done the viscera. Such complications as chronic abscess, urinary fistulæ, and aneurism, have occurred in my own experience, and, I doubt not, to a far larger extent, in that of practitioners with wider opportunity for study.

(*a.*) *Fractures of the Innominate* are for the most part produced by extreme violence, such as falls from a height, or the passage of a cart wheel across the pelvis. There are a number of minor fractures, such as the separation of the anterior superior spinous process, or the rim of the acetabulum, that are occasionally produced by slighter and indirect violence. The latter, however, will be more appropriately considered, in connection with dislocations of the hip, with which it is very frequently associated. The separation of the spinous process, always by direct violence, is quite easily recognized, its prominent position, facility of examination, and mobility easily detected forbids error, unless under very exceptional circumstances.

Considering the os innominata as a single bone, we rarely find fracture confined to one portion of it. In some few instances in which falls on the feet have driven the head of the femur through the floor of the acetabulum, the lines of fracture have been found to radiate from the point of injury along the line of union between the original divisions of the bone, that is the ileum, ischium, and pubis. So also, even in the case of young children, those in whom the bones have not become firmly united, a fracture in one division rarely fails to extend over into another.

Excluding gun-shot injuries, the force necessary to produce a fracture of the pelvic bones, protected from ordinary violence as they are, must be so great that some injury is usually communicated to the pelvic viscera. The associated injury may be caused by spiculæ of bone driven into the various organs, crushing from the severe compression, concussion from the jar of a fall, or contusion from a sharp blow. The lesion will under all circumstances greatly add to the gravity of the accident, perhaps the greatest danger being from urinary extravasation, or hæmorrhage. Indeed it would seem that the fracture itself is the least important in the group of lesions, at least as far as menace to life is concerned. The symptoms of visceral lesion are precisely the same as when occurring from other causes, perhaps in cases slightly modified by the injury to the bones.

The *symptoms* of fracture of the innominate bones, depend somewhat upon the seat. Thus when the spinous process is separated, there will rarely be displacement, the abdominal muscles holding the

fragment in position. Should the injury be of sufficient severity to detach the muscles, there may be displacement inward. There will be pain at the seat of fracture, marked mobility, and crepitus is quite readily elicited.

The fracture at some other point, if complete, the symptoms are pronounced, yet if the case is not seen until swelling has become established there may be a risk of confounding the fracture with some spinal lesion. There will be great pain in the pelvis, quite generally distributed, as long as no attempt is made to move the body or part; the slightest motion of the hip, however, will cause a sharp pain at the seat of fracture. Motion is almost impossible, partly from the pain the attempt causes, and partly from the loss of support of the muscular attachments. Applying one hand on each hip and pressing them together, will give crepitus and mobility, if the fracture is complete. Should there be much displacement the diagnosis will be easy. The greatest difficulty is experienced when the fracture is incomplete, stellate, or in the acetabulum. As in the case of the cranial bones, and flat bones generally, the inner table may be splintered without much if any obvious injury to the outer plate, and the most serious injury inflicted on the neighboring soft parts without the surgeon being able to detect it. In such cases it is easy to mistake the condition, the diagnosis being a mere conjecture based upon the history of the accident, and such symptoms of bone lesion as can be elicited.

The comparatively superficial position of the pubic portions of the innominata, renders the recognition of fracture usually easy. The spermatic cord and femoral vessels and nerves are much exposed to injury; in all cases of fracture from direct violence, therefore, these organs must be carefully looked to.

The ischii are not often broken by direct violence, being somewhat protected, by their situation, from such influences. Not infrequently, however, they are fractured by extension from other portions of the bone. Their relation to the sciatic and ischiatic vessels and nerves, renders a fracture in their neighborhood a matter demanding the closest attention of the surgeon. In the case of fracture of either of these two latter divisions of the bone, the ordinary signs of fracture are easily recognized, and the existence of any symptoms of nerve lesion would much facilitate the location of the fracture in cases of doubt.

The *prognosis*, as far as the mere fracture is concerned, is good if the general health of the patient is unimpared. There are many instances of extensive comminuted fracture consolidating perfectly, and the patient living years afterwards with little if any impairment of bodily function. The existence of visceral lesion, and the detachment of spiculæ of bone, will greatly influence the prognosis. In the first instance the probabilities are the same as if no fracture existed, and have been fully considered in previous chapters. In the case of detached spiculæ of bone, suppuration and fistula is to be apprehended,

or perforation of the bladder, rectum, or vagina by ulcerative absorption. In a case under my care two years ago, there was a comminuted fracture of the pelvis, from the fall of a tree, with two urinary fistulæ in the perineum, and months afterward the discharge of a spicula of bone from the rectum.

Treatment.—Visceral lesions are to be treated as already laid down. The fractured bones are to be placed as nearly in apposition as possible, the patient placed in such a position that muscles are fully relaxed which might otherwise tend to draw the fragments asunder; and the part securely bandaged, or encircled with broad adhesive strips. Union is usually speedy, if other complications do not interrupt or delay the treatment.

(*b.*) *Fracture of the Sacrum* is an exceedingly rare accident. MALGAIGNE has records of eight, and HAMILTON states that he is unable to find any others. It may occur in one of two ways, either by extension of the fracture from other parts of the pelvis, or by direct injury. When the former is the case, few if any cases have recovered, more from the extent of the injury, involving many and various visceral lesions, than from the mere fact of fracture of the sacrum. When broken independantly of the other pelvic bones, the line of fracture is usually below the sacro-iliac symphysis, and recovery is usually prompt. Displacement is usually forward, but not often to a degree to interfere with the functions of the rectum, although one case is mentioned (BERMOND,) in which this passage was completely occluded.

The *symptoms*, in addition to those usual to fracture, are pain on sitting, motions of the pelvis, and during defecation. The lower end of the sacrum will be felt tilted forward, on rectal examination, but the fragment is quite movable. Occasionally, as probably occurred in the case of BERMOND, the displacement may be at the point of fracture, when either the whole fragment will be thrown forward, or the tip will be directed backward. Such cases are quite difficult to treat, at once from the possibility of non-union, and union with a degree of displacement that must seriously reduce the capacity of the rectum.

Treatment will usually be limited to placing the patient on the back, with a firm cushion under the sacrum, which will prevent the displacement forward of the end of the bone. If this is ineffectual, and the bone will not remain reduced, HAMILTON recommends that in place of packing the rectum with some material to act as an internal splint, that opium or dry food be used or some other means taken to secure perfect immobility of the bowels, the hard fæces acting the part of a splint perfectly. I should prefer to test the utility of adhesive strips first, by attaching one end over the extremity of the sacrum, and drawing it tense, fasten the other end above the sacro-iliac symphysis.

(*c.*) *Fracture of the Coccyx* is not easily distinguished from dislocations, and for all practical purposes there is no necessity for differentiation. They are usually produced by kicks, or falls on the bone

although there are cases reported in which it is alleged to have occurred during child birth.

The *symptoms* are similar to those of fracture of the sacrum, perhaps slightly less pain in general, but more on defecation, and when sitting. The mobility of the part is so great that non-union is the rule, or at least of frequent occurrence, and coccyodynia is a common concomitant.

The *treatment* is the same as for fracture of the sacrum.

IV. DISLOCATIONS OF THE PELVIC BONES.

The systematic works on fractures and dislocations, ignore the latter accident in connection with the pelvis, notwithstanding the articulation between the various bones is not a whit more intimate than occurs between the clavicle and the sternum or scapula. It is true that the sacro coccygeal articulation is the only joint that has a capsular ligament, or is endowed with any degree of motion, but the ilio-pubic, and sacro-iliac symphyses, are not destitute of other characters, being provided with ligaments and cartilages, and in some cases a certain degree of mobility exists.

From the fact that the structures entering into the formation of the various articulations in the pelvis are of unusual strength, and the superincumbent parts are also unusually strong and disposed in thick layers, fracture will occur far more readily than dislocation; it will require a far greater exertion of force to produce a separation of the bones, than a fracture. As a matter of fact, dislocation is usually associated with fracture, either of the edges of the bone forming the joint, or as a complication of more extensive fracture.

The *symptoms* of dislocation, at the *sacro-iliac* or *ileo-pubic* articulations, are too obvious to need mention, it would seem. Differing from dislocations in general, in this respect, there will be noticeable mobility, and quite a wide separation of the bones. This latter is more particularly marked in the ileo-pubic form. There will generally be some crepitus, which should not cause suspicion of fracture preponderating; it is oftener caused by slight fracture of the articulating surfaces.

In the case of the *coccyx* the symptoms of fracture and dislocation are so similar that it is often impossible to distinguish one from the other; it is not necessary that a distinction should be made, for practical purposes, further than to estimate the prognosis, which is generally better in the case of fracture. I have had the privilege of seeing one case, in which the coccyx was thrown backwards, almost at right angles with the sacrum. A cure promptly followed upon reduction.

The *treatment* of these accidents presents few indications. The patient must be kept quiet, and the parts held firmly together by appropriate bandaging, or adhesive strips.

V. WOUNDS OF BLOOD VESSELS.

The blood vessels external to the pelvic cavity that may require ligature, and which have not received attention elsewhere, will properly claim attention in the chapter on injuries of the lower extremities.

Within the pelvis, or in close relation with it, the vessels are usually of large size, such as the iliacs, and while time is seldom allowed to take them up when wounded, yet there are cases on record in which shot perforations of the external iliac have occurred, and the surgeon had ample opportunity to expose the vessel, ligate it, and save the life of his patient. Furthermore, the large trunks in the pelvis may require ligature to arrest hæmorrhage in some of the branches lower

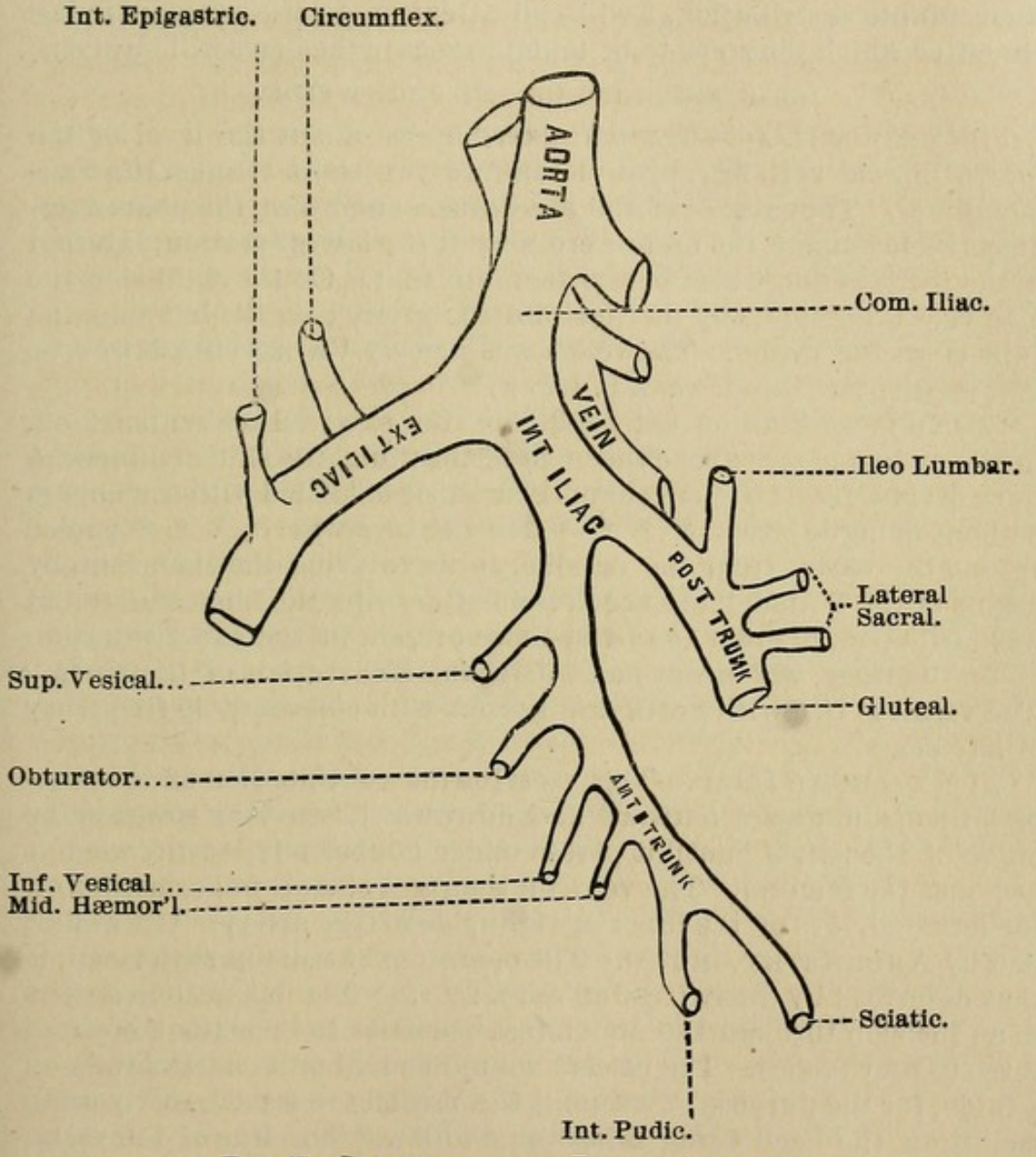


FIG. 47. DISTRIBUTION OF PELVIC ARTERIES.

down, and it is proper to refer to them at this time. It may be said, of the large vessels generally, that hæmorrhage *may* be controlled by the use of a spring compressor introduced into the rectum, the other blade over the lumbar or sacral region externally, as is quite the custom now, in operations on the lower extremity too high up to give room for tourniquet. It should only be employed, I think, as a temporary expedient, ligature being the only proper treatment.

The vessels that may require ligature, at least more frequently, are as follows: The common iliac, the internal and external iliac, with

the numerous branches given off from each. The sacra-media may be of a size to cause fatal hæmorrhage if wounded, but its situation renders it practically impossible to reach it, and being a branch of the aorta, there is nothing to be done, but to favor spontaneous coagulation, as in the case of large vessels in other cavities. Inasmuch as some of the vessels referred to have been spoken of in other chapters, and it is more important to know the source of these vessels than their minute distribution, I will call attention to the accompanying cut, after which the steps to be taken to secure the iliacs will be given.

ILIAC ARTERIES OF THE RIGHT SIDE.

(*a.*) COMMON ILIAC.—The aorta terminates about the level of the fourth lumbar vertebræ, by dividing into two short trunks, the common iliacs. They rest over the sacro-iliac symphyses, the psoas magnus muscle outside, the ureters crossing at the lowest portion, external to the peritoneum, which covers them in front. On the right side the iliac vein is outside, and then behind the artery; on the left side, the vein is on the inside. The vessel was tied by VALENTINE MOTT, as follows (SMITH *Operat. Surg.* p. 462):

"By an incision which extended from the external abdominal ring, to one or two inches above the crest of the ilium, the skin and muscles were divided, and the peritoneum cautiously detached with the fingers without being injured. * * * * The ligature was * * * * passed around the vessel from the outside, so as to avoid the iliac vein, by means of the Philadelphia needle, and after tying the knot, the wound was held open, in order to satisfy those present of the exact situation of the ligature, which was just below the bifurcation of the aorta." The vessel is tied with gratifying success with considerable frequency of late years.

(*b.*) EXTERNAL ILIAC.—This vessel is the continuation of the common iliac, and passes outward and downward, "curving towards the curve of the pelvis" until it passes under Pouparts ligament, when it becomes the femoral. The vein, on the right side, is underneath; on the left side, it is on the inner or right side of the artery. It was first tied by ABERNETHY, in 1796. The operation as usually performed, is thus described by SKEY (*Operat. Surg.* 256): "The operation consists in an incision through the abdominal parieties to the extent of from three to four inches. The patient should be laid quite horizontally on a table, for the purpose of keeping the muscles in a moderately tense condition, the head being raised on a pillow. The line of the vessel should * * * be marked out with ink. The integuments being divided to the above extent, commencing at the distance of four inches above Pouparts ligament, the stratum of fat and cellular tissue, which bears the name of superficial fascia, should be divided down to the level of the aponeurosis of the external oblique muscle. If in this division of the fascia, the superficial epigastric artery bleed freely, it should be tied, for much of the success of the after stages of the operation depends on the wound being kept clear of blood. The aponeurotic tendon of the external oblique should be cut asunder in the same

direction, continuing the incision downward, to within one inch of Pouparts ligament. To the same extent is the division of the internal oblique and transversalis muscles to be made, care being taken to leave untouched the spermatic cord, emerging below the lower border of these two muscles. The muscles should be fully divided *nearly* to the extent of the outer wound. The fascia transversalis is then brought into view, and should be carefully divided on a director, to the length of the division in the muscles. The peritoneum is now exposed. By easy manipulation, with a clean hand, and with the nails reduced, if necessary, to an ordinary length, and not projecting beyond the extremity of the fingers, the peritoneum is to be drawn inward from the iliac fossa, with the left hand for the artery of the left side, and *vice versa*, towards the mesial line of the abdomen, with the intestines enclosed within it. The psoas magnus is then brought into view, and upon its inner side lies the external iliac artery, advancing forward on its anterior surface. * * * * * With a silver or other blunt knife, the fascial sheath investing the artery should be divided at the part of the vessel around which it is intended to apply the ligature, the coats of the artery fully exposed to the eye, and the genito-crural, a very small nerve, avoided if in contact with it. The peritoneal bag may be held off the vessel on the left side, by the two fingers of the operator; if on the right by the application of a sufficiently broad retractor."

(c.) INTERNAL ILIAC.—The different steps of the operation to tie this vessel, are very obvious modifications of the last one, and will be sufficiently well understood by quoting the introductory remarks of Mr. SKEY (Ibid 251): "The internal iliac artery descends from the point of bifurcation of the external iliac along the walls of the pelvis. It diverges from the external iliac, at an angle of about 25°, and proceeds forward to the extent of about an inch before it yields any branches, of which the first is the ileo lumbar. The right artery lies in front of the corresponding vein, but the left crosses in front of the left *external* iliac vein, having on the right side the left internal vein immediately behind it. But many, yet large though lesser veins congregate around and empty themselves into it in this situation. The ureter on each side is placed internal, and a little posterior to it. Both arteries and veins are invested in a layer of the pelvic fascia, upon which is placed the peritoneum. If a line be drawn from the mesial line of the abdomen, half an inch below the umbilicus to Pouparts ligament, midway between the anterior superior spine of the ileum and the symphysis pubis, and the two upper inches of such line be allowed for the common iliac artery, a second line, drawn downward from this point, at an angle of about 25° with the first, nearly parallel to its fellow of the opposite side, will indicate with tolerable exactness, the course and direction of the internal iliac artery, with respect to the anterior wall of the abdomen."

These operations, as a matter of course, are among the decidedly major operations of surgery, but it seemed impossible to omit a brief description at this place, as accidental hæmorrhage will not afford much opportunity for study or delay.

XXVI. INJURIES OF THE LOWER EXTREMITIES.

The lower extremity is exposed to injury with equal frequency to the upper, and of pretty much the same character. What has been said, in an earlier chapter, of injuries of the upper extremity, applies with equal relevancy to those of the lower, the general principles of practice being the same, with the exception of fractures, dislocations, and injuries to the blood vessels and nerves, all of which require special treatment and consideration. Prognosis may be considered as somewhat different in the two regions, it being a quite generally admitted rule, in estimating importance of structural lesions, that important factors will be the size of the part, the source of its nutrition, and its functional importance. The lower extremities being larger than the upper, consequently supplied with a greater number of vessels and nerves, and correspondingly more complex in structure, injury will be more serious than under similar circumstances in the upper extremity. So, also, the greater distance from the centers or life and nutritive supply, must exercise an important influence upon repair of injury. Joined to considerations such as these, the fact that serious injury to the organs of locomotion must confine the sufferer more or less constantly to the recumbent posture, at all events must impede moving about, will sufficiently account for a difference in prognosis in favor of the upper extremity.

The relative frequency of accidents in the upper and lower limbs has never been definitely settled, but the presumption is that the upper suffer with greater frequency than the lower, whilst the lower are usually more serious, both on account of circumstances noted above, and that a greater degree of violence is usually inflicted.

I. FRACTURES.

The lower extremities present an extensive list of interesting forms of fracture, all of which can be included under the classification adapted in the chapter on *Injuries to the Upper Extremities*. The power of the muscles in this region, and the difficulty experienced in preserving immobility in the part, renders the question of treatment one of exceptional interest. As to the relative frequency of the fractures, compared to those of the upper extremity, statistics differ very widely. Mr. Holthouse (Holmes II,) thinks many of the hospital records are defective, as they only exhibit the number of in-patients, which

would be necessarily greater in fracture of the lower extremity than the upper, locomotion if not impossible being much restricted, preventing daily appearance as out-patients. With this view of the case he quotes the returns of MR. LONSDALE, of the Middlesex Hospital, in which both in and out cases are reported. The report shows that out of one thousand nine hundred and one fractures, treated between 1831 and 1837, there were seven hundred and sixty-four of the upper, and five hundred and sixteen of the lower extremity. In the Pennsylvania Hospital, between 1715 and 1838, eighteen hundred fractures were treated, nine hundred and one of the lower and five hundred and seventy-two of the upper extremities. MALGAIGNE, and other reporters give similar results, but the presumption is that Mr. HOLTHOUSE is correct in his summary, and the greater number of fractures occur in the upper extremity.

1. FRACTURE OF THE FEMUR.—In relation to other fractures, those of the femur, it is thought, stand about fifth in the order of frequency, in adults, and about second in childhood and infancy. We shall consider fracture as occurring at three points, viz., head, shaft, and lower extremity, or as intra-capsular, extra-capsular, of the shaft, and the condyles.

(*a.*) INTRA CAPSULAR FRACTURE of the neck of the femur, a somewhat rare form of injury, derives its interest principally from its occurrence in the old, or those beyond middle life; oftener being observed in women; the rarity with which bony union is effected, and the difficulty, at times, of arriving at a correct diagnosis.

Whilst the injury is unquestionably common to old age, yet there are several well authenticated instances of its occurrence in young people, even in childhood. It was supposed that such cases might prove to be a separation of the epiphyses, but actual inspection has shown that the line of fracture was often oblique, and extending much beyond the capsular insertion, thus constituting a true fracture.

Women suffer more than men, probably from the more acute angle of the neck to the shaft, as well as the slighter structure of the bone generally. I think in nearly all the cases in which this injury has been observed in those under middle life, women were the subjects, even the children were usually female.

Union by bony connection is very rare, so much so that some authorities deny the possibility of its occurrence. We have too many instances to the contrary to doubt the possibility of such an occurrence. A glance at the causes for this non-union will sufficiently account for its rarity. In the first place, the least disarrangement of the fragments must prevent union, aud the smooth globular head of the bone, when completely separated from the shaft makes it impossible to fix it in any position, save as it may be caught in some of the serrations of the fractured extremity. The least carelessness in manpulations to form a diagnosis may readily displace the fragments, which were before in a desirable position, and at once put the parts beyond the possibility of readjustment. Unlucky movements during

the healing process may work the same mischief. Again, the blood supply is chiefly derived from the capsular ligament, and the shaft of the bone, very limited supply being received through the round ligament. If the periosteum is untorn, or the fracture incomplete (which last is held to be almost impossible, by many competent observers), there is a better prospect of bony union. Added to these almost insurmountable obstacles, the usual age of the patient will operate as a retarding cause, both with reference to the impaired nutrition incident to age, and the intolerance of restraint and confinement. The absorbents of the part being equally defective with the blood supply, the effusion into the capsule of blood and the increased amount of synovia prevents perfect coaptation, as it is slowly absorbed. It can readily be seen that the opponents of the possibility of bony union have good ground for their incredulity, for as SIR ASTLEY COOPER truly remarks "it requires such a combination of favorable circumstances as is very rarely met with."

The diagnostic difficulties are not to be despised, as will appear when we reach that branch of the topic. It is one of the few instances in surgical practice, when we are debarred from making a thorough physical examination from the fear of disarranging fragments that cannot be restored to position, and which may be already in an unfavorable situation, only to be rendered worse by manipulation.

The *causes* of intracapsular fracture are to be considered as predisposing and exciting, the latter being often quite insignificant. Mr. HOLTHOUSE quotes from Mr. BRANSBY COOPER to show that the popular idea of a preponderance of the organic elements of bone in the aged being a predisposing condition of fracture is an error, as far as the neck of the femur is concerned. There is an alteration in nutrition that renders the cervix weak, but the *organic* elements are in excess, the cellular spaces being multiplied and enlarged, and filled with an oily matter, very similar to mollites ossium. The shaft of the bone does show an increasing preponderance of earthy salts, but not the neck, due probably to the conditions of nutrition at that point. COOPER'S experiments show "the average quantity" (of bone earths,) "in the necks of five middle aged bones was 50.1 per cent. in three old bones, 33.5, and in five old bones whose necks has been fractured it was only 23.9 per cent. The shaft of the same bones contained respectively 56.7; 55.5; and 50.1, per cent. of bone earth."

The exciting cause is usually a very trivial injury, such as slipping off a step or curb-stone, tripping on the carpet. Upon the occurrence of the break the injured party falls to the ground, falling in *consequence* of the fracture. Usually they are unable to raise themselves, and on attempting fall again; there are exceptional instances, however, in which they have attained their feet and walked some distance. The chief cause, therefore, is the condition of the parts, the senile atrophy, or partial fatty degeneration, which is also, probably the greatest obstacle to repair.

The *line of fracture* has been determined by RODET to depend very greatly upon the direction from which the fracturing force is received. MR. HOLTHOUSE finds the conclusions arrived at quite reliable, and others have still further confirmed them. Thus "a force acting vertically will produce an oblique intracapsular fracture; a force acting from before backwards, a transverse intracapsular fracture: one from behind forward, a fracture partly within and partly without the capsule; and a force applied transversely, a fracture entirely without the capsule." The terms oblique and transverse, as applied to fracture of the cervix femoris, refers to the prevailing direction of the line of separation, in most instances the line of the insertion of the capsular ligament being quite accurately followed.

The *symptoms* of intracapsular fracture are not usually pronounced, in the earlier stages at least, and are often readily mistaken for those of dislocation. They may be stated to be as usual in fractures, pain, swelling, deformity, and crepitus, each of them needing a few words of comment in the present instance.

Pain is not localized, or felt at the seat of fracture in the commencement, often it is not complained of during the first few hours, as long as quietude is preserved; the least attempt at motion causes pain, however, felt chiefly in the groin and inner side of the thigh, in the course of the crural nerve particularly. Pressure on the trochanter, or attempting to rotate the leg will cause more or less pain in the articulation, and later all pain will be referred to the seat of injury, as a starting point, streaming down the inside of the thigh, rarely extending below the knee. In some instances, particularly when nonunion is the case, the pain will continue as a sort of neuralgia for an indefinite period, perhaps through life; yet in most cases it disappears entirely after six or eight weeks.

Swelling occurs from effusion into the capsule, chiefly noticeable in the groin, which is also fuller than usual from the frequent rotation of the head of the bone so that the broken extremity of the neck presses on the anterior part of the capsular ligament. From the latter cause we would expect no swelling unless there was displacement of the fragments; when from effusion, it is not a primary symptom, coming on only after localization of the pain. The hip *may* be prominent, or even flattened, depending upon the existence of displacement, and the direction and extent. A person sustaining such a fracture, who is raised by bystanders without personal effort, placed at once on a bed, and seen early by a competent surgeon, may not suffer from displacement, and there will be no swelling; more particularly is this the case as there is little if any tendancy to inflammation as occurring in old people. Should the displacement be complete, upward and backward, the fractured end may be buried so deeply in the tissues back of the acetabulum, that the trochanter becomes less prominent, and the hip appear notably flattened.

Deformity, when it exists, is quite pathognomonic, yet as it is impor-

tant to recognize the accident early, and deformity quite frequently appears as a purely secondary symptom, it is of less value than usual in cases of fracture. It is entirely due to displacement, both in degree and direction. The usual deformity consists in shortening, and eversion of the foot.

