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A

TREATISE ON DISLOCATIONS.

BY

LEWIS A. STIMSON, B.A., M.D.,

PROFESSOR OF CLINICAL SURGERY IN THE UNIVERSITY OF THE CITY OF NEW YORK; SURGEON TO THE NEW YORK, PRESBYTERIAN, AND BELLEVUE HOSPITALS; MEMBER OF THE NEW YORK SURGICAL SOCIETY; CORRESPONDING MEMBER OF THE SOCIÉTÉ DE CHIRURGIE OF PARIS.

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PREFACE.

THE interval of nearly five years that has elapsed between the publication of the volume on Fractures and the completion of this one on Dislocations is longer than was anticipated, and the delay is in the main due to the great amount of material that had to be collected and examined in the preparation of the work. The *Index Medicus*, the Index Catalogue of the Surgeon-General's Library, the encyclopædias, and the greatly multiplied text-books on surgery and periodicals contain or give references to a number of reported cases vastly in excess of those that have heretofore been within the reach of writers; and while this has greatly facilitated the search for cases, it has also rendered necessary a corresponding amount of labor to collect and utilize the material. An effect of this increase in the amount of material appears in the accounts given of the rarer forms of injury, of some of which I have been able to give systematic descriptions, instead of simply quoting the one or two cases which have heretofore embodied all that was known upon the subject.

So far as possible, I have always gone to original reports, and have subjected them to careful scrutiny; this has resulted in the rejection of some cases, and in the transfer of others to different groups. A number of errors—some of them of long standing and wide circulation—have thus been corrected, some of which arose through reliance upon incomplete or faulty abstracts or reports, and others through faulty diagnoses which have been corrected by the aid of post-mortem examination or by critical review of the history in the light of later researches and accumulated evidence. When the scantiness of the report or the use of ambiguous terms has left some detail in doubt I have never given my own interpretation, except as such, and have usually quoted the reporter's description literally. This, of course, has required the

transfer to these pages of the ambiguity of the original reports, but I have deemed this preferable to the introduction of unexplained changes or substitutions, however justifiable they might seem.

In the classification of the different forms I have sought, while avoiding the introduction of new terms, to group them in a few large classes characterized by some feature of importance in reduction, and to mark the variations by subdivision of these classes; the distinguishing feature of a class has usually been the direction of the primary displacement, and it is also usually indicated in the name given to the class, while the names of the subdivisions have been derived from the secondary displacements or from the newly established relations of the dislocated bone.

A special effort has been made to secure accuracy in the references given in foot-notes, and while I cannot hope that errors in transcribing and printing have been entirely escaped or corrected, yet I believe them to be but few, and that, practically, all the references that I have been able to verify—those given here without quoted authority—will be found correct.

LEWIS A. STIMSON.

34 East Thirty-third St., New York,
April, 1888.

CONTENTS.

PART I.

TRAUMATIC DISLOCATIONS.

CHAPTER I.

GENERALITIES.

PAGE

Definitions 17
Statistics 20

CHAPTER II.

ETIOLOGY AND MECHANISM.

a. Predisposing causes 24
b. Immediate or determining causes 25
Recurrent or habitual dislocations 27

CHAPTER III.

PATHOLOGICAL ANATOMY IN RECENT DISLOCATIONS; COMPLICATIONS; PROCESS OF REPAIR AFTER REDUCTION.

Complications 30
Bones 31
Bloodvessels 33
Nerves 35
Viscera 38
Soft parts and integument 39
Repair 40

CHAPTER IV.

PATHOLOGY OF UNREDUCED (ANCIENT) DISLOCATIONS . 43

CHAPTER V.

SYMPTOMS AND DIAGNOSIS.

PAGE

Objective signs 50
Deformity 50
Loss of mobility 52
Crepitation 53
Subjective symptoms 53
Pain 53
Loss of function; history 54

CHAPTER VI.

COURSE AND PROGNOSIS 56

CHAPTER VII.

TREATMENT.

Spontaneous reduction 59
Obstacles to reduction 61
Anæsthesia 63
History of methods of reduction 65
After-treatment 72
Habitual dislocation 73

CHAPTER VIII.

ACCIDENTS THAT MAY BE CAUSED BY ATTEMPTS TO REDUCE A DISLOCATION.

. 74

Integument 75
Emphysema of the cellular tissue 76
Rupture of the muscles 77
Avulsion of a portion of a limb 78
Injuries of the main bloodvessels 79
Injuries to nerves 89
Fracture 91
Inflammation, suppuration, gangrene 93
Persistent œdema 94
Syncope and sudden or early death; fat embolism 95

PART II.

NON-TRAUMATIC DISLOCATIONS.

CHAPTER IX.

CONGENITAL DISLOCATIONS.

PAGE

Statistics 97
Etiology 88
Pathology 103
Symptoms and diagnosis 106
Treatment 108

CHAPTER X.

SPONTANEOUS DISLOCATIONS 111

By distention 112
Paralytic 114
Voluntary 115
By destruction; by deformity 115

PART III.

SPECIAL DISLOCATIONS.

CHAPTER XI.

DISLOCATIONS OF THE LOWER JAW.

Backward with fracture 117
Forward 119
Pathology 120
Symptoms 122
Treatment 123
Pathological 126
Congenital 127

CHAPTER XII.

PAGE

DISLOCATIONS OF THE VERTEBRÆ AND OF THE OCCIPUT FROM THE ATLAS 128

Classification and pathology 131
Etiology, symptoms, and diagnosis 137
Prognosis 140
Treatment 141
Dislocations of the occiput 143
Dislocations of the atlas 145
Dislocations of the lower six cervical vertebræ 149
Dislocations of the dorsal vertebræ 157
Dislocations of the lumbar vertebræ 159

CHAPTER XIII.

DISLOCATIONS OF THE STERNUM.

Of the body from the manubrium 161
Of the ensiform process 165

CHAPTER XIV.

DISLOCATIONS OF THE RIBS AND COSTAL CARTILAGES.

Of the head of the rib 167
Of the ribs from the costal cartilages 169
Of the costal cartilages from the sternum 170
Of one cartilage upon another 171

CHAPTER XV.

DISLOCATIONS OF THE CLAVICLE 173

A. Of the sternal end 174
Forward 175
Backward 179
Upward 182
B. Of the acromial end 184
Supra-acromial 185
Subacromial 191
Subcoracoid 193
C. Simultaneous of both ends 194

CHAPTER XVI.

DISLOCATIONS OF THE SHOULDER.

PAGE

Anatomy 196
Statistics 200
Classification 202
Anterior (and downward) dislocations 207
1. Subcoracoid 207
Pathology 211
Symptoms and diagnosis 214
2. Intracoracoid 217
Treatment of anterior dislocations 219
Direct reposition; traction downward and outward . . . 222
Traction upward 224
Traction with leverage 225
Heel in the axilla 226
Forcible traction 227
Manipulation 227
After-treatment 232

CHAPTER XVII.

DISLOCATIONS OF THE SHOULDER—*Continued.*

Downward dislocations (subglenoid) 234
Symptoms; treatment 237
Luxatio erecta 237
Subtricipital dislocation 239
Posterior dislocations (subacromial, subspinous) 240
Symptoms 245
Treatment 247
Upward dislocations (supracoracoid, supraglenoid) 248

CHAPTER XVIII.

DISLOCATIONS OF THE SHOULDER—*Continued.*

Associated injuries and complications 253
Prognosis and after-treatment 261
Habitual dislocation 262
Treatment of old dislocations 266
Subcutaneous section 267
Arthrotomy 268
Excision of the head of the humerus 269
Fracture of the surgical neck 270
Congenital dislocations 271
Pathological dislocations and subluxations 276
Dislocations due to paralysis 278

CHAPTER XIX.

DISLOCATIONS OF THE ELBOW.

PAGE

Anatomy 280
Classification 283
Dislocations of the forearm backward 285
Pathology 287
Complications 290
Symptoms 291
Treatment 294
Lateral dislocations 298
Incomplete lateral 299
A. Inward 301
B. Outward 302
Complete, outward 306
Forward dislocations 310
Divergent dislocations of the radius and ulna 315

CHAPTER XX.

DISLOCATIONS AT THE ELBOW—*Continued.*

Dislocation of the ulna alone 319
Dislocation of the radius alone 323
1. Backward 324
2. Outward 328
3. Forward 331
4. By elongation, or subluxation in children 335
Dislocation of the head of the radius, with fracture of the ulna . . 340

CHAPTER XXI.

DISLOCATIONS OF THE ELBOW—*Continued.*

Treatment of old dislocations 343
Congenital and pathological dislocations 349

CHAPTER XXII.

DISLOCATIONS AT THE WRIST.

A. Dislocations of the lower radio-ulnar joint 353
B. Dislocations of the radio-carpal joint 356
Backward 357
Forward 361
Outward 362

PAGE
Pathological 363
Congenital 366
C. Dislocations of the carpal bones 367
Medio-carpal 368
Scaphoid 369
Semilunar 370
Unciform; pisiform; os magnum 372
Trapezoid; trapezium 373
Os magnum and trapezoid 374
D. Carpo-metacarpal dislocations 374

CHAPTER XXIII.

DISLOCATIONS OF THE THUMB AND FINGERS.

Proximal phalanx of thumb 380
Anatomy 381
Backward 382
Forward 388
Metacarpo-phalangeal of the fingers 389
Dislocations of the middle phalanges 391
Distal phalanges 392

CHAPTER XXIV.

DISLOCATIONS OF THE PELVIS AND OF COCCYX.

Dislocation of the pelvis 394
Coccyx 395

CHAPTER XXV.

DISLOCATIONS OF THE HIP.

Anatomy 397
Statistics 401
Simultaneous dislocation of both hips 402
Compound dislocations 402
Classification 404
Backward dislocations 408
1. Dorsal dislocations 409
Causes 409
Pathology 410
Symptoms 414
Diagnosis 417

PAGE
2. Everted dorsal dislocations 418
Pathology 420
Anterior oblique 421
Symptoms 422
Treatment 423

CHAPTER XXVI.

DISLOCATIONS OF THE HIP—*Continued.*

Dislocations downward and inward 428
1. Obturator dislocations 428
Pathology 429
Symptoms 431
Treatment 433
2. Perineal dislocations 435
Dislocations forward and upward or inward (suprapubic) . . . 435
Pathology 436
Symptoms 438
Treatment 440
Dislocations directly upward 441
Dislocations downward (infracotyloid) 446

CHAPTER XXVII.

DISLOCATIONS OF THE HIP—*Continued.*

Complications 449
Accidents caused by attempts to reduce 454
Prognosis and after-treatment 455
Habitual dislocations 455
Treatment of old unreduced dislocations 457
Spontaneous or pathological dislocations 463

CHAPTER XXVIII.

DISLOCATIONS OF THE KNEE.

Anatomy 467
Statistics 469
Dislocations forward 469
Dislocations backward 473
Lateral dislocations 476
A. Outward dislocations 476
B. Inward dislocations 479
Antero-lateral dislocations 479

PAGE
Dislocations by rotation 480
Dislocation of the semilunar cartilages 482
Congenital dislocations 486
Spontaneous or pathological dislocations 488

CHAPTER XXIX.

DISLOCATIONS OF THE PATELLA.

General considerations 490
Outward dislocations 493
1. Complete 493
2. Incomplete 496
3. Outward edgewise, or vertical 497
4. Complete reversal 498
Inward dislocations 498
Congenital dislocations 500
Spontaneous or pathological dislocations 501

CHAPTER XXX.

DISLOCATIONS OF THE FIBULA.

A. Dislocations of the upper end. 503
B. Dislocations of the lower end 506
Spontaneous or pathological dislocations 506

CHAPTER XXXI.

DISLOCATIONS AT OR NEAR THE ANKLE.

Anatomy 508
1. Dislocation of the foot. Tibio-tarsal dislocations 509
A. Dislocations backward 509
B. Dislocations forward 511
C. Dislocations inward 513
D. Dislocations outward 514
E. Compound and complicated dislocations 515
2. Subastragaloid dislocations 516
A. Dislocations inward or inward and backward 516
B. Dislocations outward 518
C. Dislocations backward 519
D. Dislocations forward 520
Diagnosis 520
Treatment 521
3. Total dislocations of the astragalus 522
A. Forward 522

PAGE
B. Outward and forward 523
C. Inward and forward 523
D. Backward 523
E. By rotation 525
Treatment 528
4. Medio-tarsal dislocations 529
Congenital dislocations of the ankle-joint 530

CHAPTER XXXII.

DISLOCATIONS OF THE TARSAL AND METATARSAL BONES AND OF THE TOES.

Calcaneum 531
Scaphoid 531
Cuboid 531
Cuneiform bones 532
Of the metatarsal bones from the tarsus and from one another . . . 532
Dislocations of the toes 534
A. Metatarso-phalangeal dislocations 534
1. Of the great toe 534
2. Of the other toes 534
B. Dislocations of the phalanges 534

LIST OF ILLUSTRATIONS.

FIG.		PAGE
1.	Recurrent or habitual dislocation of the shoulder, showing the opening into the subacromial bursa	41
2.	Old supracotyloid dislocation of the femur, with very complete new acetabulum	45
3.	Scapula showing new socket formed in an old unreduced subcoracoid dislocation	45
4.	Old unreduced dislocation of the right humerus, with interposition of the capsule	47
5.	Diagram to show the effect of position upon the apparent length of the arm in dislocation of the shoulder	52
6.	Diagram to show the action of a ligament in limiting the range of motion in a dislocation	52
7.	Diagram to illustrate the action of an untorn ligament or portion of capsule in opposing reduction	62
8.	Jarvis's adjuster	71
9.	Section through the Y cartilage of the acetabulum into the obturator foramen	102
10.	Congenital dislocation of the head of the radius upward and forward, with exaggerated growth in length	103
11.	Left hip of an eight months fœtus with double dislocation	104
12.	The femur of the same, divided longitudinally	104
13.	Double congenital, subacromial dislocation	105
14.	Congenital dislocation of the left elbow	106
15.	Unilateral congenital dislocation of the hip	107
16.	Double congenital dislocation of the hip	107
17.	Nélaton's specimen of dislocation of the lower jaw in which the coronoid process was caught below the malar bone	120
18.	Diagrammatic of the external lateral ligament of the lower jaw	121
19.	Bilateral dislocation of the lower jaw	122
20.	Dislocation of the jaw of long standing	123
21.	Stromeyer's forceps	125
22.	Congenital dislocation of the lower jaw	126
23.	Cervical vertebra	130
24.	Dorsal vertebra	130
25.	Direction of the median axis in the different sections of the spinal column	131
26.	Complete unilateral dislocation by rotation or abduction; cervical vertebra	132
27.	Dislocation of the neck by flexion; median section	151
28.	Bilateral dislocation by flexion; fourth cervical vertebra; from behind	152

FIG. PAGE
29. Bilateral dislocation by flexion; fourth cervical vertebra; from the left side 152
30. Complete unilateral dislocation by rotation or abduction . . . 152
31. Ayre's case of bilateral dislocation forward of the fifth cervical vertebra 155
32. Frontal section through the sterno-clavicular joint 174
33. Récamier's dressing for fractured clavicle 178
34. Dislocation upward of the sternal end of the clavicle . . . 183
35. Ligaments uniting the clavicle to the scapula 184
36. Complete supra-acromial dislocation of the clavicle 188
37. Showing the relations of the humerus and scapula 196
38. Horizontal section through the shoulder-joint 197
39. The shoulder-joint; from in front 198
40. The interior of the shoulder-joint from behind 198
41. Showing the range of positions that may be taken by the head of the humerus after primary displacement forward or downward . . 205
42. Subcoracoid dislocation, reduced 210
43. Subcoracoid dislocation on a cadaver 210
44. Subcoracoid dislocation; the bones 212
45. Scapula showing new socket formed in an old unreduced subcoracoid dislocation 212
46. Subcoracoid dislocation; showing the different degrees of rotation of the humerus in different positions 212
47. Old unreduced dislocation of right humerus, with interposition of the capsule 213
48. Reunited fracture of the greater tuberosity of the humerus . . 214
49. Subcoracoid dislocation of the left shoulder 215
50. Subcoracoid dislocation 215
51. Diagram to show the effect of position upon the apparent length of the arm in dislocation of the shoulder 216
52. Intracoracoid dislocation, with arm fixed in horizontal abduction . 219
53. Reduction by traction; fixation of scapula 223
54. Reduction by vertical traction 224
55. Reduction by the knee in the axilla 225
56. Reduction by the heel in the axilla 226
57. Reduction with the pulleys 227
58. Collin's instrument for reduction of dislocation of the shoulder . 228
59. Kocher's method of reduction by manipulation; 1st movement, outward rotation 229
60. Kocher's method of reduction; 2d movement, elevation of elbow . 229
61. Kocher's method of reduction; 3d movement, inward rotation and lowering of elbow 230
62. Subglenoid dislocation 234
63. Subglenoid dislocation 236
64. Subspinous dislocation of the shoulder 243
65. Supracoracoid dislocation 249
66. Supracoracoid dislocation; Busch's case 250
67. Horizontal section of the head of the humerus in Cramer's case of habitual dislocation 264

FIG. PAGE
68. R. W. Smith's case of double congenital subcoracoid dislocation of the shoulder; scapula of left side 271
69. The same; left humerus 271
70. The same; right scapula 272
71. The same; right humerus 272
72. Double congenital, subacromial dislocation 273
73. R. W. Smith's case of double congenital subacromial dislocation of the shoulder; right humerus 274
74. The same. left humerus 274
75. The bones of the elbow 281
76. New formation of bone in an unreduced dislocation of the elbow backward 288
77. Dislocation of the elbow backward 291
78. Reduction of dislocation of the elbow backward 295
79. Showing the extent of separation of the bones necessary in reduction with the elbow at a right angle 295
80. Old incomplete dislocation inward; Broca's case 301
81. Incomplete outward dislocation 303
82. Complete outward dislocation 309
83. Complete outward dislocation of the elbow 309
84. Forward dislocation of the elbow; Canton's case 312
85. Dislocation of ulna alone backward, first form 320
86. Dislocation of the ulna alone backward; inner side 322
87. The same; outer side 322
88. Dislocation of the head of the radius backward 327
89. Dislocation of the head of the radius outward 329
90. Hilton's case of dislocation of the head of the radius forward. . 332
91. Subluxation of the head of the radius 338
92. New formation of bone in an old unreduced dislocation . . . 346
93. Dislocation of the head of the radius upward in consequence of arrest of development of the ulna 349
94. Congenital dislocation of the left elbow 350
95, 96. Allen's case of congenital dislocation of the elbow . . . 350
97. Fracture of the radius and ulna. 355
98. Dislocation of the carpus backward 359
99. Dislocation of the wrist backward, and Colles's fracture of the radius 360
100, 101. Madelung's case of spontaneous dislocation of the carpus forward 364
102. Bones of the wrist; posterior aspect 367
103. The metacarpo-phalangeal joint of the left thumb 381
104, 105. Incomplete dislocation of the thumb. 382
106, 107. Simple complete dislocation of the thumb 383
108, 109. Simple complete dislocation of right thumb 384
110, 111, 112. Complex dislocation of thumb 384
113. Farabeuf's instrument for reduction of dislocation of the thumb . 386
114. Levis's instrument for making traction in reduction of dislocations of the phalanges 386
115. Faulty method of use of Levis's instrument 387
116. Position of sesamoid bones during forcible traction 387
117. Interposition of the sesamoid bones by premature flexion . . 387