Shortening occurs when there is upward displacement of the shaft, which is the only direction in which it can occur. There are cases in which there is no displacement in the earlier stages, or the first hours after the accident, either from the periosteum remaining intact, the interlocking of the serrated extremities of the fracture, or the temporary atony of the muscles from contusion. Later the displacement will occur suddenly, and shortening will be marked and readily made out. Measurements must be taken from the anterior superior spine of the ileum, to the external malleolus.

Eversion of the foot is an almost constant feature, in this form of accident, although there are occasional instances of inversion, more or less pronounced. Of the former there are many explanations offered, none of them, probably, covering the whole ground, In the first place the natural position of the extremity is partial eversion, as referring to the axis of the body, and the loss of resistance in the hip produces a simple exaggeration of the normal conditions. The powerful external rotators of the thigh, acting on an unnaturally movable joint, have a tendency to still further increase a predisposing deformity. HAMILTON (*Disl. and Fract.* p. 359), offers what seems the best explanation, as far as a single condition is concerned. The compact bony portion of the neck, is thin at *all* points, as compared to the shaft, but for special reasons is particularly so on the posterior aspect, the very portion, as far as this symptom is concerned, that *should* be the strongest. Referance to the diagram will show that the lamina divides just below the head, one plate extending downward obliquely,

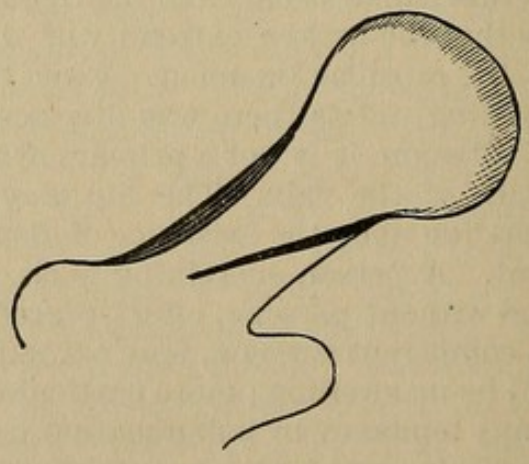


FIG 48. HEAD OF FERMUR.

and the other continued externally, greatly attenuated. The extreme tenuity of this plate reverses the usual order of things in fractures, and we find the point of compression gives way in preference to the

point of extension. As HAMILTON remarks: "This delicate papery wall easily gives way under the application of force, while the anterior wall yields only partially, constituting thus a sort of hinge upon which the rotation of the thigh is performed." For the same reason eversion is progressive, increasing day by day, up to a certain point, the delicate tissue yielding more and more as continual pressure is brought to bear upon it.

Inversion of the foot, often amounting to little more than a forward pointing of the toes, has never been witnessed by many eminent men, with ample experience; it has been met, however, although rarely. LANGSTAFF, GUTHRIE, STANLEY, CRUVIELHIER, and HAMILTON record single instances, while ROBERT SMITH has seen two. It is more difficult to account for than eversion. HOLTHOUSE inclines to the opinion, that in many cases the injury was received when the foot was strongly inverted, or the foot has been held fast while the body was rotated outward. BIGELOW, who has had the privelege of positive examination of such a case, states it to be "due to the extent of the comminution, which had separated the walls of the shaft so as to receive in the interval the whole neck, instead of the posterior wall only, as commonly occurs."

Crepitation, a certain sign when elicited, is often absent, or cannot be procured, but the absence does not by any means indicate non-fracture. The fractured bones remaining in more or less exact co-optation, crepitation should be readily elicited. But the danger of disturbing the relation of the parts will forbid persistent attempts, and the mobility of the smooth spherical head of the bone in the equally smooth acetabulum, may defeat the attempt for want of stability in the proximal fragment. For these reasons too much importance must not be attached to crepitation in this region, whatever may be said of it elsewhere, the diagnosis depending upon an intelligent view of the other symptoms, the history and presumption as to age.

The *pathology* of these fractures has been extensively studied by HAMILTON and others. It appears that the line of fracture, whilst following quite closely the line of the insertion of the capsular ligament, is more or less oblique. In the majority of instances it will be found extending beyond the ligament, externally, complete, with more or less separation of the fragments, the head rotated so that the broken extremity is directed upward or backward. The periosteum is torn across, and the capsule torn through at least on one side, often completely. In some very rare instances, the break has been found to be only partial, or even complete without any separation of the fragments. In other cases the serrations on the broken extremities have been so large, that the fragments remained literally dovetailed together, and displacement was impossible.

The *prognosis*, as already sufficiently indicated, is bad, both as to continuance of life, in some cases, and to future usefulness of the member. While, as said in an earlier paragraph, there may be a

fortuitous occurrence of circumstances that would favor a bony union of the fractured cervix, the rule is an utter failure. In some cases ligamentous union will occur; in others the torn ligament is repaired, and the functions of the joint are partially restored by a false joint between the fragments, the shorter one being hollowed out, and the longer rounded and eburnated to be received in the depression. The gait will be halting, as "if from a wooden leg," the member will become atrophied, and the muscles lose strength correspondingly.

The fracture occurring for the most part in the aged, it is impossible to keep them confined for a length of time sufficient to secure union, without the health suffering, or even placing them in danger of death. It is not the violence sustained that endangers life, but the low recuperative powers, and intolerance of confinement.

Treatment.—The unfavorable character of the prognosis should not for a moment deter the surgeon from attempts to secure union, particularly when the accident occurs in a young person. The examination must be made with great care and thoroughness, every precaution being had to secure against error, as well as to prevent doing mischief by the manipulations. First measure the limb carefully, and compare it with its fellow of the opposite side, taking care to have the hips square on the bed or table, and both legs drawn down as straight as possible. For this purpose the parts must be uncovered. Placing the fingers on the trochanter, and the thumb deep in the groin, keeping the leg still extended, have an assistant make very gentle traction, and rotate it slightly by the foot. The trochanter moving under the fingers, following the motions of the femur, if fracture exists, it is probably intra-capsular. Now shift the fingers above and behind the trochanter, still making pressure *deeply* with the thumb in the groin, rotate the leg again, very carefully and slightly, with a view to the elicitation of crepitus. Securing this the diagnosis is made out, but its absence, as already remarked, does not contraindicate fracture.

Fracture being made out, treat it as follows: In the absence of a proper fracture bed, a good hair, or "woven wire" mattress must be provided. The patient will rest in a far easier position if laid straight on the back, experience proving that in the long run any other position is soon rendered intolerable. The chief indication is to maintain utter immobility of the parts, for at least six weeks, if the confinement can be borne so long. The best apparatus has proved to be the simplest, and is as follows:

A FERGUSSON long splint is made, to reach from the axilla, to a foot or more below the sole of the foot. At the upper extremity an iron strap is attached, firmly with screws, which is bent up over the front of the shoulder, and bent again upward to the front, finished with a hook at the end. A well padded perineal band is attached by straps to the iron hook, for counter extension. The foot is attached to the foot board so as to overcome the eversion, but the extension must be very small. With flannel bandages attach the leg to the

splint, in three or four places, not drawing them too tight, simply enough so to keep the parts in position. If the confinement can be borne so long, after six weeks, remove the dressings, and re-examine. If no consolidation has occurred, it is proper to apply the dressings for three weeks longer. Upon the expiration of that time if there is still no union, it is idle to expect any, and all dressings may be removed. The patient must begin to exercise with a crutch, which may after a time be thrown aside for a cane, of course any prudent

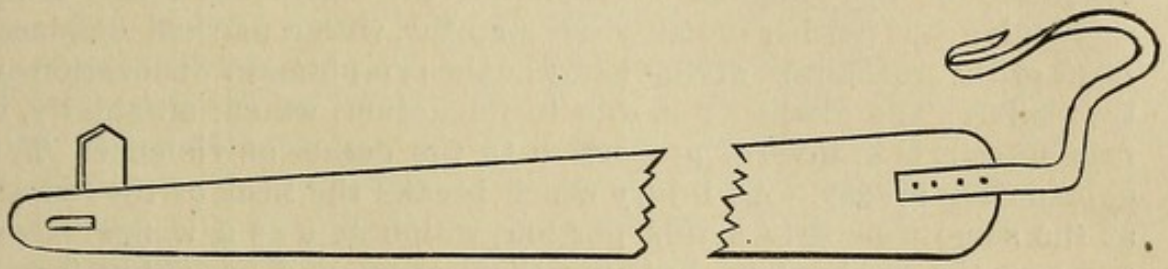


FIG. 49. FERGUSSON SPLINT.

practitioner will forestall any reflection upon his skill, by fully informing the patient at the commencement of the probable result.

(*b.*) EXTRA CAPSULAR FRACTURES, in some of our systematic works, is a term limited to fractures external to the capsular ligament, either chiefly or entirely, at all events largely confined to the neck of the bone. In the present instance, partly because it is a commonly received classification, and partly because a minute subdivision of the forms of fracture that may occur at this point is neither practical nor valuable, I shall consider extra-capsular fractures to be all those occurring in the upper epiphysis, whether extending into the capsular cavity or not.

As to *causation* a marked difference is at once manifest, viz., the injury is oftener from direct violence, greater in degree than in the intra-capsular forms ; there is much greater prominence in the local phenomena, and repair is not only more certain and speedy, but bony union is the rule rather than the exception.

In the majority of instances the injury is from direct violence, a blow received upon the trochanter; in some instances a fall upon the feet or knees has been causative, which may, occasionally, fracture the rim of the acetabulum, or even drive the head of the bone through the acetabulum into the pelvic cavity. This latter form is already referred to in a previous chapter, the former will be more particularly noticed when we come to speak of dislocations of the hip.

However produced, the pathology of the fracture is not uniform, occurring, for the most part in one of three forms. Thus the first, and least common, is one in which the bone is broken into two pieces, the direction being quite faithfully parallel to the inter-trochanteric line. I am of the opinion that this form is more common in elderly people, where the bone is more friable, than in the case of the younger.

The second form, and next in frequency, is confined chiefly to the

trochanter, which is either broken off from the shaft, in whole or in part, or comminuted. Whilst far from being common, this form is oftener met with than the preceding.

The third form, and one oftener occurring, is when the parts are broken into at least three fragments, one composed of the head and neck; a second of the trochanter, either in whole or part; and the shaft to which a portion of the trochanter usually remains attached.

This last form representing the more common form of the injury, accounts for the frequent obscurity of the diagnosis, there being shortening, but neither mobility nor crepitus, with a marked displacement of the trochanter, giving many of the symptoms of dislocation on the ileum. The obscurity is due to impaction, which, singularly, it may appear, is in inverse proportion to the degree of violence. The explanation is easy. An injury which breaks the neck of the femur, at the same time drives this portion, which acts as a wedge, down between the trochanters, splitting them apart, and becoming firmly wedged between them. If the violence has been greater, or the sufferer after falling attempts to rise and falls a second time (which MR. HOLTHOUSE considers the rule), either through the lever like action of the shaft of the femur, or the violence driving the wedge shaped neck deeper into the shaft, the trochanter is split off, and the separation of the bone becomes complete, separation into three parts.

The *symptoms* of the accident are quite similar to intra-capsular fracture, with some important constant modifications. There also will be many of the symptoms of dislocation, but with care there need be no confusion in diagnosis. Whether there is shortening or not will depend upon the degree of displacement, as a matter of course, which is in turn entirely dependent upon impaction. With impaction, there will be shortening, as a rule, but it will rarely be pronounced. In

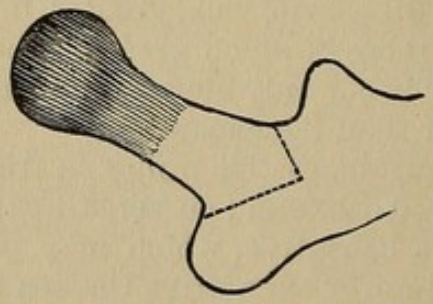


FIG. 50. LINE OF EXTRA-CAPSULAR FRACTURE.

some instances, not altogether infrequent, the fracture is somewhat triangular in form, as shown in the diagram, which will scarcely admit of displacement and shortening, unless new violence is inflicted and the trochanter split off.

The trochanter is always more prominent, whether detached from the shaft or not, is carried higher up towards the crest of the innominate, and on rotation of the leg is seen to move on a relatively shorter radius than the trochanter on the opposite side.

The leg is usually everted, as in the case of intra-capsular fracture,

although from somewhat different causes. Thus when the trochanter is separated from the shaft the external rotators lose the influence they might exert under other circumstances, and the eversion must be accounted for almost wholly by the natural tendency of the part to outward rotation being simply exaggerated. We occasionally meet cases in which inversion is marked, indeed quite frequently, and is at once recognized as the effort of muscular traction by the adductors and internal rotators, which are without opposition when the trochanter is separated.

Pain is more immediate and localized than in the case of intra-capsular fracture, because the injury is usually direct, and the parts injured are better nourished than the neck within the capsule. There is also some evidence of injury about the hip, as discoloration and bruising. In fact a severe contusion of the hip may simulate fracture to such a degree that it will require close and intelligent examination to differentiate.

Crepitation will be a certain sign, when joined to the other symptoms, but is never readily elicited, and may be entirely absent. In attempting it there must be an assurance of non-impaction, as manipulation may displace the fragments which are possibly in a favorable position for union without deformity. When mobility is present, the trochanter will rarely partake in movements of the shaft of the bone, and the other symptoms of fracture are so pronounced that crepitus would not add to the certainty of the diagnosis. It may be secured, however, by making extension of the leg, and pressure on the trochanter; there will be no difficulty in detecting it.

There is the same loss of power in the leg that occurs in other cervical fractures, and a greatly increased intolerance of motion, whether passive or voluntary. Swelling will occur early, and may not subside during the whole progress of the treatment of the case; indeed, for reasons shortly to be considered, the swelling may never leave the hip through life.

Prognosis is much better, both as to repair and preservation of life, than fracture of the neck intra-capsular. From six to eight weeks are required to bring about union, which occurs between the trochanter and shaft long before the other portions are united. The trochanter will remain enlarged, from the quantity of ossific deposit thrown out, but the limb will retain its natural strength and size, and apart from the impediment to motion from the enlarged trochanter, the function of the joint will not suffer, there being a slight halt, with a natural hip motion. The accident oftener occurring in persons under middle life, there is less intolerance of confinement, and the remaining conditions are more easily secured than in older persons with fracture within the capsule.

The differential diagnosis is given by HAMILTON (p. 379) in a tabular form, which I have condensed as follows:

Intra-Capsular.	Extra-Capsular.
Slight Violence,	Greater Violence.
Indirect Injury,	Direct Injury.
Over fifty years of age,	Often under middle life.
More frequent in women.	Not established.
Pain minus, and deep,	Pain plus, superficial.
Shortening at first less or none,	At first greater.
Shortening later greater,	Later less,
Trochanter turns on long radius,	Shorter radius.
Three or four months for union, if at all,	From six to eight weeks.
No enlargement of the trochanter,	Trochanter enlarged.
Wasting of limb afterwards,	Natural strenght and size.
Excessive halting, as from wooden leg.	Slight halt.
Hip motion defective.	Hip motion natural.

Treatment.—The indications to be fulfilled are the same in all varieties of cervical fracture of the femur, as already laid down in the preceding section of this chapter, with an important exception. No attempt must be made to extend the leg to overcome shortening, if there is impaction, as the fragments becoming disarranged will place the part in a less favorable condition for repair. The apparatus is more retentive than extending, and must be kept applied for at least eight weeks, and as much longer as the patient can endure the confinement. After this time some relaxation can be permitted, the splints removed, and the posture changed for an increasing length of time each day. After a week or two the bed may be left, and if crutches are needed by reason of failure of union, the patient become habituated to their use. Union having occurred, however, I am of the opinion that a well applied pasteboard splint, or starch bandage, with a sling for the foot, aiding locomotion with a cane, rather than a crutch, will be the better practice.

(c.) Fracture of the Shaft of the Femur, for reasons similar to those mentioned under fractures of the clavicle, oftener occurs at the middle third, when from indirect causes, viz., that being the point of greatest convexity. A force applied at both ends of a long bone will nearly always produce fracture at the middle, unless some peculiarity in form renders some other point weaker; this will more certainly be the case if the bone is at all bowed, as is the case in the femur. When the fracturing force is direct, as shot injury, a fracture may occur at any point, governed entirely by the nature of the injury and the portion of bone struck, although even under these circumstances, some peculiarity in form or function renders fracture at this point more common.

The direction of the line of fracture is somewhat governed by the age of the subject, the kind of violence, and the location of the break. Thus in young persons, and the aged, the line will be more or less transverse; in the middle aged, it will oftener be oblique. As to the kind of violence, when it is indirect, the line will incline to the oblique, slightly modified by age. When direct, if the force is extreme and diffused, comminution is the rule, with a general transverse

direction ; when extreme and confined to one point, as a shot wound or stab, it will be longitudinal. With a less degree of violence obliquity is the rule. In the upper and middle third of the shaft an oblique direction is usually assumed; in the lower it will oftener be transverse.

From causes already referred to, the leg will usually be everted, the lower fragments rotated outward. The upper fragment will usually override the lower anteriorly, as the bevelling is at the expense of the posterior aspect of the proximal part. The upper fragment, therefore, is usually tilted forward, and the lower directed backward and outward. This is due to three causes : First the action of the psoas and iliacus muscles, tilts the lower end of the upper fragment forward. Second, the anterior surface of the bone being the point of extension, the primary direction of the lower extremity is to the front. Third, the lower fragment pressing upon the posterior face of the upper fragment, still further forces it upward and forward, sometimes almost to a right angle, which tendancy is increased by the action of the powerful muscles of the thigh, both flexors and extensors, which in this case exert their force directly upward.

The *causes* of fracture of the shaft of the femur, as to indirect causation, are very many. Crushing force, as when the thighs give way from a heavy weight on the shoulders; catching the foot in something when running, the body being propelled onward; falls from a height on the feet or knees; or, in rare instances, simple muscular force. Direct causes are those common to all fractures, or gun-shot injury; passage of cart or wagon wheels across the thigh ; falls of heavy weight on the thigh ; or being caught between two bodies, as the buffers of cars, and the like.

The *symptoms* of this form of fracture are sufficiently unique to forbid frequent error in diagnosis. There is, we may say, always shortening, except in the rare instances where the fracturing force is mild, the line of fracture transverse, and the fragments are not displaced. The limb will be noticeably bowed outward, and everted ; and there will be great mobility. Pain is not violent, but is primary and quite constant, usually radiating from the point of fracture. The only question that will cause embarrassment, will be an occasional difficulty in differentiating between transverse and oblique fracture, a point of interest in estimating prognosis, the degree and certainty of future shortening depending entirely upon this fact. Whilst the presumption of the direction of the fracture can be estimated from the indications given above, yet it will require more accurate data for purposes of actual practice. In general the means demanded to elicit crepitus will go far towards settling the question. Thus if crepitus can be produced without extension, simply by rotating the leg, the presumption is that the fracture is oblique. If it cannot be produced until the shortening has been overcome, and the ends of the fragments brought into apposition, the fracture is probably transverse. Not only will the prognosis depend very largely upon the direction of the fracture, but the treatment will be governed by it also. For these reasons,

as well as the additional one, that a thorough practitioner will desire to know all he can about a case, great care must be exercised in the examination.

The *pathology* of this form of fracture varies greatly with reference to whether it is comminuted, compound or simple, or produced by greater or less violence. The conditions can be well comprehended with this general statement, the lesions to the subjacent tissues depends upon the nature of the force. Thus a perforating gun-shot wound will tear the soft parts with reference to the size of the projectile, the speed with which it traveled, and whether the bone was splintered and comminuted, or simply perforated and split. A severe contusion would implicate the soft parts as in the different degrees of contusion, plus the broken bone. An oblique fracture, from indirect force, may become compound secondarily, from muscular contraction forcing the fragment through the soft parts, or be so primarily from the violence of the force. It is impossible, therefore, to give any useful or practical account of the pathology in a mere *resume*, notwithstanding it is a matter of prime importance. It is less desirable in this instance, however, the symptoms of wounded nerves, blood-vessels, and muscles being already laid down in other chapters of this work.

Prognosis has reference both to continuance of life, and future state of the part. A simple fracture, with the injury confined to the part, with no dyscrasia, cachexia, or unhealthy state of the body in general, the patient being not past middle life, there need be no fear of a fatal result. Compound fractures, particularly if comminuted as well, must always be considered a grave accident, and a prognosis withheld. If there is no immediate danger to life, the question of amputation will arise, the menace to life being correspondingly increased. As to the future state of the member there has long been an animated controversy whether recovery without shortening was possible. The weight of testimony, as far as I can collect information from hospital records, is entirely in favor of certain shortening, varying from a quarter of an inch, to three and three quarters. MR. HOLTHOUSE, after giving close attention to the matter, and visiting all the London Hospitals to compare results, and personally measuring all fractured thighs found therein, puts the ratio of shortened limbs as high as ninety per cent; two cases in which no shortening was found, and which reduced the ratio to 90 per cent. were still in the apparatus, one of them very recent, which, judging from the uniform experience in London, would certainly show shortening later, when the apparatus was removed. Judging from his personal experience, and the result of his examination in other hospitals, he reaches the conclusion that shortening is inevitable, in other words the ratio is fully 100 per cent. My own limited experience, as would necessarily be that of any private practitioner, fully sustains this estimate, and I feel safe in asserting shortening must always be a result, no matter what the method of treatment is, or the conditions of the case, in every instance when there is the least displacement of the fragments, whether the displacement is primary or secondary.

Treatment.—The certainty of shortening should not induce the practitioner to relax his efforts, in the slightest degree, to overcome the primary shortening. In a complete fracture with primary displacement, in the absence of measures to oppose the tendency, the fragments may, and frequently have attained a position at right angles to each other, constituting a deformity of the most serious character. The indications for treatment are sufficiently simple, but are nevertheless strongly debated to-day. Extension, to overcome shortening; counter extension, for the same purpose; co-aptation of the fractured surfaces; and immobility of the part, are the paramount indications. Many eminent men have taken opposing views of the methods to fulfill these indications; some have contended for a straight position of the extremity, others as earnestly assert the flexed to be proper; some advocate the use of splints, others of Buck's extension method, and others for putting the part up in an immovable dressing. There is no question that the majority of the surgical profession have settled upon the straight position of the limb, and yet there are circumstances that might well warrant a resort to the flexed position, in the old double inclined plane. Just what these circumstances are it is difficult to point out in the absence of an actual case to report, but that such a contingency might arise, either from the intolerence of the groin to the perineal band, or some peculiar condition in the limb itself, none will probably deny. The only serious objection I have found to to the flexed position, is the liability of strong eversion. Two cases, that I have treated, could not be treated by the ordinary methods of extension and counter extension, one from an unusual sensitiveness of the groin to pressure, and the other from a severe ulceration of the leg. In each the double incline was employed, and the results were equally satisfactory with other cases treated with the limb in a straight position.

Treated with ordinary splints the methods are the same as in fractures of the neck of the femur given above, excepting that extension and counter extension must be secured, so that if possible the limb is even longer than natural. The splint must be secured to the part by firm bandaging, from the toes up, the seat of fracture being particularly confined without exercising injurious pressure. In the case of compound fracture, the bandage may terminate below the wound, a new one applied from above the wound to the end of the splint. The wound may be lightly covered with a separate roller, including the splint. The great objection to this method of dressing, is the almost utter impossibility of changing the dressings without disturbing the fractured bone more or less.

The "American" method of extension, recently introduced in this country by GURDON BUCK (but which Mr. JAMES, of Exeter, Eng. employed long anterior), is the best dressing, for this form of fracture, to my mind, at least in the earlier stages. We have learned, in an earlier chapter, that while repair commences immediately upon the occurrence of a fracture, there is a period in which nothing active, occurs, the time being utilized in the disposition of effused blood and

other foreign material between the ends of the bone. During this time there is the maximum of swelling and inflammation, when BUCKS' apparatus is to be employed. Upon the subsidence of these symptoms it is a matter still in dispute, whether to continue the primary dressing, or substitute some form of permanent dressing for it. MR. ERICHSEN even prefers the starch bandage from the commencement, but he stands nearly alone among the authorities in our art. Apart from the continued confinement of the patient, there is nothing to be urged against the retention of the original dressings, the parts being accessible to inspection, without disturbing them, and securely retained. The question of changing the dressing, therefore, rests solely upon considerations of the comfort of the patient, which should at all times take precedence, other things being equal, I much prefer, therefore, to remove the extension apparatus as soon as the inflammatory symptoms have passed, and put the leg up in a stout plaster dressing, keeping the leg extended until the dressing has become thoroughly dry.

After six weeks the dressings may be removed, and the limb daily exercised. After a week, the patient may be permitted to get up, but care must be taken to prevent resting the body on the injured leg, the young attachments yielding to the pressure so that shortening is much increased. Under all circumstances, I think, shortening will be greater a month after the dressings are finally removed, than it was at the time; it will be much lessened by postponing the full use of the member as long as possible.

(*d.*) FRACTURE OF THE LOWER END OF THE FEMUR is a somewhat rare accident, occurring in four forms, e. g., longitudinal fissure between the condyles; splitting off of the inner or outer condyl, and separation of both condyles, from each other and from the shaft. In young subjects, before the final ossification of the bone, the whole of the lower epiphysis may be separated from the shaft with comparatively little violence. True fracture of the lower extremity, however, is only producible by great force, in a normal condition of the bones, and is at all times a serious accident.

The *causes* are usually direct, as falls on the knee, or blows from some weapon. A few cases are noted in the books, of longitudinal fracture particularly, resulting from indirect causes, as falls on the feet. As a rule it will require extreme violence, expended directly on the condyles, for which reason, if the patella escapes injury, the leg must be strongly flexed on the thigh.

The *symptoms* are obscure, when there is no separation of the fragments (as occurs in the longitudinal forms), there being no mobility and crepitus, the degree of the violence usually inducing such rapid swelling that the greater width of the joint is an unreliable sign. With separation of the fragment the diagnosis is greatly simplified, the position and prominence of the condyle rendering manipulation easy. In all cases, however, there will be much pain in the knee joint, and extreme and rapid swelling, the fracture often opening the joint.

Even when the joint itself is not implicated, the violence of the accident is such that there are all the symptoms of severe sprain, with acute synovitis as a necessary resultant. The symptoms therefore, are always severe yet of a character to mislead if not careful to exclude all sources of error.

The *pathology* is sufficiently indicated by what has been said above. The cartilages will be more or less detached, the synovial surfaces torn or contused, and the ligaments. particularly the lateral, may be torn completely, or only a few fibres. There is rarely displacement sufficient to be at all remarkable; when the separation of the condyles is complete, as occurred in the only case that I have seen, the heads of the gastrocnemius muscle have a tendency to draw them downwards, and slightly rotate them forward, excepting the inner, which is less displaced from the resistence of the adductor magnus, which is inserted just above that condyle.

The *prognosis* depends, of course, upon the extent of the fracture, particularly whether complete or partial. The proximity to the joint, in fact the frequent implication of the joint in the injury, must always render the accident a severe one, threatening life, under some circumstances, and at all times causing some solicitude as to the future state of the joint. Anchylosis is a frequent occurrence, particularly if there is any dyscrasia that might develop destructive changes in the tissues of the part. Apart from these important considerations, such fractures heal with rapidity, as compared to fractures of the opposite extremity of the bone, and the treatment does not present any special difficulties.

Treatment.—In view of the danger of anchylosis, and the frequency of inflammation in the joint, some special precautions must be taken. *Arnica* should be administered to guard against the latter, and position must be considered, to alleviate the functional loss if the former should occur. With the possibility of anchylosis kept in mind, the member should be dressed in a semi-flexed position, which is a much more useful position of the leg than straight. The application of a circular bandage, about the seat of injury, the limb being well padded with cotton, with a long straight splint to keep the parts quiet, will constitute the primary dressing. The inflammation and swelling having subsided, a plaster dressing may be applied, unusually reinforced with strips of tin, but locomotion must be very guarded. After the fourth week, daily systematic rubbing must be instituted, and after the fifth gentle passive motion. The dressing may be removed after six weeks, and the joint regularly exercised.