FIG. PAGE
118. The ilio-femoral, or Y-ligament 398
119. Relations of the head of the femur and the obturator internus . . 399
120. The left hip-bone viewed from a point directly opposite the acetabulum 407
121. Morris's case of dorsal dislocation 411
122. Dislocation below and then behind and above the obturator internus 412
123. Dorsal dislocation below the obturator internus 413
124. Dorsal dislocation 413
125. Recent dorsal dislocation 414
126. Dorsal dislocation 414
127. Dorsal dislocation below and then behind the obturator internus . 415
128. Dorsal dislocation 415
129. Dorsal dislocation below the tendon 416
130. Dorsal dislocation downward and outward toward the tuberosity . 416
131. Old everted dorsal dislocation 421
132. Supraspinous dislocation 422
133, 134. Anterior oblique dislocation 422
135. Anterior oblique dislocation 423
136. Everted dorsal dislocation 423
137. Obturator dislocation, showing rent in the capsule 430
138. Old obturator dislocation 430
139. Obturator dislocation 431
140, 141. Obturator dislocation 432
142. Reduction of obturator dislocation by rotation and circumduction inward 433
143. The same, showing the mechanism of the manœuvre . . . 434
144. Old obturator dislocation of the left hip 434
145. Old unreduced suprapubic dislocation of the hip 438
146. Ilio-pectineal dislocation 439
147. Suprapubic dislocation 439
148. Gély's case of old supracotyloid dislocation 442
149. Milner's case of supracotyloid dislocation 443
150. Infracotyloid dislocation 447
151. MacCormac's case of old obturator dislocation 458
152. Dislocation of the knee forward 471
153. Robert's case of dislocation of the knee outward, with abduction . 478
154, 155. Marsh's clamp for the treatment of dislocation of the semi-lunar cartilages 486
156. Congenital dislocation of the knee 487
157. Diagram of the various dislocations of the patella 492
158. Complete dislocation of the patella outward 493
159. Andrew's case of dislocation of the patella outward 494
160. Dislocation of the patella outward 495
161, 162. Subastragaloid dislocation inward 517
163. Subastragaloid dislocation outward 518

A

PRACTICAL TREATISE ON DISLOCATIONS.

PART I.

TRAUMATIC DISLOCATIONS.

CHAPTER I.

GENERALITIES.

A DISLOCATION is a permanent, abnormal, total or partial displacement from each other of the articular portions of the bones entering into the formation of a joint.

Some authors have sought to restrict the application of the term dislocation to such injuries of the diarthroses or movable articulations, and to use for those of the fixed or much less movable joints the term *diastasis*. This proposed discrimination has not become generalized, and as it corresponds to no actual need, removes no uncertainty of meaning, and is simply an academical refinement of expression, there seems to be no pressing reason to adopt it. A positive objection to it, moreover, exists in the fact that the term diastasis is already employed to indicate a direct separation of articular surfaces, without lateral gliding of one upon the other, as when the pubic bones separate at the symphysis, or the tibia and fibula are torn apart, or in many injuries of the spinal column.

If the displacement is only momentary, the parts immediately returning to their normal relations, the injury is classed as a *sprain*.

When a coexisting wound of the soft parts establishes communication between the outer air and the cavity of the joint, the dislocation is said to be *compound;* and when there exist associated lesions of the joint or neighboring tissues so extensive or peculiar as to present special indications or create special difficulties in treatment, such as fracture or laceration of vessels, nerves, or integuments, it is said to be *complicated;* under other circumstances it is described as *simple*.

When the articular surfaces are so far displaced that they no longer touch each other, or that they touch only by their edges, the dislocation

is said to be *complete;* if the displacement is less, it is called an *incomplete* dislocation or *subluxation.* Incomplete dislocations are frequent in the ginglymoid and arthrodial joints, and the controversy as to their frequency or infrequency in the enarthroses has arisen not from any doubt as to the nature of the new relations of the articular surfaces to each other or of the extent of the displacement, but solely from differences in definition, some authors maintaining that only those dislocations should be deemed complete in which the head of the bone has entirely left its bony socket, and all those incomplete in which any portion of the head remains within the area bounded by the rim of the socket, whether portions of the articular surfaces are in contact with each other or not. Under that definition many dislocations of the shoulder and of the hip would probably have to be classed as incomplete, if the exact relations of the bones could be determined; and as such accuracy of diagnosis would rarely be attainable, and the doubtful cases would not differ clinically from those in which the displacement is greater, the adoption of such a classification would serve only to embarrass and obscure. It seems to me much simpler and more practical, even if somewhat arbitrary, to call all traumatic dislocations of the hip and shoulder complete in which the centre of the head of the bone has passed beyond the rim of the socket. The incomplete dislocations would then be exceptional, practically only those in which a portion of the rim of the socket is broken off and pushed aside by the displaced head, as in a case mentioned by Robert[1] in an animated discussion of this subject before the Société de Chirurgie.

In the great majority of cases the dislocation is of a single joint only, but occasionally two or more joints may be simultaneously dislocated, and the injury is then said, according to circumstances, to be *bilateral*, *double*, or *multiple*. When a symmetrical bone, having joints on both sides of the median line of the body, as the lower jaw or a vertebra, suffers dislocation of these joints, the injury is called *bilateral* or *double*. When both ends of a bone are dislocated, as has been observed in the clavicle, ulna, and fibula, the dislocation is said to be *double* or *total*. The same term is also applied to symmetrical dislocations on opposite sides of the body, as of both shoulders or both hips. The former has been caused by muscular contraction during an epileptic fit[2] and by external violence; of the latter, two cases having a singular resemblance to each other have been reported, one by Boisnot,[3] the other by Schinzinger.[4] In the former a bale of wool fell upon a powerful man, forty years old, striking him upon the left side of the head and neck and bending him to the right, and caused a dorsal dislocation of the hip on the left side and a suprapubic one on the right. In Schinzinger's case the patient, while bending forward, was struck upon the right side by a falling mass of earth and sustained an ischiatic dislocation on the right side and a suprapubic one on the left. Schinzinger thought it probable that the latter was caused by the efforts of the bystanders to drag out the man. For other cases see Chapters XVIII. and XXVII.

[1] Robert: Bull. de la Société de Chirurgie, January 19, 1853, p. 389.
[2] Krönlein: Deutsche Chirurgie, Lief. 26, p. 25.
[3] Boisnot: Amer. Journal Med. Sciences, October, 1867, p. 396.
[4] Schinzinger: Wiener med. Presse, 1880, quoted by Krönlein.

Multiple dislocations are those in which two or more bones are simultaneously dislocated, as two fingers, a shoulder and a hip. Some authors include under this term dislocation of two or more joints of a single bone, as when one of the small bones of the foot or wrist is forced completely out of its place.

A method of nomenclature accurately descriptive of the different varieties of dislocation has not been established. As a general rule, subject, however, to some exceptions, the bone which is more distant from the trunk or median line of the body, the one that is generally moved upon the other, is said to be dislocated; thus a dislocation at the hip, at the shoulder, is called a dislocation of the femur, of the humerus. Or the joint alone is named, as a dislocation of the elbow, of the hip, of the shoulder. As an example of the exceptions may be mentioned dislocation of the outer end of the clavicle, a term universally preferred to dislocation of the acromion.

The same lack of uniformity appears in the names given to the various dislocations that may occur at the individual joints, and the practice has grown up of using in each case such a name as may most readily and accurately indicate either the general character of the displacement or some important special feature connected with it. When the name of the joint is used, and a term indicating direction is added, as dislocation of the elbow backward, forward, to the inner or to the outer side, the latter denotes the direction in which the *distal* member of the joint has been displaced. Whenever the use of the name of the joint would give rise to ambiguity, it is common to prefer the name of one of the bones constituting it, as a dislocation of the radius and ulna backward, instead of dislocation of the elbow backward. Strictly speaking, it is true that this might be mistaken for a dislocation at the wrist, and that, therefore, it would be well to add "at the elbow," but custom has so well established the meaning of the different terms now in use that in practice such a mistake would hardly be made. Other dislocations, again, have received names denoting the relations of the dislocated bone to certain muscles or bones, as subcoracoid or subpectoral dislocation of the humerus, and dislocation of the (head of the) femur upon the dorsum of the ilium or into the sciatic notch.

The *primitive* or *primary* displacement is the one immediately effected by the causative violence which produces the dislocation; if the dislocated bone afterward shifts to another position, the displacement is said to be *consecutive* or *secondary*. This shifting of the position of the dislocated end sometimes has very important consequences as regards treatment, because the end of the bone may thereby be removed from its position opposite the rent in the capsule through which it escaped from the cavity of the joint, and, unless this rent is very large, it may need to be brought back to that position before it can be replaced in the joint.

The earlier surgeons attributed this change of position to the action of the attached muscles, and although this opinion has been combated by high authorities, and although other causes undoubtedly take part in effecting the change, yet muscular action must, I think, be admitted to be one of the agents. Among the other causes are the action of gravity upon the limb, a new traumatism or a continuation of the primary one,

and movements communicated accidentally by the patient or bystanders, or intentionally by the surgeon in the effort to reduce the dislocation. Thus, in illustration of the last, it is not very rare to see an iliac transformed into an ischiatic or a thyroid dislocation of the hip in the effort to reduce by flexion, abduction, and rotation.

In the great majority of cases a dislocation is produced suddenly by external violence or by extreme muscular action, or by the two acting together upon a healthy joint, and when thus produced it is called *traumatic*. In other cases the joint has been diseased for some time previous to the occurrence of the dislocation, and this latter is effected by the gradual action of the muscles or even by gravity; these are known as *spontaneous*, and present many varieties. (See Chapter X.) A third class, *congenital* dislocations, is composed of those in which the dislocation occurs during intrauterine life, presumably as the result of a malformation or defective development. Dislocations produced during delivery are traumatic. The second and third classes will be separately considered. (See Chapters IX. and X.)

Statistics.—Compared with other surgical injuries, dislocations are infrequent. The statistics compiled by Gurlt[1] from the annual reports of the London Hospital for the years 1842 to 1877, give 51,938 fractures, 5212 dislocations, 98,373 wounds, 23,180 contusions, 39,947 sprains, 20,396 scalds and burns, 3715 dog-bites, and 975 suicidal attempts. The proportion of dislocations to fractures in this table is 1 to 10. Most of the statistics that have been published, especially the earlier ones, are defective in that they are based upon hospital, to the exclusion of dispensary, records, and therefore do not contain the due proportion of the less important varieties, or because of errors of diagnosis, notably in regard to dislocation of the wrist and ankle. It is only within the last forty years that the common injury now known as fracture of the lower end of the radius has been recognized as a fracture; it was formerly deemed a dislocation. And in like manner Pott's fracture at the ankle is often found recorded as a dislocation. Krönlein's[2] statistics have the merit of being based upon the records for six and a half years (1874–1880) of a single hospital and polyclinic, and yet containing a number larger than that of any other except Malgaigne's, and large enough in itself to make it probable that the percentages do not vary widely from those that a larger number collected at the same place would give. They are as follows:

[1] Gurlt: Archiv für klin. Chirurgie, 1880, p. 467.

[2] Loc. cit., p. 5.

TABLE I.—TABLE OF 400 RECENT TRAUMATIC DISLOCATIONS (KRÖNLEIN).

JOINTS.	KIND.	SEX. M.	SEX. F.	AGE. 1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	TOTALS.		PERCENTAGES OF FREQUENCY.	
Hip	Iliac,	4	...	2	...	...	1	...	1	...	...	4			
	Obturator,	2	1	2	...	...	...	...	...	1	...	3	8	2	
	Pubic,	1	...	...	...	...	...	...	1	...	...	1			
Knee	Lateral,	4	...	...	1	1	1	...	1	...	...	4			Lower extremity, 20 = 5
	Patella outward,	2	1	...	2	1	...	...	...	...	...	3	7	1.7	
Foot	Backward,	1	1	...	...	...	1	...	...	1	...		2	0.5	
Metatarso-phalangeal	.....	3	...	...	1	...	...	...	2	...	...		3	0.7	
Shoulder	Subcoracoid and axillary	180	23	...	2	53	44	48	35	19	2	203			
	Erecta,	3	...	...	...	2	1	...	...	...	...	3	207	51.7	
	Infraspinous,	1	...	..	...	...	...	...	1	...	...	1			
Elbow	Of forearm, backward,	77	17	22	44	14	5	4	3	1	1	94	109	27.2	Upper extremity, 369 = 92.2
	Of radius,	9	6	9	5	1	...	...	...	...	...	15			
Wrist	Dorsal of ulna,	1	...	...	...	1	...	...	...	...	...		1	0.2	
Metacarpo-phalangeal	.....	23	4	6	8	4	8	1	...	...	...		27	6.7	
Interphalangeal	.....	7	1	1	...	5	1	1	...	...	...		8	2	
Sterno-clavicular	.....	4	2	1	3	2	...	...	...	...	...		6	1.5	
Acromio-clavicular	.....	11	...	...	1	...	2	4	3	1	...		11	2.7	
Lower jaw	Unilateral,	2	2	...	1	1	...	2	...	...	...	4	10	2.5	Trunk, 11 = 2.8
	Bilateral,	...	6	...	1	3	1	...	1	...	...	6			
Cervical vertebræ	.....	1	...	1	...	...	...	...	...	...	...		1	0.2	
		336	64	44	69	88	65	60	48	23	3		400		
		400		400											

In addition, I quote those made up by Prahl[1] from the records of the Breslau Hospital and Polyclinic for the years 1830 to 1880, although they are probably affected by the errors of diagnosis above mentioned. Compared with Knönlein's, they show some important differences in the percentages, which may, perhaps, be due to an insufficient number of cases, or to differences in the habits and occupations of the population from which the cases were drawn.

TABLE II.—TABLE OF 420 TRAUMATIC DISLOCATIONS (PRAHL).

JOINTS.	AGE. 10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90	TOTALS.		PERCENTAGES OF FREQUENCY.	
Hip	12	8	11	5	3	2	...	...	...	41		9.76	
Knee	1	1	1	...	...	1	...	...	...	4	9	2.14	Lower extremity, 65 = 15.48
Patella	1	2	2	...	...	...	...	...	...	5			
Foot	1	4	3	1	1	2	1	...	...	13		3.09	
Toes	...	1	...	1	...	...	...	...	...	2		0.47	
Shoulder	6	6	27	50	36	40	24	3	2	194		46.19	
Elbow	17	26	12	7	3	3	1	...	...	69		16.42	
Wrist	1	2	3	5	...	1	1	...	...	13		3.09	Upper extremity, 327=77.85
Thumb[2]	3	4	4	2	5	3	1	...	...	21		5	
Fingers	1	1	1	9	1	1	1	1	...	17		4.04	
Sterno-clavicular	1	2	1	4	1	...	1	...	...	10		2.38	
Acromio-clavicular	...	...	...	2	1	...	...	...	...	3		0.73	
Lower jaw	...	3	5	6	7	2	2	...	...	25		5.95	Trunk, 28 = 6.66
Cervical vertebræ	...	1	...	1	1	...	...	...	...	3		0.73	
	44	61	70	93	59	55	32	4	2	420			
	420												

[1] Inaug. Dis. Breslau, 1880. Abstract in Centralblatt für Chirurgie, 1881, p. 57.

[2] As divided according to age, the numbers of the cases of the thumb and fingers amount to 22 and 16, respectively, instead of 21 and 17 as given in the main table.

The total number of cases on the records was 453, of which 420 were traumatic, 100 females, 290 males, and 23 were congenital; of the latter, 18 were of the hip, 15 females, 3 males, 2 each of the elbow and patella, and 1 of the knee. During the same period 2958 fractures were treated, a proportion of 7 to 1, reckoning the traumatic dislocations alone.

The following table has been made by combining Krönlein's statistics with a compilation made by Prahl of his own and others to show the direction in which the inclusion of dispensary or polyclinic statistics affects the percentages.

TABLE III.

Joints.	Combined Hospital and Polyclinic.			Hospital.		
	Cases.		Percentages.	Cases.		Percentages.
Lower jaw	49	57	3.4 Trunk,	12	19	1.2 Trunk,
Vertebræ	8		0.5 4	7		0.7 1.9
Sterno-clavicular	45		3.1	68		7
Acromio-clavicular	14		0.9 Upper	...		... Upper
Shoulder	648	1173	45.2 extremity,	581	794	60.2 extremity,
Elbow	315		22 81.2	97		10 82.3
Wrist, thumb, and fingers	151		10.5	48		5
Hip	127		8.8	85		8.8
Knee	18		1.2 Lower	16		1.6 Lower
Patella	13	202	0.9 extremity,	5	151	0.5 extremity,
Ankle	35		2.4 14.1	33		3.4 15.6
Tarsus and toes	9		0.6	12		1.2
	1432			964		

The following table summarizes the others with Malgaigne's statistics of the Hôtel Dieu.

TABLE IV.

	Upper extremity.	Lower extremity.	Trunk.
Malgaigne, hospital	85.7 per cent.	12.6 per cent.	1.6 per cent.
Krönlein, hospital and polyclinic	92.2 "	5 "	2.8 "
Prahl, hospital and polyclinic	77.8 "	16 "	6 "
Table III., hospital and polyclinic	81.2 "	14.1 "	4 "
Table III., hospital	82.3 "	15.6 "	1.9 "

These tables show the great relative frequency of dislocations of the upper extremity as compared with those of the lower. Each set of statistics shows that dislocation of the shoulder is far more common than that of any other joint, the percentages varying from 45.2 to 60.7; that next in frequency come dislocations of the elbow, with percentages varying from 10 to 27.2. These two dislocations may be estimated as together comprising from two-thirds to three-fourths of all cases; of the remaining one-third or one-fourth, dislocations of the fingers and hip form the majority.

The *side* upon which the dislocation took place is so seldom mentioned in the records from which the statistics have been compiled that no posi-

tive opinion can be formed as to the relative frequency with which the two sides are affected. Krönlein found in 100 consecutive cases observed by himself the right side was affected 46 times, the left 54.

As between *males* and *females*, Malgaigne and Gurlt found the injury three times as frequent in the former as in the latter; Krönlein found it five times as great. Dislocations of the lower jaw are an exception, being four times (Krönlein) as frequent in women as in men.

Age.—No age is exempt; dislocations have occurred as early as the moment of birth and as late as the age of ninety years. The relative liability to the injury at different ages is not shown by simply comparing the number of cases observed at those ages, but by also comparing these numbers with the number of people at those ages living in the community where the observation is made. This comparison has been made by Krönlein for Berlin, with the following results:

TABLE V.—FREQUENCY OF DISLOCATIONS AT DIFFERENT AGES.

	1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
Absolute frequency	44	69	88	65	60	48	23	3
Relative number of people living . . .	1872	1620	2529	1679	940	599	282	117
Relative frequency as computed for equal numbers of people	10	18	15	16	27	35	35	10+

From this it appears that a smaller proportion of individuals between the ages of 1 and 10, and 71 and 80 years receive dislocations than in any other decade of life; and the highest proportions are found between the ages 51 and 60 and 61 and 70. It is further to be noticed that dislocation of the shoulder is very rare, and that of the elbow very common, before the age of 21 years. Krönlein's table (Table I.) shows that of 207 cases of the former, in only 2 were the patients less than 21 years old, and that of 109 cases of the latter 80 were no older, the age in 31 being between 1 and 10 years, and in 49 between 11 and 20 years. Prahl's table (Table II.) corroborates this. Compared with fractures, it appears that the liability to dislocation is least during those periods of life in which the liability to fracture is greatest—that is, in infancy and youth and in old age; the latter part of this statement may need some modification, for while dislocations are rare after the age of 70, they are relatively frequent in the preceding decade. The liability to each increases from adolescence through middle life.

CHAPTER II.

ETIOLOGY AND MECHANISM.

THE causes of dislocation may be grouped in two classes: *a*. Predisposing; *b*. Immediate or determining.

a. Predisposing Causes.—These are found in certain normal differences of form and function characterizing certain joints, and in accidental or pathological conditions that sometimes arise.

The joint which is most frequently dislocated is the shoulder-joint, and it differs normally from others in the wide range and variety of motion made possible by its form, the laxity of its capsule, and the absence of any firm ligament to hold the bones closely together. A wide range of motion in one direction is not necessarily a circumstance favoring dislocation; on the contrary, it may protect against it by making it difficult to bring into action the fulcrum which is furnished by the edge of the bone when it arrests the motion. In a young healthy person the elbow or knee cannot be dislocated by flexion, because the motion is finally arrested by broad contact of the soft parts, not by the edge of the joint; while, on the other hand, in each case extension is limited by the structures of the joint itself, and hyper-extension at once causes dislocation by rupturing those structures. A long range of motion in one plane does not make the joint insecure, so long as the two bony surfaces rest squarely against each other, as they do in the hinge-joints; but when the change of position makes this contact oblique, as in abduction of the arm, a displacing force exerted in the direction of the long axis of the humerus is resisted only by the capsule. Under certain conditions, therefore, it may be said that freedom of motion in a joint diminishes, and limitation of motion increases, the liability to dislocation. A force which, exerted in the plane of normal motion of a hinge-joint, would be taken up by the muscles without damage to the joint, would, if exerted in another (lateral) plane, rupture the ligaments and dislocate the joint. If the edges of bone or the processes about a joint are exceptionally prominent they may, by virtue of this condition, become predisposing causes of dislocation by arresting motion.

Dropsy of such a joint as the shoulder favors its dislocation by removing the obstacle which the necessity of creating a vacuum between the articular surfaces would otherwise interpose, and by giving to the head of the humerus a different range and character of motion and the possibility of finding new bearings (see Chapter X., Dislocations by Distention).

The destruction of the ligaments by violence or disease, and fracture or disease of the bony constituents of the joint, favor dislocation, and the fracture of an associated or parallel bone may have the same effect, as fracture of the ulna favors dislocation of the head of the radius.

b. Immediate or Determining Causes.—A bone may be dislocated by (1) external violence applied (*a*) directly to it at or near its end, or (*b*) indirectly and at a distance from its end; (2) by muscular action.

1. External violence. Dislocations by direct violence are rare, especially if the class is restricted to those cases in which the violence falls upon only one of the bones forming the joint and forces it directly away from the other. Thus, the head of the humerus has been driven backward (subspinous dislocation) by a blow of the fist (Busch) or by a fall in which the front of the shoulder struck against the corner of a table (Krönlein), or inward by a fall upon the outer side of the shoulder, or even downward into the axilla by a force received upon and first breaking the acromion (Krönlein).

Intermediate between these cases and those in which the force is transmitted through the entire length of the shaft of the bone or of the limb, are those in which the force acts at right angles to the axis of the limb, and is received either at the joint or at a variable distance from it. Thus, the foot and body being fixed, the knee is forced to one side, producing rupture of a lateral ligament, lateral flexion, and dislocation; or, the femur being fixed, the leg is carried forcibly to one side and the same injury is produced. The mechanism and the consequences are identical in the two cases, but the former would be classed by some authors as a dislocation by direct violence, and the latter as one by indirect violence.

In dislocations by indirect violence the mechanism may vary greatly. The force in some cases is exerted directly along the long axis of the bone while the limb is in a position in which the articular surfaces do not rest squarely upon each other, and the head of the bone is driven out of its socket, as in some dislocations of the shoulder by a fall upon the outstretched (abducted) arm, or by muscular action, or in dislocation of the outer end of the clavicle by a fall upon the shoulder. The mechanism is similar to that of the first form of dislocation by direct violence mentioned above. Or a much slighter force, favored by conditions of leverage established at the joint, tears the capsule or a ligament and produces a dislocation. This is the most common mechanism. The conditions of leverage are found at all points where normal movements are arrested or no movement permitted. The head or neck of a moving bone is arrested by the edge of the corresponding articular cavity, or by a projecting point of bone, or by a tense ligament or portion of capsule; this at once becomes a new centre of motion, a fulcrum, and, the force continuing to act at the end of the bone or limb (the long arm of the lever), the head of the bone (or short end of the lever) is forced away abnormally with rupture of the opposing ligament or capsule. A position may be given to a limb by rotation or by abduction or adduction, such that the capsule of the joint is made tense and a dislocation by flexion or extension of the limb becomes imminent long before the normal limits of the latter motion are reached. Thus, when the thigh is slightly flexed and adducted, inward rotation of the limb will usually produce a dislocation of the hip with comparative facility.

When the force is exerted in a direction in which normally no motion is permitted, as laterally at the elbow, ankle, or knee, it meets at once with greater resistance than that habitually found at the extremes of

normal ranges of motion, and if it is great enough to overcome this resistance it is more likely to cause in addition other and perhaps extensive injuries of the soft parts or of the bones. The injury produced in this manner at the ankle is, indeed, classed as a fracture, although the partial or complete displacement of the astragalus, from its relations with the tibia, gives rise to the most prominent features of the injury, and may, if uncorrected, cause great permanent disability.

Violence, then, acting in a given manner, may cause a fracture, a dislocation, or a sprain according to its force, the strength of the resistance offered by the ligaments and the bones to which they are attached, and the prolongation of its action.

2. Muscular action. Contraction of the corresponding muscles can cause the dislocation of a sound joint in either of two ways: it can, by rapidly moving the limb, communicate to it a momentum which acts in the same manner as external violence and produces a dislocation when the normal limits of the range of motion are reached and conditions of leverage are established. A case, probably of this kind, was observed by Sédillot:[1] a woman, forty-six years old, who dislocated her shoulder by raising her arm to strike a blow. Or, secondly, the muscular contraction acts like external violence received at or near the end of the bone, or transmitted along its longitudinal axis, and draws the bone out of its socket. For this it is essential that one or two muscles should contract violently, while the others that normally act upon the joint remain passive, or that the limb should be in such a position that the line of traction of the muscles makes an acute angle with the opposing articular surface. Instances of this kind are common at some joints; dislocation of the lower jaw is commonly caused by muscular action, in yawning, laughing, vomiting, and others have been caused in like manner at the shoulder and hip, and, very exceptionally, at other joints. As illustrative examples may be mentioned the following:

A man sought to draw in through a window a heavy bale of goods suspended from a crane, and as he pulled upon it with his arms raised he felt a painful snap in the shoulder, and was found to have dislocated the humerus into the axilla. Apparently this was effected by the direct traction of the pectoralis major and latissimus dorsi.

A man, fifty-one years old, dislocated both shoulders (subcoracoid) by drawing himself up with his hands; a painter dislocated his shoulder while painting a ceiling; a woman, by trying to lift a heavy object from a shelf; a man, by trying to lift at arm's length a heavy book from the floor; and a woman, by carrying a heavy load upon her head with both arms uplifted.

Many cases have been reported in which dislocation has been caused by the convulsive contractions of individuals affected with epilepsy, tetanus, or uræmia, or poisoned with strychnine. In many of the cases reported as such the dislocation may have been caused by violence received in falling during the fit or by striking the limb against some object, but in a number of them the history positively establishes the absence of any other cause than the contraction of the muscles.

[1] Sédillot: Dict. Encyclopédique, art. Luxations, p. 23.

In these cases, as in fractures by muscular action, it is unnecessary to suppose, and unwarranted to claim, that the strength of the capsule or ligaments is less than usual, or that the structure of the joint varies from the normal in such a way as to facilitate the production of the dislocation. Such a supposition is based on the theory that a normal joint is so constructed as successfully to oppose any force that can be exerted upon it by its own muscles. Nature's precautions are based upon what is probable only, as we are taught by daily experience in many things; and it is no more remarkable that a healthy, normal joint should be dislocated by excessive muscular action than that a sound bone should be broken in the same way; it is only necessary that the force should be exerted in the same direction and should be equal in amount to that of the external violence which can produce the same injury, and anatomy shows us that both these conditions may exist. Moreover, in the first class of cases the mechanism is identical with that of dislocations by external violence, the only point of difference being that in them the place of external violence is taken by the momentum developed in the limb by the action of the muscles.

The power of *voluntary* dislocation of one or several joints has been occasionally observed. In a large proportion of the cases its appearance has followed the occurrence of a traumatic dislocation of the same joint, but in a few instances the history of the individual contained the record of no traumatism or diseased condition to which the peculiarity could be reefrred. In a case reported by Chassaignac[1] the subject was a saltimbanco, and seemed to have developed the power by forcing his joints in the practice of his art; he could dislocate each hip backward and upward, and then change the displacement into an ischiatic dislocation. Another man, Charles H. Warren, who possessed the power in a remarkable degree, has been examined and reported upon by several surgeons, notably by Hamilton,[2] who has given a very full account. In a case reported to Sir Astley Cooper,[3] a man, fifty years old, could dislocate either hip backward "by turning the limb considerably inward and bending the knee slightly, when the head of the femur immediately, with a crack, slips out in the direction backward and a little upward, the neck resting upon the acetabulum, and by reversing the position of the limb the bone returns into its natural position." He had possessed the power for about twenty-six years; the dislocation first occurred in consequence of simple change of position, and was reduced without surgical aid.

Recurrent or Habitual Dislocations. — Individuals are occasionally observed in whom dislocation of some one joint, commonly the shoulder, but also the hip and jaw, frequently recurs under the influence of some slight cause, and who have acquired this liability as the result of an ordinary traumatic dislocation, or of paralysis of one or more of the muscles of the joint, or of fracture. The first class will be considered in Chapter III.; of the others the following case, reported by Sir Astley Cooper,[4] will serve as an illustration: "A gentleman happened, as a junior officer on board his ship, to be placed under the orders of one of the mates when the captain was on shore, and for some trifling offence

[1] Chassaignac: Bull. de la Société de Chirurgie, 1853, vol. iii. p. 391.
[2] Hamilton: Fractures and Dislocations, 7th ed., p. 807.
[3] Cooper: Dislocations and Fractures, Am. ed., 1844, p. 7.
[4] Loc. cit., p. 9.

was punished in the following manner: his foot was placed upon a small projection on the deck, and his arm was lashed tightly toward the yard of the ship, and thus kept extended for an hour. When he returned to England, he had the power of readily throwing that arm from its socket merely by raising it toward his head, but a very slight extension reduced it; the muscles were also wasted, as in a case of paralysis."

The explanation is to be found in the loss of support occasioned by the diminution or loss of the tonicity of the muscles, which, in such joints as the shoulder, take the place of short, firm ligaments and hold the articular surfaces in contact with each other, a loss which allows the bones to be separated by the action of gravity, or by an effusion into the joint, until the separation is arrested by the capsule. When thus separated, a slight force is sufficient to throw the head of the humerus past the edge of the glenoid cavity and produce a dislocation without rupture of the capsule.

The cases of dislocation due to limited paralysis of peripheral origin must not be confounded with those sometimes accompanying the arthropathies that complicate some paralyses of central origin and some cases of central nervous disease without paralysis. In the latter the articular portions of the bones are absorbed in the progress of the disease, and thus even a joint the bones of which are normally held close together by ligaments becomes a loose one by loss of bone substance. I have seen a case of this kind in which the left femur could be very easily dislocated upward and backward. The symptoms were very different from those characteristic of the common traumatic form, since the loss of the head of the femur permitted free motion of the limb when dislocated and allowed the foot to be notably everted.

In another case, probably of the same kind, which I saw in the wards of La Charité in Paris, the patient, a woman, forty-six years old, had been received into the medical wards for supposed disease of the spinal cord, and while in bed there was suddenly seized with sharp pain in the left hip. Prof. Gosselin, called in consultation by Bernutz, found the limb shortened and everted, pain on pressure in front of and behind the hip-joint, some swelling in Scarpa's space, and crepitation on moving the limb, and made the diagnosis of spontaneous fracture of the neck of the femur. Two days later the patient was free from pain and could move the limb freely and vigorously, the foot remaining constantly everted. A few weeks later, her temperature rose suddenly to 106½°, and she soon died. The autopsy showed that the head and neck of the femur, the upper and outer portion of the rim of the cotyloid cavity, and all the articular cartilage of the latter had disappeared, leaving an eburnated surface. The joint was full of pus, which communicated through a hole in the capsule with an abscess in the buttock, and there was pus in the knee-joint. Prof. Gosselin then said that the non-existence of a fracture was incontestable, but he was indisposed to accept Bernutz's theory that the affection was an arthropathy of nervous origin.

Strictly speaking, cases like this, in which the articular end of the bone has been entirely absorbed, do not come within the definition of dislocation, but clinically it is proper and convenient so to designate them. (See Chapter X.)

The *unequal growth* of parallel and associated bones, tibia and fibula, or radius and ulna, may cause dislocation at one or the other end.

CHAPTER III.

PATHOLOGICAL ANATOMY IN RECENT DISLOCATIONS; COMPLICATIONS; AND THE PROCESS OF REPAIR AFTER REDUCTION.

As a traumatic dislocation consists in the forcible overcoming of the normal restraints upon the motion of the joint in one or more directions, restraints offered by the ligaments and capsules of the joint, it is almost invariably accompanied by rupture of a ligament or of the capsule. There is some reason to think that dislocation of the inferior maxilla may be an exception to this rule, but the lack of opportunities directly to examine such cases leaves the question in doubt. In a case examined by Nélaton and Malgaigne the ligaments and capsule were found intact, but the patient was old and the dislocation had taken place five different times, so that the examination cannot be held to prove even the possibility of a first dislocation without laceration of the soft parts. In enarthrodial joints, especially the shoulder, where the ligaments are loose and where the bones are held together by the tonicity of the muscles and the atmospheric pressure, such a change as dropsy of the joint may so annul the effect of the latter agent and overcome the former by filling the capsule with liquid that insinuates itself between the contiguous articular surfaces, that the head of the bone falls away from its socket and the joint becomes loose like that of a flail; under such circumstances dislocation may occur without rupture or laceration.

The capsule of an enarthrodial joint is torn upon the side toward which the distal bone is displaced; in joints of other forms the ligaments may be broken on either or both sides, the extent and character of the injury varying with the character of the force. Thus, if a ginglymoid joint, like the elbow, is bent laterally toward the inner side until the external lateral ligament gives way, the ulna and radius may then be displaced backward without further laceration; but if the force continues to act and displaces the bones laterally, the internal lateral ligament must also yield. The rent in the capsule may be limited in extent and simple in form, merely a longitudinal or transverse slit, or it may be irregular and may even involve the entire periphery. Instead of suffering a rent, the capsule may be torn away from the bone, sometimes bringing with it portions of the bone itself, or remaining continuous with the periosteum stripped up from the shaft.

Under similar conditions the position of the rent in the capsule is very constant, for it is determined by the posture of the head and the direction of the force, and as the end of the bone may pass through the rent, and then be brought by a change in the posture of the limb to a point where an untorn portion of the capsule lies between it and the cavity of the joint and whence it can be replaced only by first bringing it back to the

place where it escaped, it is sometimes of the greatest importance to ascertain the position occupied by the limb at the moment the dislocation occurred, and to replace it in this position as the first step in making the reduction.

In addition to the laceration of the capsule and ligaments produced by the pressure of the bone, others may be caused by the tearing off of attached muscles that are put upon the stretch by the displacement. This is commonly accompanied by the avulsion of the tuberosities upon which the muscles are inserted; the bone yields, and the laceration, starting from the broken surface, extends across and through the adjoining soft parts. This is an habitual accompaniment of dislocation inward and downward of the shoulder; the supra-spinatus and infra-spinatus muscles, inserted respectively upon the upper and middle facets of the greater tuberosity of the humerus, are put upon the stretch and one or both are torn away from the bone. I possess a specimen of dislocation inward in which this avulsion of the tuberosity, with a slight rent extending into the capsule from it, is the only lesion.

The soft parts overlying the capsule may be torn by extension of the rent in the capsule if they are closely adherent to the latter, or by the forcible passage through them of the displaced bone. The surrounding muscles on the side toward which the displacement takes place are contused or torn by the passage of the bone, and those upon the opposite side may be torn by being put upon the stretch. Blood is freely extravasated into the cellular tissue from the ruptured vessels.

The cartilages of incrustation may be bruised and sometimes chipped in the passage of the surfaces across each other, and projecting portions of bone, apophyses, or the rim of an orbicular cavity may be broken off.

The bone itself seldom passes to any great distance from its normal position; its progress is arrested by the ligaments and muscles that remain untorn and the resistance of the soft parts that it presses upon, and it comes to rest lying directly upon the adjoining bone or with some soft parts interposed. Its position, as taken in the primary displacement, may be changed by the renewal of external violence, by gravity, by a change in the position of the limb, or by the spasmodic contraction of attached muscles, but the secondary position ("consecutive displacement") is habitually determined by the resistance of untorn ligaments which constitute the fulcrum or pivot about which the bone turns. This fact, the resistance of untorn ligaments, should always be kept prominently in mind, for it not only constitutes one of the great obstacles to reduction, but it also determines the direction and extent of the manœuvres by which reduction may be accomplished.