(*e.*) SEPARATION OF THE EPIPHYSES is a very rare accident, I should infer from the literature of the subject, particularly as it refers to the upper one. The lower has been separated once or twice, but in either case the treatment and prognosis is identical with fracture in those regions, with presumption in favor of more certain, speedy, and solid union in the upper extremity, and less danger of inflammatory sequelæ when occurring at the lower end.

2. FRACTURE OF THE PATELLA.—This is a somewhat common accident, and one that is more serious in its results, as regards function, than many might suppose, without previous experience, and judging from the small size of the bone. Acting as a fulcrum, in one sense, over which the lever like action of the extensors of the leg is exerted, and at the same time sustaining an intimate relation to the conjoined tendon of these muscles, within the fibres of which it is situated, it is manifest that an injury which divides it, transversly more particularly, must at once cripple the muscles with which it is in relation, more especially as the accident is equivalent to a section of the tendon itself.

The *causes* are both direct and otherwise, the former predominating; a few well authenticated cases are recorded of fracture from muscular exertion. With the leg flexed upon the thigh, a sudden sharp blow on the upper edge of the patella, even if not very severe, may readily cause fracture. With the leg straight, the force must be grea ,and even then fracture will only be accomplished at the expense of great injury to associated parts.

The line of fracture may be transverse, or perpendicular; some cases occur in which the bone is comminuted, and others in which a double transverse fracture occurs. The prognosis and treatment depends largely upon the form of fracture, the great impediment to union being the difficulty of keeping the fragments together.

The *symptoms* must at all times be unique and striking, although in the earlier stages, for the first few hours after the accident, the swelling may somewhat obscure them. This having subsided, the patella will at once be seen to be broken; if the fracture is transverse, the upper fragment drawn up on the femur, to a distance varying from one-half to two or three inches, depending upon the degree of laceration of the parts. With complete separation, and laceration of the periosteum and tendinous fibres laterally, the strong extensors may draw the upper fragment upward, almost to any extent. The injured party usually falls to the ground, and on attempting to rise will find all power of extension of the injured member gone. In the majority of cases the fissure between the fragments will be apparent, pressure with the finger, at all events, will easily discover it. Upon flexing the leg, the gap will be notably increased. No crepitus will exist, the fragments being so far asunder. The line of fracture being transverse the accident may altogether escape detection, the symptoms being attributed to contusion or sprain.

The *prognosis*, as to bony union particularly, is bad, in the majority of cases, in the experience of most practitioners and writers, although HAMILTON claims quite uniform success in his practice. Ligamentous union is common, but the separation is so often to such an extent that it is equivalent to non-union. HAMILTON does not claim *bony* union in his cases, but that function is perfectly preserved, owing to the *short* ligaments, which furnishes as good results as firm union.

Notwithstanding this experience of our distinguished author, I fear it will be safer to promise only a partial success, and expect ligamentous union, in the large majority of cases, in such a manner that the member will forever be crippled more or less.

Treatment.—The indications are to keep the leg extended, and the fragments in close connection. Various measures have been devised to secure this end, but they all, with one exception, seem to have some defect. In the report of proceedings of the German Surgical Congress, April 1881 (*N.Y. Med. Record* xix, 528), Dr. Schwalbe, of Magdeburgh, reports a case of fracture of the patella, in which the fragments were wired together, the wire cut off close to the knot or twist, and the wound closed. Healing of the wound, and bony union of the patella occurred, the wires remaining undisturbed, and are still ,some months afterwards, where first placed, and cause no annoyance. As is often the case we find the simpler methods oftener the best, and HAMILTON's splint seems to fill all the requirements.

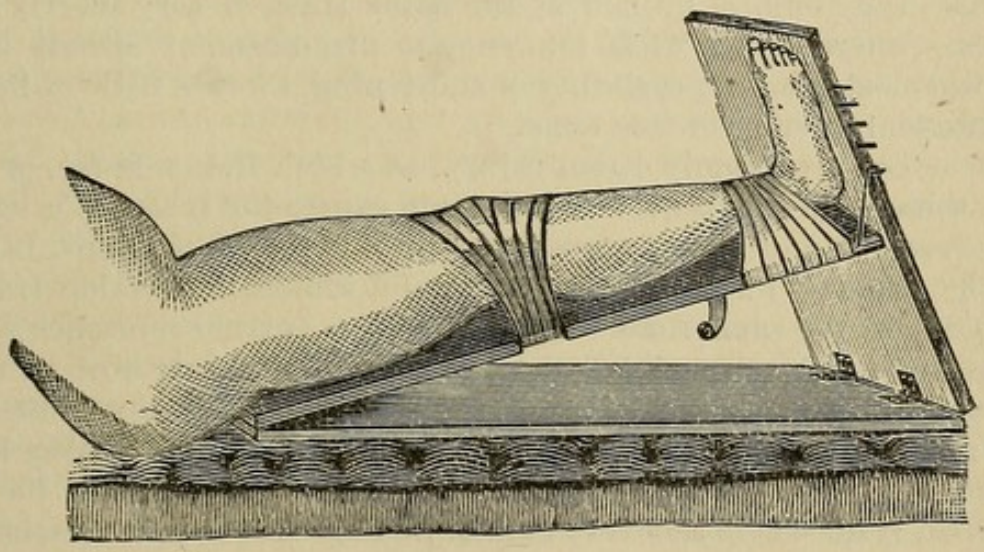


FIG. 51. SPLINT FOR PATELLA.

The above figure (51) represents the apparatus, and is thus described : (*Fract.* etc., 439) : "The dressing which I prefer in the treatment of this fracture, consists of a single inclined plane, of sufficient length to support the thigh and leg, and about six inches wider than the limb at the knee. This plane rises from a horizontal floor of the same length and breath, and is supported at the distal end by an upright piece of board, which serves both to lift the plane, and support and steady the foot. The distal end of the inclined plane may be elevated from six to twelve inches, according to the length of the limb and other circumstances. Upon each side, about four inches below the knee, is cut a deep notch. The foot piece stands at right angles with the inclined plane, and not at right angles with the horizontal floor."

"Having covered the apparatus with a thick and soft cushion, carefully adapted to all the irregularities of the thigh and leg, especial

care being taken to fill the space under the knee, the whole limb is now laid upon it, and the foot gently secured to the foot board, between which and the foot another cushion is placed. The body of the patient should also be flexed upon the thigh, so as the more effectually to relax the quadriceps femoris muscle."

"A roller is now applied to the knee, by oblique and circular turns; commencing above the patella, and traversing the notch in the splint; each successive turn covering more of the front of the knee, until the whole is enclosed. With a second roller the entire limb must then be secured to the splint, this roller extending to the groin."

I have had an opportunity of using this apparatus three times, or a modification of it, and have succeeded admirably in each case in securing good *short* ligamentous union. It will require about four weeks to secure sufficiently firm union to throw aside the dressings.

3. FRACTURE OF THE TIBIA.—Without corresponding fracture of the fibula, this is quite a rare form of fracture. In the large majority of cases the fibula is broken at the same time, or very shortly afterwards. There being little tendency to displacement, speedy union, and the most remote possibility of shortening, there is little of literary or practical interest in this bone.

The *causes* are usually direct injury, as a kick from a horse, or blow with some hard substance. From such causes the fracture is usually transverse, and oftener occurs in the middle third. Indirect injuries usually produce an oblique fracture, and almost invariably fracture the fibula at the same time. For this reason further reference will be postponed until we reach fractures of the leg involving both bones.

The head of the bone has been broken, from direct injury, the fracture necessarily extending into the joint, and thus constituting a very serious accident, one which may demand amputation, or, if the limb is saved, from which recovery cannot be expected without anchylosis. So, also, with fracture of the malleolus, which rarely occurs apart from dislocations of the ankle, or such other serious injury to that joint that anchylosis is to be feared if the foot is not entirely lost. These complications must also be referred to a subsequent paragraph.

The *symptoms* of fracture of the tibia without implication of the fibula, are those common to all fractures, with the exception of deformity. Sometimes the fragment is drawn slightly to the fibula side, but the rule is that the parts retain their position without any appreciable deformity. From the superficial position of the bone, compound fractures are quite common, either primary when the injury is direct, or secondary, when from indirect violence, or the fracture is oblique. In either case, however, unless the articulation of the fibula is broken up, there will be no protrusion of either fragment.

There being no shortening or displacement, and union usually proceeding rapidly to completion, the *treatment* is very simple, and the *prognosis* good. The leg will be laid in the most comfortable position,

simply steadied by a light splint, and sand bags, or other improvised dressings, until the primary symptoms abate, when it may be put up in a permanent dressing. It will require from four to five weeks to complete repair, although there are a few instances of non-union. In such cases the suspended reparative process is readily re-established, as shown in a previous chapter (*Fractures in General*).

4. FRACTURES OF THE FIBULA.—The fibula is often broken in its lower third, sometimes involving only the malleolus. from indirect force. Even when the force is direct, unless it be from gun-shot injury, the fracture will oftener occur at this point. The more frequent cause, according to HAMILTON, is what he calls a "rotation" of the foot outward; not a displacement of the foot outward, sub-luxation, as many have taught. This is the more reasonable, as he shows that in the ankle there is considerable rotation possible, while lateral displacement is exceedingly difficult. In one case, seen with my friend Dr. Miller, there was an unquestioned outward displacement, which, however, was very readily reduced.

The proximal extremity of the distal fragment is usually carried inward, towards the tibia, and the malleolus downward and outward. The foot is carried outward, and everted, and the internal malleolus is much more prominent than natural. Crepitus is not readily elicited, but the remaining symptoms are so pronounced that it is hardly possible to make a mistake in the diagnosis.

The *prognosis* as to union of the fractured bone, is good; as to future deformity, or functional loss bad. As HAMILTON says, (*Fract.* etc., p. 451): "The subsequent deformity is due less to the fracture of the fibula and its consequent displacement, than to the loss of the internal ligaments, which loss nature can rarely fully repair." This he shows further by citing cases in which the fracture has never been reduced, and yet function was fully regained, and deformity, as to the foot, did not occur.

Stiffness of the joint will remain for a long time; in some cases two years have been required to overcome it. At other times anchylosis has followed; in one of my cases this occurred, and flexion and extension of the foot became almost fully established by a compensatory change at the tarso-metatarsal articulation. With these facts before us, it is manifest that passive motion must be instituted early.

Treatment.—The indications to be fulfilled are to rotate the foot inwards, and elevate the depressed end of the lower fragment. The mode of dressing devised by DUPUYTREN, and which still bears his name, fulfils them better than any other, but is not infallible in the results obtained. In spite of all precautions and the most sedulous care, deformity has so often resulted that most experienced surgeons expect more or less in every case. The method as described by HAMILTON (ibid 451) is as follows: "A pad, or long junk, made of a piece of cotton cloth, stuffed with cotton batting, is constructed of

sufficient length to extend from the condyles of the femur to a point just above the malleolus internus This pad must be about five or six inches in width, and thicker by two or three inches at its lower than its upper end. This is to be laid upon the inside of the leg, with its base or thickest portion resting against the tibia just above the internal malleolus. Over this pad is to be placed a long firm splint,

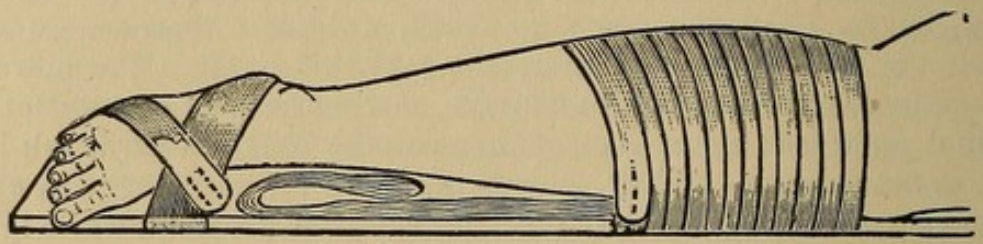


FIG. 52. DUPUYTRENS SPLINT.

extending also from above the knee to three inches beyond the bottom of the foot. With a few turns of a roller the upper end of the splint will now be made fast to the knee, and with a second roller the lower end must be secured to the foot. The application of this last bandage requires, however, some care in its adjustment. Its purpose is simply to rotate the foot inwards, while at the same time the tibia is pressed outwards; and to this end must be applied in the form of a figure-of-8 over both foot and splint, embracing alternately the heel and the instep. In order to be affectual it must be drawn pretty firmly, and no portion of the bandage must pass higher than the malleolus externus. * * * * *" When the limb is thus dressed, the knee may be flexed, and the leg laid upon its outside, supported by a pillow, or upon its inside, as in the accompanying cut.

Whilst the dressings may be retained three or four weeks, and must then be removed, the leg must be kept quiet, resting on a pillow, and no attempt made to use it for a fortnight longer. In fractures of the middle third, or upper part of the bone, nothing will be needed in the way of retentive dressings, the leg simply laid upon a pillow, and supported by sand bags.

5. FRACTURE OF THE LEG, (BOTH BONES.)—Both bones of the leg are fractured with greater frequency than either bone singly. The fracture is, also, oftener compound than in any other part of the body. Whether this is due to the exposure to severe injury being greater in this part than elsewhere, or the superficial position of the tibia, I am unable to determine. The causes are both direct and indirect, the form and direction of the fracture being much influenced thereby. Thus, whilst fracture at the lower and more expanded part of the tibia is usually transverse, and that of the shaft more or less oblique, obliquity predominates when the causes are indirect, and transverse when direct.

The *symptoms* are those of fracture in general in a somewhat exagerated form, viz.: great mobility, deformity, shortening and crepitus. On attempting to raise the leg with the hand, proof of fracture will at once appear, and the surgeon has only to determine its location, whether single or comminuted, and whether both bones are involved. From direct injury, such as the passage of a loaded vehicle across the part, both bones will be fractured at corresponding points. The force being indirect, however, it is very rarely that they correspond, the fibula frequently being broken after the tibia. Under these circumstances the fibula will often be found broken at its upper extremity, or in the upper third, the tibia giving way at the lower third.

The displacement is usually with the lower fragment overiding and in front of the upper, slightly rotated outwards, but displacements in almost every direction has been observed.

With judicious treatment *prognosis* may be considered always good in all cases in which the distruction of tissue is not so great that amputation seems to be demanded. In simple fractures union will occur in about forty days; a few cases of non-union are noted, but they are quite the exception.

Treatment.—I know of few accidents about the treatment of which there has been so much dispute as this of fracture of the leg. Authors and teachers of the most ample experience widely differ, and contradict each other with the utmost dogmatism. After carefully comparing the results given in our standard works, I am unable to see that there is much differance; one apparatus seems to be about as successful as another. In my own experience, which is far from insignificant, I have derived all the benefit from the old double-inclined plane, that can be claimed for other methods of dressing, HAMILTON to the contrary notwithstanding. Spread a few folds of soft muslin on the splint (*Surg., Principles*, fig. 76, p. 154,) which is extended at full length, and the sides turned down. Lay the leg on this, in a perfectly straight position, with the extension-gaiter laced on the foot. Reduce the fracture, and then secure the foot to the foot-board. Now raise the splint until the desired angle has been attained, taking care that the popliteal space is well proteced from pressure. Support the leg by bags of bran or sand, and close up the sides. In one case in which there was a tendancy to outward bowing of the leg, it was successfully overcome by adhesive strips so disposed as to counteract it.

6. FRACTURE OF THE TARSAL BONES.

(*a.*) The *Calcaneum* has been broken by muscular action, the fragment rarely including more than the portion affording attachment to the heel tendon. By relaxing the gastrocneme crepitus can be detected, but the mobility of the fragment, and its position high up the leg, from the contraction of the muscles, should render a diagnosis com-

paratively easy. It has also been broken by falls on the heel, in which case the line of fracture is transverse, close to the articulation with the astragalus.

Many ingenious methods of dressing have been devised, but none seem to be superior to that employed for ruptured heel tendon (see fig. 15.) The sole indication being to release the muscles of the calf of the leg, and extend the foot as much as possible, it should not be a very difficult matter to devise an apparatus should anything forbid the employment of the dressing above referred to.

(*b.*) The *astragalus* is generally, in fact always broken by direct force, chiefly from falls on the feet, or the application of some crushing force. The location of the fracture is not all constant, and the symptoms are often exceedingly obscure. The foot may appear to be driven backward, with some flattening of the palmar arch, the ankle broadening, or the heel shortened, according to the line of fracture, and degree of displacement of the fragments. Crepitus can usually be elicited, but it furnishes no evidence as to which of the bones of the tarsus is fractured, or its extent. In very many cases there is more or less dislocation of the ankle, and fracture of the malleoli, and in a considerable number of cases the soft parts will be torn.

The *treatment* is purely expectant, being confined to allaying as far as possible inflammation in the part, and combatting the tendency to anchylosis, which is a very common, and almost unavoidable sequlæ, to some extent. If pieces of bone are detached, they had better be extracted; if they do not perish they will form such a deformity of the joint that a boot or shoe cannot be worn, or constitute a serious impediment to motion. Beyond placing the injured part in a comfortable position, and paying close attention to symptoms as they arise, the surgeon can exercise but little control of the case. Some degree of functional loss is inevitable, and he is fortunate who escapes without anchylosis and much deformity.

(*c.*) The *Tarsus* in general, or other bones therein, may be broken by similar exibitions of force as above, and are in all respects to be treated as fractures of the astragalus; viz., removing loose fragments, when completely detached and an external wound already exists, and directing the effort to the mitigation of sequelæ that surely will follow.

7. Fractures of the Metatarsus.—In all essential particulars these fractures are the same, as to cause, symptoms, prognosis, and treatment, as in the case of fractures of the analagous bones in the hand, save only in such minor particulars as grow out of the very slight differances in form and function.

8. Fractures of the Phalanges.—The same language as above may be applied to these fractures, merely observing that the small size of the bones renders simple fracture almost impossible. The bones are usually broken by some crushing force, and are found com-

minuted to such an extent that there can be no reasonable hope of restoring them to usefulness. With referance to the bones of the great toe, its importance to locomotion renders it imperative that it be not sacrificed without an effort at preservation, although my experiance has uniformly been that in a longer or shorter time it must be *removed*.

II. DISLOCATIONS.

Dislocations of the lower extremity, at once from the greater size of the joints, the greater complexity of their structure, and the presumption of greater violence in their production, as compared to dislocations elsewhere, have much occupied the attention of special students and are every where recognized as accidents of a notably major character. There is much difference in the nomenclature, by different authors, which would seem needless; one will refer entirely to the joint; one to the distal bone; and another to the proximal bone; while still others, happily few in number, seem to be utterly without established principle, and confuse an already sufficiently complex subject, by employing all three of the above systems, without apparent reason for preferring one to the other, as applied to different regions. I shall adopt a classification that seems to be the most generally satisfactory, as occurring in the chapter on *Injuries to the Upper Extremity*, *viz.*, considering the distal bone as the one dislocated. Thus in hip dislocations it is the femur that is out of place; in those of the knee, it is the leg; in those of the ankle the foot.

1. DISLOCATIONS OF THE HIP.

The hip is liable to dislocation by the head of the bone being carried in one of four directions, or to points between; on to the ileum, the pubis, into the foramen thyroidean, or the sciatic notch. I am of the opinion that the frequency with which the different forms appear, is in about the order named. As is not uncommon in dislocations of other joints, a displacement may present all four of these positions, from subsequent movements of the head of the bone after the primary luxation, either through muscular action, ill judged attempts at reduction, or some unfortunate attempts at locomotion or secondary accident, sustained by the patient. The first form, the iliac, is the typical form, and is usually the primary dislocation, the others oftener proceeding from this. We shall consider each variety with reference to distinct causation, having it understood that they may each and all be secondary upon the first.

It was formerly supposed that the difficulty usually experienced in reducing dislocations of the hip, was entirely due to the strength of the muscles of the part, and it was thought that anæsthesia, by overcoming this, would render reduction far easier. In this hope surgical practitioners were much disappointed, and it became necessary to look elsewhere for the cause. It was reserved for PROF. BIGELOW, of BOSTON, to point out the exact nature of the impediments, and to

suggest a rational system of treatment, based upon these conditions which has almost entirely superceeded the antiquated pulleys, and the many more modern devices for making extension. We will find that the impediments to reduction are chiefly three fold, *viz.*, the malposition or altered relations of the internal obturator muscle, the ileo-femoral ligament, and a partial laceration of the capsular ligament. Unquestionably muscular contraction will play a more or less important part in the opposition to reduction, but it is not of a character to resist intelligent manipulation alone. It is too late in the day to occupy space in eulogizing the method of manipulation originating with PROF. BIGELOW, all who practice surgery, or are attracted by surgical literature are sufficiently aware of the extent of our obligations. Whether from good fortune in the character of the cases presented to me, or from other causes, I have certainly not yet had occasion to return to the old methods of reduction since 1863, when my first attempt was made at manipulation. Nevertheless, recognizing the fact that there may be cases that will resist the usual methods, I shall present the more useful of the methods of extension.

(*a.*) DISLOCATION ON THE ILEUM.—Coxo-femoral, upward and backward, upward and outward dislocations, are all terms used by various authors to designate that form in which the head of the femur is carried upward and backward on to the ileum. As said in an earlier paragraph it is the typical and oft times primary form of hip luxations, as it is the most frequent of any. The head of the bone will rest upon the dorsum of the ileum, just above the acetabulum, with the lesser trochanter resting upon the edge or lip of that cavity.

The *causes*, apart from any predisposing tendency, are forces compelling extreme abduction of the thigh with rotation. The most common causes are from falls, in which the foot is caught and the body rotated inward in falling. Crushing weights on the shoulders or back, with the body bent forward or sideways, are also causative. One of the first cases I saw, in 1862, was produced by the stroke from an apple falling from a tree, striking on the trochanter while the member was greatly extended in a strained posture. Such slight causes, however, are extremely rare and infrequent.

Among predisposing conditions, it must not be forgotten to include preternatural length of the ligaments, age, and sex. Under the first category are many examples; all of us are more or less familiar with such instances, where the individual can dislocate and reduce the hip voluntarily. As to age, the tables show that most cases occur under fifty years of age, a marked contrast to fractures of the femoral neck, with which dislocations may be confounded. The accident has occurred at both extremes of life, infancy and old age, yet the greater number seems to fall between fifteen and thirty-five. If women have a monopoly of intra-capsular fracture, hip dislocations are as markedly a male characteristic, partly from the usual occupation of men favoring exposure to accidents that are liable to result in this way, and

partly, perhaps, to the somewhat different form and greater strength of the parts concerned.

Among other predisposing causes may be enumerated morbid action that weakens the ligaments, or lessens the capacity of the acetabulum: such as hip disease; excessive callus from fracture in the neighborhood of the joint; or the filling up of the cavity by ossific deposit.

The *pathology* of this form of dislocation is not constant, depending upon the distance to which the head of the bone is carried, and the violence with which the dislocation is produced. Surgical pathologists speak of two varieties, which they call the *regular* and *irregular*. The terms have reference to the extent of the injury sustained by the ileo-femoral ligament. Thus it is *regular*, when this ligament is untorn, or but very slightly, as is the ordinary occurrence. It is irregular when the ligament *is* torn, completely, or to a considerable extent, indicating an unusual degree of violence. Furthermore, the luxations are spoken of as "above" or "below the tendon," with reference to the position of the obturator internus muscle. These varieties will receive attention in order.

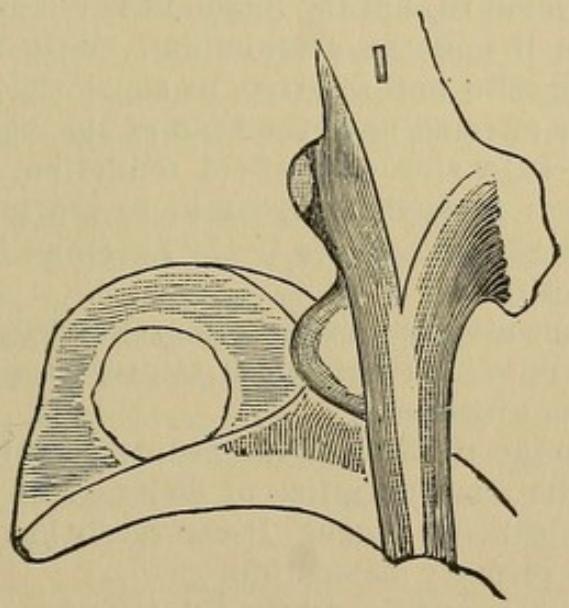


FIG. 53. ILEO-FEMORAL LIGAMENT.

In the ordinary *regular form*, the capsular ligament will be found torn, often only sufficient to permit the head of the bone to pass through, usually on the posterior and upper surface; at other times it is completely torn across, or torn from its attachments. The capsular ligament is torn, almost as a matter of course completely. The muscles covering the outside of the pelvis, particularly the glutei, are more or less contused, some of the fibres torn, fully relaxed and disposed in a sort of folds. The head of the bone will be found buried in them. Sometimes the rim of the acetabulum will be extensively broken, particularly on the upper and posterior margin; at all times some fracture may be anticipated.

The most interesting feature, and one of paramount importance in deciding on methods of treatment, is the condition and relation of the ileo-femoral ligament, or as BIGELOW styles it, the "Y ligament." Reference to the accompanying diagram will render the pathology easily understood. It will be seen that a strong ligament originates just below the inferior spine of the ileum, and passing downward is inserted at the two trochanters, by a division, giving it the form of an inverted Y. Now when the head of the bone is driven directly upward, and backward, this ligament simply becomes relaxed. The great trochanter is now usually rotated forward, which leaves the Y ligament out of the way, if care be taken, in the subsequent manipulations. Occasionally the rotation of the trochanter is backward, which will bring the ligament *under* the neck, the head of the bone pointing forward. Such a position, however, can rarely occur, unless the attempts at reduction are carelessly made. All this refers to primary dislocations.

Suppose now that the primary luxation is on to the pubis, and some cause induces a secondary displacement upon the dorsum of the ileum. Here the head of the bone is directed backward, and the trochanter rotated forward, but the ligament is underneath the neck, interposed between it and the acetabulum. With the parts in this position, or the opposite one referred to above, it is manifest that reduction cannot be effected until the head of the bone is disengaged from this tendon; extension may effect reduction, but only by the ligament giving way. Thus it is important to procure an intelligent history of the accident, particularly if the knee and foot has changed any from its first position.

The *irregular* forms are thus easily comprehended, the differences in pathological states being entirely due to greater violence, and rupture of this important ligament.

With reference to the relation of the obturator muscle, it will fall more properly under consideration of dislocations downward and backward, into the ischiatei notch. It can rarely have any relation to the iliac form, as a primary dislocation.

The *symptoms*, as represented on the printed page, are pronounced and unmistakable, and yet, in actual practice, the accident has been more than once mistaken for fracture of the femoral neck, and the reverse. There may be cases in which, for some reason, there is sufficient abnormality to mislead the surgeon, but none such have fallen under my notice; it seems almost impossible that a mistake should occur, when a careful intelligent examination is made.

Shortening of the extremity is a necessarily prominent symptom, and occurring immediately should serve to differentiate from fracture, in which it occurs later, as a rule, and then to a much less extent.

The leg is drawn up frequently to the extent of three inches, even more in some cases.

Inversion of the foot, is the rule; in fact in all the cases I have seen

the foot was turned in more or less. Occasionally it may occur that the foot turns out, particularly in secondary dorsal luxations; it is probable that the primary luxation was sciatic or pubic, the head of the bone rotated forward, and slipped upward or backward with the Y ligament underneath the neck.

The thigh, moreover, is strongly adducted, the knee resting on the front of the opposite thigh, just above the patella; the leg is rotated inwards; the toes of the injured side rest on the instep of the opposite foot. The hip appears flattened, the trochanter less prominent and carried farther back than normal. The head of the femur may be felt, even *seen* in its new position, if the subject is not too corpulent or muscular. Motion of the joint is absolutely impossible, either passive or voluntary, except a slight mobility in the direction of the deformity, viz.: bringing the knee inwards and upwards. If standing, the body is bent forwards, no attempt made to put the foot to the ground, on the injured side, but support is sought with a cane, or resting the hand on a table or some convenient object. Lying down, the deformity as to the leg is much more marked as a rule. The muscles about the hip and thigh, are felt to be tense and contracted, and pain is violent, constant and localized. Unlike fracture the pain is always referred to the injured spot. The examination must be made with the patient standing and lying, the indications, as has appeared above, varying a little with change of posture.

Here we have a group of symptoms so peculiarly characteristic that it is difficult to understand how a mistake in diagnosis could occur. It is true that there are many cases in which some of the symptoms may not be so prominently developed as appears in a written catalogue, but apart from the evident injury to the hip-joint, I can see no similarity in the conditions. The following comparative table may be of service in fixing the dissimilarity in the mind of the student:

Fractures.	Dislocation.
Crepitus, often.	No crepitus, unless cotyloid fracture.
Mobility.	Immobility.
Pain slight and diffused.	Pain great, and localized.
Eversion of foot usually.	Inversion of foot, usually.
Shortening little, and secondary.	Shortening much, and primary.
Able to walk some distance.	Cannot bear the weight of the body on the member.
Advanced life.	Below middle life.
Chiefly women.	Chiefly men.

The immobility of the joint, common to all dislocations, is here most marked. It is true that the muscles are much contracted, some of them put painfully on the stretch, but even those which are primarily relaxed, as the three gluteal, soon become irritated, and are found contracted and shortened. It was long thought that both the immobility and the difficulty in reduction are due to this state of

tonicity in the muscles. As to the former it is partly correct, but not at all, or at least to a very limited extent, as to the latter. This I have attended to elsewhere, but will call attention to an oft quoted experiment of Dr. FENNER, of New Orleans, as additional evidence. The cause was the result of a steam boat accident, the subject of the experiment dying soon afterwards, with a dislocated hip unreduced. Dr. Fenner exposed the head of the bone, found the gamelli and gluteal muscles torn from their attachments, and the capsular ligament freely torn. It was utterly impossible to reduce the dislocation by any method of extension. One muscle after another was divided, until nothing but the capsular and the illeo-femoral ligaments remained, and still reduction was impossible. It was not until these were divided that the head of the bone slipped into place. The deductions that were drawn from this instructive experiment, were that the muscles opposed at best a feeble barrier to reduction, and the chief impediment was the capsular ligament. From this time (1848) until 1863, these conclusions were quite generally accepted, but Dr. H. J. BIGELOW, of Boston, has, it is believed, conclusively shown, that the most resistance, if not all of it, is furnished by the internal obturator muscle, the illeo-femoral ligament, and the torn capsular, in all *regular* dislocations, as already referred to.

The *Prognosis* differs with the length of time the dislocation remains unreduced, and the state of the rim of the acetabulum as to fracture. In recent cases, in the abscence of complication, reduction is easy, and restoration of the part to full usefulness assured, with the exception that re-dislocation is somewhat to be feared, on comparatively slight injury, in the future. The torn ligaments and muscles are soon repaired, and motion of the part is free and unimpeded, and no peculiarity in gait or appearance would suggest the accident. The rim of the acetabulum being fractured, there is some difficulty experienced in retaining the parts in position after reduction, in some cases proving impossible.

In cases of ancient dislocation, particularly those in which no attempt at reduction has been made, after a period of immobility, some degree of mobility is gradually restored to the joint, and in time a new joint often forms, provided with proper ligaments and synovial membranes, which allows such latitude of motion that, apart from the shortening of the limb, locomotion is easy, and with ability to perform many kinds of labor. A new acetabulum may form on the ileum, or even in the muscles, the old cavity filling up; the head of the bone may become absorbed, the neck and upper part of the shaft forming a pseudo-joint in connection with the altered fascia, or other soft parts. In many ways a new joint will be formed, and as far as mere locomotion is concerned the individual will suffer very little inconvenience. The great difficulty will consist in the distortion of the pelvis, due to the shortening of the leg, which induces corresponding deformity in the spine, with all the evil consequences attached to

such a condition. In short the results in cases of unreduced luxation are very similar to those of hip disease after the arrest of the morbid action, and is already sufficiently noticed in another place.

Treatment.—There are three methods of reduction of this dislocation, forming bases for many combinations and modifications. In historical order they are extension, manipulation, and a combination of the two. I shall take them up in that order.

(*a.*) *Extension* by mechanical appliances, has been a prominent means for the reduction of hip-dislocations, since the earliest historical period. Notwithstanding surgeons had applied more correct scientific principles to the treatment of dislocations of smaller joints, manipulation was little understood, and rarely practiced until Dr. REID, of Rochester, N. Y., published the results of his practice in dislocations of the hip, in the *Buffalo Medical Journal*, in June, 1851. Brute force, as exemplified in the methods of extension, even when made by the most recent instruments and appliances, was slow to give way to the "march of ideas," and even to-day is sometimes thought to be required in exceptional instances. While not presuming to say that the necessity for such harsh measures never arises. I have certainly not found them called for in my own practice. Entertaining these views, I do not feel under any obligation to go into a description of these methods minutely, the choice of apparatus usually being determined by accessibility of one over another, the governing principle being the same in all.

The object being to drag the bone down until the head drops into its proper position, regardless of any obstacles that may exist, the first thing to be determined is the actual position of the head of the bone, and determine the shortest route which it must be made to traverse to reach the desired end. The line of traction must be in the direction indicated by these conditions, and will usually be determined by the direction in which the dislocated member points. In the form of dislocation under immediate discussion this will be downwards, inwards and forwards. The patient is placed on the back, on a table or hard mattrass, counter extension being secured by a strong perineal band, leading in a direct line upwards, with the long axis of the dislocated member. If one of the patent so-called "adjusters" are employed they are fitted with their proper counter-extending apparatus. A stout hook is secured into a door or window casing, in a direct line with the desired line of traction, to which one block of a tackle made for the purpose is hooked. The other block is secured to the lower end of the thigh, immediately above the knee, by a smoothly applied bandage, over which a band is "clove-hitched" to hook the block into. The patient must now be completely chloroformed, to relax the muscles of the part completely, as well as to save from pain, and traction on the part made *steadily*. The strain must be steady and constant, avoiding all jerking, or what the sailors call "surging" on the fall. During this time the surgeon endeavors to assist the

movements of the bone by moulding the parts with the hands. The head of the bone being brought down to the acetabulum, it will greatly facilitate matters, if a broad strong towel is passed around the thigh, high up in the groin, and by lateral traction, made by additional assistants, endeavor to lift the head over the projecting rim of the acetabulum. Persistent effort not bringing the bone down, the direction of the traction may be changed, so that the deformity is somewhat increased.

If the efforts are successful in further lacerating the capsule of the joint, tearing the ileo-femoral ligament, and all else in the way, the joint will be restored, leaving the patient in an oftentimes pitiable condition; skin excoriated, flesh contused, and occasionally with a broken bone to add to his former injuries. *Arnica* will be needed, and strict attention to quiet must be given for a number of days. The hip must be dressed as in the case of fracture, both with splint and bandage.

If the pulleys referred to are not at hand, and one of the "adjuster" cannot be secured, a very convenient improvisation can be made as follows: Cover the lower part of the thigh with a smooth firm

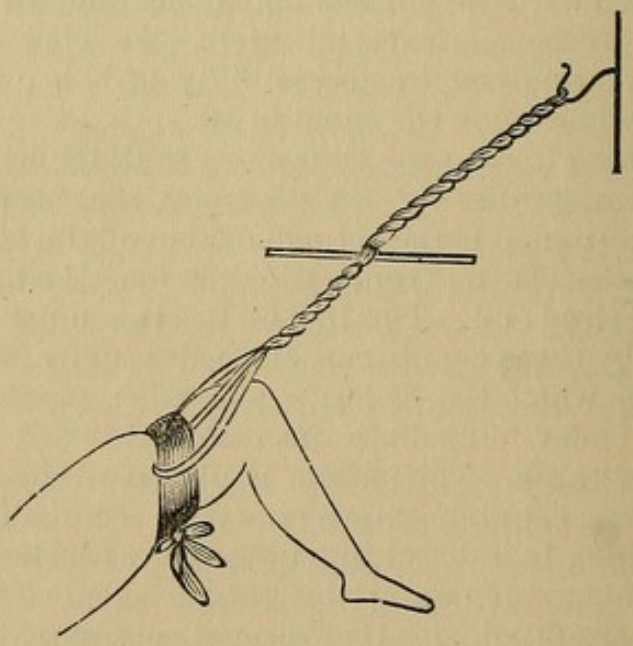


FIG. 54. SPANISH WINDLAS.

bandage. Fix a strong hook in the wall as when the pulleys are used. Double an ordinary clothes line, or other small rope, until it forms six parts, long enough to reach from the hook to the leg with some degree of tightness. Having previously applied the counter extension band, as above, attach the ropes to the thigh by passing a towel through the loops at one end, tying it firmly. The opposite loops being hooked over the hook in the wall, insert an ordinary walking stick through the bundle of strands, and make traction by twisting the ropes. It

will be a "steady drag," and in that respect is superior to the pulleys; but the amount of traction must be quite insignificant, which joined to the construction of the thigh, which increases in proportion to the tension, must make it a measure of doubtful utility, notwithstanding the authority of many well known names is loaned to give it respectability.

With this brief description I shall leave this subject, trusting that the day will soon come when works on surgery will not be compelled to give space to it, from the better knowlege further experience will give of more desirable methods.

(*b.*) *Manipulation*, the prevailing method of to-day, accomplishes its object by the fulfillment of the following indications: Relax the ileo-femoral ligament, and other opposing structures; lacerate the capsular ligament still further; and convert the femur into a lever to lift the head of the bone into the socket. These different objects are attained in the following manner.

The deformity is to be studied to determine, if possible, whether the femoral cervix is over or under the Y ligament. The dislocation being primary, the latter is almost necessarily the case. When secondary, and the foot is everted, the presumption is that the ligament is under the neck, and interposed between it and the acetabulum. We will first suppose a primary dislocation.

Chloroform the patient thoroughly, not so much to relax the muscles as to guard against involuntary resistance. The ligament (Y) is very tense, and binds down the head of the bone to the ileum. It is relaxed by forcing the knee well over to the opposite side, and flexing the thigh upon the abdomen at the same time. Carrying the knee far over as is convenient, all the time flexing the thigh, when full flexion has been secured, rapidly abduct the thigh, extending it at the same time, performing a sort of circumduction or rotation. This lacerates the capsule, as the first effort, the extension from a position of extreme abduction giving the lever like influence that lifts the bone into place. The first movements of the leg, brings the head of the bone down behind the acetabulum; the abduction tears the capsule enough to admit the head of the bone passing through, and raises the latter partly over the rim of the acetabulum. Extension deposits the bone in its proper place. It is not always that the reduction is accomplished at one attempt; the capsule may not be torn enough to allow the head to pass through; the abduction and extension may be made so slowly that an ischiatic displacement is produced; or some other unforseen or unusual circumstance may defeat not only the first, but many subsequent attempts. The presumption will be, after failure two or three times, that the Y ligament is *under* the neck. We will now proceed in a slightly modified way.

In obedience to a general maxim in such operation, slightly increase the deformity, which will be by carrying the knee outward, and backward. Now rotate the thigh inward, making a lever of the leg which

is partly flexed on the thigh; next flex the thigh upon the abdomen, carry the knee across the body, and proceed as before. The movements may be tabulated as follows:

HEAD UNDER THE LIGAMENT.	OVER THE LIGAMENT.
1. Abduction: Flexion.	1. Abduction: Backward.
2. Abduction: Rotation.	2. Rotation: Abduction, Flexion.
3. Extension.	3. Flexion; Abduction.
	4. Rotation: Extension.

Reduction having been accomplished, the patient must be put comfortably to bed, the hip bandage, or a long splint applied, and motion of the part forbidden for about a fortnight, when passive motion may be instituted.

If after reduction, which will be announced by quite a loud snap, the bones are again displaced, particularly if some crepitus is heard and felt during the process, the presumption is that there is a fracture of the rim of the acetabulum sufficient to prevent retention. Under these circumstances the case must be treated as one of extra-capsular racture in every particular, with extension, counter extension, and firm support.

In ancient cases, or in dislocations in old people, great care must be taken lest the neck of the bone is broken, and the case thereby rendered utterly hopeless as far as reduction is concerned. In the case of younger persons, the epiphysis has been detached. In this case, however, after reunion has occurred, renewed efforts may be made, with caution suggested by the former experience. Under all circumstances *Arnica* will be the remedy indicated for several day.

(*b.*) DISLOCATION OF THE HIP, ON TO THE PUBIS.—Statistics differ, as to the relative frequency of this form of dislocation; the presumption is, however, that it is among the more infrequent forms. The symptoms are unmistakable, and the treatment exceptionally easy.

The *causes* are many. In some cases a blow has been received on the back of the trochanter, driving the head of the bone forward and upward. In others, the leg has been forcibly abducted, rotated outward, and forced backward. This is particularly the case when in running, the foot is caught, the sudden arrest of motion throwing the body backward, and rotating it at the same time. I have seen but one case of this form of dislocation, produced as above; the patient was running across a rail road track, when the right foot caught in a frog, throwing him to the ground in the manner described. One case is noted as occurring when swimming, from some unusually violent motion.

The *pathology* is not constant. When the bone is thrown far over upon the pubis, towards the symphysis, or the head is thrown up under Pouparts ligament, the obturator internus is usually completely torn from its attachment, the ileo-femoral ligament either torn or

very tense, and the muscles in relation with the bone posteriorily also torn or stretched. The ileacus internus, and other structures passing out of the pelvis over the pubis are more or less contused, and stretched over the head of the bone, the lesion to the crural nerves producing considerable pain. The trochanter will be rotated backward, often occupying the acetabulum, the head of the bone correspondingly rotated forward. The capsular ligament will usually be completely torn, or at all events to such an extent that reduction will not be embarrassed.

The *symptoms* should be readily suggested by the forgoing. The leg is generally shortened, although in some cases there is no change in this respect, and in one instance it was slightly shortened. The leg is flexed, also the thigh, strongly abducted, and everted, so that the heel is found resting about the middle of the tibia of the opposite side The trochanter is lost entirely, or is carried very far backward, and the head of the bone can be felt, or seen, in many cases, in its new position. In those exceptional cases in which the head of the bone is forced under Pouparts ligament, the symptoms are somewhat different. Thus the trochanter is carried to the front, the leg rotated inwards, abducted, and presents many of the symptoms of the iliac displacement.

In the ordinary forms of this variety of dislocation, a secondary displacement quite often occurs, chiefly into the thyroidean foramen, and more rarely upon the dorsum of the ileum. This may occur spontaneously, or as the result of additional accident. Perhaps, however, it ottener takes place from attempts at reduction. When the latter occurs, the Y ligament is often found underneath the femoral neck, particularly when it has been secured by rotation of the leg outward. This has already received attention in an earlier paragraph.

Treatment.—Manipulation has proved to be unusually effective in treating this form of luxation. No mention will be made of extension, further than to state that the general principles are already laid down, and the modification of the methods noticed when speaking of iliac dislocations are too manifest to call for extended notice.

The ileo-femoral ligament being untorn, which will always be assumed in the regular forms, the indications are two-fold as related to that structure, *viz.*, relax it, and prevent the head of the bone riding over it. It will be relaxed by flexing the thigh on the abdomen, slightly increasing the deformity, as usual, by adducting the leg still further. Taking care not to extend the leg, and guarding against rotation of the femur outward, rapidly abduct the thigh, carrying the knee well across the body. Extend at full length, with a slight outward rotation. The variety may become changed into the thyroidean, by these methods, for the relief of which a future section must be consulted. The reduction will be much facilitated by making pressure with the hand on the head of the bone in the desired direction. Other methods of manipulation have been practiced, but as there is danger

of complicating the relation of the neck of the bone to the Y ligament, or rupturing it entirely, I much prefer to practice that laid down above.

(c.) DISLOCTION OF THE HIP UPON THE ISCHIUM.—Next to dislocations upon the dorsum of the ileum, those in which the head of the bone is thrown into the sciatic notch are the most frequent. Some authors have asserted that this luxation always occurs as secondary upon iliac displacement. HAMILTON, however, has collected a sufficient number of cases to determine the fact that ischiatic dislocations are not only often primary, but that the iliac variety are not seldom secondary thereto. I have no experience of my own to offer, but think reason and analogy must fully sustain the latter position.

The *causes* are forces that result in forcing the head of the femur downward and backward. The leg must be thrown into a very advanced position, almost at right angles to the pelvis, as would occur from falls on the knee with the leg advanced in front of the body, or abducted very greatly.

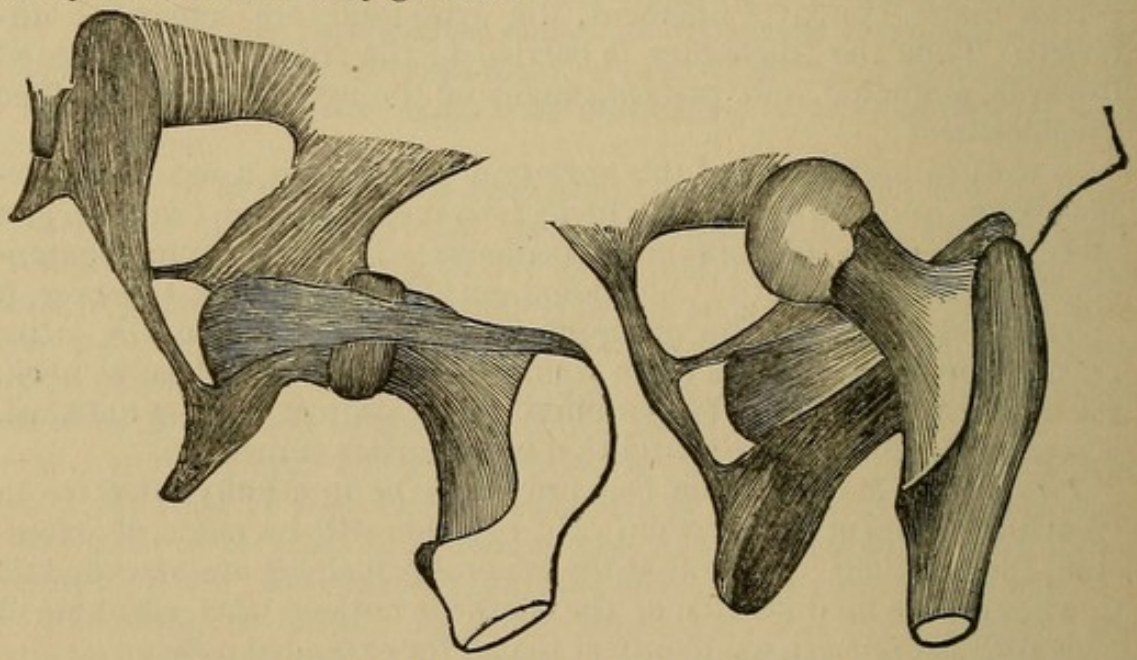


FIG. 55. OBTURATOR INTERNUS MUSCLE.

The *pathology* is of great interest, factors now being introduced that played a very unimportant part in the varieties already considered. The capsular ligament is extensively torn, the gluteus minimus, and gamelli muscles particularly lacerated, and the other muscles more or less contused and torn. The head of the bone will rest upon the margins of the sciatic notch, greater or lesser, sometimes within the foramen formed by the ligaments; it will be rotated backward, the great trochanter thrown correspondingly forward. The greatest importance and interest, however, attaches to the obturator internus muscle. This muscle, in its normal relations, and as affected by dislocation of the hip, will be comprehended from the following diagrams. It originates from the anterior margin of the obturator foramen, and the parts subjacent thereto, passes directly outward and forward, and is inserted into the digital fossa of the great trochanter.

It will be seen that the head of the bone being driven directly backwards, it will slip under the tendon of the obturator, and become an ordinary dorsal dislocation. When it passes outside of the tendon, it is arrested in its progress, and becomes a sciatic dislocation. For these reasons Prof. BIGELOW terms them all dorsal dislocations, qualifying them by the terms "above" or "below the tendon." When above the tendon it is in all respects a dorsal dislocation as I have described it elsewhere; when below it, the symptoms are so peculiar, the means for reduction are so different, that the older term ischiatic, or scitatic are proper and will be retained. In this form of dislocation, therefore, the femur being advanced at the instant the head slips out of the acetabulum, it passes up outside of the tendon of the obturator, and is checked by the tension of that muscle, unless it be torn, before it reaches the dorsum of the ileum. This will produce an exagerated appearance of dorsal luxation, the knee of the injured side being carried far over the thigh of the other side.

The *symptoms* in slight degrees of this displacement are so similar to dorsal dislocations that great care must be taken to avoid mistakes. The leg is greatly rotated inwards; is in a state of extreme abduction; flexion is extreme, and the head of the bone may often be felt in its new position. SYME has pointed out a symptom that will always be reliable, so much so that a diagnosis must always be held in reserve when it is not present. This is an arching of the lumbar spine when the leg is extended. The patient must be laid perfectly flat on the back on the floor, a table, or hard mattress, and the leg elevated at an

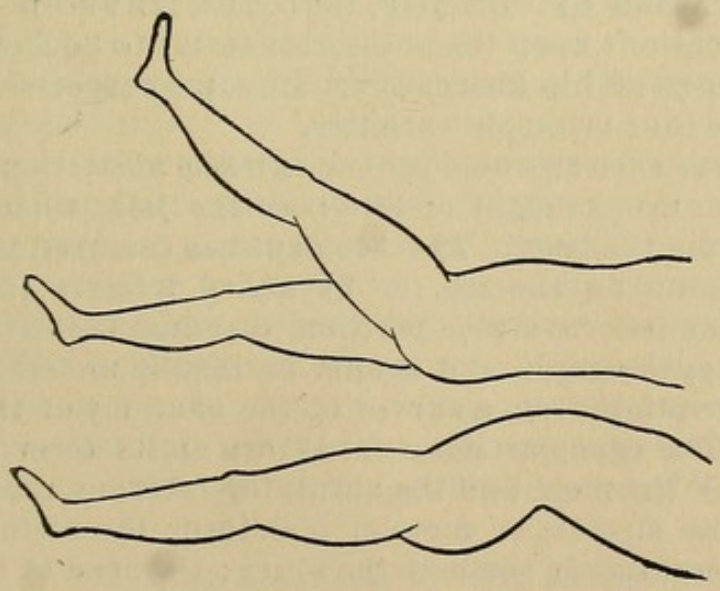


FIG. 57. ARCHING OF SPINE IN ISCHIATIC DISLOCATION.

angle of about 45° with the body. The back will be seen to be straight, and laid flat on the table. Now extend the leg, and press the

knee down with the hand. The lumbar spine will now be seen to arch in a condition of pronounced lordosis.

Prognosis is always good in recent cases; in ancient cases, particularly when the cotyloid cavity has become filled up, there is nothing to be done in the way of reduction, although cases occur in which the surgeon's art is called into requisition. I have seen two cases in which the hip was dislocated as a result of morbid action, and firm anchylosis had occurred. The thigh was carried almost at right angles with the body, directed outward, walking being only possible with the aid of a crutch, or by resting the hand on the knee, and thus distorting the spine very greatly. It is this distortion of the spine that calls for surgical aid, the health sooner or later seriously suffering therefrom. In one case the neck of the femur was severed by the subcutaneous method, a joint with some considerable degree of motion secured, and perfect restoration of the spinal distortion. The second case would not submit to an operation, and has passed out of my sight.

Treatment.—In reducing this dislocation by manipulation, the first indication is to release the neck from the tendon of the obturator, and to relax the Y ligament. By increasing the deformity, in carrying the knee farther over and higher, the head of the bone is carried away from the notch, and below the tendon. Rotating the leg outward, at the same time flexing the thigh fully, places the head underneath the tendon more completely. Now carry the knee to the greatest possible position of abduction, keeping it still flexed, and rapidly extend it. Usually the dislocation will be at once reduced, yet sometimes it is transformed into the dorsal variety. In the latter instance reduction is effected precisely as if the case were primary.

(*d.*) DISLOCATION OF THE HIP, INTO THE THYROID FORAMEN.—Next to dislocations upon the pubis, this seems to be more infrequent than other forms of hip dislocation. In some respects it is the most marked of the four principle varieties.

The *causes* are such as would induce extreme abduction of the thigh, or bringing unusual weight or strain on the joint when the limb is carried out from the body. The accident has occurred when skating, or from slipping on the ice, or by heavy weights falling on the shoulders when in a favorable position to abduct the extremity.

The *pathology* is simple, and should be readily understood, without detailed description, from a survey of the anatomy of the parts, and the causes. The capsular ligament is torn on its lower and anterior surface; the Y ligament and the obturator internus muscle put very much upon the stretch, or more or less torn; the abductor muscles may suffer laceration in some of the fibres; the head of the bone will be more or less engaged in the thyroid foramen, resting upon the obturator externus muscle.

The *symptoms* are prominent, and quite remarkably free from any complication with those of fracture. The extremity is lengthened from one to three inches; rotated outward or inward, usually suffi-

ciently inward to point the toes forward. Abduction is quite considerable, so much so that the knees cannot be brought together without the exertion of considerable force; the hip looks flattened; the trochanter is less prominent; the head of the bone may be felt sometimes in its new position; and the abductor muscles on the inside of the thigh are felt to be extremely tense. Pubic dislocation has occurred as a secondary phenomena, but cannot be of frequent occurrence.

Treatment.—From the fact that the head of the bone is sometimes quite firmly engaged in the foramen, it is often necessary to resort to a combination of extension and manipulation in effecting reduction. Having never had the privilege of treating a case of this character, I borrow the following description from HAMILTON (*Fract.* p. 670), as seeming to be that which I should adopt should occasion arise: "If we attempt to reduce by manipulation, it will be proper to follow the same rule which we have stated as applicable to dislocations backward, namely, to carry the limb in the first instance only in those directions in which it is found to move easily. Instead, therefore, of holding the leg in a position of adduction while the thigh is flexed upon the abdomen, it will be necessary to carry it up abducted; and when the further progress of the knee towards the belly is arrested, the limb must be moved inward, and finally brought down adducted. When the knee is about opposite the pubis, or a little lower, in its descent, the femur should be gently rotated inward, for the purpose of directing the head towards the acetabulum. The reduction may also be sometimes facilitated by lifting the head of the bone with the aid of a band passed under the upper portion of the thigh, and over the shoulder of an assistant; by giving to the shaft of the femur a slight rocking motion when it is about to enter the socket; and also by pressing with the hand against the head of the bone, or by lifting at the knee moderately."

As said in an earlier place, the terms used to designate these four varieties of dislocation represent the directions in which the head of the bone is carried; it is understood that there are very many modifications, with reference to extent. A dorsal luxation, represents an upward displacement of the bone, but has no reference to the extent or degree of the displacement. In a work of a general and practical character, such as this is designed to be, it is not necessary to notice all of these possible sub-varieties; the prevailing direction will indicate the slight modification in treatment, necessary to effect reduction.

2. DISLOCATIONS OF THE KNEE.

The size and structure of the parts entering into the formation of the knee, as well as the limited motion, renders dislocation an exceedingly rare accident. The various forms of displacement to which it is necessary to call attention, are dislocations of the patella, the cartilages, and the tibia.