Complications.—Other injuries, and severer or more extensive forms of those already mentioned, may coexist with a dislocation as complications. They include fracture of the bone, partial or complete rupture of large bloodvessels or nerves, and extensive laceration of the soft parts. In order that the associated injury should constitute a "complication" of the dislocation, it is agreed that it should be the direct or consecutive result of the original violence upon adjoining tissues, and should create special indications for, or difficulties in, treatment. A fracture of the leg caused by the same fall that dislocates the shoulder is not, in this sense,

a "complication" of the dislocation; but a fracture of the ulna accompanying dislocation of the radius, or a fracture of the surgical neck of the humerus accompanying dislocation of the shoulder is a complication, for the two injuries are mutually interdependent in their origin and in their treatment.

Bones.—All fractures that coexist with dislocation of even the same bone are not necessarily to be deemed complications, since many such habitually accompany certain dislocations, may even not be recognizable clinically, and neither receive nor require special treatment. Such are fractures of apophyses or tubercles to which muscles are attached, and fractures of a portion of the articular end of the bone or of the rim of an orbicular cavity. In others the dislocation is rather to be deemed the complication of the fracture, since it presents the less prominent symptoms and it may be entirely impracticable to meet the special indications for its treatment; such are some fractures through the anatomical neck of the humerus or femur with dislocation of the head. On the other hand, there is one injury habitually classed with fractures, Pott's fracture at the ankle, the treatment of which would, I think, yield much better results if it were looked upon as a dislocation and if the treatment were more distinctly directed to the reduction of the displacement and the prevention of its recurrence. It is far more common than it should be to meet with cases of this kind in which repair has taken place with the foot permanently displaced to the outer side, a result which is not only a deformity, but often also involves great disability.

A very rare manner in which this combination of fracture and dislocation is produced is that in which the fracture is first effected by direct violence, and thereby a way is opened for the production of the dislocation by the continued action of the original violence. Krönlein (loc. cit., p. 30) reports two examples that came under his own observation: in one the acromion was broken by a blow received directly from above, and then the humerus was dislocated inward and downward; in the other, by a fall upon the fully flexed elbow a compound transverse fracture of the olecranon was caused, and then a complete dislocation of both bones of the forearm forward. A more common form of similar character is that in which, by the fracture of one of two parallel bones, the dislocation of the other is facilitated, as in a case now under my care in which a lad seven years old by a fall upon the outstretched hand broke the ulna just below its centre and dislocated the head of the radius forward and upward.

Much more common are those in which the force is exerted through the distal segment of the limb and the head of the bone upon the margin of the opposing articular surface, breaking off the latter; the dislocated bone leaves the joint through the gap thus created, driving the fragment before it, or also tears the capsule and escapes in the usual manner. The commonest examples of this kind are found in fractures of portions of the rim of the glenoid and cotyloid cavities. Others, that are closely analogous, are fractures of the coronoid process of the ulna in dislocation backward of both bones; and I have once seen the inner third of the head of the radius broken off in the same dislocation.

A case of similar partial fracture of the head of the femur accompanying its dislocation backward is reported by Mr. Birkett, in the *Medico-*

Chirurgical Transactions, 1869, vol. 52, p. 133. The patient, a woman, thirty-five years old, received the injury, together with others that caused her death on the fifth day afterward, by a fall from a height of twenty feet; the head of the femur was divided by a vertical line of fracture, and the inner fragment, which included the attachment of the ligamentum teres, remained in the cotyloid cavity, while the remainder, with the neck, was dislocated backward between the pyriformis and the obturator internus. Another very similar case was reported by Moxon in *The Medical Times and Gazette*, 1872, i. p. 96. It is quoted in Chapter XXV.—*compound dislocations of the femur.*

In connection with this, although the mechanism appears to have been different, a very remarkable case recently reported by Riedel at the Fourteenth Congress of the German Surgical Society[1] needs mention. A lad fifteen years old was run over by a heavy car, probably while lying on his side. The appearance of the limb suggested an iliac dislocation of the hip, but was not characteristic, and, on manipulation, indistinct crepitation was felt. After removal of the trochanter the head and neck of the femur were found to be fractured longitudinally into two pieces. Both fragments lay outside the acetabulum, the upper and posterior portion of which was crushed. It seemed as if the head must have received a second blow at the moment when it rested on the edge of the acetabulum, and was thereby split in two.

A very rare complicating fracture is that of the central part of the acetabulum when the head of the femur is driven through it into the cavity of the pelvis by great violence. Sir Astley Cooper[2] briefly reports one such case "having the appearance of a dislocation backward; the patient lived four days. On examination, the fracture was found passing through the acetabulum, dividing the bone into three parts; and the head of the thigh bone was deeply sunk into the cavity of the pelvis."

Still more common, but seldom deserving to be classed as complications, are those fractures by avulsion, already referred to, in which, ligaments or muscles being put upon the stretch, the bony prominences to which they are attached are torn off. Some of them may be looked upon as habitual, or at least frequent, accompaniments of certain dislocations, for example, fracture of the greater tuberosity of the humerus in dislocation of the shoulder inward or downward, and fracture of the internal malleolus by displacement outward of the foot. This variety of complicating fracture, and also that in which a portion of the margin of the orbicular cavity is broken off, may become of special importance by facilitating recurrence of the dislocation.

The form in which the complication most seriously affects the treatment and prognosis is that in which the bone is broken completely across near the dislocated end. The commonest examples are found at the shoulder, where the line of fracture follows either the anatomical or the surgical neck, and the special difficulty in treatment arises from the smallness of the upper fragment, whereby it is made difficult or impossible so to act upon it as to return it to its normal position in the joint. In 68 cases of

[1] Riedel: Beilage zum Centralblatt für Chirurgie, 1885, p. 92.
[2] Cooper: Dislocations and Fractures, Am. ed., p. 101.

this kind collected by Thamhayn[1] 14 were of the anatomical neck of the humerus, and of these in only 2 was the dislocation reduced; while of the 46 cases in which the fracture occupied the surgical neck, 20 were reduced. A number of illustrative examples have been given elsewhere (Fractures, p. 372). The mechanism of the combined lesions is sometimes obscure, as regards its details, and varies in the different cases, the dislocation sometimes preceding and sometimes following the fracture, and perhaps sometimes occurring simultaneously. When it follows the fracture it is due to a continuation of the external violence acting directly or indirectly upon the upper (dislocated) fragment, or, if the fragment is very small and loosely attached, as after fracture through the anatomical neck of the humerus, to any slight force that may rotate or displace it in the loose capsule. In a specimen figured by Krönlein the head of the humerus, after fracture of the anatomical neck, has been completely reversed and lies wedged between the tuberosities. When the fracture follows the dislocation its production is doubtless aided, in most cases, by the comparative immobility of the head of the bone in its new position due to the creation of new bearings or fulcrums which fix the position of the limb. This is clearly illustrated by those cases in which the fracture has been caused by the surgeon in an attempt to reduce the dislocation.

The importance of this form of the complication lies not so much in the coexistence of two serious injuries, as in the difficulty of reducing the dislocation and in the necessity, if reduction fails, of seeking to establish a pseudarthrosis that will leave the limb measurably useful.

Bloodvessels.—Injury of a large bloodvessel adjoining a dislocated joint (the dislocation not being compound) is a comparatively rare accident, and one that depends either upon the close relations of the vessels and the bones, as at the shoulder and knee, or upon violence so great as to displace the bone to a greater distance than usual, or in an unwonted direction.

In most of the recorded cases the dislocation has been of the shoulder, inward and forward, and the lesion has consisted either in the rupture of a large arterial branch, the anterior circumflex or the subscapular, at or near its origin, or in such stretching of the axillary artery that its inner and middle coats have been torn across, the outer one remaining undivided. The injury may result in the immediate formation of a traumatic aneurism or in the gradual formation of an encysted one, or in gangrene of the distal portion of the limb. In some of the recorded cases it is not possible to determine whether the injury to the vessel was the immediate result of the dislocation or of the efforts to reduce it. (See Chapter VIII.)

The symptoms vary greatly, but, except at the shoulder, are not likely to leave any doubt concerning the nature and details of the injury. Injury to the inner and middle coats alone may in some cases be recognized by the immediate cessation of the brachial and radial pulse, in others only by the subsequent gradual formation of an aneurism. In other cases the prompt appearance and rapid growth of a fluctuating swelling in the axilla, perhaps accompanied by extensive ecchymosis and alarming symptoms of collapse or shock, sufficiently prove the fact of an

[1] Thamhayn: Schmidt's Jahrbuch, vol. 140, 1868

internal hemorrhage; but the source of the bleeding, whether from an arterial branch, the main artery, or the vein, may remain in doubt, for the radial pulse may persist even when the hemorrhage comes directly from the axillary artery. The subject will be more fully discussed in Chapter VIII.

In a case observed by Körte,[1] this complication accompanied a dislocation of the shoulder caused by a blow received upon its upper surface while the arm was abducted; the dislocation was spontaneously reduced before the arrival of the surgeon, and probably the displacement was only slight. An aneurism formed, and was opened under the impression that it was an enlarged lymphatic gland. The autopsy indicated that the lesion was avulsion of the anterior circumflex artery at its origin, and showed also that the inner and middle coats of the axillary artery were torn transversely at a higher point, but the calibre of the vessel was not thereby obstructed.

A somewhat similar case was reported by Desprès,[2] in which the patient's arm had been violently twisted in different directions. Although a dislocation had not been suspected, the autopsy (death having followed gangrene of the arm in the ninth week) showed a rent in the capsule on its inner and anterior side, and the joint was filled with blood-clots, so that it is probable a dislocation had occurred. The axillary artery was intact, but the common trunk of the circumflex arteries had been torn off at its origin.

These two cases illustrate one variety of the complication at the shoulder and the mechanism by which it is produced. Of another, damage to the wall of the axillary artery by over-stretching, the following may serve as an example, although it is possible that the injury was produced during reduction. Nélaton[3] refers to a case under the care of Bérard, a subcoracoid dislocation of the humerus, in which the axillary artery was torn completely across through its inner and middle coats, and the outer coat was "elongated like a glass tube drawn out in a flame." The lesion was followed by gangrene of several fingers, and, finally, by the death of the patient. He speaks, also, in two places[4] of what appears to have been a single case of similar character under his own care; the two inner coats of the axillary artery were torn to a very limited extent, and an aneurism formed, for which he tied the subclavian artery three months later, with a fatal result.

The following cases illustrate other varieties:

Mr. J. W. Turner[5] reported two cases of rupture of the popliteal artery complicating dislocation of the knee. In the first a man, twenty-four years old, fell from a height of thirty feet and sustained a compound dislocation of the knee, the condyles of the femur projecting through the integument of the ham. The limb was immediately amputated, and the two inner coats of the popliteal artery were found to be ruptured, the outer coat remaining untorn.

[1] Körte: Archiv für klinische Chirurgie, 1882, p. 636.
[2] Desprès: Bulletin de la Société de Chirurgie, 1878, p. 116.
[3] Nélaton: Pathologie Externe, 1st ed., vol. ii. p. 368.
[4] Loc cit., pp. 302 and 368.
[5] Turner: Trans. Edinburgh Med.-Chir. Soc., vol. iii. p. 308.

In the second case a middle-aged woman fell while carrying a heavy burden on her back. When she was brought to the hospital there was found a dislocation of the knee together with a wound in the ham through which, it was said, the condyles of the femur had projected. There was no bleeding; the limb became greatly swollen, and the patient died on the tenth day. The artery and vein were found to have been torn completely across.

Dr. M. Goldsmith[1] reported the case of a man, forty years old, who suffered a dislocation of the left femur, "the head of the bone being thrust under Poupart's ligament overrode the margin of the pelvis in such a manner as to underlie the femoral artery; it remained unreduced for two months, when he came under observation with a diffused swelling occupying the groin, filling the iliac fossa, and extending to the middle of the thigh; feeble pulsation; tumor appeared a few days after the accident; pain severe; diagnosis, aneurism; treatment, ligature of the common iliac artery; death on fifth day." The femoral and external iliac arteries were perforated to the extent of an inch on the postero-external aspect; the head of the femur lay in the cavity of the aneurism.

Cases also have been reported of rupture of the anterior and posterior tibial arteries in dislocation of the ankle; and Sédillot[2] published one in which the brachial artery was ruptured at the elbow by being stretched over the end of the humerus in a dislocation of the radius and ulna backward.

Nerves.—Injuries of the nerves may be demonstrated by direct examination or inferred from the symptoms. Examples of the former are uncommon, and in some of the latter it may remain in doubt whether the nerves were injured by the displacement of the bone, or by the efforts to reduce the dislocation, or by the independent action of the violence upon them. It is asserted[3] that a fall upon the hand or shoulder, without lesion of the skeleton, is competent to cause palsy of the arm; hence, it is not always to be inferred that a palsy following a dislocation has been caused by the pressure of the head of the bone upon the nerves, and this is especially true of those cases in which a blow has been received directly upon the shoulder, and the deltoid alone is paralyzed.

The injury may be a complete rupture or laceration of one or more nerve trunks, or a contusion with extravasation of blood about the nerve and amid its fibres, or a neuritis originating in an injury of some lesser nerve and extending thence to the main trunk, or an inflammatory process extending to the nerve and causing its compression by newly formed connective tissue, or simple compression by the displaced bone.

Rupture or laceration of the nerve is caused by violent pressure against it of the displaced end of the bone, and, in the case at least of the larger trunks, it appears commonly to be associated with extensive laceration of the other soft parts, including even the overlying skin. Contusion of the nerve may be produced in the same manner, and then represents a less degree of the same injury, or by compression of the

[1] Goldsmith: Amer. Journ. Med. Sciences, July, 1860, p. 30; abstract from Louisville Med. Journ., February, 1860.
[2] Sédillot: Dict. Encyclopédique, art. Luxations, p. 261.
[3] Weir Mitchell: Injuries of Nerves, p. 99.

nerve between the displaced bone and an adjoining portion of the skeleton, as between the head of the humerus and the wall of the thorax.

The symptoms vary with the character of the injury; laceration is immediately followed by motor paralysis and loss of sensation in the region supplied by the nerve which are permanent or persist until the integrity of the nerve is restored; in the others there are varying degrees of paralysis and loss of sensation, numbness, pain, alteration of local nutrition, and other symptoms of neuritis, limited at first to the nerve directly injured, and afterward perhaps extending to others. In many of the recorded cases a cure has followed the systematic use of electricity.

The relative frequency of the occurrence of this complication at the shoulder is indicated in the statistics of the Friedrich's Hospital, collated by Holm;[1] of 112 cases of dislocation of the shoulder there was general paralysis of the arm in 7, and paralysis of the deltoid alone in 10. In one of them all the muscles supplied by the median nerve were paralyzed, while those supplied by the musculo-spiral were unaffected.

The recorded cases of rupture of a nerve verified by direct examination are few; the following are examples of different forms:

Hilton[2] examined the body of a man who died thirteen weeks after having received a dislocation of the shoulder into the axilla; the deltoid was much atrophied, the circumflex nerve was small and was "distinctly lacerated, but its actual condition was changed by some strong cellular adhesions, fixing it with the radio-spinal nerve and the axillary artery to the inner surface of the subscapularis muscle." Bouley[3] presented to the Société Anatomique a specimen of complete dislocation outward of both bones of the forearm at the elbow, with fracture of the outer condyle of the humerus, caused by a fall upon the elbow from a height of twenty-four feet. The patient refused amputation and died twenty days after the receipt of the injury. "The lateral ligaments of the elbow were entirely ruptured, both bones of the forearm were situated external to the lower end of the humerus, and the ulnar nerve was lacerated at the level of the articular surface."

Holl[4] found in the dissecting room a cadaver with a marked deformity of the elbow, and on examination it appeared that the individual had suffered fracture of the upper end of the ulna and dislocation of the head of the radius upward and inward, and that the ulnar artery and ulnar and median nerves had been completely divided and had not reunited.

Boyer is commonly quoted as having seen the median nerve ruptured in a compound dislocation at the elbow, but his reference to the case[5] has apparently been misunderstood. He speaks of rupture of the brachial artery, and says he cannot conceive how the median nerve could escape. The injury was followed by gangrene of the limb and the death of the patient.

[1] Holm: Schmidt's Jahrbuch, vol. 121, p. 82.
[2] Hilton: Guy's Hosp. Reports, 1847, vol. 5, p. 93.
[3] Bouley: Bull. de la Soc. Anatomique, 1837, p. 101.
[4] Holl: Medicin. Jahrbuch, Wien, 1880, p 151.
[5] Boyer: Traité des Malad. Chirurgicales, 4th ed. vol. 4, pp. 317 and 322.

In a case reported by Ferret,[1] a compound dislocation of the elbow in which the bare end of the humerus projected two inches through a wound on the antero-inner aspect of the joint, the brachial artery was ruptured and the median nerve was exposed for a distance of three or four inches and was tightly stretched across the wound. Six days later all the denuded portion of the nerve had become gangrenous. The patient, a boy, fourteen years old, recovered with full use of the muscles and unimpaired sensibility in the region supplied by the median nerve. This restoration was attributed to an anastomosis between the median and ulnar nerves; electrical stimulation of the latter in the arm caused the flexor muscles of the forearm to contract.

Of the cases that have been observed clinically the injury in most has been attributed to the reduction, as a consequence of too forcible traction, extreme abduction of the limb (arm), or to the presence of adhesions between the nerve and the parts with which it has been temporarily brought into contact. In some of these cases the correctness of this view cannot be questioned; in others the necessary data for an opinion are lacking.

A man[2] fifty-four years old was seized by the right arm and shaken so violently as to dislocate the humerus into the axilla, causing pain in the shoulder and instant loss of feeling and motion in the hand. Reduction on the third day. "Six weeks afterward the whole hand and lower side of the forearm were œdematous, and the former also hard and brawn-like, resisting pressure. The fingers were in the same state, and the whole hand was dark and congested, but not shiny or smooth. The joints from the wrist to the finger ends were sore, swollen, and very stiff. The whole palm was the seat of pretty severe burning, with no darting or other pain." Partial loss of touch and pain-sense in the median and radial distribution. The elbow motions were perfect, wrist flexion good, extension lost; flexion of the fingers good, extension and lateral motions lost from palsy of the extensors and interossei.