DISLOCATIONS OF THE PATELLA.—The patella may be displaced in one of four directions, upward, downward, outward, and inward; yet inasmuch as the accident is more properly a rupture of muscles or tendons, in the so-called upward or downward dislocations, I shall exclude them from the category. This leaves but an outward or inward displacement, as true luxations, to which we may add a third, as an important modification of them, what is called the vertical, or rotary. In a normal condition of the parts the patella is seldom dislocated, and when the displacement is pronounced, to such an extent that surgical treatment is necessary to replace it, it is a matter of some doubt if the injury to the muscles and ligaments should not be considered the chief feature in the case, the dislocation being a complication thereof.

(*a.*) *Dislocation of the Patella Outward*, is caused by muscular action very frequently, a predisposition being an unnatural elongation or, laxity of the ligaments. Other causes are, twisting the thigh and body inward, while the leg and foot is fixed; falling on the knee, turning the leg outward; blows on the inner edge of the patella, particularly if the leg is flexed, or the extensor muscles of the thigh are contracted. These muscles being relaxed, the force must be extreme that would drive the bone into such a position that it would not immediately return to its proper place.

The *pathology* depends upon the extent of the displacement. In the majority of instances the luxation is partial, the inner facet of the patella resting upon the inner surface of the external condyle of the femur. Owing to the obliquity of both of these surfaces, the outer edge or margin of the patella is tilted forward, the sharp edge being easily felt and seen. In more extreme cases, the whole base of the patella rests upon the outer surface of the condyle, the inner edge then being prominent in front of the knee. The ligaments are injured also in proportion to the degree of displacement, some fibres torn, or very much stretched, in the minor degrees, and extensively torn when the displacement is complete.

The *symptoms* are unique, and unmistakable. The leg is more or less flexed, quite immovable; the knee is broader; the edge of the patella can be *seen*, as well as felt, if the swelling is not extreme; the inner condyle is unnaturally prominent; and the patient complains greatly of pain. The muscles are seen and felt to be in a state of tension, particularly the quadriceps extensor.

The *prognosis* is usually good, both as to facility in reduction, and future usefulness of the joint. In some instances reduction has not been effected, either through the difficulty in retaining the parts, or some peculiarity in position that forbids removal, and a fair degree of usefulness of the part has remained; in fact, in one or two instances of ancient luxation, the patient declined treatment, as no inconvenience of any kind was experienced. In all cases in which the luxation has been complete, reluxation is to be expected, upon very trivial

provocation, and measures should be taken to guard against it, such as wearing an elastic knee cap bandage, or some other permanent dressing.

Treatment.—The indications for treatment are very simple and obvious. The quadriceps extensor must be fully relaxed, and the bone pushed into its place with the hand. In many instances the relaxation of the muscle will alone suffice, the bone returning to its position spontaneously. To relax the muscle, extend the leg, elevate the thigh, and bend the body forward. Seating the patient in a chair, and placing the foot over the shoulder of the surgeon, seated in front, fills the requirements accurately. After reduction the leg must be laid on a pillow, and a few doses of *Acon.*, *Arn.*, or *Rhus.* given, according to the indications, and upon the subsidence of the inflammatory symptoms, place a proper apparatus on the knee to guard against re-dislocation. In most cases nothing fulfills this better than a light rubber bandage.

(*b.*) *Dislocation of the Patella Inward*, is less frequent than the opposite displacement, but in every essential particular is the same in causation, pathology, and treatment.

(*c.*) *Vertical dislocation of the Patella*, called by HAMILTON, "dislocation upon its axis," and by MILLER "semi-rotation," is a rare form of displacement, only eighteen examples being known to HAMILTON in 1871, when the fourth edition of his classical work was issued. It appears as a rotation of the bone upon its axis, and is thus described by HAMILTON (*Fract. and Disl.* p. 699): "They may be regarded as only exaggerated forms of incomplete lateral dislocations. In these latter accidents, as we have already noticed, the external or the internal margin of the patella, according as the sub-luxation is to the outer or inner side, is thrown more or less obliquely forward; a position into which it is carried partly by the peculiar form of the articulating surfaces, and partly by the action of the vasti and rectus femoris muscles. If now these muscles were to contract suddenly and violently, and the return of the patella to its normal position were prevented by the lodgment of one of its margins in the inter-condyloidean fossa, the other or free margin would be compelled to rise until it became perpendicular to the limb, or it might perhaps even become completely reversed in its socket. The signs of the accident are such as to render an error in the diagnosis almost impossible. The limb is generally found forcibly extended, occasionally it is in a position of moderate flexion, but the projection of the sharp border of the patella directly forward under the skin is itself sufficient to determine the true nature of the injury.

Reduction can usually be secured as in the case of ordinary lateral displacements, or by forcibly extending and flexing the leg a few times. It is recommended that the patient be required to make a strong effort at flexion. After reduction the same measures are to be pursued as in the case of other forms of dislocation.

DISLOCATIONS OF THE CARTILAGES OF THE KNEE JOINT.

This accident is rather infrequent, and yet few surgeons of experience have failed to see one or more cases. It is oftener preceded by some inflammatory affection of the part, or injury; at other times it seems due to some congenital peculiarity, by which the ligaments that confine these cartilages are lengthened. I have had the privilege of treating two of these cases, and in each there had been no dislocation of the cartilages until some time after sustaining a severe strain of the joint. The accident is an extremely painful one, and is severe inasmuch as the displacement is prone to be reproduced frequently, as well as the possibility of the so-called "false cartilages" forming in the joint, from portions being broken off.

The *causes*, in addition to such maintaining or predisposing conditions as are noted above, are oftener a sudden twist of the leg, rotation of the tibia. It has occurred from slipping on the ice, tripping on a carpet, or the toes catching in the bed clothes on turning in bed.

The *symptoms* are unique, and should be unmistakable. There is a sudden sharp pain in the knee, with complete loss of power in the extremity, and the sufferer usually falls to the ground "as if shot." The leg may be flexed or extended, but in either case the joint is intolerant of motion. In acute or recent cases, there will be rapid swelling and inflammation of the knee, and some considerable fever or other constitutional disturbance. In chronic cases, those inw hich the accident has been frequently repeated, the inconvenience may be but momentary, flexing and extending the leg a few times causing reposition, and disappearance of the symptoms. On tactile examination the edge of the cartilage may be felt, very often, projecting on the inside or outside of the joint, as it is displaced in one or the other direction.

The *treatment*, as far as reposition is concerned, is sufficiently simple. Grasping the knee with the right hand, making pressure inward on the displaced cartilages, with the other hand grasping the leg near the ankle make forcible extension and flexion a few times, at the same time slightly rotating the leg outward and inward. To prevent recurrence of the accident, it will be necessary to wear for a long time an elastic bandage or knee cap. In acute cases synovities will probably occur, and must be treated according to principles laid down in another place (*Surg. Therap.* p. 272). The "false cartilages" will probably require removal by surgical measures, but many cases have been cured in the following manner. When they can be felt and moved under the fingers, they must be pushed into some position where they can be held between the soft parts and the bones, as over one of the condyles, where it can be secured with adhesive strips properly disposed. There are instances in which it has contracted adhesions in this new situation, and ultimately become absorbed; the latter result may be occasionally hastened by the use of *Sil.*, in a medium attenuation, given two or three times a week.

DISLOCATIONS OF THE TIBIA.

The knee-joint, as said in an earlier paragraph, can only be dislocated by the exertion of great force; there being no lateral motion of the joint, the least possible rotary mobility, and full motion only in the direction of flexion, the strength of the ligaments nescessary to preserve the integrity of a joint so essential to locomotion, and exposed to such severe trials as this one must be, combine to render the accident not only infrequent, as compared to many other forms of dislocations, but makes the accident one of greater severity, with more serious symptoms at the time, and more important sequelæ. The subject can be properly considered under two heads, as occurring laterally, and antero-posteriorily, the sub-varieties being plain and easily comprehended without detailed description. Thus internal displacement is precisely the same as external, with a simple reversal of the terms.

(*a.*) *Lateral dislocations of the knee*, will be described as occurring outwards; when occurring in the opposite directions there will be a simple reversal of the direction of the force, and the means pursued to reduce it. The *causes* are blows received upon the lower and outer part of the lower extremity of the femur, or the inner side of the head of the tibia; extreme external lateral flexion of the leg; or a combination of these causes as occurring from falls.

The ligaments on the inner part of the knee-joint will be more or less torn; the internal condyle of the femur will rest on the external condyloid fossa of the tibia, and the crucial ligaments will not infrequently be torn, and in extreme cases the vessels and nerves in the popliteal space will be contused, or even torn when the displacement is complete. In young subjects the epiphysis of the femur will be detached, and the case become hopeless, as far as retention of a useful joint is concerned.

The *symptoms* are unmistakable. The displacement being complete, by which I mean the internal condyloid fossa is carried beyond, or nearly so, the external condyle, the case is usually compound. There will be extreme pain, in any case, the joint immovable, the thigh flexed on the abdomen, the leg more or less flexed, and abducted, as the displacement is more or less complete. The leg will also be somewhat rotated, usually everted; the knee will be much distorted, unusual prominence of the inner condyle, and the head of the tibia will be strongly pushed out externally. The patella will be displaced with the head of the tibia, when extreme, the ligament may be torn and the bone drawn up above the condyles of the femur.

The *prognosis* is always unfavorable, in any case in which there is displacement to a degree to call for surgical treatment to replace. There will almost surely be severe synovitis, much constitutional disturbance, and imminent danger of future anchylosis. Should the soft parts be lacerated, and a compound dislocation exist, the leg may usually be condemned, particularly if there is fracture. In fact there

is no little menace to life in such very severe lesions. Under all circumstances, a prognosis must be guardedly given ; in fact it is well to defer it until sufficient time has elaped to observe the efforts that are being made for repair, and the endurance of the patient.

Treatment.—The dislocation being compound, or complicated by fracture, or lesion to some of the important parts in the popliteal space, competent counsel should always be called, and the question of amputation seriously considered. In many cases it will be demanded to save life. Fracture of the femur, or separation of the epiphyses, must also call for careful and judicious weighing of the chances as to life, and future condition of the part as to repair and ultimate usefulness. If it is decided to attempt reduction and preservation of the joint, the dislocation must first be reduced, *after* which the fracture receives attention.

Reduction can usually be secured as follows: Anæsthetize the patient completely. If the leg is abducted, carry it still further outward, and flex it as far as possible at the same time. Make extension and adduction, with as much of a rocking motion as can be produced without disturbing the adduction. If the leg is already adducted, increase it and make flexion as before. Whether it be changed to abduction or not depends upon whether the luxation is internal or external. When the latter, abduct and extend; when the former, keep up adduction during the extension. In either case while the manipulations are carried on, an assistant must make strong pressure on the inner side of the thigh, and press inward on the head of the tibia.

Reduction being completed, the extremity must be put into a splint, and kept absolutely quiet for at least a week, or until the inflammation has very sensibly abated. After this, passive motion must be practiced to guard against anchylosis. A consolidation will rarely be perfect under three weeks, and even then, for some time the joint must be protected by an elastic bandage.

(*b.*) *Antero-posterior Dislocations of the Knee*, are produced by causes operating similarly to those considered under lateral luxations. Thus when the tibia is carried posteriorly, a blow on the back part of the lower end of the femur, or the front of the head of the tibia; extreme flexion of the leg, or falling with the leg doubled underneath the body. When the displacement is anteriorly, the conditions of causation are reversed.

The pathology depends upon the direction as to particulars, although it is similar as to generalities. Thus the ligaments will be torn or stretched on the side of extension; relaxed, in those of a minor degree, or contused and torn on the side of compression, in more extensive displacements. The ligamentum patellæ will be probably torn, in backward dislocations; the vessels and nerves in the popliteal space can scarcely escape injury of some kind if there is decided displacement.

The *symptoms* are very marked and prominent. In backward dislocations the leg is flexed, thigh also as a rule; the condyles very prominent, and on attempting extension the head of the tibia will be felt and seen in the flexure of the knee, as a large firm prominence. In anterior displacements the leg will be extended in moderate degrees of displacement, extended to an angle, where the displacement is greater, and even somewhat flexed if the displacement is small. Pain is quite severe under all circumstances, and it is impossible to place the foot on the ground, or attempt any motion of the part.

The *prognosis* is somewhat better in these forms of dislocation than in the lateral varieties, probably from the fact that there is really less injury done the parts than in the latter case. There seems to be less inflammation, as a rule, and there is less danger of compound injury, or serious complications. In most of the recorded cases the patients were enabled to throw away their crutches in from two to three months, although some used them for a year.

Treatment.—Reduction is to be accomplished by attention to the principles generally applicable to dislocations, *viz.*, slightly increase the deformity, and then moving the part *quickly* in the opposite direction, with pressure on the head of the bone. Perhaps as HAMILTON remarks, it will occasionally be necessary to resort to some of the methods of extension. After reduction the case is to be treated as other forms of dislocation of the knee.

3. DISLOCATIONS OF THE ANKLE.

HAMILTON, and most of the older English surgeons, speak of dislocations of the ankle joint as chiefly affecting the tibia, and use the terms dislocation of the lower "end of the tibia," outward, inward, etc. The continental, and most of the American practitioners, refer to the *foot* as being the part dislocated. It is not unimportant which classification we adopt, as the meaning of the terms are completely reversed. As the majority of practitioners, in this country at least, consider the foot to be the part dislocated, and if it were otherwise my regard for consistency and system would forbid a different arrangement, I shall adhere to the plan already adopted, and refer to the distal portion of a joint as the part displaced. It will be seen that a forward luxation of the lower end of the tibia would be a backward luxation of the foot; an outward of the former, an inward of the latter; it is unfortunate that such confusion should exist, as without bearing the differences constantly in mind, the student can scarcely acquire an intelligent knowledge of this accident.

The foot may be dislocated in one of four directions, in the order of frequency, outward, inward, backward, and forward.

(*a.*) OUTWARD DISLOCATION OF THE FOOT.—It was remarked in a former paragraph that there was always room for doubt, in injuries of the ankle joint in which the foot was turned outward, whether the condition of fracture or dislocation claimed pre-emminence. Many excellent authorities are inclined to ignore the existence of such a

dislocation, *per se*, based upon the observations of MR. POTTS, in which it is shown that a fracture of the internal or external malleolus will necessarily produce more or less dislocation of the astragalus from the tibia. The accident is often spoken of as "*Potts Fracture.*" As a matter of fact the fibula is always fractured; *per contra*, in fractures of the fibula, there is always dislocation. However, in obedience to custom, the accident will be referred to in this place as a dislocation.

The causes are similar to those operating to produce fracture of the fibula; such as a violent twist or rotation of the foot outward; falls on the feet, turning the foot outward, or the action of machinery.

The *symptoms* and *pathology* are singularly well defined, so much so that an error in diagnosis seems almost impossible. The foot is turned outward, so that the inner edge rests upon the ground; often the foot is more or less flexed; the internal malleolus is sometimes fractured, more or less, usually little more than the portion to which the internal lateral ligament is attached becoming separated; when not detached, it is prominent; the external malleolus will not be very prominent, but the depression toward the tibia of the upper fragment of the fibula, will cause an appearance of prominence that would not otherwise exist. In cases in which the displacement is extreme, there is often, indeed in my experience, always, a wound opening the inner side of the joint. The internal lateral ligament is nearly always torn. A peculiarity of this accident, considering it as a dislocation, is that there is not that rigidity and immobility so characteristic of dislocation elsewhere; in fact there is all the mobility of fracture.

Treatment rarely if ever presents any difficulties, either of reduction or retentions. Reduction is very easy, following ordinary mechanical indications. Simply draw the foot inward, making slight extension. As long as the foot is kept perfectly quiet, the parts will remain in position; any attempt at motion, however, displaces them again. The part must be dressed, therefore, as laid down in fractures of the fibula, with proper splint.

(*b.*) INWARD DISLOCATION OF THE FOOT.—This is a rare form of dislocation, and one that is the result of greater force than a displacement in the opposite direction. The symptoms are similar, only reversed. The foot is turned inward, the outer edge resting on the ground. The lower end of the tibia is broken, more or less obliquely; the external lateral ligament will remain entire if the fibula is broken, but will give way if the fibula remains intact. Frequently the astragalus also partakes in the fracture, having been found broken into as many as three pieces.

Reduction and retention are to be conducted upon the same principles already laid down, the case being very similar in all essential particulars.

(*c.*) ANTERO-POSTERIOR DISLOCATIONS OF THE FOOT.—The astragalus may be dislocated backwards or forwards from the tibia, by

force acting in one or the other direction. The fibula is often broken, when the displacement is backwards, and the tibia oftener when in the opposite direction.

Backward dislocations show an unusual prominence of the heel, with a shortening of the foot, and a prominent proportion of the end of the tibia in the instep; the toes are pointed downwards, and turned a little inward or outward, as the external or internal malleolus has been fractured.

Forward dislocation permits exactly opposite indications. The foot is longer; the heel is lost; the head of the tibia projects backwards; the foot is somewhat flexed; and the toes usually inverted.

In either case the principles of reduction are the same, *viz.*; traction and pressure, no great difficulty ordinarily being experienced. The foot and ankle must also be put up in a regular fracture dressing.

In each of these dislocations there must be scrupulous attention paid to passive motion after the primary symptoms have abated. There is, it seems to me, unusual danger of anchylosis, whether bony or ligamentous, chiefly from the number of tendons passing over the joint, and which have such an important part to play in locomotion.

4. DISLOCATIONS OF THE TARSUS.

The tarsal bones are liable to dislocation, only by the exertion of very great or unusual force, and usually constitute a very grave injury, at once from the violence of the force applied, and the destruction or injury to near parts essential to the functional life of the part. With two exceptions, it is not at all necessary that works of a purely practical character should devote much space to a minute description of these accidents; in the vast majority of instances the condition being such that the most superficial knowledge of anatomy must lead to a correct conclusion. Moreover, whilst dislocation of the astragalus and calcaneum are often accidents of the highest degree of importance, those of the smaller bones are not so, as a rule. I shall confine my remarks, therefore, to these two bones, the principles of treatment being the same in all, so far as circumstances will favor their application.

1. DISLOCATIONS OF THE CALCANEUM, a rare form of luxation, has been produced by blows or falls upon the sole of the foot, or the heel, producing a characteristic deformity. The leg being held in a perfectly straight position, with reference to the tarsus, the heel will be readily traced as deflected outward, or inward, sometimes upward or downward. Flexing the thigh and leg fully, to relax the tension of the flexors of the leg, and for the same purpose extending the foot, the dislocated bone has always been readily reduced in the few examples recorded in the books. Recovery has been prompt, one case being discharged as early as the fifth week with "complete use of the foot." A case of Sir ASTLEY COOPER'S required more than six months, but recovery was complete.

2. DISLOCATIONS OF THE ASTRAGALUS, meaning dislocation from

the other tarsal bones in general, but particularly from *all* of its articular connections, is an exceedingly severe accident. The bone is displaced in many directions, and produces very prominent symptoms. Inasmuch as I have never been fortunate enough to have such a case under treatment, I will quote from HAMILTON (*Fract. and Dis.* p. 728), his description of the appearance: "The great prominence occasioned by the displacement of the bone in either of these several directions, accompanied generally by more or less lateral deviations of the foot, is alone sufficient to indicate the true nature of the accident. In some cases, also, the foot is forcibly flexed or extended; the leg is shortened in consequence of the tibia having fallen down upon the calcaneum; the superincumbent skin and tendons are rendered tense; blood is effused, and swelling speedily occurs. In the backward dislocation, the position of the foot is not much changed, but the tibia being slightly carried forward, the length of the dorsal aspect of the foot is poprortionally diminished."

"Such are the symptoms which plainly enough indicate the dislocation in the most simple cases; but in a majority of the examples which have been seen, the integuments have been more or less extensively torn, exposing to the eye at once, the naked bone, and thus removing all chance of error in the diagnosis."

"Norris mentions a case, seen by Hammersly, in which the astragalus was thrown completely out, and was subsequently found in the earth where the patient had received his injury. Inflammation, gangrene, and tetanus supervened, and the patient died on the seventh day."

Treatment.—The first indication is to reduce the dislocation, if no wound in the integuments exist. The foot must be well extended by assistants, even the tackle of COOPER'S may be employed, while the surgeon attempts by pressure and manipulation to force the bone into position. At times this will be easily accomplished, and again only with the greatest difficulty, if at all. HAMILTON (*loc. cit.*) says: "There are certain principles, however, which seem to be sufficiently settled to allow of an authoratative announcement; these may be briefly stated as follows: If the dislocation is simple, reduce the astragalus immediately, provided this is possible. If the luxation is complete, and it cannot be reduced, even partially, proceed at once to resection or to amputation. In compound dislocations, resection or amputation affords the only safe resource. In all cases the inflammation is likely to be intense, in order to prevent which complication the surgeon must be unremitting in his use of the appropriate remedies."

As to dislocations of the metatarsus and phalangeal bones, there are no essential points of difference from similar accidents in the upper extremities, and what is there written will apply with perfect relavancy in the present instance, the student is, therefore, referred to that article.

III. INJURIES TO THE BLOOD VESSELS.

The blood vessels of the lower extremities, having a primary origin in the iliacs, there is less difficulty in determining the source of hæmorrhages, and the main trunk of the smaller branches, than exists in many other regions of the body. The vessels that may require ligature are as follows: Obturator, sciatic, gluteal, superficial epigastric, superficial circumflex ilii, external pudic, muscular, anastomotica magna, profunda, external circumflex, internal circumflex, popliteal anterior tibial, dorsalis pedis, posterior tibial, external and internal plantar.

(*a.*) *Obturator Artery.*—This artery is the second branch of the anterior trunk of the internal iliac, (see Fig. 47. p. 491), but is liable to some anomalies in this respect; thus it occasionally arises from the epigastric, and again has a double origin, from both. It passes out of the obturator foramen, at the upper margin, a little forward of the centre, and immediately divides into two branches, supplying the dductor muscles, and the hip joint. Should it be impossible to secure the vessel in the wound, the trunk *may* be tied, but the incision must be deep, and the operation one of some magnitude. The branches curve around the foramen, and anastomsee below. The vessel will be sought for, therefore, deep in the groin, underneath the large adductors, and beneath the obturator externus.

(*b.*) *The Sciatic Artery.*—The anterior trunk of the internal terminates by dividing into two secondary vessels, the pudic and sciatic. The latter is much the larger, and may be considered a continuation of the primitive trunk, passing out of the pelvis between the cocygeus and pyriformis muscles, in company with the sacral nerves, lying between the nerve and vein, the nerve being external or in front. It will be found under a line, two inches in length, made parallel to the posterior margin of the pyriformis, close to the anterior margin of the tuber-ischii. The gluteus maximus will require partial division.

(*c.*) *Gluteal Artery.*—The artery is the termination of the posterior trunk of the internal iliac artery, passing out of the pelvis at the upper part of the great sciatic notch, above the upper border of the pyriformis muscle, being separated from the sciatic artery by the breadth of this muscle. The line for the incision is given as follows: Draw a line from the anterior superior spine of the ilium to the trochanter major, the leg being extended. The incision, which must be four or five inches long, is made parallel to the fibres of the gluteus maximus, separate the fibres with the fingers; next separate, still with the finger, or handle of the scalpel, the pyriformis and gluteus medius muscles, beneath which the vessel will be found deeply placed.

(*d.*) The *Femoral Artery.*—This is the continuation of the external iliac, passing out of the pelvis, over the brim, under Pouparts ligament, passing downward and inward to the opening in the adductor magnus, through which it passes, and becomes the popliteal. A line

drawn from the centre of Pouparts ligament to the inner condyle of the femur, will quite accurately indicate its course. The inner edge of the sartorius muscle is a good guide, the lower two-thirds of the vessel being situated just beneath it. In the upper part of its course, in the triangle of Scarpa, the vessel is very superficial. It is not deep at any part of its course, until just before it pierces the adductor, where it is deep. The nerve is on the outside, the vein inside and partly beneath the artery. The relations this important vessel bears to the other blood vessels of the thigh, both anterior and posterior, or for that matter to those of the lower extremity generally, must be well borne in mind, as it is often required to take it up for hæmorrhage from other vessels, and every inch the ligature approaches the trunk adds to the gravity of the case.

(*e*) *Superficial Epigastric Artery.*—This vessel is the first branch from the femoral, given off about half an inch external to Pouparts ligament, passes through the saphenous opening in the fascia lata, and ascends the abdomen in the direction of the umbilicus. A line drawn from these points will quite accurately cover the course of the vessel. It is better to tie in the wound, or some parts of its course, and owing to the anastomosis with the deep epigastric and internal mammary vessels, a ligature will be required on both sides of the wound, to guard against recurrent bleeding.

(*f.*) *Superficial Circumflex Ilii.*—This vessel, the second branch of the femoral, arises close to the epigastric, and passes upward along Pouparts ligament to the iliac crest, ultimately anastomosing with the circumflex iliac, the gluteal, and another femoral branch, arising lower down, the external circumflex. For this reason a double ligature is required in this instance also. The line for the exposure of the vessel is Pouparts ligament.

(*g.*) *Superficial External Pudic Artery.*—The superficial pudic artery is really two distinct vessels, the superior and inferior. They are the third in order, from above downward, and given off close to the preceding.

The *superior* passes out of the saphenous opening, and passes inward, across the spermatic cord, supplying the integuments of the genitals. The *inferior* does not pierce the fascia lata until it reaches the ramus of the pubis, whence it is distributed to the genitals, terminating by anastomosis with the superficial perineal.

(*h.*) *Anastomotica Magna.*—Is a large trunk, the last given off by the femoral, originating just above the opening in the adductor magnus for the passage of the femoral. It soon divides into a deep and superficial branch, the former of which is lost in the substance of the vastus internus muscle, whence it emerges lower down to supply the inside of the knee. The latter, or superficial branch, ultimately pierces the fascia lata, and is distributed to the integument. The trunk of the vessel is found by continuing the line drawn for the femoral.

(*j.*) *Profunda Artery.*—The older anatomists speak of this as the *deep femoral*, distinguishing it from the common femoral by terming the latter the superficial. It arises about one and a half or two inches below the pelvic rim, from the outer and back part of the femoral, keeping outside until about the centre of the thigh, then crossing under the artery and vein, descending the inner side of the extremity, until it terminates in a small branch, which piercing the adductor magnus is distributed to the flexor muscles. The line of the vessel is so nearly similar to that for the femoral, that one will sufficiently answer for both. There are a number of small vessels thrown off from the profunda, which are chiefly muscular branches, and difficulty will often be experienced in determining whether they are from the femoral or profunda. Those of more importance are two in number, as follows:

(*k.*) *External Circumflex Artery.*—This vessel, or system of vessels, arises from the profunda within an inch of its origin, by a short large trunk, which passes directly outwards between the crural nerves. It immediately divides into three branches, which again subdivide into many, and supplies the muscles on the front of the thigh. The ascending branches anastomosing with the gluteal and circumflex iliac arteries; the descending with the articular branches of the popliteal; and the transverse with the sciatic, the internal circumflex, and the perforating branches of the profunda. This free anastomosis calls for double ligatures, when the vessels are tied for wounds, distal and proximal. The trunk of the vessel may be found by drawing the sartorius muscle strongly outward, the thigh being extended, and the leg flexed and rotated inwards to fully relax it.

(*l.*) *Internal Circumflex Artery.*—This is a smaller vessel than the above, and is given off nearly opposite the external vessel, on the inner side of the profunda. It passes directly inwards, underneath the femoral artery and vein, and winds around the femur between the pectenius and psoas muscles. It is finally distributed to the muscles on the back of the thigh, and the structures of the hip, anastomosing with the external circumflex, the sciatic, and the perforating arteries.

(*m.*) *Popliteal Artery.*—This large vessel is a continuation of the femoral, commencing where the latter pierces the abductor magnus, and continuing across the popliteal space until it divides into the anterior and posterior tibial arteries. The vessel is directed from within outwards in the flexure of the knee, but the natural contour of the parts is such, that a line drawn directly in the center of the space, will cover its course. It is deeply situated above, quite superficial in the middle, and deeper again below, where it is covered by the heads of the muscles of the calf. The vein will usually be found quite adherent to the artery, and external to it; the nerve is still more external. A number of branches are given off, quite transversely, which supply the joint, and muscles in the neighborhood; any vessel

injured in this region, must be a branch of the popliteal, and no lengthy description is needed.