A soldier[3] fell from a tree, striking upon and dislocating his left shoulder; the dislocation was reduced within twenty-four hours, and, the previous pain and numbness disappearing, he remained well for four weeks, when the arm began to waste, with loss of power which became complete in a few months. Sensation was much less altered. At the close of a year there was only partial ability to flex the arm, and slight use of the flexors and extensors of the fingers. Marked atrophy; contraction of the pronators. Rapid relief and final cure were obtained by electricity.

A man[4] twenty-five years old was admitted to the Hôtel Dieu with an intracoracoid dislocation of the left shoulder, caused shortly before by a fall. Any motion communicated to the limb caused great pain and violent involuntary contraction of all its muscles. The next morning the dislocation was found to have become subglenoid, the limb was completely paralyzed, but without loss of sensation, and although communicated motion was still painful, it did not cause reflex contractions of the

[1] Ferret: Le Progrès Méd., May 7, 1887.
[2] Weir Mitchell, Injuries of Nerves, p. 103.
[3] Weir Mitchell, loc. cit., p. 101.
[4] Duchenne: De l'Electrisation localisée, 2d ed., p 179.

muscles. Reduction was readily effected with the aid of anæsthesia. The muscles of the shoulder reacted to the faradic current; those of the arm and forearm did not. The limb wasted rapidly; under electrical treatment an almost complete cure was obtained in about two years.

Rothe[1] reported a case of suprapubic dislocation in a girl fifteen years old, in which, three weeks afterward, the extensors of the leg upon the thigh were found to be paralyzed. The case is quoted by Krönlein as an instance of pressure upon the anterior crural nerve, but Rothe attributes the disability to extreme flexion of the knee at the time of the accident. Krönlein (loc. cit., p. 34) also quotes Hutchinson as having seen paralysis of the sciatic nerve follow an ischiatic dislocation of the femur; and Sir Astley Cooper (loc. cit., p. 67) quotes a case in which numbness of the limb accompanied the same injury. Cooper (loc. cit., p. 74) also quotes a case of suprapubic dislocation in which the pressure of the head of the femur upon the anterior crural nerve caused numbness of the thigh; pulsation was also arrested by the pressure of the head of the bone upon the artery.

The tetanus which has been occasionally observed after dislocation, especially after compound dislocation of the fingers, may provisionally be classed among the results of injury of the smaller nerves.

Viscera.—Excluding the common implication of the spinal cord in dislocations of the vertebræ, there are few recorded cases of injury to parts lying within the body or neck by dislocated bones. Such injuries must, to a greater or less extent, accompany dislocation of the head of the femur through the floor of the acetabulum into the pelvis, and complete dislocation backward of the sternal end of the clavicle has in some cases been accompanied by symptoms indicating pressure on the trachea or œsophagus. In one case[2] this pressure upon the œsophagus was so great as to lead to an operation for its relief. The patient, a woman, "had a great deformity, arising from a distorted spine, increased by an accident which displaced the sternal extremity of the left clavicle and threw it behind the sternum. The progressive distortion of the spine gradually advanced the scapula, and occasioned the sternal end of the clavicle to project inward, behind the sternum, so as to press upon the œsophagus and occasion extreme difficulty in deglutition. Her deformity had become excessive, and her emaciation extreme." The sternal end of the bone was removed by operation; the patient survived six years "and recovered considerably from her former emaciation."

A case that is entirely unique, and interesting not only because of the distance to which the bone was displaced, but also because of the changes subsequently undergone by the bone, and of the ease with which the deformity was borne, is reported by Prochaska[3] and by Larrey,[4] who had examined the specimen. A lad, sixteen or seventeen years old, dislocated his right humerus by a fall upon the abducted elbow, and the head of the bone was driven between the second and third ribs (Prochaska says the

[1] Rothe: Deutsche Klinik, 1868, No. 38, p. 343.
[2] Sir Astley Cooper, loc. cit., p. 309.
[3] Prochaska: Disquisitio Anatomico-physiol. Org. Humani. Wien, 1812, quoted by Malgaigne.
[4] Larrey: Mém. de Chir. Militaire, vol. 2, pp. 405-407.

third rib was fractured) into the chest, stripping up the pleura, but not perforating it. All attempts to reduce it were unavailing, and the subsequent treatment was limited to venesection, warm baths, and antiphlogistic measures for the relief of urgent symptoms. The patient survived until the age of thirty-one (forty, Prochaska), and, although the arm remained abducted, gained his livelihood by woodchopping. At the autopsy the head of the humerus was found within the thorax, covered by the pleura, and its neck firmly placed between the second and third ribs. The head was so soft that it yielded to the slightest pressure of the finger; the articular cartilage and bony texture of all the portion that lay within the chest had entirely disappeared, leaving only a few membranous remains of the humerus, of which the greater part seemed to belong to the costal pleura. Prochaska describes it as "naked, soft, yielding to the softest pressure, presenting only a thin envelope, and almost empty within, since it had lost more than half of its internal bony substance."

Soft Parts and Integument (compound dislocations). — Although instances of this complication have been recorded for almost every joint, they are yet of rare occurrence, and mainly restricted to the elbow, knee, ankle, and phalanges. Except in the latter case, they are commonly the result of extreme violence, and the wound of the skin is produced either by the direct action of this violence, or from within outward by the projecting end of the bone.

The complication in the case of the larger joints is very grave, because of the extent of the injury, which is usually great and marked by much laceration and bruising of the tissues, and also because of the special dangers due to the contact of the air with the wound. It is hardly to be expected that even with the most careful and skilful treatment the wound will heal without suppuration, and even if this suppuration should fail to invade the joint, and thus imperil life, it is quite certain so to modify the periarticular tissues as to limit the range of motion and impair the usefulness of the limb.

The treatment may require, in addition to the most rigorous antiseptic measures, the partial excision of the joint, because of the difficulty of otherwise providing efficient drainage of all the recesses and pouches of the synovial sac. The injury, in a word, has much in common with gunshot wounds of joints, and shares their well-known gravity. To what extent the results of former experience will be improved upon by those of modern methods, remains to be determined; it can only be said that the promise is good, and that it is sustained by some excellent cures already obtained.

Most systematic writers upon the subject assert that there is no recorded case of compound dislocation of the hip, and account for the fact by the thickness of the soft parts that overlie this joint, and the resistance they oppose to the displacing violence. Yet there is a case recorded in full in Bransby Cooper's edition of Sir Astley Cooper's work (case 63, p. 80), and briefly mentioned by Hamilton. It was communicated to Cooper by Dr. Walker, of Charlestown, Mass. The patient, a very muscular man, fell under a wagon, the wheel passing "over the posterior part of his pelvis and right thigh, forcing the head of the femur out of the acetabulum

forward upon the groin, lacerating the soft parts, and pressing the head through the integuments." After several attempts to reduce by traction, the bone was replaced by manipulation. Extensive suppuration followed, and the patient died at the end of about three weeks. Case 61 of the same author, although not described as such, appears at least to have become compound, if not originally so.

Another case is contained in the statistical Sanitary Report of the Fourteenth Prussian Army Corps for the period from 1874 to 1878.[1] A mounted artilleryman, while galloping, fell with his horse in front of the gun, and his left leg was bent back so violently that the heel lay against the back of the shoulder, and the head of the femur with the torn ligamentum teres projected through the fold of the groin. There was profuse bleeding from the femoral vein, and the man died within twenty-four hours. For additional cases, see Chapter XXV.

Compound dislocations of the shoulder also are rare, those of the elbow and knee less so, and those of the smaller joints much more frequent. When at the elbow or knee the wound is made by the projecting end of the humerus or of the femur in the flexure of the joint, the overlying artery can hardly escape rupture.

Repair.—Only a few observations have been made of simple dislocations undergoing, or that have undergone, repair. Clinically it is known that, after a period of a few days or weeks marked by gradually diminishing tenderness and swelling, the joint can be freely used without pain, but that sometimes the range of motion remains limited for a much longer period, and that in some cases there is a marked tendency to recurrence of the dislocation. In a few cases, in which patients have died within a few days after having suffered a dislocation, the surrounding tissues have shown the remains of the extravasation of blood that had taken place amid them, and the rent in the capsule has either been occupied by a clot, or has been empty and without evidence of repair. It is to be presumed, however, that repair usually takes place after dislocation, as it does after many other subcutaneous injuries, without suppuration or even much inflammatory reaction, that the ruptured capsule reunites or that the gap in it is filled by condensation and adhesion of the adjoining connective tissue, that the lacerated muscles and ligaments are repaired in like manner, and that these cicatrices pursue the evolution common to their class.

This process may, however, be disturbed by various complications. If the injury has been exceptionally severe, if the bone has been widely displaced, and the surrounding tissues much lacerated, if the efforts to reduce have been violent and long continued, if the joint has not been properly immobilized, if passive motion has been injudiciously begun and maintained, or, finally, if the general condition of the patient is unfavorable for repair, the inflammatory reaction may become excessive, and even end in suppuration and pyæmia. If it stops short of this disastrous result, it may yet lead to partial or complete ankylosis through the formation of adhesions between the opposed articular surfaces or the thickening and retraction of the capsule and periarticular tissues. The older records

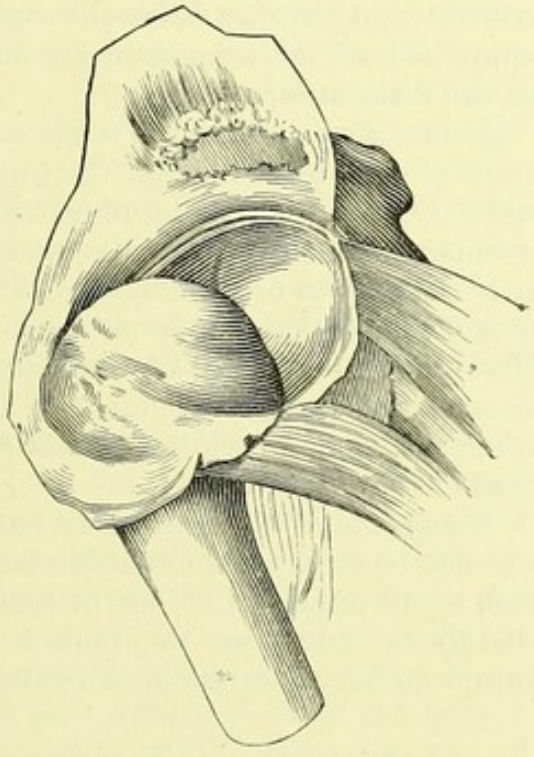
[1] Abstract in Centralblatt für Chirurgie, 1880, p. 504.

contain numerous instances in which suppuration appears to have been caused by the efforts to reduce, but this accident has become much less common since the introduction of anæsthesia and the substitution of the so-called "mild" methods by manipulation for the forcible traction by pulleys which was formerly so much in vogue. In the following cases reported by Cooper,[1] it does not appear whether or not the reduction was a controlling factor in exciting the suppuration.

"A man had his thigh dislocated upward and backward on the ilium, which was soon after reduced; the next day a considerable swelling was observed in the part, which continued to increase, accompanied by rigors, and in four days the patient died. On dissection, the capsular ligament and ligamentum teres were found entirely torn away, and a considerable quantity of pus extravasated in the surrounding parts." "I attended the master of a ship, who had dislocated his thigh upward; an extension was made, apparently with success; but in a few days a large abscess formed in the thigh, which destroyed the patient."

Fractures of apophyses, or portions of bone to which muscles or ligaments are attached, are repaired either by bony callus or by a fibrous band, the difference depending on the extent of the separation and the independent motion of the fragment. The fragment may be withdrawn to such a distance that the attached muscle or muscles permanently cease to exercise any control over the main bone, which, in consequence, is exposed to frequent and easy recurrence of the dislocation. The same infirmity may result from defective repair of fracture of the rim of an orbicular cavity. Instances of the former variety are most common at the shoulder-joint, those of the latter are found at the hip and shoulder. The existence of a marked liability to recurrent dislocation (Fig. 1) is often found at the shoulder, and its explanation has been recently furnished by Jössel,[2] who had the opportunity to examine four such cases after death; he found in all that the supraspinatus and infraspinatus muscles had been torn loose from their attachment to the greater tuberosity, had retracted behind the acromion, and had undergone atrophy and fatty degeneration. The relations of the tendons of these muscles with the articular capsule are so close that the rupture of the former involves also that of the latter, and the retraction of the former creates, by drawing back one side of the rent, a

FIG. 1.



Recurrent or habitual dislocation of the shoulder, showing the opening into the subacromial bursa. (JÖSSEL)

[1] Loc. cit., p. 4.

[2] Jössel: Deutsche Zeitschrift für Chirurgie, 1880, vol. xiii. p. 167.

large gap in the upper part of the capsule opening into the subacromial bursa. In the process of cicatrization the front part of the capsule, that lying between its attachment to the humerus and the rent, becomes adherent at the edge of the rent to the under surface of the deltoid close by its attachment to the acromion, while the posterior lip of the rent, after retraction with the tendon, becomes permanently fixed at the posterior part of the acromion. The under surface of the acromion is thus left to fill the gap between the two lips, to form the upper limit of the articular cavity, and to be in direct contact with the head of the humerus. In none of Jössel's four cases was the normal communication between the cavity of the joint and the subscapular bursa found to be enlarged; in one the subcoracoid bursa communicated with the joint, and in one the tendon of the long head of the biceps was ruptured, and its torn end had become fixed in the bicipital groove. In two of the cases a small defect with smooth edges was found in the capsule below the tendon of the subscapularis, and in the others the capsule appeared thinned at the same point. Apparently this indicated the place at which the head of the humerus escaped through the capsule at the time of the first dislocation.

The cavity of the joint was greatly enlarged by these changes in the capsule; in the first its capacity was 90 cubic centimetres, as against 28 in a normal joint, and its length along the upper portion 10 centimetres instead of the normal 3¾.

This condition of the capsule, and especially the withdrawal of the control and support normally supplied by the supraspinatus and infraspinatus muscles, seem entirely adequate to explain the easy recurrence of the dislocation.

It has been observed in some cases of old, and even unreduced, dislocations of the shoulder, that the broken portions of the greater tuberosity have reunited with the humerus, and as this fracture is much more common than the alternative lesion of rupture of the tendon, as, indeed, it is thought to be an almost constant accompaniment of the dislocation, it is evident that the latter lesion, rupture of the tendon, is much more likely to be followed by a tendency to recurrent dislocation, presumably because the broken fragment of the tuberosity remains attached to the humerus by the periosteum, while there is nothing to oppose the retraction of the torn tendon.

Gangrene of the limb may ensue upon the rupture of the principal vessels, or even upon extensive laceration and violent inflammatory reaction; and *paralysis* of one or several muscles may manifest itself immediately or only after the limb is again brought into use, the result of injury to nerve trunks or of contusion of the muscle itself.

CHAPTER IV.

THE PATHOLOGY OF UNREDUCED ("ANCIENT," "INVETERATE") DISLOCATIONS.

THE changes that take place about joints that have long remained dislocated are well understood, through direct observations of many specimens in man and through experiment upon animals. These changes are partly the direct result of purely inflammatory processes excited by the traumatism and the changed relations of the parts, partly that of disease, and partly that of a seeming effort of nature to create a new and serviceable joint. Striking as the latter sometimes is, it is not to be supposed that the organism possesses and is stimulated by the changed conditions to exert a creative or formative power similar to that existing in the impregnated ovum or even to that of certain batrachians by which a lost limb can be reproduced; the changes are all the result of properties normally possessed by the connective tissues and habitually stimulated to activity by unwonted irritation, the powers of multiplication, growth, and transformation. The changes consist, in general terms, in the condensation and thickening of connective tissue about the displaced bone in such a manner as to protect it against further displacement, and in the change of the bones at the new points of contact partly by absorption and partly by the formation of new bony outgrowths through continued slight irritation of the bone itself, the periosteum, and the adjoining fibrous and ligamental tissues. The irritation which leads to these changes is furnished by motion, use, of the limb; hence the most striking examples are found at the shoulder and the hip, and these will be used as the basis of the following description:

The first changes, in point of time, are those in the bruised and torn soft parts amid which the end of the bone has lodged after its escape through the rent in the capsule. The loose connective tissue lying about the vessels, nerves, and muscular bundles, bruised and pressed back by the head of the bone and infiltrated with extravasated blood, reacts in the usual manner under the traumatism by becoming the seat of an exudation and by multiplication of its cellular elements. The latter follow their natural evolution into fibrous tissue, and thus is formed about the bone a continuous fibrous envelope enclosing a cavity within which the end of the bone lies, more or less free, and continuous structurally on its outside with the adjoining tissues, some of which—vessels, nerves, and muscular fibres—may be firmly imbedded in it. Its inner surface is smooth and lined with flat cells resembling those found on the surface of normal or accidental bursæ, and it is moistened by a small amount of liquid which, in some cases, closely resembles synovia. It seems probable that when real synovia is present it is furnished by portions of the original capsule

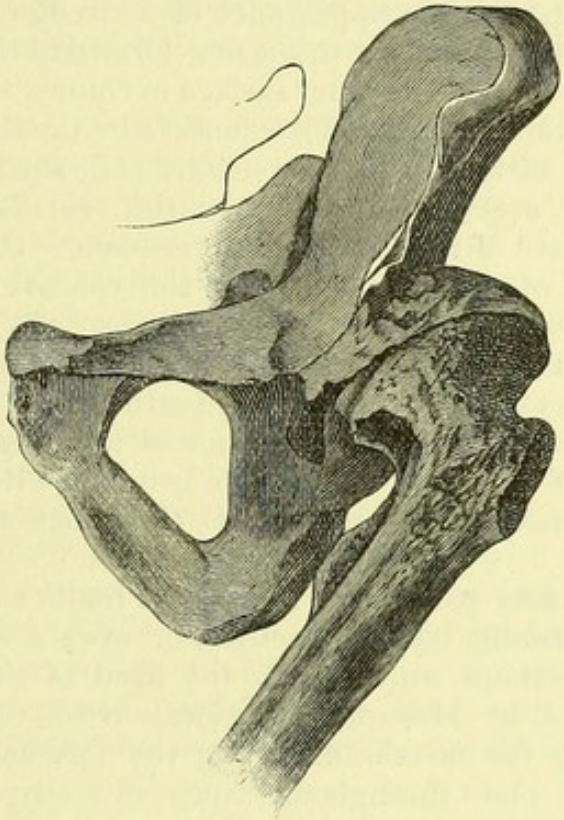
which have remained adherent to the bone and have formed part of the new cavity.[1] Indeed, the new cavity is usually only an enlargement of, or addition to, the original one; its connection with, or its entire independence of, the old one is determined by the character and extent of the rent in the capsule and the distance to which the head of the bone has passed through it. If the head of the humerus, for example, has passed entirely through the rent and the capsule is widely torn away from the humerus, its freed, torn portion may slip in between the bone and the glenoid cavity and completely shut off the latter by contracting new adhesions along its torn edge; or, as in the case described by Thore,[2] the outer portion of the capsule may be drawn across the face of the glenoid cavity, and, uniting with the torn tissues on the inner side of the latter, shut it off entirely from the cavity of the new capsule. But in the great majority of cases a sufficient amount of the capsule remains untorn to insure the continuity of the new cavity with the old one, although the communication between them may be small and the torn portions may have become so fixed in an intermediate position as to create an insurmountable obstacle to reduction. Another obstacle is found in the new and strong bands formed by the condensed tissues between the bones, bands often of great strength and thickness because the adjoining tissues, of which they are primarily composed, are matted together and supplemented by others of inflammatory origin. In many of the far too frequent cases in which death has been caused by an attempt to reduce an ancient dislocation the post-mortem examination has shown the dislocated bone so firmly bound in its new position that it could not have been reduced without lacerations far in excess even of the fatal ones occasioned by the unsuccessful attempt.

But while these changes in the soft parts tend permanently to fix the bone in its new position, other changes take place in the periosteum and the bone itself upon which the displaced articular end rests and moves, which, on the other hand, tend to make this new position a more suitable resting-place and to give it a form and character like those of the part it is to replace. Thus, a new cotyloid cavity may be formed upon the dorsum of the ilium, or a new glenoid cavity on the inner side of the scapula adjoining the old one. In this new formation of bone two processes may take part—production of bone by the periosteum, and ossification of the old ligaments and new fibrous tissue. The periosteum may produce bone either after it has been stripped up or while it is still in place. If, in the dislocation of the head of the bone, a portion of the rim of the corresponding articular cavity is broken off and pushed away, carrying with it a strip of periosteum torn from the adjoining surface, but preserving its connection with both pieces, this loosened strip forms on its side the limit of the new cavity, and produces on its under surface new bone which is continuous with the old and with the fragment of the rim, constituting a bridge between them. Fig. 2 shows a new cotyloid cavity of which the upper portion seems to have been formed in this manner.

[1] Yet in some cases of pseudarthrosis following fracture of the shaft of a bone a similar liquid has been found in the cavity of the false joint. Fractures, p. 199.

[2] Thore: Bull. de la Soc. Anatomique, 1839, p. 33.

FIG. 2.



Old supracotyloid dislocation of the femur, with very complete new acetabulum. From the collection at Bonn. (KRÖNLEIN.)

If the periosteum is not stripped up, but the head of the bone escapes entirely from the cavity and comes to rest upon the outside of a layer of periosteum still adherent to its bone, this periosteum, irritated by the pressure and movements, produces new bone between itself and the old, and this production is greatest in the zone just around the point of greatest pressure. The portion of periosteum directly pressed upon disappears under the pressure, leaving a bare surface of bone in contact with the displaced head, or becomes fibrous or fibro-cartilaginous in structure; while in the immediately adjoining portion the osteogenetic property is called into play and a ridge or rim of bone is built up around the central denuded area. Sometimes the denuded bone is worn away or disappears by absorption under the influence of the pressure; but this is rare, and the appearance of erosion is deceptive, being given by the elevation of the surrounding part. This elevation may be a sharply defined rim rising to a considerable height and closely resembling that for which it is a substitute, or it may be a mass of irregular height and outline (Fig. 3), having little or no resemblance to either the glenoid or cotyloid cavity.

FIG. 3.



Scapula showing new socket found in an old unreduced subcoracoid dislocation. (COOPER.)

The details of this formation, as observed by Baiardi[1] at the hip in animals, consist, first, in the appearance of a circular cartilaginous wall whose free border is continuous with the new-formed fibrous capsule, its base resting upon the ilium and its inner surface in contact with the head of the femur; its ossification (in rabbits) is complete by the thirtieth day, except along its concave surface, where it remains soft, shading off toward the centre of the new acetabulum into a whitish, cartilaginous-like tissue, which takes the place of the destroyed periosteum. On its free border it has the structure of fibro-cartilage; on the concave surface it closely approximates that of hyaline, articular cartilage. At the very centre, as above said, the underlying bone is left bare or is covered by fibrous tissue and fibro-cartilage, and becomes denser in structure. Grinewetsky,[2] who experimented on dogs, says he never found a lining of periosteum or cartilage inside the new acetabulum; the bone was always sclerosed. He also notes the absence of endothelium on the inner surface of the new capsule.

The ossification may pass beyond the usual limits and include portions of the capsule,[3] forming bony stalactites, or even a complete bony case enveloping, and perhaps united with, the head of the bone;[4] and in a specimen presented by Moreau,[5] a dislocation of the femur into the obturator foramen, the membrane filling the foramen had been transformed into a bony plate throughout, except in a strip along its anterior margin.

Some of these experimental observations have been repeated upon specimens of ancient dislocations in man, in some of which the new cavity has been found to be lined with fibro-cartilage,[6] in others with a granular fibroid tissue without apparent cartilage of incrustation.[7]

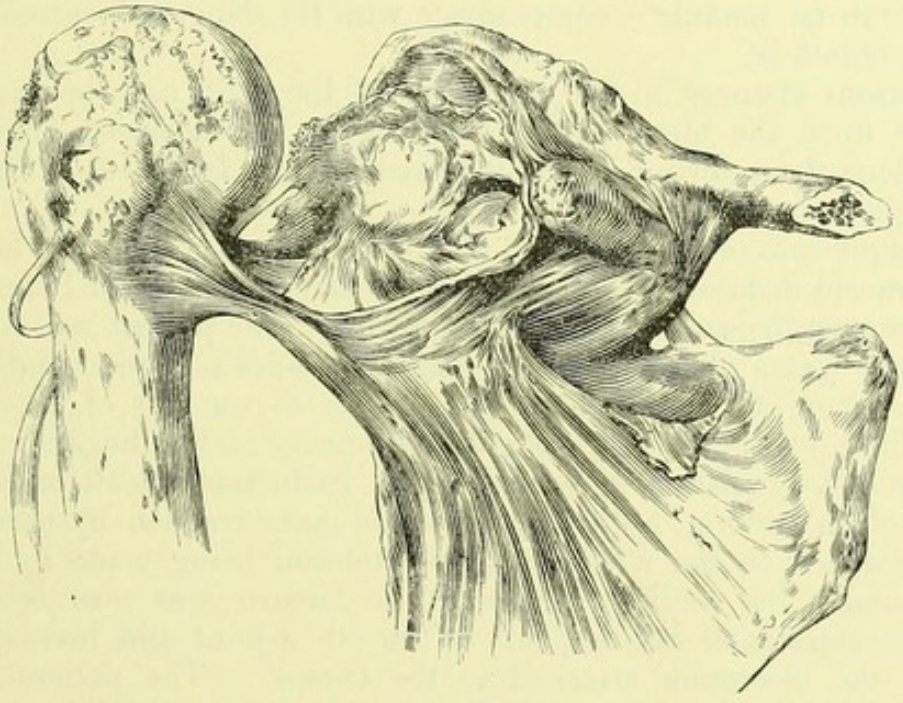
The displaced head shows changes varying in extent and consisting in loss of its cartilage, erosion of the bone in places and its increase in others, and occasionally in profound changes of structure throughout. Thus in the case just referred to, reported by Duguet, a dislocation inward of the shoulder of six months' standing, the head of the humerus was worn away behind at the point where it rested against the rim of the glenoid cavity, which also had in great part disappeared; its anterior portion had preserved its cartilage at almost all points, while its posterior portion had none, it being there replaced by rather tight, short fibrous bands uniting the head to the old glenoid cavity. In Lepine's case, a subcoracoid dislocation, the head of the humerus was considerably enlarged, with a deep vertical groove on its posterior surface corresponding to the outer edge of the new glenoid cavity, partly bare, partly covered by a fibrous layer. In a specimen presented by Walsh to the Royal Surgical Society of Ireland, 25th April, 1840,[8] of an old dislocation of

[1] Baiardi: Arch. per le Scienze mediche, 1880, vol. iv.; quoted by Krönlein.
[2] Grinewetsky: Centralblatt für Chirurgie, 1879, p. 279.
[3] Thore: Bull. de la Soc. Anatomique, 1839, p. 33.
[4] Cooper: Loc. cit., p. 50; and Cruveilhier: Anat. pathol., vol. i. p. 425.
[5] Moreau: Mém. de l'Acad. royale de Chirurgie, 1769, vol. ii. p. 153.
[6] Lepine and Désormeaux, in Bull. de la Soc. Anat., 1844, p. 167.
[7] Duguet: Bull. de la Soc. Anat., 1863, p. 144.
[8] Walsh: Gazette des Hôpitaux, 1840, p. 330.

the shoulder forward, the subscapularis muscle was raised from the scapula by the head of the humerus, the new glenoid cavity was covered by fibro-cartilage, the synovial sac was complete, and the cartilage of the humerus perfect.

The empty glenoid or cotyloid cavity diminishes gradually in size either by absorption of that portion against which the head of the bone rests or by a general atrophy, presumably due to its disuse, similar to that observed in the alveolar process after removal of the teeth, and its cavity fills up with fibrous tissue that springs from and replaces its lining cartilage. The glenoid cavity has in some cases been still further rendered unfit for use and inaccessible by union with the outer portion of the original capsule, when that has been drawn across its face as the humerus was displaced inward. In a case reported by Hilton, and referred to in Chapter III., in which death followed thirteen weeks after a dislocation of the shoulder which could be reduced with great facility but constantly recurred, the anterior and inner portion of the capsule was found interposed between the head of the humerus and the glenoid cavity, and the centre of this interposed portion had been thinned and in part absorbed in consequence of the pressure; apparently, if the patient had lived all the interposed portion would have been absorbed and the natural relations between the articular surfaces would have been restored.

FIG. 4.



Old unreduced dislocation of the right humerus, with interposition of the capsule. At the inner side of the head of the humerus is the rent in the capsule through which it passed, and above the rent is the greater tuberosity which had been torn off. At the outer side of the coracoid process is an opening in the apsule which had been produced by the pressure of the humerus; through it the glenoid fossa is seen. (HILTON.)

When the use made of the limb is very slight and the head of the bone is immovably fixed in its new position, the development of articular characteristics is slighter and the bone may even diminish notably in size

or consistency, as in the case quoted in Chapter III. in which the head of the humerus passed into the chest and remained fixed there. This atrophy of disused parts is a general rule, and although observed in bone is more marked in other tissues whose nutritive changes and functional activity are greater. In accordance with this general law the muscles which are rendered inactive by the greater or less fixation of the dislocated bone diminish in size, and if their inactivity is complete, or even nearly so, their fibres undergo an actual degeneration and their fibrous tissue predominates to such an extent that they are hardly more than ligaments. The bone, too, is similarly affected throughout its entire length; it becomes smaller, or, if the dislocation has occurred during youth, before development is complete, fails to develop to the same extent as its fellow on the opposite side, and even its normal curves disappear.

These facts show both the danger and the futility of attempts to reduce dislocations that have long existed; they show that the reduction can be accomplished only at the cost of lacerations far more extensive than those involved in the original injury, that among these lacerations may be included rupture of important vessels or nerves that have become adherent to or included in the fibrous bands of new formation, and that even if the bone can be successfully liberated from its attachments and brought back to the cavity from which it was displaced the latter may have become entirely unfit for its reception and for a resumption of its own original functions. Such a "reduction" is illusory, and its advantages are in no manner commensurate with the dangers incurred in the effort to obtain it.

Important changes in the condition of the limb may be caused by pressure upon the bloodvessels or nerves by the displaced bone or by injury done them during attempts at reduction. Instances of the latter will be given in Chapter VIII.

A unique case of degeneration of all the tissues of the limb following a subcoracoid dislocation of the shoulder that had remained unreduced for three months was reported by Guérin.[1] The patient was a woman sixty-three years old, and when brought to Guérin three months after the occurrence of the dislocation was unable to use any of the muscles of the limb, except to make slight movements of the fingers; its temperature and circulation were unaltered. Reduction was attempted, with the aid of chloroform, by having four men make traction by means of a band attached to the wrist, counter-extension being made by a band passed under the axilla. Suddenly the forearm was torn completely away, the separation taking place at the elbow-joint and leaving a portion of the olecranon attached to the tricips. The patient died of septicæmia in the second week. Examination of the limb showed great friability of the muscles with degeneration of their tissue and of their nerves, and rarefaction of the bones which had made them so friable that the radius and ulna had been broken by the pressure of the band at the wrist. The changes were apparently due to the pressure of the head of the humerus upon the nerve trunks, the degeneration of which extended a little above the point at which they were pressed upon. The other

[1] Guérin: Bull. de la Société de Chirurgie, 1864, pp. 121 and 131.

bones, muscles, and nerves of the body were normal. The axillary vessels were not pressed upon.

Persistent œdema, resulting in a condition resembling elephantiasis, was observed by Bartels[1] in a patient whose shoulder had been dislocated for more than a year. There was also rigidity of the fingers in a position indicating ulnar paralysis, which was relieved by increasing the mobility of the shoulder, but the œdema persisted.

[1] Bartels : Arch. für Klin. Chir., 1874, vol. 16, p. 638.

CHAPTER V.

SYMPTOMS AND DIAGNOSIS.

THE symptoms of a dislocation—those changes in the form, functions, and sensibility of the part by which the presence of a dislocation is recognized—are classed as *objective* and *subjective* or *rational.* The former, which alone are deemed demonstrative, are those which can be recognized by the surgeon on examination; the latter are those for his knowledge of which he must depend, to a greater or less extent, upon the statements of the patient.

The examination of the patient should always be conducted systematically, with the view to learn not merely the existence of the dislocation, but also such details and complications as may be present, and may affect the treatment and prognosis; and it should include an examination of the condition of such bloodvessels and nerves as may have been injured at the same time, in order that such injuries, if their later consequences should become manifest, may not be attributed to the treatment. If swelling, a large amount of subcutaneous fat, or pain should prevent a satisfactory examination, anæsthesia should be employed. The character and direction of the force that produced the dislocation should be learned, and also, if possible, the position of the limb at the moment of its dislocation, and whether a "consecutive" has been substituted for a "primary" displacement, or, as evidence of the latter fact, whether one fixed position of the limb has been substituted for another. In doubtful cases the uninjured limb should be used for comparison, and the question should be asked whether or not the suspected joint has been previously the seat of disease or injury the consequences of which may affect the conclusions to be drawn from the examination. The essential point in the examination is to determine the position of the end of the bone, its relations to that one from which it is thought to have been violently separated, and the best evidence of this fact is furnished by feeling the end of the bone with the fingers, by tracing its outline, by feeling it move when the lower part of the limb is moved.

OBJECTIVE SIGNS.

Deformity.—Besides the attitude of the patient or of the limb, which is often strikingly characteristic, the aspect of the region of the affected joint is changed by the inflammatory swelling, which may appear promptly or tardily and be accompanied by ecchymosis and by alterations in the depth or position of the fold of its flexure and in its normal depressions and prominences. Thus, in a dislocation downward or inward of the shoulder, the patient usually sits with his body inclined toward the

affected side, the shoulder lowered, the elbow abducted, and the forearm flexed across the abdomen. The roundness of the outer aspect of the deltoid region is diminished or lost, and the subclavicular depression is effaced. In dislocation backward and upward of the hip the thigh is flexed, adducted, and rotated inward, the toes of the affected limb resting on the dorsum of the other foot; the gluteal fold is displaced upward, the trochanter is higher and more prominent, and the upper portion of the thigh is broadened outwardly. The swelling varies with the length of time that has elapsed since the injury was received, increasing for a day or two, remaining stationary for a variable time, and then diminishing; in old cases the region is atrophied. If the dislocation has been caused by external violence acting directly upon the region of the joint, the swelling is increased by the effects of the contusion, and ecchymoses appear more promptly than in other cases.

The position, with reference to each other, of the articular surfaces or ends which constitute the joint can often be determined by palpation, and this, as has already been said, furnishes the most exact and positive evidence of the character of the injury. In joints that are not thickly overlaid by soft parts or masked by swelling or extravasated blood, this position can be readily made out, as at the knee, fingers, or even the shoulder; at the hip it is easy in some dislocations—*e. g.*, suprapubic—to recognize the head of the femur, in others it is much more difficult. At the shoulder the head of the humerus may be readily felt in the axilla or under the pectoral muscle, and its absence from its normal position is shown by ability to press the fingers under the acromion; at the hip the emptiness of the cotyloid cavity cannot be so certainly determined, because of the resistance offered by the overlying muscles and ligaments. At the elbow, in a dislocation backward, the outline of the olecranon can sometimes be made out, and then its changed relations to the two epicondyles of the humerus in extension and flexion clearly indicate the dislocation; if the head of the radius is dislocated, the recognition of its saucer-shaped surface furnishes absolute proof.

If the head of the bone cannot be felt, its position (if there is no fracture) can be determined from that of its shaft and recognizable prominences or apophyses by reference to its anatomy. Thus, if the great trochanter can be recognized, the position of the head of the femur can be readily inferred by prolonging from it in imagination the neck of the femur in the line indicated by the position of the shaft. In like manner prolongation upward of the line of the lower portion of the humerus indicates the position of the head of the bone, and if it passes to the inner side of the acromion the shoulder must be dislocated or the bone broken. Similar inferences can be drawn at the hip from the relations of the trochanter to the ischio-iliac (Nélaton's) line.

The continuity of the supposed head with the shaft is determined by recognizing that it participates in slight movements communicated to the lower segment of the limb. The aid of needles passed down through the soft parts to the head of the bone is sometimes resorted to when the thickness of the soft parts makes examination with the fingers difficult or uncertain. By prolonged firm pressure with the fingers an inflammatory swelling may sometimes be pushed aside and the bone distinctly felt.

The limb may appear to be, or may actually be, shortened or lengthened, but this sign is not of so much value as it is in cases of fracture, both because it varies greatly with varying positions of the limbs and cannot usually be determined with accuracy, and because the measurement is not of the length of a single bone, but of the distance betwen points or different bones. It is true that in fracture the measurement is often made from a point on one bone to a point on another, but the limbs can usually be placed symmetrically, while this is more difficult in dislocation. The reason why the length of the measured distance varies in different positions of the limb can be made clear by taking an example, as the shoulder. Here the distance usually measured is that from the edge of the acromion to the external epicondyle of the humerus. Now, this distance diminishes as the arm is abducted, for (Fig. 5) when the arm hangs by the side, the line *A B* (*A* being the acromion, *B* the external epicondyle, and *C* the centre of the head of the humerus) is almost exactly equal to *C B plus* the distance that *C* lies below the level of *A*; while, on the other hand, when the arm is abducted the distance *A B′* is equal to *C B minus* the distance of *C* beyond the line of *A*. Similar conditions exist in dislocation at the hip, where the measurement is habitually made from the anterior superior spine of the ilium. In dislocation of the elbow a comparison of the two limbs can be more easily made and with less chance of error if there is no lateral deviation, since it is only necessary to have the elbows flexed at the same angle and to measure from the internal epicondyle to the lower end of the ulna.