(*n.*) *Anterior tibial*—This artery commences at the bifurcation of the popliteal, at the lower border of the popliteus muscle, passes forwards between the origins of the tibialis posticus, through the interosseus membrane at the heads of the leg bones, and descends on this membrane to the ankle joint. It lies rather deeply through most of its course, particularly at the commencement; at the ankle it becomes quite superficial. The course of the vessel may be marked out by drawing a line from the inner side of the head of the fibula to a point in the ankle midway between the malleoli. The venæ comites are placed one on each side of the artery, the nerve lying on the outside above and below, curving over the artery about the middle. The operation for ligature varies somewhat with the point selected, although the artery will be found about ten lines exterior to the spine of the tibia.

In the *upper third*, turn the leg inwards, extending the foot, and divide the integument, in the line already given, about four inches; divide the deep fascia by a crucial incision, to give room. The intermuscular fascia is then found, by noting, according to STEPHEN SMITH (Oper. Sug. p. 267), "(1) as the first intermuscular space from the tibia; (2) on pressure from within outwards the resistance of the other muscles; (3) at the lower part of the wound the white line of the muscular interspace is more marked." Divide this, flex the foot, separate the muscles, and the vessel will be seen.

At the *middle third*, the vessel is not so deep. Incise the integument, to the same extent as above, in the same line. Divide the deep fascia, known by the white line, and with a spatula or retractor draw the tibialis anticus internally, and the long extensor externally; the nerve is first found, which on being pressed outward exposes the artery.

At the *lower third* the incision, three inches in length, is made on the line of the external border of the tibialis anticus, being careful not to extend it into the annular ligament. This muscle and the one next outside, the extensor propprius policis, are separated, and the vessel will be readily found, the nerve slightly in front.

(*o.*) *Dorsalis pedis artery.*—This vessel is the continuation of the anterior tibial, and will lie under a line drawn from between the malleoli to the space between the first metatarsal bones. An incision two inches in length, through the integument and fascia, had better be made on a director to avoid injuring the ligaments. The external tendon of the extensor brevis digitorum, is to be drawn outwards, exposing the artery.

(*p.*) *Posterior tibial artery.*—This artery is a continuation of the popliteal, passing downwards in a line drawn from the center of the popliteal space to the inside of the internal malleolus. It lies very deep, throughout most of its course, requiring a somewhat different operation in each of the three divisions.

In the upper third the artery is found underneath the gastrocnemius and soleus, resting upon the popliteus. The different layers must be taken up separately; the heads of the gastrocnemius may be separated, but the fibres of the soleus will require division. This exposes the deep fascia, which being divided brings the nerve into view, crossing the vessel obliquely from within outwards. The nerve is to be held inwards, and the ligature carried close to the vessel to avoid the vein which is on each side, in close relation. There are few conditions in which it would not be preferable to take up the popliteal.

In the *middle third*, the vessel will be found about an inch internal to the tibia. Divide the integument and fascia by a free incision, and draw back the free border of the gastrocnemius now brought into view. The fibres of the soleus, at the bottom of the wound, are to be divided, parallel to their course, when the artery can be felt pulsating below the apeneurotic fascia. This is divided on a director, and the vessel tied.

In the *lower third*, the incision is made parallel to the tibia, about a fingers-breadth behind the malleolus. The vessel is found embedded in a mass of fat immediately beneath the superficial fascia.

(*q.*) *The Peroneal Artery.*—This vessel is a branch of the posterior tibial, given off immediately below the lower border of the popliteus muscle. It can be marked out by carrying a line from the centre of the popliteal space to the inner border of the internal malleolus, then rubbing out the line above the level of the internal tuberosity of the head of the tibia. It lies deeply, and is exposed and tied by the same procedures given for the posterior tibial, the incision being on the line indicated.

(*r.*) *The Plantar arteries.*—These vessels are the continuation of the posterior tibial, and may be marked out in the sole of the foot, by the following lines: Draw one line from the center of the heel to the base of the metatarsal bone of the great toe, externally. Draw another, from the inner edge of the internal malleolus, to the head of the metatarsal bone of the little toe. Draw a third line, from one malleolus to the other, across the bottom of the heel, rubbing out the posterior portion of the line on the heel. The inner line will mark out the internal plantar; the outer line, to the little toe, will mark out the external plantar, and the last part of the posterior tibial.

IV. INJURIES OF THE NERVES.

The nerves of the lower extremities are exposed to the same injuries, with the same symptoms and indications for treatment, as those of the upper extremities. One case will serve to illustrate the subject.

CASE. C. aged about twenty-five. Some years before had sustained an injury to the right leg, by being caught between the steps of a buggy and a tree, in such a manner that a deep wound was made in the popliteal space by the corner of the steps. There was no injury to

the artery as far as could be learned. The wound healed promptly with little if any surgical treatment, there remaining slight flexion of the leg from cicatricial contraction. The scar was painful, more particularly upon pressure, but the symptoms were not at all severe. Some time afterwards, how long has not been learned, he commenced having epileptiform convulsions, with a sort of cataleptic complication, which became so frequent that he was taken to Chicago and placed under the care of PROF. GUNN, who cut down upon and stretched the popliteal nerve. The operation was followed by some benefit, for a time, but he soon became worse than ever.

In March 1877, he came to the clinic at the University, and after giving remedies a faithful trial, he was turned over to me for surgical treatment. At that time his condition was as follows: Bodily appearance good, quite robust; mind very slightly, if at all impaired. The right leg was found partially flexed, giving a limp in his gait; full extension was impossible. Temperature was normal, and no atrophy or loss of muscular power. There was a firm cicatrix in the popliteal space, quite sensitive to pressure or touch. Had severe spasms once or twice a day, but which could be excited at any time by touching or irritating the scar. The spasms, when not excited by injury to the scar, would come on suddenly, with loss of consciousness, and frequent grasping the head with the hands. During the spasm, which would often continue during ten or fifteen minutes, he would sing, declaim, recite long poems, propound conundrums, etc., being frequently interupted by a convulsive shuddering, and grasping the head in the hands. He was entirely oblivious to all external impressions, and had no recollection of what had occurred upon regaining consciousness. Numerous remedies had been administered by my colleague Prof. Jones, but no benefit followed. It was finally determined to attempt surgical measures, and on consultation with Prof. J. C. Morgan, who ably assisted me, it was determined to proceed as follows:

An Esmarch bandage was applied, and the cicatricial tissue, included in an eliptical incision, was dissected out. All trace of nodular tissue was removed from the deeper parts, the popliteal nerve carefully freed from adhesions contracted with near parts, and then stretched by making traction upwards, to the extent of an inch, or an inch and a half. The bleeding having entirely ceased, after the removal of the tourniquet, the wound was covered in by transplanting a flap of integument from above, sliding it over without making a complete twist in the pedicle, and securing it by many points of interupted suture. The wound left by removing the flap was allowed to close by granulation. It was thus hoped that the injured tissues beneath the flap would heal as in subcutaneous wounds, without new adhesions to the nerve. This seems to have been the case. After the operation the pain was atrocious, and was only partially relieved by *Allium cepa* and other remedies, but there was no return of the spasms.

Dr. JONES advised *Stram.*, which was given in the 30th dilution, with what result can never be estimated. The case did well, and fourteen months afterwards reported at my clinic in perfect health, the leg straight, all the motions perfectly performed, and apparently completely cured. One year and a half still later, nearly three years after the operation, he remained well.

This case illustrates one phase of the injury, and also the former inability to control the pain which, when a nerve has been stretched, invariably ensueing. Later I have been able with *Hypericum*, to demonstrate the potency of the indicated remedy to alleviate suffering.

XXVII. INJURIES OF THE MALE GENITALS.

Injuries of the pelvic organs, common to both sexes, have been spoken of in a preceding chapter, so that it now remains to consider those of the genito-urinary apparatus peculiar to the sexes. In the present instance I shall include the injuries to which the scrotum, testicles, urethra, and penis are exposed, in the order named. This class of lesions might well demand extended notice, when we recall that even when life itself is not immediately threatened, mutilation may render it a burden. The interest, in many instances, lies chiefly in the great destruction of tissue and functional loss succeeding urinary infiltration, and the fact that the establishment of perineal or other urinary fistula renders the sufferer as much an object of aversion to his friends as he is disgusting to himself. Whilst it is desired to be as brief as possible in the treatment of these subjects, yet an attempt shall be made to be as thorough as is consistent with that object.

I. INJURIES OF THE SCROTUM.

Whether from its protected position, or some peculiarity in resiliency in the dartos, certainly the scrotum is very seldom injured, in proportion to injuries of other tegumentary structures. Its extreme vascularity is at once a promise of speedy repair, and a menace; the latter from the possibility of extravasation of blood, which may become disorganized, but whether or no is often a serious complication in what might otherwise be a trivial accident.

(*a.*) *Contusions* of the scrotum can only occur without associated injury to the testicles, by a portion of it becoming caught between two hard substances, as has occurred when riding on horseback. It is very rarely, under ordinary circumstances, that contusions are of sufficient gravity to call for surgical attention, the effects soon passing off without any kind of treatment. There are instances, however, although the accident occurs very seldom, in which a blow has been received from some hard substance, or an individual has fallen astride on some hard body, as a fence rail, and the parts severely contused, the skin even giving way. One or two instances of "splinter wounds" in naval combats are on record. The effects are usually immediate swelling, with much pain, and feeling of weight in the parts. The pains run up the spermatic cord, and if the swelling is extreme there

will be the "sickening" pain so characteristic of injury to the testes. Blood will be effused in greater or smaller quantities, and a hæmatocele be developed. When the effusion is large, the swelling may extend up into the abdominal rings becoming a possible provocation of future hernia. Should the blood coagulate, there will be great danger of permanent injury to the testicle, which becoming compressed has sometimes entirely disappeared from absorption. Gangrene is not a frequent termination, but there are instances of sloughing proceeding to such an extent that the whole scrotum has been lost.

Treatment.—The first indication, in all cases, is to protect the testicle from injury. The degree of danger, in the absence of any direct injury to that organ, is proportionate to the swelling. There being much extravasation of blood, contrary to the usual practice in contusions in other parts of the body, a free incision must be made to give it ready exit, and the bleeding vessel, if still open, sought for and tied, or otherwise secured. It is essential to distinguish the swelling of inflammation from that of extravasation, the indications for treatment being radically different. In inflammation the swelling is smooth and uniform, the skin red, hot, and shining; there is no pitting on pressure, and the swelling feels elastic.

In the case of hæmorrhage, on the contrary, the swelling is at the bottom of the scrotum, at the commencement gradually rising as the amount of blood increases. There is not necessarily evidences of inflammation, although it usually is present, and much complicates the diagnosis. At first the swelling is fluctuating, but later it is apt to become more doughy and boggy, as coagulation proceeds, and pits more or less on pressure.

Having arrested the hæmorrhage, and turned out the extravasated blood, if it seems necessary, the ordinary conditions of contusion are to be met with *Arnica*, both locally and internally, or *Bell.*, if the inflammation runs very high. It will add to the comfort of the patient and materially promote a cure, if the scrotum is suspended in a sling, even when occupying the bed. The more quiet the patient is kept, the more rapid will be the recovery. Warm applications may also add to his comfort.

(*b.*) *Wounds of the Scrotum* are either lacerated or punctured, in the large majority of instances, in civil practice; in military reports some instances occur of gun-shot injury without implication of the testicles. In most cases, even when the laceration is of sufficient extent to denude the testicles, repair is usually rapid. In fact, quite considerable loss of tissue may occur and repair be very speedy, without any subsequent inconvenience. A case is noted in my "case-book" of a large portion of the right scrotum being torn completely off, by the sufferer falling on an iron hook, which was followed by complete repair, and no injurious compression of the testicle, the gap being closed by drawing the parts together with fine sutures.

If there is any tendency to inflammation, either from plethora,

anæmia or constitutional peculiarity, it is well to be on the guard against an attack of erysipelas, which, as is the case in most organs of such loose texture, may spread with rapidity, and be very severe. During the late war the army reports state many such cases occurred, and it was proved necessary to treat them by free incision. I have seen three or four such cases, yet have usually succeeded in curing them with *Rhus.*, *Apis.*, *Ars.*, or *Bell.*, much more satisfactorily than would have been the case had the integument been opened.

(c.) *Injuries to the blood-vessels*, occurs to a greater or less extent in all injuries of the scrotum. The tissues of the part, particularly the dartos, are extremely vascular, the size of the vessels being much diminished by their number. The small size renders the application of a ligature seldom necessary, certainly preferable to attempting to take up the primitive trunk, which cannot easily be determined. Thus the supply is drawn from branches from the femoral, the superficial external and internal pudic arteries; the deep pudic branches, also supply twigs; the superficial perineal, from the internal pubic; and the cremasteric, from the epigastric. The free anastomosis between all of these vessels in the scrotum, and the almost insuperable difficulty in determining which vessel supplies the part immediately under observation, would expose the surgeon to the liability of mistake if a search was instituted for the parent vessel, the chances of failure being as one to three. Even if found, secondary hæmorrhage would likely come on, and another vessel require ligation, and so on until the whole blood supply was cut off. For this reason, if the bleeding vessels cannot be found and taken up, it is far better to trust to styptics (hot water), than to engage in a search that will rarely be rewarded with success.

II. INJURIES OF THE TESTES.

As effects the generative function, there can be no question that injury of the testes is a matter of some moment; as it may effect the moral nature, much depends upon the age and habits of the individual. The menace to life, under all circumstances, even when the injury is severe, is quite insignificant. Thus the records of the War Department show, thatin our late war there were 506 cases of gunshot injury of the testes, of which only 66 died, chiefly from "complications;" the remaining 520 making perfect recoveries, in many instances claiming no pension for disability. The symptoms of injury are severe, however, and much may be done to hasten repair, and lessen the functional loss.

An injury to an unformed boy, by which the testes are lost, will be likely to develope the characteristics of eunuchism, feminine voice, abscense of the beard, and other traits generally familiar, by description at least. The same effects may be noted when the accident occurs after puberty, if the individual has not been accustomed to sexual commerce. In the case of adults, particularly those who have

had habitual sexual intercourse, it is not seldom that no change whatever is observed in the individual. In some instances mental disturbances may be observed, melancholy, or even dementio, but there can be no question that it is due more to an ignorant mortification at the loss of procreating power, and has no physical connection with the loss of the organs.

(*a.*) *Contusions of the Testes* are of frequent occurrance, yet unless of unusual severity are not followed by ill-consequences. Varying with the degree of severity, the pain is somewhat peculiar and altogether indescribable; it is not sharp, but induces faintishness and nausea. In most cases it is only momentary, soon passing away, although some tenderness may be experienced for a day or two upon making pressure on the parts, or persistent pain in the back.

The consequences depend upon the severity of the contusion. When of sufficient violence to rupture any portion of the envelope, or materially injure the parenchyma, more particularly if the individual is suffering from any dyscrasia, some disorganizing power, chiefly of a hypertrophic or hyper-plastic character is set up, the organs assuming a fungous character, or some form of sarcocele. The secretion may become implicated, ulcerate or slough, and the vegetations appear externally.

In other cases, probably with a less degree of injury, atrophy will result, the organ, in some cases, according to GROSS, completely disappearing by absorption. Notwithstanding the distinction here made as to the different results of different degrees of force, I have seen instances of hypertrophic and atrophic degeneration resulting indiscriminately, in this particular, as far as the history of the case was of any value.

Neuralgia is occasionally noticed as a remote consequence of contusion, I think oftener when there has been considerable force applied, sufficient to cause structural lesion of a minor degree.

Treatment.—In the earlier part of the treatment, certainly during the primary symptoms, *Arnica* will be the most frequently useful; some attention must be paid to the condition of the scrotum, however, it being very rarely that the testes can suffer serious contusion without this part of its envelope suffering to an equal or greater degree. Should secondary processes become established, I have found *Iodine* a curative agent in one case of atrophy, and *Coni.*, in two instances of hypertrophy. Diligent and intelligent use of these agents failing to correct the trouble, we may be compelled to resort to other measures. It is said, I fear only upon a basis of hypothesis, that Faradism has arrested atrophy. It should not be neglected. Failing with this I am not familiar with any recorded successes by other means.

As to hypertrophic changes, certainly castration is to be reserved as a very last resort, but not too long delayed. The organ is functionally lost as soon as it is evident that retrogressive changes cannot be induced. The enlargement being slight, without symptoms of malig-

nity, there is no argument for its removal beyond its uselessness. If the morbid action seems to be extending up the cord, or is progressing with some rapidity, the testicle must be removed; to allow it to remain will endanger the remaining one. If too long a delay is permitted, removal may be powerless to save the remaining organ. The rule should be, therefore, castrate as soon as it is evident that remedies are exerting no influence. Some authors have referred to compression, with elastic bandages, as promising much. I do not see that their use can subserve any good end. First, it will, if it does anything, simply change the condition to one of atrophy, and we only destroy the organ in another way. We *save* nothing. Secondly, and of far more importance, should the morbid action be carcinomatous, or myeloid, our knowledge of the danger of dispersing germinal elements, should teach caution in such attempts.

(*b.*) *Wounds of the Testes*, are rarely incised; I have been unable to find a report of such an accident. They are either lacerated or gunshot, which represents an extensive destruction of tissue. The symptoms of such an accident are obvious, particularly as the organ will be exposed to actual inspection in most instances.

The *treatment*, it would seem, must be a removal of the part from the body. The organ is lost, practically, from the nature of the injury, and yet when it is still contained within the scrotum, the external wound being small, there may be no urgency in proposing surgical measures. A large lacerated wound in the scrotum, with a corresponding wound in the testicle, the latter being exterior to the opening, calls for removal of the latter, not alone because its functional life is forever lost, but that its return into the scrotum may delay or complicate repair, and it is possible that at some future time it will demand removal.

In the cases recorded in which it has not been removed, the testicle almost invariably undergoes atrophy, sometimes entirely disappearing. At other times it has taken on some morbid form of hypertrophy, and an operation for its removal demanded. The former will more probably be the case where the lesion is promptly repaired; the contraction of the cicatrix first destroying its function, and next causing its absorption.

A case occurred in my practice some time since, reported in the second volume (*Surg. Therap.*) of this series, in which a cystic sarcocele was the result of a puncture of the testicle, by a trocar carelessly used by a physician. The cystic character, however, supervened upon a primary sarcocele, and was caused probably by a seton having been passed through the enlarged gland, and developing extensive suppuration.

(*c.*) *Injuries of the Vas Deferens*, are noted by MR. BIRKETT (HOLMES II, 738), as related to him by MR. HILTON, as occurring in at least three cases, one of which I will quote, at this place, which will serve to give a good account of the accident.

"CASE I. A gentleman, between nineteen and twenty years old, was skating, and, in attempting to cut a peculiar figure, in which act he swung himself around with great effort, he suddenly slipped, so that his right leg was violently abducted. At the same moment he felt something give way in his right groin accompanied with great pain. The right testes had not been the seat of direct injury, yet it began to swell almost immediately, and in a few hours blood passed from the urethra. Perfectly clear urine flowed away through the catheter, introduced into the bladder, without any blood. This was an indication that the blood had entered the urethra, and that it did not come from the bladder or kidneys. The blood seemed to be arterial, but it was in small quantity. There was continuous tenderness and pain near the right inguinal ring, and swelling of the right testis. Leeches were applied over the lower part of the abdomen, and he was confined to bed for two or three days, suffering much local pain resembling peritonitis, with considerable pyrexia.

The bleeding from the urethra did not continue after the second day. The testis remained swollen for several weeks, and then began to waste, until at last it was reduced to about one-third its normal size. At this time, now six years since the accident occurred, the patient reports that the testis is of the ordinary size of the organ of a boy of twelve years old. In its present condition it causes no inconvenience." Cases of atrophy are quoted as discovered in the dissecting room, with old rupture of the duct; these three of MR. HILTON'S are the only ones known to me as recognized in life.

III. INJURIES OF THE URETHRA.

The urethra is exposed to many forms of accident, which derive their greatest surgical interest from the influence on the urinary excretion, in the formation of cicatricial structure, and the extravasation of urine into the areolar tissue about it. There is not only a simple inconvenience in urinating, but hernia, multiple abscess, perineal or other fistula, and even death itself may be the near or remote consequence. I shall consider in this lacerations of the urethra, including rupture; wounds, made from without and from within; and foreign bodies.

(*a.*) *Laceration, or Rupture of the Urethra*, has already been alluded to in the chapter on pelvic injuries, but as occurring from slightly different causes in the first region, *i. e.* external to the prostate. The causes usually are violent blows received on the perineum, as kicks or falling on sharp or pointed bodies. There are instances in which the tube has been completely divided, and no immediate notice was taken of the accident, it not being recognized until an attempt was made to urinate, when the inability with the sense of fullness in the bladder, suggests catheterism. The nature of the injury will produce much ecchymosis in the perineal region, and this might induce many to attribute the swelling to that cause alone. The rule should be, in all these cases, to require an attempt at micturi-

tion; if it is not successful, the catheter must be used; if no urine passes through it, the presumption is that the urethra is ruptured, and other measures must at once be instituted. Time is a great and important element of cure; the waste of it, through errors in diagnosis, may be productive of the most disastrous consequences.

Much will depend, as to sequelæ, upon the location of the rent, whether anterior or posterior to the triangular ligament, or the opening in the perineal fascia. When anterior to this, the extravasation is into the tissue of the penis and scrotum, and while the consequences are even then sufficiently serious, yet there is not that menace to life as occurs when the urine is poured into the pelvic floor, and parts adjacent. In either place there will be unhealthy profuse suppuration, and sloughing, with the probable formation of a urinary fistula; but if the extravasation is anterior to the perineal fascia, there is little if any danger to life.

The *symptoms* are pain at the point of rupture, and passing of blood through the urethra; swelling and discoloration in the perineum, more than would be apt to succeed a simple contusion, with an occasional sensation of fluctuation. There is an urgent and constant desire to urinate, but the effort made is purposeless, or only forces out a few drops of blood. The sufferings gradually increase from the retention of urine, the swelling in the perineum increasing *pari passu*. Upon examining the perineum, after some twelve hours have elapsed (and the surgeon is rarely called, in such cases, until the appearances are desperate), it will be found black, turgid, and fluctuating. Attempting to pass a catheter, it *may* enter the bladder, if the division is not complete, but usually it will not enter. In some cases, even of complete division, the instrument has passed the first time, but could not be introduced at a second attempt. There will be fever, and all the symptoms of retained urine, with the local symptoms of urinary extravasation.

Treatment.—The treatment has to fulfill three indications; relieve the bladder; restore the urethra; and prevent a urinary fistula.

1. There being a reasonable certainty that the urethra is ruptured, two methods are presented to relieve the distension of the bladder. One is to tap it with the trocar through the rectum; the other to incise the perineum, and establish an outlet in that direction. There are no arguments, of any weight, in favor of the trocar; it is a phase of timid surgery, and, as usual, ineffectual. The presence of infiltrated urine in the pelvic and perineal tissues, must always result in suppuration, and sloughing; a fistula will surely form, regardless of an outlet through the rectum. The second method, therefore, or incision through the perineum, is the course to pursue. An incision is to be carried deeply, in the line of the raphe, until urine flows through; all clots of blood, and other equally foreign material is to be removed, and a catheter left in the wound, as in the old operation of lithotomy. In the majority of instances the symptoms will immediately improve,

and the urine will soon commence to flow through the urethra, perhaps not until the third or fourth day. When this occurs the catheter is to be withdrawn from the wound, and steps taken to close it up. If the catheter can be passed through the urethra at the commencement, it is a question, yet undecided, whether to keep it in the bladder or not. The majority of writers seem to think it had better be withdrawn and introduced frequently, as when it is retained in the urethra the urine finds its way along the sides, and adds to the extravasation. If there is reason, however, to expect an extensive or complete rupture, particularly if the lesion is posterior to the deep fascia, and the catheter is successfully introduced, I am unable to see any good reason why it should be withdrawn; in fact every reason seems to exist why we should use every effort to retain the great advantage gained.

2. The restoration of the urethra is the second indication to be fulfilled, and will be secured very much without any assistance from the surgeon. The passage of the urine through the perineal incision will relieve the parts from constant irritation and displacement, more or less, and thus one step is gained; yet if no attempt is made to maintain an opening, the canal will become closed up by cicatricial contraction or plastic deposit, and the perineal opening become a permanent fistula. In spite of the objections so constantly urged, I should certainly keep a catheter in the urethra, if one could be introduced, continuously for a time sufficient to allow of some considerable repair. This is the only method feasible; if it is unattainable, the cure must be left to nature, which will be the formation of a fistula and the obliteration of the urethra.

3. The second indication being successful, the third, or the prevention of a urinary fistula, is attained as a matter of course. With the urethra impervious, a fistula is a necessity and cannot be avoided.

A fistula having formed, and the urethra closed up, we have still hopes of a cure without resorting to operative measures. The urethra must be carefully examined, with instruments of all shapes and sizes. If the slightest opening, no matter how small or tortuous can be found, there is a chance of effecting a cure without a regular operation. Electrolysis with *Silicea*, as described in another place (*Surg. Therap.*), is first to be considered. Failing with this, dilatation may be attempted. Still failing, an operation will be demanded, but it is of a decidedly major character, and must therefore be deferred to another place.

The stricture being overcome, the fistula will usually close spontaneously, sooner or later; if not it may be treated on general surgical principles which will receive attention later. It should be closed, however, by appropriate bandaging, every effort being made to prevent the passage of urine through it.

(*b.*) *Wounds of the Urethra* are of two general characters, from within, and from without. The latter, as more nearly allied to the accidents last considered, will receive attention first.

Wounds made from without, are of all general characters, oftener contused, lacerated, gun-shot, or incised. They are readily recognized, and need no description as to the ordinary appearances. When lacerated, it has occasionally occurred, that a portion of the spongy body has been completely torn out, leaving a gap in the tissues which will fill up by cicatricial tissue if allowed to close without the aid of art. At other times there will be slight dispartition, greater when the section is complete.

A piece being torn out, as above, there is great danger of loss of the urethra, or, if the cut or torn ends are approximated, there will be inconvenient curvature of the penis from the shortening of the spongy body. Steps must be taken, if possible, to avoid this, by careful treatment, there being considerable promise of success, judging from a single experience in my practice.

CASE. Jno. L. aged twenty-seven. In diving from an old wharf, by some mischance the urethra struck a nail, projecting from a plank, and a portion of the external wall, involving about two thirds of the circumference, and a quarter of an inch in length, was completely torn off. When called to the case, some three hours after the accident, the parts were found very much swollen, and highly inflamed. A catheter was introduced, and retained in the bladder four days, being taken out night and morning, and cleansed thoroughly before being replaced. On the fifth day, the inflammation having almost completely subsided, a full sized me talic catheter was introduced, and the opening closed by a small flap of integument taken from the side of the penis, in the immediate neighborhood of the opening. In two weeks the pedicle of the flap was shaved off, and firm union had taken place. The catheter was withdrawn every night and morning for a day or two, and afterward once a day. After the second week it was withdrawn finally, and the case made a good recovery. As long as he was under observation, for a few months only, there seemed to be no stricture, the only inconvenience being some curving of the penis when in a state of erection. My experience, I fear, could not be generally expected; the results were somewhat unusual it must be confessed, cicatricial contraction seeming to be an almost certain and unavoidable sequelæ.

Wounds less in extent than this, a simple divis ion, if not complete, will heal as ordinary wounds, but the urine must always be drawn with a catheter to avoid passing over the surfaces. When it is complete, or there is much retraction, a catheter must be worn as in the case just related. Cicatricial contractions or plastic deposits must be treated as strictures generally, viz., electrolysis, Silicea, dilatation, or divulsion, as occasion may demand.

Wounds made from *within*, are of greater or less importance as they are made by bodies coming from the bladder, or the meatus.

The passage of rough calculi, the extraction of foreign substances, that are sharp or pointed, may wound the urethra so that an opening

is made leading to a greater or less depth into the tissues. The opening being directed toward the bladder, the result will be either an infiltration into the areolar tissue, with consequent suppuration and probable sloughing, which may form a fistula, or a cicatricial stricture; or, failing this, the stream of urine impinging on the valve-like tissue thus torn up, may cause calcareous deposit in the *cul-de-sac*, or thickening of the walls and organic stricture. Whichever is the case, treatment can only be expectant, at least until the more active symptoms have abated. After this, the catheter which had been previously employed but four times in the twenty-four hours, had better be retained, until all symptoms have disappeared. The patient must be enjoined to retain his urine, never, unless under very great necessity, voiding it without the catheter. Any stricture that may result, is to be treated as strictures in general.

Wounds made by forces acting from the meatus permit entirely different symptoms. They are oftener the result of rough and ignorant use of catheters, or the entrance of foreign bodies for erotic purposes. They are of all degrees of severity, from a simple excoriation of the mucous lining to deep channels running up behind the prostate into the recto-vesical pelvic fascia. They are commonly spoken of as "false passages," and oftener occur at one of two points, either at the bulb, the beak of the instrument being caught in the cul-de-sac, failing to enter the membranous urethra; or at the deep perineal fascia. If not disturbed by subsequent irritation of the same kind, no great harm will result beyond the inflammation primarily ensuing. This will thicken the tissues, and thus produce an "inflammatory stricture," but under *Acon.*, or *Arn.*, it will usually readily subside. The opening being directed away from the bladder, there is little if any danger of urinary infiltration, more particularly as the opening is more or less valvular. In fact the stream of urine will have a tendency to keep the opening closed. Unfortunately those who produce these accidents, whether professional people or not, are too ignorant, as a rule, to be able to detect the mischief they have done, and it is only very rarely that the surgeon is called to such a case until it has become fairly chronic, and no hope of a cure is left. The only opportunity for a cure is when the accident has recently occurred, and no repetition of it is perpetrated. Then by enjoining perfect rest, and administering the proper remedy, inflammation may be subdued, and recovery secured without accident.

It is said that very small instruments have been passed into the orifices of the various ducts found on the floor of the urethra. I can find no well authenticated cases on record, either in the journals or systematic works, and have nothing in the way of personal experience to offer. Such an occurrence would necessarily be of a most serious character, the injury being almost irreparable.

(c.) *Foreign Bodies in the Urethra* are occasionally met with, either introduced from without, formed in the canal from urinary deposits,

or coming from the bladder. The two latter are nearly always calcareous formations, arrested in the urethra on their passage from the bladder, or formed from the decomposition of urine retained in the urethra by strictures, or some other impediment to its flow.

Bodies introduced from without are such articles as pieces of catheters, sounds or other urethral instruments broken off by some accident; or various articles introduced for immoral purposes, and escaping from the grasp of the manipulator. Slate-pencils, lead pencils, sticks of wood, knitting needles, and a long list of articles have been found in this situation. From whatever cause, or whatever the material, except calculi formed in the canal, they at first give rise to very great irritation and inflammation, and cause retention of the urine, or very greatly impede its flow. Examination must at once reveal the nature of the case, and steps will be at once taken to remove the offending material. If the body is of any size, it can be felt or seen through the urethra externally, otherwise the sound or catheter will detect it. When the foreign material is small, or long and pointed, or for some reason it has escaped detection for a long time, it has occasionally happened that the point has ulcerated through the urethra.

The best means for the extraction of such objects as are usually found, is the employment of proper urethral forceps. The kind that has done me the best service, is known as the Alligator forceps, as shown in the cut. (See Fig. 30. page 299.)

They are to be warmed and oiled, and introduced very gently, with the jaws closed. On reaching the foreign body, great care must be taken to avoid pushing it in deeper; the jaws are opened, the body grasped, and after rotating the forceps slightly to avoid pinching up a fold of the mucous surface, the jaws are to be firmly closed, and extraction made by a slightly rotary movement; the rotation *must always be in one direction*, not backwards and forwards.

Should the foreign material have come from the bladder, be of a size or shape that forbids extraction through the meatus, or if from any cause the usual methods cannot be employed, the urethra must be compressed *behind* the foreign body, and removal effected by incision. The wound is to be treated as other wounds in the part, with the exception that sutures may be at once applied, and the wound closed. In either case, *Arn.*, will be required for some days afterwards. The incision, it can scarcely be necessary to state, must be made in the long axis of the canal, otherwise there will not only be great dispartition, and subsequent contraction, but the urethra may be served by an unlucky movement.

IV. INJURIES OF THE PENIS.

The penis is injured by contusion and various kinds of wounds, with some frequency, but when uncomplicated with other lesions do not seem to be of any great moment, frequently healing without leaving any inconvenience, of any kind, and certainly without any

menace to life. The extremely liberal blood-supply might induce those unfamiliar with the subject, to consider free incisions a necessarialy fatal accident, but experience shows that it is quite the reverse. I shall take up at this time, as closing the present chapter, contusions, wounds, strangulation, paraphimosis, rupture of the frænum, and injuries to the blood-vessels.

(*a.*) *Contusions* are usually insignificant, the symptoms and effects passing away shortly, as is the case with ordinary contusions in other regions. There are some peculiar results, however, noted by GROSS more particularly, examples of which I have never seen. In these the cavernous body has suffered a sort of atrophy, on one side, or a slight laceration has occurred, which induces a lateral curvature of the organ. The curvature is at all times noticable, but is particularly so when the organ is erect.

HELMUTH (the referance has unfortunately been lost), relates a case of "fracture of the penis," the cavernous body being completely disorganized, and failing to fully recover. Erections were perfect in the proximal portion. I have sought diligently for a similar case, but have hitherto failed to find one.

A remarkable occurrance is related by Mr. BIRKETT, and quoted by BRYANT, which cannot be properly considered a contusion, and yet no other place can be assigned for its consideration. It is a dislocation of the corpus spongiosum, which is thus described, (HOLMES II, p. 735): "The following singular deformity * * * * was seen in Guy's Hospital in 1867. The man was admitted under the care of Mr. Hilton for another complaint.

* * * * * * W. D. aged fifty, nineteen years ago, whilst grooming a stallion, was knocked down by the animal, knelt upon, and bitten on the thigh. The horse taking hold with his teeth of the trowsers and penis of the man, lifted him sufficiently from the ground to enable him to clutch the manger and thereby escape. On examination of the penis he saw something projecting from the urethra, * * * * There was no wound on the penis, but a little blood flowed from the end of the protrusion and from the ordinary passage by its side. He was confined to the house for four weeks. The * * cylindrical body * * * was pinkish, soft, and about one-third of an inch in diameter and one and one-fourth inches long. Its end was rounded and at the point there was a small white cicatrix. The carpus spongiosum urethræ terminated abruptly about one inch behind the glans penis, and being torn away from its attachments to the corpus cavernosum, became everted at the meatus. Micturition was performed without impediment, the urine being voided by the side of the protrusion."

The *treatment* of contusions, considering these unique accidents as belonging to that category, cannot be laid down; each case must be met by the ingenuity and general medical skill of the attendant. In ordinary cases, no medical aid will be sought, as a rule; should such

cases be seen, however, *Arn.*, *Con.*, or *Hamma.* are to be employed as in the case of contusions elsewhere.

(*b.*) *Wounds of the Penis* have been met with of all characters. A large number of gun-shot injuries are noted as occurring during the late war, one bayonet stab, and a number of incised wounds. In a few cases the ball was found encysted, in some cases was not discovered until some time had elapsed. In one instance the missile was fully exposed by an incision, and great force was exerted to remove it, the tissues holding it as firmly as if they were made of india-rubber.

Wounds of all kinds are of interest from three considerations, viz., the effect on the urethra and urinary examination, hæmorrhage, and the future condition of the part. To these might be added, the prospec of repair with referance to extent and character.

A wonnd extending into the urethra, will be at all times a serious complication, particularly when the cavernous body is extensively divided. BOYER long ago laid down the rule, that when two-thirds the thickness of the organ had been incised, repair was hopeless, and the duty of the surgeon was to complete the division. The rule may be a little arbitrary, as applied to all cases, but in cases in which one or both sides of the corpus cavernosum has been divided, and the urethra injured, even to a comparatively slight extent, it is proper to consider the organ lost, and BOYER injunction's may be carried out. When the injury is less extensive, the proper practice would be to secure restoration of the urethra without stricture, as already discussed and close the wound in the cavernous bodies.

Hæmorrhage is always free in wounds of the body of the penis, but according to those who have had the most experience there is no arterial spirting, the blood flowing out as if from a large vein. The blood supply is almost entirely from the internal pudic artery, which might be taken up if other means fail to arrest the bleeding. Compression or mild styptics will usually suffice; attempts to take up bleeding points in the wound cannot be successful, as the number would necessitate such a number of ligatures that all hope of repair would be vain. Firm bandaging seems to give the best results. I have seen one case in which all of the external genitals was shaved off. close to the body, in a fit of religious frenzy, in which the hæmorrhage had ceased spontaneously before my arrival.

The largest wounds, both lacerated and incised, have been received, recovery being perfect, without the slightest subsequent inconvenience. When the case is seen early, all hæmorrhage arrested, the parts accurately adjusted, and erections do not occur to interrupt the process, repair will be good and speedy. Sutures must be employed, of fine wire or silk, and supported by adhesive strips. The dressings must be light, and every precaution taken to avoid erections, the occurrence ofwhich very greatly prejudices the result.

(*c.*) *Strangulation of the Penis* often occurs among boys, from rubber rings, or tying strings about the organ, the consequences sometimes

proving quite serious. At first a feeling of shame prevents the sufferer from making his condition known. When the sufferings increase to an extent that causes alarm, a surgeon is called. The parts are found enormously swollen, red, hot, and painful; the skin is distended almost to the point of rupture, apparently, and there is more or less fever. Later the appearances may become gangrenous, and in some cases will subside, after which a urinary fistula may form in the urethra. The explanation of this last phenomenon is the section of the integument by the constricting band, by a process identical to that of the ecraseur, the urethra being opened by the same means. On examining a case as ordinarily seen, there will be no appearance of a string or ligament, but the swelling will seem to be divided by a deep sulcus or cleft, which on being widely separated will reveal the cause of the trouble. If the substance is a metallic ring, it may be divided by cutting pliers, or a small saw, care being had to protect the parts from injury during the operation. After being divided, seize each side of the ring with strong forceps, and straighten it out. Rubber rings, or threads, may be divided by insinuating a probe-pointed knife underneath.

The parts must be bathed with warm water, and *Acon.*, administered in frequent doses for several hours. Usually all ill effects will pass away within twenty-four hours, unless the constriction has been of long standing or a fistula has formed. In the latter case some such treatment will be demanded as in the case of lacerated urethra.

Paraphimosis is a condition in which the prepuce has been retracted behind the corona glandis, and cannot be reduced. It can only occur in those who have a very small preputial orifice, in whom the glans is always covered, and whilst an opposite condition to phimosis is often a consequence thereof. It is a very frequent occurrence, but it is very rarely the case that reduction is not self-effected, sooner or later, and the case is never brought to the attention of a medical man. In other cases the sufferings are as severe as in the case of strangulation, just referred to, and demands equally as prompt treatment. The glans will be hot, swollen, and discolored; the prepuce itself somewhat inflamed, and micturition much interferred with. In many cases reduction can be secured as in the case of dislocation, viz., increasing the deformity. Retract the prepuce still further, by rolling out the mucous surface, when occasionally the constricting portions will roll up likewise, and reduction will be readily effected. Failing in this, annoint the parts well with vasaline, or some other unctuous substance. Encircling the penis with the first and second fingers of each hand, interlocking with each other, just behind the prominence made by the corrugated prepuce; the thumbs are applied to the glans, and pressure made directly backward, in the axis of the penis, the fingers drawing the prepuce forward at the same time.

The constriction still remaining unrelieved, insinuate a director beneath the edge of the prepuce, and divide it freely with the bistoury.

It is a good practice, I think, to take occasion of the accident to perform an operation for phimosis in all these cases, on the spot.

(*e.*) *Rupture of the Frœnum Preputialis* occasionally occurs from violence in coitis, particularly when the frænum is preternaturally short. It is not a common accident, and of no moment, apart from the immediate consequences. There is usually pretty smart hæmorrhage, for a short time, which will cease upon the application of cold water. There will be some soreness for a long time, particularly on urinating or when retracting the prepuce, and more or less inflammation for a time. A few doses of *Aconite* will usually be all that is required.

XXVIII. INJURIES OF THE FEMALE GENITALS.

Whilst the organs of generation of women are exposed to injury of various kinds, perhaps with greater frequency than occurs in the other sex, the greater number occur in connection with the process of gestation, whether occurring from attempts at abortion, or some unfortunate occurrance during delivery. All such accidents do not come within the province of the general surgeon, constituting a department of practice, just now coming very rapidly into notice, that of gynæcology. All such conditions will be relegated to the many able works on this special subject before the profession, for the triple reason that the writer has little personal experience to record (probably from a lack of interest in the study), they are not now essential in a work on general surgery, and every practitioner has access to works on the subject which will prove far more acceptable than anything I can edit at this time. This omission will leave a short list of topics, viz., contusions, and wounds of the genitals, and foreign bodies in the vagina.

CONTUSIONS.

Contusions of the external genitals, whether resulting from a sudden sharp blow, or long continued pressure, as occurs in some cases of tedious child-birth, are sufficiently common to furnish one or more examples to almost every practitioner. In all ordinary cases, unless force is sufficient to greatly injure deep structures, recovery is rapid, and no surgical aid is required. Even under other circumstances, when blood vessels have been torn sufficiently to cause considerable extravasation, recovery, as a rule, is remarkably rapid. Beyond the inconvenience, and the impediment to locomotion, there is nothing of local interest in these lesions except the fact that the loose texture of the parts permits very extensive extravasation, forming large fluctuating swellings, which may become converted into abscesses by degeneration of the contents.

Contusions of the urethra occasionally produce an atonic or paretic condition, which in some cases, results in incontinence of urine, in others retention, depending upon the location of the injury, whether anterior or posterior to the constrictors. *Arnica*, both internally and topically, will usually bring about a cure, although the catheter may be called for for a day or two in cases of unusual severity.

WOUNDS.

Wounds of all kinds have occured in different parts of the genital apparatus, chiefly lacerated and contused. They are oftener caused by kicks, falls astride on hard bodies, by the breakage of earthen vessels while sitting on them, or the unskillful use of obstetrical or other instruments. The extreme vascularity of the tissues in this region, will always furnish a more or less abundant hæmorrhage, but unless some considerable vessel as the internal pudic or its larger branches, is injured, no concern need be felt as to the result. This is particularly the case as relates to the labia.

Wounds of the Vagina have been seen of the most formidable character, in which full recovery was had without any embarassment from hæmorrhage. One case mentioned by BIRKETT a hay knife had been driven into the vagina so far that only the transverse handle was visible. The perineum as well as the vagina was very extensively cut yet recovery was speedy and perfect. In another case, a lady sat down with some violence, on the broken edge of a pitcher, mistaking it in the dark for a chamber vessel; a sharp point wounded the vagina, and when seen by a medical gentleman, a short time after the accident, was found moribund from hæmorrhage. Contused wounds are of interest from a possibility of the establishment of fistula, rectal or urinary, from sloughing. The same is true, to a somewhat limited extent, however, from wounds of all kinds; yet when the injnry is seen early, the hæmorrhage promptly arrested, and the parts put into a condition for repair, the occurrance of fistula can only reflect on the skill of the medical attendent, in the absence of any dyscrasia in the patient.

Wounds of all characters are to be treated upon general surgical principles, remembering wounds in the neighborhood of the rectal or vesical septum, or the urethra, may result in fistula unless carefully cared for and repair promoted. In large contused wounds, or wounds of any kind involving a large extent of surface, care must be had that opposing surfaces do not become adherent, resulting in atresia of the vagina or vulva, and that subsequent contraction is not produced. In some cases dilators will be needed; in others simple inspection and separating the surfaces frequently will suffice. When dilators are needed, I think Furguson's speculum is much more satisfactory than the ordinary glass instrument of Sims.

FOREIGN BODIES IN THE VAGINA.

The list of foreign substances that have been found in the vagina, is very large, embracing almost every conceivable article capable of such introduction. Many of them are undoubtedly introduced for immoral purposes; some in attempts to produce abortion; a large number are pessaries, whole or in pieces, that have become impacted, or *forgotten!* In one case a long retained sponge was mistaken for carcinoma. Unless the foreign body causes pain or some other incon-

venience, it will usually be a long time after introduction before medical aid is sought. Dr. LUNGREN, of Toledo, Ohio, relates a case in the *Trans. of the Amer. Institute*, (1871), in which a small tumbler was retained in the vagina for, I think, two years.

The consequences of long retention are various. If the instrument is hollow, with one end open; or a ring, like some forms of pessaries, the mucous tissue will grow into and around it, so that it will be perfectly hidden from view. With sharp edges or points, the walls of the vagina are liable to be pierced by ulcerative processes, the rectum bladder, or urethra opened, or even the uterus become implicated. Cases have been reported in which the pelvis has been opened, the foreign body partly entering it. In all cases there is more or less leucorrhœa, often of a purulent character.

Treatment, of course, is confined to removal of the foreign body, and the repair of any injury it has inflicted. The indications, however, are not at all times easily fulfilled. The immense growth of the mucous tissue, or the shape and size of the object, often causes much embarrassment in extraction. No explicit directions can be given; each case will require special consideration and treatment.

The hypertrophy of the mucous membrane will take care of itself, soon disappearing, as a rule, upon the removal of the foreign body. Fistulæ are to be treated as laid down in the books on gynic surgery.

AUTHORITIES AND REFERENCES.

ARLT. Contusion of the eye, 243; dislocation of the lens, 248; wound of the eye, 253-257; rupture of the inner tunics of the eye, 244; scalds of the lids 239-241; ulceration of cornea, 247.

ARNOTT, JAS. Local anæsthesia, 36.

BAIN. Artificial respiration, 127.

BAYARD, W. Fracture of the axis, 348.

BECKER. Grafting conjunctiva of Rabbit, 242.

BELL, JNO. Cutthroat, 325; wounds of joints, 167.

BERLIN. Rupture of choroid, 248.

BICHAT. Fracture of jaw, 287.

BIGELOW. Local anæsthesia, 36; intra-capsular fracture, 499; reducing dislocations, 188; "Y" ligament, 520.

BIRKETT, J. Dislocation of corpus spongiosum, 559; rupture of vas-deferens, 553.

BRANDE. Sulphuric ether, 28.

BRYANT. Persistence of scars, 267.

BUTLER, JNO. Atresia of Œsophagus, 294.

CARNOCHAN. Nature of shock, 21; ligature of femoral artery, 133.

CARTER. Artificial eyes, 260; ulceration of the cornea, 247.

CIRCULAR No. 2. *Surg.; Genl. U. S. A.;* excisions of hip, 23.
" " 3. " " " " Gun-shot wounds 78; Arteries, wounds of, 73; lungs, wounds of, 426; snake-bites, 90-93.

CLARKE, J. LOCKHART Nerve lesions, 156.

COLLES. Fracture of the wrist, 399.

COOPER, SIR A. Reunion of severed nose, 269; intra-capsular fracture, 496; spinal fracture, 346.

COOPER, BRANSBY. Structure of cervix femoris, 496.

COREY, H. M. Cause of death from shock, 25.

DAVIE. Excision of clavicle in dislocations, 406.

DAVY, SIR HUMPHRY. Nitrous oxide gas, 27.

DRUITT. Poisoned wounds, 88.

DUNOS. Chloroform, formula, 32.

DUPUYTREN. Suppuration of brain, 229; burns, 108; dislocation of spine, 354; wounds of heart, 439.

DURHAM. Cutthroat, statistics, 310; larynx, fracture of, 326, and wounds of 311–322.

EMMET. Hot water in hæmorrhage, 148.

FENNER. Hip dislocations, 522.

FISCHER, G. Mortality from heart wounds, 435.

FLOWER and HULKE. Fractures of upper extremity, 376; dislocations of upper extremity, 403.

GANT. Hydrophobia, 98.

GIBBS. Fracture of hyoid, 329; dislocation of, 328.

GOSSELIN. Lime in the eye, 242.

GROSS, S. D. Hæmorrhage, 45; hydrophobia, 101; contusion of penis, 559.

GRYZMAL. *Xanthuim spin.*, for hydrophobia, 104.

HALL, MARSHALL. Artificial respiration, 125.

HAMILTON. Dislocations, 176; Muscular action in do, 181; differential diagnosis of hip injuries, 504; dislocation of patella, 435; of astragalus, 540; fracture of hip, 498; fracture of humerus, 383; of olecronon, 395; of upper jaw, 283; of patella, 510; of fibula, 513; of spine, 340–352; of sacrum, 489.

HARLEY. Asphyxia, 121; drowning, 125.

HAYNES, J. R. *Iodine* for snake bites, 96; blood changes from snake venom, 95.

HELMUTH. Cicatrix from burns, 116; fracture of penis, 559; nerve stretching, 154.

HERING. Radiated heat for poisoned wounds, 103.

HEWETT, PRESCOTT. Suppuration of diplœ, 214; fracture of base of skull, 215; cranial fractures, 224–225; suppuration of brain, 229.

HIGGINS. Analysis of snake venom, 92.

HOLMES-COOTE. Persistence of scars, 267.

HOLMES, T. Burns, 114.

HOLTHOUSE, C. Relative frequency of fractures of the upper and lower extremities, 494; shortening in fractures of femur, 506.

HORNER. Salivary fistula, 271.

JAMES, J. E. Nephrectomy, 458.

KANE, E. K. Disunion of fractures from scurvy, 202.

KEENER, H. N. Dislocation of axis, 357.

KNAPP. Laceration of lens capsule, 248.

LARREY, BARON, D. J. Rupture of intestines, 458; effects of nerve lesions, 150.

LANGENBECK. Suturing nerves, 155.

LEMBERT. Suture of intestines, 471.

LISTER. Chloroform, 34.

LONG. Fracture of the trachea, 322.

LONSDALE. Fractures of lower extremities, 495.

MEDICAL AND SURGICAL HISTORY OF THE WAR. Rupture of abdominal viscera, 459; ventral hernia, 463; abdominal wounds, 462; ligature abdominal arteries, 472; gun-shot wounds of abdomen, 465; mortality from wounds of joints, 168; do. from amputation, 23; fractures of pelvis, 486; chest wounds, 423; spinal lesions, 351; wounds of head and scalp, 221–235; blood cysts of scalp, 208.

MACLEOD. Gangrene from cold, 118; probing chest wounds, 428.

MALGAIGNE. Paracentesis thoracis, 432; repair of fractures, 189; nomenclature of fracture, 194; "election" of fractures of spine, 344; fractures of lower jaw, 283.

MARTIN, SIR R. Rupture of peritoneum, 451.

MASON, F. Persistence of scars, 266; face wounds, 266; salivary fistula, 270.

MATTHEWS, C. B. Sulphuric Ether, 27.

MCCLELLAN. Wound of par vagus, 317.

MCCLELLAND, J. H. Nephrectomy, 458.

MITCHELL, S. WEIR. Analysis snake venom, 92.

MOORE, C. H. Air in the veins, 134.

MORTON, W. T. G. Sulphuric Ether, 27.

MOTT, VALENTINE. Air in the veins, 136; ligature of common iliac, 492.

NELATON. Gaping of wounds, 59.

OTIS, G. A. Classification of operations, 23.

PACINI. Artificial respiration, 127.

PACKARD. Surgical incisions, 63.

PAGET, SIR JAS. Repair of wounds, 50; effects of nerve lesions, 151.

PARE, AMBR. Local anæsthesia, 36; hæmorrhage in chest wounds 442.

PARSONS, S. B. Vicious cicatrices, 56.

PENSION REPORT for 1871. Ventral hernia, 462.

POLAND, A. Wounds of chest, 424; ligature of internal mammary artery, 441; heart wounds, 435; hydrophobia, 102,

POLLOCK, GEO. Abdominal contusions, 448; foreign bodies in abdomen, 476; abdominal wounds, 471; rupture of peritoneum, 443.

POTTS. Dislocation of the ankle, 538.

POULET. Foreign bodies in the throat, 290.

PRATT. Hernia cerebri, 234.

REID. Dislocations of the hip, 523.

RICHARDSON, B. W. Methylene, 35.

RODET. Fracture of femoral neck, 497.

ROOSA. Foreign bodies in the ear, 262; traumatic deafness, 264.

SCHROTER. Rupture of the eye ball, 253.

SHAW, A. Injuries of the spine, 332; concussion of the cord, 359.

SILVESTER. Artificial respiration, 126.

SIMPSON, SIR Jas. Y. Accupressure, 146; Chloroform, 30.

SKEY. Ligature of external iliac, 493.

SMITH, A. H. Effects of compressed air on the ear, 264.

SMITH, STEPHEN. Ligature of anterior tibial artery, 544.

STANTON, L. L. Reunion of severed hand, 366.

STELLWAG. Dislocation of lens, 250.

STEINMETZ. Sword wounds, 73.

SYME. Arching of spine in dislocations of the hip, 529.

TAYLOR, G. H. Anatomy of muscle fibre, 164.

TORREY. Lodgment of gun-shot, 79.

TREVES. Air in the veins, 316.

VELPEAU. Suppuration of brain, 230; air in veins, 135.

VIDAL DE CASIS. Sword wound of chest, 432.

VIRCHOW. Rabies, 98.

WALDIE. Chloroform, 30.

WELLS, HORACE. Anæsthesia, 27.

WELLS, SŒLBERG. Wounds of infra-orbital nerve, 238.

WEIR, ROBT. Rupture of tympanum, 264.

WISEMAN. Fracture of upper jaw, 281.

WOODS, J. T. Wound of lungs, 427.

WOOLSTON, SAML. Sulphuric Ether, 28.

YOUATT. Hydrophobia, 97.

INDEX.

Abdomen : Arteries, wounds of, 472.
Contusions of, 448.
Viscera, 450.
Foreign bodies in, 473.
Injuries of, 448.
Muscles, Rupture of, 450.
Wounds Fatality, 463.
Muscles, 462.
Non-penetrating, 460.
Penetrating, 465.
of viscera, 462.–469.
Acetabulum, Fracture of, 468.
Accident, case, 18.
Acromial thoracic, artery ; ligature, 369–440.
Accupressure, 146.
Air passages; foreign bodies in 300.
Air in Veins, 134, 309, 316.
Amputation for Burns, 111.
Contused wound, 70.
Contusion, 41.
Frostbite, 119.
Gun-shot, 86.
Lacerated wound 66.
Anastomotica magna; ligature, (Arm), 369.
Anastomotica magna; ligature, (Leg), 542.
Anchylosis from Wounds, 170.
Anæsthesia, 27.
History of, 27.
Local, 36.
Physiology of, 32.
Gen'l Chloroform, 31.
Ether, sulphuric, 28.
Methylene, 35.
Nitrous oxide, 28.
Ankle, Dislocations, 537.
Fracture, 515.
Anus, artificial, 469.
Apnœa, 121.
Arm, Injuries of, 364.
Arterial hæmorrhage, 136.
Arteries : Injuries of Abdominal, 472.
Arm, 358.
Chest, 440.
Face, 274.
Head, 212.
Lower Extremities, 539.
Lumbar, 472.
Mouth, 293,
Neck, 312.
Pelvis, 492.
Scalp, 212.
Spine, 358.
Artery : Ligature, 137.
Acromial thoracic, 369–440.
Anastomotica Magna, 369.
Anterior tibial, 544.
Axillary, 368.
Brachial, 369.
Carotid Common, 312.
Carotid External, 313.