Fig. 5.

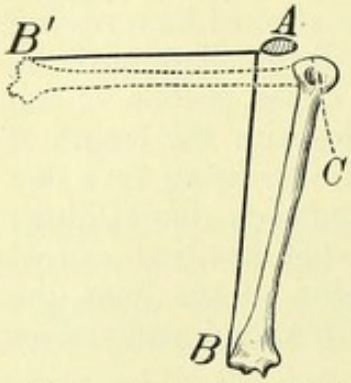


Diagram to show the effect of position upon the apparent length of the arm in dislocation of the shoulder. *A*, acromion; *B*, lower end of humerus.

The methods of measuring and the precautions to be taken are the same as in the case of fracture and have been elsewhere considered; and the possibility of the previous existence of asymmetry of the limbs, of a difference in their length, has also been described. (Fractures, p. 101.)

Fig. 6.



Diagram to show the action of a ligament in limiting the range of motion in a dislocation.

Loss of Mobility.—As has been said, in every dislocation there is a position which is characteristic of it and which the limb tends spontaneously to assume and retain. This position depends rather upon the tenseness of ligaments and untorn portions of the capsule than upon the contraction of the muscles, although the latter may aid, either by their contraction or by being already overstretched, in limiting motion or change of position in certain directions. The head of the bone takes up a new position at some distance from its normal one and there establishes a new centre of motion for the limb; consequently the ligaments on the side opposite that toward which the head has been displaced are put upon the stretch if the attempt is made to move the lower part of the bone in the same direction, and, unless torn, fix it at an angle with the other bone to

which they are attached. (Fig. 6.) The bone can be moved toward the attachment of the untorn ligament but not further away from it. In dislocation of the hip this fixation is very marked because of the angle which the neck of the femur makes with the shaft; when the head of the femur is displaced backward the strong Y-ligament which covers the front of the joint opposes extension, abduction, and rotation outward of the limb, flexion alone being comparatively free; in dislocation inward or downward of the shoulder the limitation of adduction is the most marked feature of this kind.

Since the limitation of motion has its principal cause in the non-muscular structures, it cannot be entirely removed by anæsthesia, but such additional limitation as may be due to contraction of the muscles excited by the fear of pain can be thus removed, and whenever the fixity of a limb is used as an element in making the diagnosis, the part taken by the muscles in its production should be determined. The diagnostic formula given by some authors, that abnormal fixation is characteristic of dislocations, and abnormal mobility of fractures, is a partial statement that may be misleading, for in fracture, or even in contusion, near a joint complete fixation may be effected by the muscles, and in dislocation with extensive laceration of the capsule and ligaments the range of motion may be very wide.

The comparison of the mobility of fracture with the immobility of dislocation is especially misleading if employed as a means of differential diagnosis, for the only fractures that can enter into this question are those near a joint, and in such the immobility is often as marked as in dislocation, because of the pain and the resistance of the muscles excited thereby; and if anæsthesia is employed to overcome this difficulty it also makes other signs appreciable which are more positive and valuable than loss of mobility.

A therapeutical fact that may often be of importance is to be deduced from the fact that the dislocation must, in most cases, have taken place when the limb was in one of the positions in which, while still dislocated, it is shortened—that is, one in which the distance from its normal opposing articular surface to its lower end is less than that between the corresponding points of the opposite limb; by replacing the limb in the position it occupied when the dislocation took place, the first step in reduction, that of bringing the head of the bone opposite the rent in the capsule through which it has escaped, is taken.

Crepitation.—A sound or sensation somewhat resembling the crepitation of a fracture is occasionally perceived while a dislocated limb is being handled. It may be the real crepitation of a fracture accompanying the dislocation, or merely the grating of the head of the bone against the edge of the periosteum of the other, or against a fibrous band, or even (it is said) against a blood-clot.

Subjective Symptoms.

Pain.—The occurrence of the dislocation is immediately followed by sharp pain in the region of the joint, which may gradually diminish or may continue for some time with unabated severity. In the former case

it is presumably due in great part to the laceration and bruising of the tissues; in the latter to the tension of those parts that have not yielded to the strain. In the former case the pain is not materially relieved by reduction; in the latter it immediately disappears when the bone is restored to its place. In addition to this pain about the joint, there may also be tingling or numbness through the limb in consequence of pressure upon the larger nerve trunks.

Loss of Function.—Inability to use the limb is ordinarily complete, and is due partly to the fixation created by the changed relations of the bones and partly by the pain which movement causes. There is nothing characteristic in this symptom, since it is present also after fracture, and even after a severe contusion. Furthermore, it is sometimes absent, or present in so slight a degree that the patient continues to use the limb, conscious only of some slight pain and of a certain inconvenience or lack of freedom in its use. Sédillot[1] reported that in three of the five cases of dislocation of the hip into the obturator foramen observed by him, the patients were able to walk with but little pain and a limp. One of them sought treatment only after a fortnight had elapsed, and then only because he noticed that the injured limb was abducted and could not be brought straight.

The *history* of the case includes the character of the violence, the position of the limb at the moment of the accident, possibly the perception by the patient at that moment of a sound, of the sensation of displacement, and the history of any previous injury to or disease of the part or of the opposite limb so far as it may affect its use for the purpose of comparison. It is well to obtain this history before proceeding to the direct examination of the limb.

There can be no uncertainty as to the main fact if the relations to each other of the articular ends can be made out, and the surgeon should not rest content with less than this when it can possibly be attained. In every doubtful case an anæsthetic should be employed, and among the doubtful cases are those in which there is the possible coexistence of a fracture either of a portion of the articular surface or of the entire breadth of the bone near the joint. The latter form of fracture is itself the one with which a dislocation is most frequently confounded; either may be mistaken for the other; and in any such case every effort should be made to determine the exact positions occupied by the ends of the bones. When fracture and dislocation coexist, as fracture of the surgical neck with dislocation of the head of the humerus, there is no other way positively to recognize the dislocation.

In dislocations complicated by fracture of portions of the articular surface or of tuberosities to which muscles are attached, as fracture of the rim of the cotyloid or glenoid cavity or of the greater tuberosity of the humerus, or of the coronoid process of the ulna, the coexistence of the fracture is usually incapable of demonstration and can only be suspected because of the facility with which the dislocation recurs after reduction.

Such complications as injury of a main bloodvessel or nerve will be

[1] Sédillot: Comptes rendus de l'Acad. des Sciences, Feb. 1861, p. 279.

readily recognized by attention to the characteristic symptoms to which they give rise.

A late result of fracture through the tuberosities of the humerus, which closely resembles an unreduced dislocation, has been described elsewhere. (Fractures, p. 359.)

Finally, it should be remembered that the most experienced and careful surgeons have sometimes remained in doubt, or have denied the existence of a dislocation which the subsequent course of the case has shown to have been present, and the charity which the critic may himself so soon need should be cordially extended to others.

CHAPTER VI.

COURSE AND PROGNOSIS.

If the dislocation is promptly reduced and no complications are present, the course is simple and the prognosis favorable. The swelling and pain subside, and the patient is soon able again to use the limb, although usually with some limitation of the range of motion and pain when these limits are reached. This slight disability may persist for weeks, or even months, especially in those who are constitutionally prone to arthritic complications. I have known a robust, thoroughly healthy man, to dislocate his shoulder, the dislocation being so slight that it was immediately reduced by accidental traction on the arm, and he was able to use the limb without a day's intermission; and yet, three months after the accident, and although there was no paralysis, he was unable to lift the elbow in abduction to the level of the shoulder, and could not carry his hand to his hip-pocket without causing considerable pain.

If the inflammatory reaction is more severe, the pain and swelling are greater and more prolonged, and the limitation of movement may become permanent through the formation of adhesions, or the condensation and thickening of the periarticular soft parts. It is very exceptional for this process to go on to suppuration.

If the disarticulation is compound, it may follow either one of two courses; either it is transformed into a simple one by the prompt union of the wound, or suppuration ensues, and the patient is exposed to all the accidents of a deep suppurating wound, rendered all the more extensive by its continuity with the interior of the joint. In the latter case the result is certain to be marked by much functional disability, perhaps by total loss of mobility in the joint.

Other complications add to the otherwise uneventful course of a simple dislocation the features peculiar to themselves; thus, injury to a nerve may be followed by temporary or permanent paralysis of the muscles or loss of sensation in the region supplied by it, or by a long train of symptoms indicating an ascending neuritis. Illustrative cases have been quoted in Chapter III. And injury to a main artery may be followed by gangrene of the limb, or by the formation of a traumatic or encysted aneurism. The coexistence of a fracture of the neck of the bone creates a condition which for a time predominates over the dislocation; if the latter is promptly reduced the case follows essentially the course of a fracture; if it cannot be at once reduced the course at first is still in the main that of a fracture, and subsequently that of an old dislocation.

The fracture of a portion of the articular edge, or of an apophysis, is habitually followed by no symptoms peculiar to itself, except in some cases a marked tendency to recurrence of the dislocation after its reduction, and this tendency may persist throughout life.

Excluding these complications, the prognosis in a simple dislocation of a limb, *quoad vitam*, is eminently favorable; the prognosis with regard to the restoration of form and functions depends upon the reducibleness of the dislocation, and this is affected by the character of the joint and of the injury, by complications, and by the time that has elapsed since the injury was received.

The principal obstacle to the reduction of a dislocation commonly lies in the tension of the untorn portion of the capsule and ligaments, and the avoidance of this obstacle is the key to treatment; but special difficulties may arise from peculiarities in the form of the bones that constitute the joint, and in the relations of the displaced bone to the capsule and to various muscles and tendons. Thus, bony prominences may become interlocked, as when in backward dislocation of the elbow the coronoid process is lodged in the olecranon fossa, or the end of the bone may be embraced between two tendons, as in dislocation of the thumb. This latter cause has been suggested in explanation of the difficulty found in many cases of backward dislocation of the hip, the head of the bone having passed between the tendons of the pyriformis and obturator internus; but examination after death in some of these cases has shown that this obstacle was far more apparent than real, and that the head of the bone could be readily disengaged from its position between the muscles by flexion of the limb. It is probable that this theory, which at one time had great vogue and seemed to be supported by anatomical observations, is quite erroneous, and that the real reason of the inability to reduce the dislocations was that traction alone was employed, and in a faulty direction.

On the other hand, the capsule may slip in between the head of the bone and the cavity it has left, and create an obstacle (by its interposition) that cannot be removed by manipulation or traction of the limb. The cases in which this happens are those in which the capsule is freely torn at or near its attachment to the humerus or femur, and in which the head of the bone is displaced entirely to the outside of the capsule. Experiments upon the cadaver (Busch, in *Arch. für klinische Chirurgie*, vol. 4, p. 1, and Gellé, in *Arch. Générales de Médecine*, 1861, I.) have demonstrated this obstacle, and it has also been encountered in practice. A case reported by Hilton[1] is quoted above in Chapter IV., and represented in Fig. 4.

The greater the length of time since the occurrence of the dislocation, the greater will be the difficulty of reduction; and after the lapse of a certain length of time, which is different in different cases, reduction becomes impossible. The cause of this difficulty lies in the contraction and condensation of the soft parts, the establishment of adhesions, and the changes effected in the articular surfaces. The inflammatory process excited by the traumatism leads to the production of new connective tissue in the lacerated parts, which, by its contraction, forms new fibrous bonds between the bones and permanently shortens those muscles that have been relaxed by the approximation of their points of origin and insertion. The edges of the torn capsule contract new adhesions, and

[1] Hilton: Guy's Hosp. Rep., 1847, vol. 5, p. 93.

the displaced bone thus becomes so firmly fixed in its new position that its return to its original position can be effected only by the employment of a force as great as, or even greater, than that which originally displaced it, and would be accompanied by more serious and extensive lacerations. Moreover, the coincident changes that take place in the articular surface and the cavity from which it has been displaced make them unfit to resume their functions, so that even if the dislocation could be reduced the joint would not thereby be restored. The muscles themselves, through long disuse, may in great part lose their contractility, and become transformed into inextensible cords composed mainly of fibrous tissue, with a few interspersed degenerated muscular fibres.

The period at which a dislocation is to be deemed unfit for reduction cannot be positively stated; it varies with different joints and different cases. Speaking generally, it is about two months, but it is not prudent to assume that any dislocation which has remained unreduced for a shorter period than two months is reducible, or that every one that is older is, therefore, irreducible; for in the former case we may be led to apply an amount of force that will prove disastrous, and in the latter disabilities that are amenable to treatment may be left unrelieved. A better guide is to be found in an examination directed to ascertaining the changes produced in the parts by the original injury or the disuse, and in careful, judicious attempts to make reduction. The object of these attempts should not be to reduce the dislocation at any cost, but to reduce it only if the reduction can be accomplished by moderate force and without grave lacerations. And, indeed, I am inclined to believe that in a doubtful case it would be better to expose the bone by incision, and divide the obstructing tissues with the knife, rather than blindly to rupture them by the application of a force whose action cannot be intelligently directed, and whose efforts cannot be certainly foreseen and controlled. Subcutaneous division of the bands has been done in a few cases, and with success; the objections to the method arise from uncertainty of the exact nature of what needs to be done, and of what the knife is doing. Antiseptic treatment makes an open wound almost as safe as a subcutaneous one, and enables the surgeon safely to explore the field of operation, detect the obstruction, and remove it.

Encouragement to attempt reduction even when the dislocation has remained unreduced for a period much longer than that of two months above mentioned, is furnished by not a few recorded cases in which it has been completely successful; instances will be given in the following chapter.

CHAPTER VII.

TREATMENT.

As a rule, to which there can be very few exceptions, reduction of a dislocation should be attempted at the earliest opportunity. The possible exceptions are cases in which the inflammatory reaction is already very great, and in which it may be anticipated that the additional violence inflicted during reduction may be sufficient to provoke a suppuration which might otherwise be avoided. But even in such cases it would be well to make gentle efforts to reduce under ether, and to postpone the reduction only if these efforts proved unavailing. In another class of cases, dislocations associated with fracture of the shaft near the dislocated end, immediate reduction may prove impossible because of the surgeon's inability efficiently to act upon the articular fragment, and then he must postpone the attempt until after the fracture shall have united.

Spontaneous reduction is the term applied to that which takes place without the intentional intervention of any external force. It may take place while the patient is asleep, through the action of the attached muscles or through some chance violence, or by a fall or a sudden movement. In some of the reported cases, the patient not having been examined by a surgeon previous to the reduction, it may be doubted whether a dislocation was actually present, and in others there appears to have been only a subluxation, or the dislocation was one that had frequently recurred, but in others it is certain that the dislocation existed and was complete.

Krönlein[1] received at the Berlin Poliklinic a patient with bilateral dislocation of the lower jaw; reduction was postponed until after the other patients had been attended to, and then the bone was found restored to its place. Malgaigne[2] reports a similar case in his own hospital service; the interne tried in vain to reduce it, and spontaneous reduction took place during the night.

Velpeau[3] saw two cases of spontaneous reduction of dislocation of the shoulder. In the first the patient fell as she left her bed to go to the operating-room, striking upon the elbow of the injured side. In the second, in which the dislocation was ten days old and the head of the humerus was displaced far under the clavicle, the patient was put in bed with his forearm supported by a bandage; during the night spontaneous reduction took place without removal of the bandage or any effort on the part of the patient; he said he had suffered during part of the night and had felt the shoulder crack.

In a case that subsequently came under my care the patient, himself a

[1] Krönlein: Deutsche Chirurgie, Lief. 26, p. 54.
[2] Malgaigne: Luxations, p. 32.
[3] Quoted by Malgaigne.

physician, was thrown from a wagon, striking upon and dislocating his right shoulder. While continuing his journey and suffering severely, he attempted to get a flask of brandy from his valise that lay upon the seat beside him; with the hand of the injured arm he grasped the handle of the valise to steady it while he opened the lock with the other; a sudden jolt threw the valise from the seat, and by the involuntary effort to arrest its fall its weight was brought upon the injured arm and the bone slipped back into place with a distinct snap and immediate relief of the pain.

Malgaigne gives several examples of spontaneous reduction of dislocation of the hip. In one, a dislocation downward and forward, the operation for reduction was postponed and the patient placed in bed; during the night he sought to turn upon his side and raised the limb with his hands, the pain caused him suddenly to loose his hold, a snap was heard, the pain ceased, and the dislocation was found to be reduced. In another, many fruitless attempts had been made to reduce a dislocation inward, and the case had been abandoned. One day the patient was getting into a wagon and had placed the sound foot upon the step, while raising the other he heard a dull sound, and the bone was found to be in place.

In another[1] a young man fell from a height with his legs apart, and at once suffered great pain in the upper part of the thigh and felt a hard lump there. Without changing his position he pressed upon this lump, and it disappeared with a distinct sound. It was thought to have been a dislocation of the femur downward and forward.

A case observed by Cornish and quoted by Sir Astley Cooper[2] is very remarkable because of the length of time, five years, between the occurrence and the reduction of the dislocation. It was a dislocation of the hip upon the dorsum; the patient went on crutches for five years, and then, while making a voyage, was thrown from his berth to the deck, and the dislocation was reduced with a loud snap; he was afterward able to walk easily and without a limp. Cornish, who fully appreciated the remarkable character of the case, lived in the same town with the patient, and knew and examined him both before and after the reduction.

In other cases spontaneous reduction, without the aid of external force, has followed shortly after attempts to reduce which have been unsuccessful but which may be thought to have made spontaneous reduction possible by rupture of adhesions, or laceration of the tissues, or fatigue of the muscles. This variety was termed *consecutive reduction* by Léveillé, and the term was adopted by Malgaigne, who applies it both to cases in which spontaneous reduction takes place after complete failure of the efforts to reduce and also to those in which an incomplete reduction spontaneously becomes complete or is gradually made complete by the prolonged action of some force applied by the surgeon—such as pressure. The following examples are quoted from Malgaigne:

A man fifty-four years old came to Palletta with a dislocation of the shoulder a week old; many fruitless attempts to reduce had been made, and the elbow and forearm were prodigiously swollen. After some days of preparatory treatment Palletta tried to reduce with Freke's machine

[1] Gazette des Hôpitaux, 1846, p. 60.
[2] Cooper: Dislocations and Fractures, Am. ed., p. 81.

and failed; the attempt was repeated four days later, and this time the head of the bone shifted its place somewhat, with the accompaniment of a cracking sound; the patient was replaced in bed, and the arm supported in a sling. Two days afterward the bone was found apparently in place and the movements of the joint had become much more free, but still something was lacking in the form of the region, and it was not until after three or four days more that the reduction became complete.