Artery: Ligature, Carotid Internal, 314.
Circumflex, iliac, 472.
Circumflex, iliac External, 472.
Circumflex, iliac Internal, 543.
Circumflex, iliac Superficial 542.
Coronary, inferior, 274.
Coronary, Superior, 274.
Dorsalis Pedis, 544.
Epigastric, 472.
Facial, 274,
Facial, Transverse, 274.
Femoral, 541.
Femoral deep, 543.
Gluteal, 541.
Ileo lumbar 473.
Iliacs, 492,
Intercostal 442.
Labial, Inferior 274.
Lingual 274-314.
Mammary, internal 441–473.
Masseteric, 274.
Maxillary, internal, 275.
Nasal, lateral 274.
Occipital, 212–315.
Obturator, 541.
Orbital superior, 213.
Palatine, 293.
Palmar arches, 371.
Peroneal, 545.
Plantar, 545.
Popliteal, 543.
Profunda (arm) 369.
Profunda, (thigh), 543.
Pudic, superficial external, 542.
Radial, 370.
Artery: Ligature, Ranine, 293.
Scapular, posterior, 369–440.
Sciatic, 541.
Spinal anterior, 358; lateral, 358; posterior, 358.
Subscapular, 369–441.
Temporal, 213–274.
Thoracica longa, 369–441.
Thoracica superior, 369–440.
Thyroid, inferior, 314.
Thyroid, superior, 314.
Tibial, anterior, 544.
Tibial, posterior, 543.
Ulnar, 371.
Vertebral, 315–358.
Ascites-chyloses, 318.
Asphyxia, 121.
Causes, 121.
Symptoms, ante-mortem, 123.
Symptoms, post-mortem, 124.
Varieties, 121.
Astragalus, Dislocation, 539.
Fracture, 516.

B

Bee-stings, 96.
in mouth, 291.
Bile-duct, common, rupture of, 455.
Bladder, Contusion, 478.
Foreign bodies in, 485.
Rupture of, 480.
Wounds of, 484.
Bleeding of wounds, 43.
Blood-cyst in scalp, 208.
scrotum, 549.
Blood vessels, injuries of, 131.
Bones, Contusions of, 188.
Fractures of, 189.
Brain, Compression of, 230.
Concussion of, 231.
Hernia of, 233.
Inflammation of, 228.
Irritation of, 232.

Laceration, 232.
Suppuration, 229.
Wounds, 227.
Burns, 108.
Amputation for, 111.
Causes, 111.
of death, 114.
Collapse from, 112.
Degrees of, 108.
Exhaustion from, 113.
Prognosis, 115.
Reaction, 113.
of the Eye, 238.
Face, 273.
Larynx, 323.
Mouth, 293.

C

Calcaneum. Dislocations of. 539.
Fracture of, 515.
Calculus from foreign-bodies in bladder, 485.
Capillary hæmorrhage, 148.
Carbolic acid, for local anæsthesia, 36.
Cardiac plexus, shock through the, 449.
Carpus. Dislocation of, 414.
Fracture of, 402.
Cartilages, dislocations of, 175.
of Knee, 534.
of Ribs, 442.
Cerebral hernia, 233.
Chest contusions, 419.
Foreign bodies in, 434.
Fractures of, 442.
Paracentesis of, 432.
Wounds of, non-penetrating 421.
Penetrating, 424
Blood vessels, 440.
Chillblains, 120.
Acute, 120.
Chronic, 120.
Chloroform, 30.
Administration, 32.
Adulterations, 31.
Causes of death from 33.
Composition of, 32.
Effects of, 32.
History of, 30.
Narcosis from, 35.
Choroid, rupture of, 254.
Cicatrization, 55.
Defective, 56.
Circumflex artery, external; ligature, 472.
Internal; ligature, 543.
Iliac artery; ligature, 472.
superficial; ligature, 543.
Clavicle. Dislocation, 405.
Backwards, 406.
Forwards, 405.
Upwards, 405.
Fracture, 379.
Acromial end, 381.
Shaft, 380.
Sternal end 381.
Coccyx. Dislocation of, 490.
Fractures of, 489.
Cold. Effects of, 117.
Chillblains, 120.
Frostbite, 117.
Collapse from Burns, 112.
Related to Shock, 21.
Collateral circulation, 138.
Compression of Nerves, 154.
Concealed hæmorrhage, 137.
Concussion of Bladder, 478.
Concussion of Cord, spinal, 359.
Larynx, 327.
Viscera, abdominal, 450.
Viscera, thoracic, 420.
Contused wounds, 68.
Amputation for, 70.
Gaping of, 70.
Hæmorrhage, from 69.
Shock, from 69.
Sloughing, from 70.
Contusion, 37.
Amputation for, 41.
Bleeding from, 37.
Degrees of, 38.
Discoloration in, 38.
Neoplasma from, 40.
Pain, in 37.
Shock, 38.
Sloughing, 40.
Swelling, 37.
of the Abdomen, 448,

Contusion of the Abdominal viscera, 449.
Bladder, 478.
Bones, 188.
Chest, 419.
Cornea, 245.
Face, 271.
Joints, 172.
Nerves, 152.
Penis, 558.
Scalp, 208.
Scrotum, 548.
Skull, 213.
Testes 551.
Thoracic viscera, 420.
Vulva, 563.
Cord, Spinal. Concussion, 359.
Compression, 361.
Division, 363.
Puncture, 363.
Cornea. Contusion of, 245.
Wounds of, 257.
Corpus spongiosum; dislocation of, 559.
Costal-cartilages, fracture of, 446.
Cut-throat, 308.

D

Diaphragmatic hernia, 425–453.
Diaphragm, rupture of, 453.
Dissecting wounds, 105.
Dislocations, 176.
Ancient, 179.
Cartilages, 175.
Causes, 179.
Complete, 178.
Complicated, 178.
Compound, 178.
Pathology of, 181.
Partial, 178.
Primary, 179.
Prognosis, 183.
Recent, 179.
Secondary, 179.
Semeiology, 181.
Simple, 178.
of the Ankle, 537.
Arm, 403.
Astragalus, 539.
Calcaneum, 539.
Carpus, 414.
Clavicle, 405.
Coccyx, 490.
Dislocations of the Corpus spongiosum, 559.
Elbow, 410.
Fingers, 417.
Foot, 537–540.
Hand, 416.
Hip, 516.
Hyoid, 229.
Knee, 531.
Cartilages 534.
Lower extremity, 516.
Maxilla, lower, 288.
Maxilla, upper, 281.
Patella, 532.
Pelvis, 490.
Radius, 413.
Ribs, 447.
Scapula, 404.
Shoulder, 406.
Spine, 353.
Tarsus, 537.
Tibia, 537.
Ulna, 415.
Upper extremity 403.
Wrist, 414.
Dorsalis pedis artery, ligature, 544.
Duty of Surgeon, to Patient, 19.
Profession, 19.
Society, 19.

E

Ear. Injuries of, 262.
External, 262
Internal, 264.
Foreign bodies in, 262.
Fracture of bones of, 265.
Nerves, lesions of, 266.
Tympanum, rupture, 264.
Elbow. Dislocations, 410.
Backwards, 410.
Forwards, 413.
Inwards, 412.
Outwards, 411.
Emphysema, in Non-penetrating chest wounds, 422.
Penetrating chest wounds, 424.

Emphysema, in External, 429.
Inter-lobular, 430.
Pleural, 429.
Encephalocele, 233.
Envenomed, wounds, 89.
from Snakes, 90.
Fatality, 90.
Nature of venom, 92.
Prognosis, 93.
Epigastric Artery. Ligature, 472.
Superficial. Ligature, 472–542.
Epiphyses. Separation of, 194–393.
Femur, 509.
Humerus, 393.
Escharotics in Hæmorrhage, 148.
Esmarch's Bandage, 141.
Ether. Sulphuric, 27.
Administration, 28.
Composition, 27.
Effects, 29.
History, 27.
For local anæsthesia, 37.
Extraction of bullets, 84.
Extremities. Dislocation of Lower, 515.
Dislocations of Upper, 403.
Fracture of Lower, 494.
Fracture of Upper, 376.
Injuries of Lower, 494.
Injuries of Upper, 364.
Eyeball. Compression of, 242.
Enucleation of, 254.
Rupture of, 252.

F

Face. Injuries of, 266.
Arteries, 274.
Nerves, 275.
Burns, 273.
Contusions, 271.
Dislocations, 288.
Fistula, salivary, 270,
Fractures, 275.
Face. Scalds, 273.
Wounds, 266.
Femur. Epiphyses, separation of 509.
Fracture, Condyles, 508.
Neck, 501.
Neck, extra-capsular, 501.
Neck, intra-capsular, 495.
Shaft, 504.
Femoral artery. Ligature, 541.
Deep; ligature, 543.
Fibula, fracture, 513.
Fingers. Dislocation, 417.
Fracture, 402.
Fistula. Salivary, 270.
Urinary, 555.
Foot. Dislocations, 537–540.
Fractures, 515.
Flexion, (forced) for hæmorrhage, 141.
Forearm; fracture of, 394.
Foreign bodies in abdomen, 473.
Bladder, 485.
Ear, 262.
Eye, 242–258.
Chest, 434.
Throat, 296.
Air-passages, 300.
Œsophagus, 296
Urethra, 557.
Vagina, 564.
Fractures, 189.
Causes, 191.
Comminuted, 193.
Complete, 196.
Complicated, 193.
Compound, 194.
Contra-coup. 193.
Depressed, 197.
Diagnosis, 197.
Direct, 192.
Impacted, 196.
Incised, 196.
Indirect, 192.
Longitudinal, 195.
Oblique, 195.
Partial, 196.
Pathology, 200.
Perforating, 196.
Prognosis, 201.
Repair of, 201.
Semeiology, 197.
Simple, 193.
Stellate, 196.
Transverse, 194.

Fractures, Ununited, 197-390.
of the Acetabulum, 488.
Arm, 376.
Astragalus, 516.
Atlas, 348.
Axis, 347.
Base of the skull, 223.
Calcaneum, 515.
Carpus, 402.
Coccyx, 489.
Costal cartilages, 446.
Ear; bones of, 265.
Femur, 495.
Fibula, 513.
Fingers, 402.
Forearm, 394.
Frontal bone, 221.
Head, 217.
Humerus, 383.
Hyoid, 328.
Ileum, 487.
Innominata, 487.
Ischium, 488.
Larynx, 326.
Leg, 512.
Lower extremities, 494.
Malar bone, 279.
Maxilla, lower, 284.
Maxilla, upper, 281.
Metacarpus, 402.
Metatarsus, 516.
Nasal bones, 277.
Nasal septum, 278.
Occipital bone, 221.
Patella, 510.
Pelvis, 486.
Penis, 559.
Phalanges, Foot, 516.
Hand 402.
Pubis, 488.
Radius, 398.
Ribs, 442.
Sacrum, 489.
Scapula, 377.
Fracture of Skull, 217.
Spine, 340.
Sternum, 446.
Tarsus, 515.
Temporal bone, 221.
Fracture of Thorax, 442.
Tibia, 512.
Toes, 516.
Trachea, 321.
Ulna, 394.
Upper extremities 376.
Zygoma, 222.
Frontal bone, fracture, 221.
Frostbite, 117.
Amputation for, 119.
from Dry cold, 118.
Wet cold, 118,
Sequelæ, 119.

G

Gall-bladder, rupture of, 455.
Gangrene of mouth, 294.
Gaping of wounds, 59.
Genitals. Injuries of Female, 563.
Male, 548.
Glottis, œdema, 294.
Gluteal artery, ligature, 541.
Gun-shot wounds, 77.
Amputation for, 86.
Cause of death, Immediate, 82.
Remote, 83.
Direct injury, 78.
Extraction of missile, 84.
Hæmorrhage, 81.
Indirect injury, 77.
Lodgment of shot, 79-82.
Missiles, nature of, 78.
Pain, 81.
Shock, 81.
Sloughing, 82.
Symptoms, primary, 80.
Secondary, 82
from Conical balls, 78.
Large shot, 79.
Small shot, 79.
Spherical shot, 80.

H

Hand. Dislocations of, 416.
Metacarpus, 416.
Phalanges, 417.
Fracture of, 402.
Metacarpus, 402.
Phalanges, 402.

Hæmatocele, 549.
Hæmorrhage, 131.
Air in the Veins, 134, 309, 316.
Arterial, 44, 136.
Capillary, 148.
Causes, 131.
Collateral circulation 138.
Concealed, 137.
Primary, 131.
Secondary, 133.
Spontaneou · arrest, 138.
Venous, 44–134.
from Contusion, 37.
Gun shot, 81.
Wounds, 43.
Contused, 69.
Incised, 60.
Lacerated 64.
Punctured, 72.
Hæmostatics, 45–137.
Natural, 45–138.
Permanent, 46–142.
Temporary, 45–139.
Accupressure, 146.
Compression, 140.
Escharotics, 148.
Esmarchs bandage, 141.
Exposure to air, 45-148.
Forced flexion, 141.
Ligature, 46–142.
In Continuity, 143.
In the wound, 142.
Styptics, 45–148.
Torsion, 146.
Tourniquet, 139.
Hæmothorax, 430.
Head. Injuries of, 208.
Brain lesions, 227.
Contusions, 208.
Fractures, 217.
Heat. Effects of, 108.
Burns, 108.
Scalds, 108.
Heart. Lacerations of, 420–436.
Mortality from injuries, 435.
Rupture, 420–136.
Wounds of, 435.
Hernia-Cerebri, 233.
Diaphragmatic, 453.
Pulmonary, 425.
Tracheal, 323.
Ventral, 463.
Hip. Dislocations of, 518.
Dorsum ilii, 518.
Ischiatic, 528.
Pubic, 526.
Thyroidean, 530.
Fractures of, 501.
Humerus. Fracture of, 383.
Condyles, 391.
Head, 384.
Neck, 385.
Shaft, 388.
Separation of epiphyses, 393.
Hydrophobia, 97.
Causes, exciting 99.
Causes predisposing, 98.
Differential diagnosis, 102.
Nature of poison, 99.
Rabies, 97.
Hyoid. Dislocation, 329.
Fracture, 328.
Hyperæmia in Incised wounds, 62.

I

Ileum. Fracture of, 483.
Iliac artery. Ligature, 492.
External; ligature, 492.
Internal; ligature, 493.
Ileo-lumbar arteries; ligature 4 72
Innominata; fracture, 487.
Incised wounds, 58
Hæmorrhage, 60.
Insects. Bites and stings of, 96.
Intermediary operations, 23.
Intestines. Rupture of, 458.
Instruments, pocket, 18.
Intercostal arteries, ligature, 442.
Iris. Laceration of, 254.
Ischium, fracture of, 488.

J

Joints. Injuries of 167.
Anchylosis from, 170.
Contusions, 172,
Dislocations, 176.
Sprains, 173.
Wounds, 167.

K

Kidney, rupture of, 456.
Knee. Dislocation of, 531.
Antero-posterior, 533.
Lateral, 532.

L

Lacerated wounds, 63.
Laceration of Bladder, 480.
Brain, 232.
Heart, 420–436.
Intestines, 458.
Iris, 254.
Kidney, 456.
Lungs, 420.
Nerves, 155.
Urethra, 553.
(See "Rupture," also.)
Larynx, Burns of, 323.
Concussion, 327.
Fracture, 326.
Wounds, 312–325.
Leg. Fracture of, 512.
Lens, crystaline, displacement of 249.
Injuries of, 248.
Ligature of arteries, 142.
in Continuity, 143.
in Wound, 142.
Lightening, Cause of death from, 130.
Effects of, 130.
Liver, Contusion of, 454.
Rupture of, 454.
Local Anæsthesia, 36.
Carbolic acid, 36.
Ether spray, 36.
Freezing, 36.
History of, 36.
Rhigolene, 36.
Lumbar arteries, ligature, 472.
Lungs. Hernia of 425.
Laceration, 420.
Wound of, 426.
Emphysema from, 430.
Hæmorrhage from, 428.
Hæmothorax, 430.
Pneumothorax 429.

M

Male genitals. Injuries of, 548.
Mediastinum. Wounds of, 424–439.
Mesentery. Rupture of, 459.
Metacarpus. Dislocation of, 416.
Fracture of, 402.
Metatarsus. Dislocation of, 540.
Fracture of, 515.
Methylene, 35.
Mouth. Injuries of, 290.
Arteries, ligature, 293.
Bee-stings in, 291.
Burns of, 293.
Gangrene of, 294.
Œdema of, 294.
Œsophagus; atresia of, 294.
Scalds of, 293.
Tongue; injuries of, 292.
Wounds of, 292.
Muscles. Injuries of, 159.
Repair of, 160.
Rupture, 159.
Rupture of abdominal, 450.
Rupture of chest, 419.
Wounds of, 159.
Abdominal, 462.
of chest, 421.

N

Neck. Injuries of, 296.
Cut-throat, 308.
Fracture of Larynx, 326.
Wounds of Arteries, 312.
Nerves, 312-316.
Thoracic duct, 317.
Trachea, 311–318.
Veins, 309.
Needle in flesh, 365.

Neoplasma from contusion, 40.
Nephrectomy, 458.
Nerves. Injuries of, 149.
Consequences, immediate, 149.
Consequences, remote, 157.
Compression, 154.
Contusion, 152.
Division, 155.
Laceration. 155.
Puncture, 155.
Repair, 155.
Stretching, 154.
of the arm, 372.
Ear, 266.
Face, 275.
Head (cranial), 234.
Lower extremities, 545.
Neck, 312-316.
in punctured wounds, 74.
Nitrous oxide gas, 27.
Composition of, 27.
Effects, 27.
History, 27.
Notes in cases of accident, 19.

O

Obturator artery. Ligature of, 541.
Occipital artery. Ligature of, 212-315.
Bone. fracture of, 220.
Œdema of the glottis, 294.
Mouth, 294.
Œsophagus. Atresia of, 294.
Foreign bodies in, 296.
Olecronon. Fracture of, 394.
Omentum. Rupture of, 459.
Operations. Intermediary, 23.
Primary, 23.
Secondary, 23.

P

Paracentesis thoracis, 432.
Paralysis from contusion, 40.
Paraphimosis, 561.
Parietal bone, fracture, 220.
Patella. Dislocation, 532.
Fracture. 510.
Pelvis. Injuries of, 478.
Arteries, ligature, 490.
Dislocations, 490.
Fractures, 486,
Penis. Injuries of. 558.
Contusions, 558.
Dislocation of spongy body, 559.
Fracture of, 559.
Strangulation, 560.
Wounds of, 560.
Pericardium. Wound of, 435.
Peritoneum. Rupture of, 451.
Peroneal artery, ligature of, 545.
Phalanges. Foot, dislocations, 537.
Hand, " 416.
Fractures, 516.
Fractures. 402.
Phrenic hernia, 425-453.
Plantar Artery. Ligature, 547.
Pneumothorx, 429.
Pocket-case, 18.
Poisoned wounds, 88.
from Altered secretions, 97.
Chemical agents, 88.
Venom. 92.
Septic matter, 105
Popliteal artery. Ligature of, 543.
Position of body, as related to diagnosis, 19.
Prepuce. Rupture of Frænum, 562.
Profunda artery, Arm, ligature, 369.
Leg, ligature, 543.
Pubis. Fracture of, 488.
Pudic artery, superficial external, ligature. 542.
Punctured wounds, 71.
Cicatrirzation of, 75.
Hæmorrhage, 72.
Nervous lesions, 74.
Tetanus, 74.
Visceral lesions, 73.
Pyæmia, from lacerated wounds, 68.

Rabies, 97.
Radial artery, ligature of, 370.
Radius. Dislocations, 413.
Fracture of 398.
Repair of wounds, 50.
First intention, 52.
Granulation, 53.
Immediate, 51.
Remedies to aid, 54.
Scabbing, 53.
Scarring, 55.
Rhigolene, for local anæsthesia, 36.
Ribs. Dislocation of, 447.
Fracture of, 442.
Rupture of Bile-duct, 455.
Bladder, 480.
Diaphragm, 453.
Frænum (prepuce) 562.
Gall bladder, 455.
Heart, 420–436.
Intestines, 458.
Kidneys, 456.
Liver, 454.
Lungs, 420.
Mesentery, 459.
Muscles, 159.
Abdominal, 450.
Chest, 419.
Omentum, 428.
Prepuce, frænum, 562.
Peritoneum, 451.
Spleen, 456.
Stomach, 456.
Tendons, 164.
Trachea, 322.
Ureters, 458.
Urethra, 553.
Vas deferens, 553.

S

Sacrum. Fracture, 489.
Salivary fistula, 270.
Salt and ice for anæsthesia, 37.
Scalds, 107.
Prognosis of, 107.
of the Eye, 238.
of the Face, 273.
of the Larynx, 324.
of the Larynx from acids, 324.
of the Mouth, 293.
Scalp. Injuries of, 208.
Contusions, 208.
Wounds, 210.
Wounds of arteries, 212.
Scapula. Dislocations, 414.
Fracture, 377.
Scapular artery, posterior, ligature, 369–440.
Scarring, 55.
Defects in, 56.
Sciatic artery. Ligature, 541.
Sclerotic. Rupture of, 253.
Scrotum. Injuries of 548.
Blood cysts of, 549.
Contusions of, 548.
Hæmatocele, 549.
Wounds of, 548.
Secondary operations, 23.
Shock, 21.
in Abdominal injuries, 449.
in Anæsthesia, 35.
from Burns, 112.
related to Collapse, 21.
from Chest wounds, 425.
from Contused wounds, 69.
Contusions, 38.
Gun-shot wounds, 81.
Incised wounds, 61.
Lacerated wound, 64.
Shoulder. Dislocation of, 406.
Skull. Contusion of, 213.
Fracture of, 217.
Base of, 223.
Comminuted, 218.
Compound, 218.
Direct, 223.
Displacement of fragment, 219.
External table, 218.
Fissured, 218.
Indirect, 224.
Internal table, 218.
Slipping of tendons, 165.
Sloughing from contused wounds, 70.
Contusion, 40.
Gun-shot wounds, 82.
Lacerated wounds, 67.
Spine. Injuries of, 321.
Arteries of, ligature, 358.
Cord, injuries of, 359.
Dislocation, 353.
Fracture, 340.
Sprain, 322.
Strain, 322.
Spleen. Rupture of, 456.
Sprains, 173.
of the spine, 322.
Sternum, fracture of 446.
Stomach, rupture of, 456.

Strains, 164.
of the spine, 322.
Strangulation, 128.
of the intestines, 465.
of the penis, 560.
Stretching of nerves, 154.
Styptics for Hæmorrhage, 148.
Subscapular artery, ligature of, 369–440.
Subcutaneous wounds, 58.
Suppuration of lacerated wounds, 65.
Surgeon. Duties of the, 19.

T

Tarsus. Dislocations of, 537–540.
Fracture of, 514.
Temporal bone, fracture, 220.
Tendons. Injuries of, 164.
Repair of, 164.
Rupture of, 164.
Slipping of, 165.
Testes. Contusions, 551.
Wounds, 552.
Tetauss, from Lacerated wounds, 68.
Punctured, wounds 74.
Tongue wounds, 292.
Thigh. Fracture of, 504.
Thoracic-duct. Wounds of, 317.
Thoracica, longa artery, ligature, 369–441.
Superior artery, ligature, 369–440.
Thorax. Injuries of, 419.
blood-vessels, 440.
Contusions, 420.
Dislocations, 447.
Foreign bodies in, 434.
Fractures, 442.
Non-penetrating wounds 421.
Paracentesis, 432.
Penetrating wounds, 424.
Viscera. Concussion of, 420.
Contusion of, 420.
Wounds of, 421
Tibia. Dislocation of, 535.
Fracture of, 512.
Tibial artery, anterior; ligature, 543.
Posterior ligature, 544.
Tongue. Laceration of, 292.
Tetanus from 292.
Torsion of arteries, 146.
Tourniquet, 139.
Trachea. Injuries of, 317.
Fracture, 321.
Hernia, 323.
Rupture, 322.
Wounds, 311-318.
Incised, 313.
Lacerated 219
Traumatism, 21.
Trephining of skull, 216–222.
Tumors, from contusion, 40.
Tympanum. Rupture of, 264.

U

Ulna, Dislocations, 415.
Fracture, 394.
Ulnar artery. Ligature of, 371.
Upper extremity. Injuries of, 364.
Urethra. Injuries of, 553.
False passage from, 557.
Foreign bodies in, 557.
Laceration of, 553.
Wounds of, 555.
Ureters. Rupture of, 458.
Urinary fistula, 555.

V

Vagina. Foreign bodies in, 554.
Wounds of 564.
Vas-deferens. Rupture of, 553.
Veins. Injuries of, 134.
Air in 134, 309–316.
of neck; wounds of, 309–315.
Venom, snake. Nature of, 92.
Venous hæmorrhage, 134.
Ventral hernia, 463.
Viscera. Injuries of abdominal, 449.
Chest, 420.

Viscera. Injuries of in punctured wounds 73.
Vulva. Contusions of, 563.
Wounds of, 564.

W

Wrist dislocations, 414.
Fractures, 402.
Wounds, 43.
Classification, 58.
Cleansing, 47.
Closing, 47.
Dressing, 48.
Hæmorrhage, 43.
Pain, 43.
Repair of, 50.
First intention, 52.
Granulation, 53.
Immediate union, 51.
Remedies to aid, 54.
Scabbing, 53.
Scarring, 55.
Wounds. Contused, 68.
Gun shot, 77.
Incised, 58.
Lacerated, 63.
Poisoned, 88.
Punctured, 72.
Subcutaneous, 58.
of the Abdomen, 460.
Muscles, 462.
Parietal, 460.
Penetrating, 465
Visceral, 462–469.
Arm, 364.
Arteries, 131.
Bladder, 484.
Blood vessels, 131
Brain, 227.
Chest, 421.
Wounds of the Chest. Blood vessels, 440.
Non-penetrating, 421.
Penetrating, 424.
Cornea, 287.
Eyelids, 236.
Face, 266.
Arteries, 274.
Nerves, 275.
Heart, 435.
Intestines, 470.
Joints, 167.
Kidney, 456.
Larynx, 311.
Liver, 465.
Lungs, 435.
Mediastinum, 424–439.
Mouth, 290.
Neck, 309.
Œsophagus, 311, 320, 229.
Penis, 560.
Pericardium, 435.
Scalp, 210.
Arteries of 212.
Sclerotic, 253.
Scrotum, 548.
Spinal cord, 363.
Spleen, 456.
Testes, 552.
Thoracic duct, 317.
Tongue, 292.
Urethra, 555.
Vagina, 564.
Veins, 134.
Veins of the neck 309–315.
Vulva, 564.

Z

Zygoma. Fracture of, 222.

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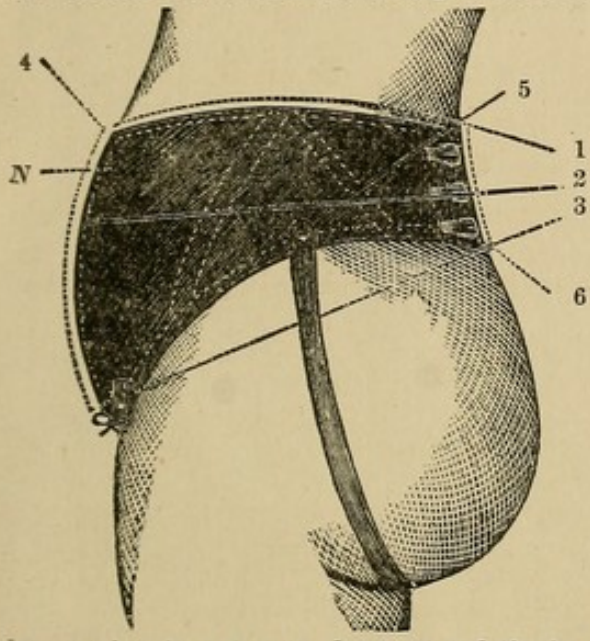

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