A similar case came under Malgaigne's own observation: a very marked intra-coracoid dislocation of the humerus which had resisted twenty-one attempts to reduce it before the patient came to Malgaigne. The swelling being enormous, he instituted a preparatory treatment and then applied the pulleys, but the pain was so great that he was obliged to desist. A week later he tried again, and while engaged in the effort he drank by mistake an emetic prepared for the patient, and was thereby again obliged to abandon the attempt after having brought the head of the bone somewhat nearer the glenoid cavity. The elbow was supported in a sling, and the shoulder covered with poultices. The next day the shoulder was found to have regained, in great part, its natural form, and during the following days the reduction became complete.

Other cases involving the hip are mentioned by different authors, but without exact references.

The obstacles to the reduction of recent uncomplicated dislocations arise from inflammatory swelling of the soft parts, muscular contraction excited by pain or the fear of pain, the inextensibility of untorn portions of the capsule or ligaments of the joint, the interposition of portions of the capsule between the head of the bone and its cavity, and the size and position of the rent in the capsule. All of these are not present in every case, and they vary in importance. For a long time the muscles were deemed the most important, but observations and experiments upon the cadaver carried on at about the same time by several different persons—Gunn[1] in 1851, Gellé[2] and Bigelow[3] in 1861, Streubel[4] in 1862, and Busch[5] in 1863—fixed the attention of surgeons upon the relations between the bone and the capsule, showed the nature and importance of the opposition commonly offered by the latter, and established the basis of treatment by systematic manipulation.

An account has already been given of the part played by the untorn portion of the capsule in determining the position assumed by the limb, a part so important that in "regular" dislocations (the term given by Prof. Bigelow to those in which the rent in the capsule is only partial and occupies a certain definite place in it) the muscles surrounding the joint may all be divided without thereby modifying the position of the limb or increasing its range of motion. At the hip the portion which remains untorn in all the typical forms is the anterior portion or Y-ligament; at the shoulder it is the thicker anterior portion forming the so-called coraco-humeral ligament. It is more correct to speak of the

[1] Gunn: Peninsular Journal of Med., July, 1855, p. 27.
[2] Gellé: Archives générales de Méd., April and May, 1861.
[3] Bigelow: The Hip.
[4] Streubel: Vierteljahreschrift für prakt. Heilkünde, 1862, ii. p. 59.
[5] Busch: Arch. für klin. Chirurgie, 1863, p. 1.

obstacle offered to reduction by this untorn portion of the capsule as an obstacle not to reduction in general, but only to reduction by certain methods, for when properly managed it offers no opposition, and may possibly even be of assistance. It may be compared to the link of a sleeve-button, which in some positions absolutely prevents the button from passing back through the button-hole, while in other positions the passage is easy. Thus, if the head of the bone is displaced, for example, to the right and lodged behind a projecting portion of the rim of the articulation, the ligament (Fig. 7, *A*) is tense, and traction in any direction which tends to separate its points of attachment is effectually opposed by it; but if these points are brought nearer together by moving the shaft of the bone in the direction indicated by the arrow, the ligament is thereby relaxed and its opposition to the movement of the head of the bone toward its cavity annulled. The position of the untorn portion of the capsule or ligament must be inferred from the posture of the limb and the directions in which motion is strongly opposed.

FIG. 7.

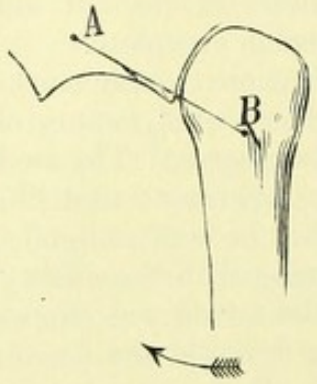


Diagram to illustrate the action of an untorn ligament or portion of capsule in opposing reduction.

In "irregular" dislocations, those in which a characteristic attitude is not taken by the limb and in which the mobility is marked, these differences are due to extensive rupture of the capsule; and this, by removing the restraint imposed in other cases by the untorn portion of the capsule, makes reduction remarkably easy without much attention to the position in which the limb is held during the attempt.

In addition to this opposition to movement or traction in certain directions, the capsule may offer other obstacles arising from the form and position of its rent and from its own possible interposition between the head of the bone and the cavity in which the latter is to be replaced. The tearing of the capsule is caused by the pressure of the head upon it, consequently the rent is on the side toward which the head is displaced, and it may be longitudinal or transverse at either attachment, or present a combination of the two forms. In order that either of these obstacles should be present, it is necessary that the head of the bone should have passed entirely through the rent—that, in other words, its displacement should be marked. As the rent, under these circumstances, is large enough to allow the head to pass out through it, it is large enough to allow it to be brought back through it if it is not made too narrow and its sides too tense by traction upon them. The effect of traction to narrow the opening can be demonstrated on the cadaver (Streubel, loc. cit., p. 70) by producing a subcoracoid dislocation of the humerus or an obturator or ischiatic dislocation of the femur, exposing the region by removal of the muscles, and then making traction in the extended position. As the capsule is made tense the sides of the longitudinal part of the rent are drawn together, and their lateral separation, which alone would allow the globular head of the bone to pass back, is prevented.

The narrowness of the gap is at once relieved by changing the position of the limb in such manner as to bring the points of attachment of the capsule nearer together, and the transverse portion of the rent can be lengthened by rotating the limb.

Interposition of the capsule between the head and its cavity may exist whenever a secondary displacement has succeeded the primary one and the head has moved from the point at which it escaped along the outside of the capsule, but unless the capsule has been so torn as to form a flap adherent by its base to the edge of the articular cavity, this interposition can be readily avoided by moving the head of the bone back to the position of primary displacement. If, on the other hand, such a flap has formed and has fallen between the articular surfaces (as in Fig 4, p. 47), there is no means, short of an operation that directly exposes it, of certainly getting it out of the way; it is attached to only one bone, and consequently cannot be acted upon by moving the other or changing the relations to each other of the two.

Another obstacle, similar in character to that offered by a narrow rent in the capsule, may be occasioned in dislocations backward of the thumb upon the metacarpal bone by the passage of the head of the latter between the flexor tendons that are attached to the base of the phalanx; the tendons, after separating to allow the head of the bone to pass between them, embrace the narrower neck tightly, because they are overstretched, and the attempt to reduce by drawing the phalanx downward only makes them more tense. The difficulty can sometimes be overcome by *unbuttoning* the head, as it were, by pressing the phalanx to one side and then, by a movement of rotation and circumduction, slipping the tendon of that side past the head of the bone.

Swelling of the soft parts interferes with reduction by increasing the bulk of the limb within the fascia and thereby mechanically opposing changes in position. If it is very great it may be proper to defer reduction and combat it by rest, cooling lotions, and pressure; it will usually subside so promptly that the loss of time thus incurred will not add appreciably to the difficulty of reduction when it is undertaken.

Contraction of the muscles, provoked by the traumatism or the fear of pain, opposes reduction by preventing the preliminary changes of position and neutralizing to a greater or less extent the traction that is made upon the limb. It may be overcome by gentle and long-continued traction, or forcibly, or by anæsthesia, or it may be avoided by taking the patient unawares or distracting his attention at the critical moment.

The methods formerly employed of weakening the patient by emetics or bloodletting, or stupefying him with alcohol or opium, have now been entirely abandoned. Other methods that have been recommended—the passage of the constant galvanic current through the muscles (Remak) and compression of the main artery (Rist)—have been entirely neglected because of the superiority of anæsthesia by ether or chloroform.

Anæsthesia is far from being needed in all cases, and as there are certain discomforts and even dangers in its use an attempt to reduce without its aid should usually be made. In New York, and, I think, in most of the large cities of the United States, ether is habitually used in preference to chloroform, and although chloroform is still used in Europe,

the greater safety of ether is almost universally admitted. The collected cases of death under chloroform apparently prove the correctness of an opinion quite generally held that its use in dislocations is especially dangerous, although no satisfactory explanation of the fact has yet been given. Of 101 fatal cases collected by Kappeler[1] between 1865 and 1876, 11 were dislocations, 20 amputations, and 11 operations upon the eyes; of 134 cases collected by Marchand[2] 17 were dislocations, and 15 extractions of teeth. It is not always necessary to push the use of ether to complete anæsthetization, for the relaxation is sometimes sufficient during the stage of primary anæsthesia, if care is taken not to excite the patient unduly. Gentle traction may be made upon the limb as the anæsthetization is begun, and its direction gradually changed or merged into the desired manœuvres as the muscles are felt to yield.

Since the nature of the obstacles to reduction has been more correctly understood the methods by forcible traction have been so far superseded by the methods of manipulation that they now possess only an historical interest. They consisted essentially in extension (traction), usually in the line of the dislocated limb, and counter-extension to bring the head of the bone down to the level of its cavity, followed then by measures of "coaptation" to force it into place. The traction was made through bands attached to the lower segment of the limb, and the force was exerted either directly by the hands of several assistants or indirectly through pulleys or screws. The amount of force sometimes exerted by these means can be inferred from the disastrous and even fatal consequences that occasionally ensued, including rupture not only of muscles and ligaments but also of the principal nerves and bloodvessels, and even complete avulsion of the limb. Suppuration of the joint, followed by the death of the patient, an accident which is now very rare, was formerly quite common, and in very many of the cases which recovered the record plainly shows the violence of the reaction and how narrowly the patients escaped with their lives. The occasion for the exertion of so much force arose from the faulty direction in which it was frequently applied, one in which the head of the bone could not be brought down to the level of the cavity without preliminary rupture of the opposing soft parts. The laceration caused by the dislocation was increased by the treatment, in order to enable the bone to follow a course which the ligaments, if untorn, would effectually bar. The method was directed against an obstacle, the resistance of the muscles, which was only one, and not the chief, of those which opposed reduction, and was pursued in ignorance of the principal one; violence was used to overcome an obstacle which correct anatomical knowledge would have enabled the surgeon to avoid.

It must not be understood that this extreme violence was exerted in every case. In many the traction was made in a proper direction, or at least in one in which the already existing laceration of the capsule allowed the bone to be moved; hence, many dislocations were reduced with comparative facility, especially those of the shoulder and those of

[1] Krönlein: Loc. cit., p. 66

[2] Marchand: Des accidents qui peuvent compliquer la réduction des luxations traumatiques, 1875, p. 134.

the hip in which consecutive displacement had not materially changed the posture of the limb, and in such cases traction was a proper means to overcome the opposition of the muscles. It was in such cases, too, that the methods of continuous moderate traction by India-rubber, weight and pulley, and suspension by the limb ("pendel-methode") were successfully employed, and will still be when it is desired to avoid recourse to the aid of anæsthesia.

As long ago as in the time of Hippocrates (fifth century B. C.) it had been known that some dislocations of the hip could be readily reduced by manipulation without the aid of violent traction,[1] and, as already mentioned, Galen (second century A. D.) had pointed out that the head of the bone should be returned to its cavity along the route by which it had escaped, yet these suggestions remained unknown or unheeded and the practice of surgery, as regards dislocations, appears to have been not only ineffectual to relieve in a large proportion of cases, but also characterized by dense ignorance of their pathology and by the crudest notions of the mechanical effects of the means by which their reduction was attempted. Thus, among the methods in vogue, according to Petit, for the reduction of dislocations of the shoulder, at the beginning of the eighteenth century, were those of the door or ladder, the bar, and the *ambi*. In the former the patient was made to stand upon a stool, and the dislocated arm was brought over the top of a door or a rung of a ladder so that the latter occupied the axilla; then, while an assistant grasped the wrist and drew it directly downward, the stool was taken away and the patient left suspended until the surgeon pronounced the dislocation reduced or abandoned the attempt. In other cases the patient was lifted from the ground upon a bar supported on the shoulders of two men and passing under his axilla; or a large, strong man seized the patient's wrist, placed his own shoulder under the axilla, and then suddenly straightening himself raised the patient from the ground, at the same time drawing the arm down forcibly in front of himself. The *method of the heel*, so strongly recommended by Sir Astley Cooper, was also employed by them, and sometimes with success.

The *ambi*, an instrument invented by Hippocrates, was also in favor; it consisted of two oblong pieces of wood joined together at the end by a hinge, of which one was placed vertically against the side of the patient, the hinge pressed well into the axilla, and the other under the arm in the position of horizontal abduction. The arm was then firmly secured to the latter piece and forcibly depressed.

As the defective mode of action of these methods became more gener-

[1] Prof. Bigelow (The Hip, p. 28) gives the following translation of the passage: "In some the thigh is reduced without preparation, with slight extension, directed by the hand, and with slight movement; and in some the reduction is effected *by bending the limb at the joint with gentle shaking.*" This translation of the last word, which has been interpreted by others as meaning *making rotation*, is made on the authority of Prof. Sophocles, who says: "Your question has reference to the meaning of the word *κίγκλισις*, the formation of which is as follows: *κίγκλος*, *wag-tail*, a well-known bird in Greece. . . . *κιγκλίζω*, *to wag* (in the original sense of the term), as the bird aforesaid wags its tail. *κίγκλισις* and *κιγκλισμός*, *a wagging: shaking rapidly within narrow limits; gentle shaking.* The words *circumactio* and *rotation* are out of the question, . . . unless rotation be used in a special sense."

ally recognized, traction by the hands of assistants or by pulleys or by other apparatus was substituted, but although this was an improvement upon its barbarous predecessors it was still employed blindly, and evidently was often ineffectual. There are indications in the older writings that the practice was not so wholly bad as the teaching, that here and there men were found who not only appreciated the importance of the direction in which traction should be made, but even occasionally reduced dislocations by manipulation alone, but the writer who seems to have been the first to recognize the importance of the principle enunciated so long before by Galen of bringing back the head of the bone by the route along which it had escaped, and of the position to be given to the limb during the attempt, was Jean Louis Petit. His *Traité des maladies des Os* was published in 1705; a second edition followed in 1723, and a third in 1741. He clearly pointed out the mechanical defects of the methods then in use, and the necessity of first bringing the head of the bone back to the opening in the capsule through which it had escaped before attempting to replace it in its cavity; and he drew from observation of the different degrees of tension of the different muscles inferences as to the position in which the limb should be placed and the direction in which traction should be made, which were of great practical value, although based upon notions concerning the obstacles that opposed reduction which were incomplete in that they took no account of the untorn ligaments and capsule. Thus, in dislocation inward or downward of the shoulder he abducted the elbow widely, and in those of the thigh backward he flexed the limb and then changed its position when the head of the bone had been brought down to the proper level.[1]

Recognizing the necessity of making counter-extension upon the scapula instead of the thorax in reducing dislocations of the shoulder, he invented a machine consisting of two parts: one, to make extension, was composed of two long parallel bars bearing a small windlass near one end; the other, for counter-extension, was a strip of stout canvas covered with soft leather, split longitudinally for some distance in the centre, and furnished with a pocket at each end. The arm was passed through this central slit to the shoulder, and the ends of the parallel bars fitted into the pockets. The limb rested between the bars. Extension was made by a cord fastened to the arm above the elbow and carried around the windlass; counter-extension was made by the canvas against the acromion and anterior border of the scapula. The machine used for the hip was similar.

Petit, in thus departing from the practice of his predecessors and contemporaries, had entered upon the right path; he erred in not following it far enough, and his error arose from a too limited notion of the obstacles to be overcome. He noticed that some muscles were tense and

[1] Si la cuisse est luxée en haut et en dedans, c'est-à-dire sur l'os pubis, le bout inferieur de la machine [which made traction and extended beyond the knee] doit être porté un peu en arriere, quand on commence l'extension; et il faut le raprocher en devant, quand on croit que l'extension est suffisante. Au contraire, si la cuisse est luxée en haut et en dehors, il faudra, en commencant l'extension, porter le bout de la machine en devant, et le repousser en arriere, lorsque les muscles paroîtront suffisament allongés." Petit, loc cit., p. 201.

others were relaxed, and he sought to place the limb in a posture that would remove these differences, while at the same time traction made in the direction of its long axis would bring the head of the bone to the point at which it had escaped from its cavity. His improvements were appreciated, and his practice was essentially followed by most surgeons until within the last few years. Yet one of his early successors, Pouteau,[1] in a paper embodying ideas conceived in 1749 (see loc. cit., vol. 2, p. 237), pointed out the defects of the method as applied to dislocations of the hip, and supported his own arguments and modifications by the record of several successes. He says (p. 222) that in the first case of dislocation of the hip upward and outward (on the dorsum of the ilium) which he was called upon to treat he employed Petit's method and failed. That is, he made extension with the limb somewhat flexed, counter-extension being furnished by the canvas band of Petit's machine, the centre of which pressed against the tuberosity of the ischium, while its ends lay, one in front of the abdomen, the other behind the buttock. The reflections excited by this failure led him, when the next case presented itself, a few months later, to make traction with the thigh flexed at a right angle, and the effort was promptly successful. He placed the patient on his back on the floor, laid the canvas band along the groin, with one end between the thighs and the other on the outer side of the injured hip, flexed the thigh to a right angle, engaged the ends of the bars in the pockets of the counter-extending band, and made traction; when he deemed the traction sufficient, he gently rotated the thigh outward[2] and reduction at once took place. Furthermore, he showed that the resistance of the muscles was due to their involuntary contraction and was to be more readily and safely overcome by prolonged moderate traction than by more violent but briefer efforts. He says (loc. cit., p. 226): "I have several times observed that it is easier to temporize than immediately to overcome the resistance of these muscles; so, when the extension seems to be sufficient I maintain it at the same point for some time and wait for the relaxation which fatigue must bring about. It is then only necessary to profit by this moment of inaction to effect the reduction."

Pouteau's practice closely resembled that which represents the application of the principles of the modern method by manipulation, and is identical with that of moderate traction upon the flexed limb which is now in common use and is, I think, generally preferred to that of pure manipulation. He flexed the limb to bring the head of the bone nearer the opening in the capsule, made traction to lift it to the level of the cotyloid cavity, and then turned it in by outward rotation or abduction, or both. He knew even that the traction could sometimes be dispensed with and the reduction effected by manipulation alone, and in quoting successes thus obtained by Maison-neuve, he predicts that a simpler

[1] Pouteau: Œuvres posthumes, Paris, 1783. Pouteau died in 1775.

[2] "Je tournai sans effort la cuisse du dedans en dehors." That by this he means external rotation and not abduction is probable, I think, from his use of a similar but more definite phrase in a later description (p. 234) of the reduction of a thyroid dislocation, "pendant qu' un aide tournoit le genou de dehors en dedans." Still, the two movements were probably associated.

method than his own will be found. The failure of his practice to become generalized is probably due to the influence of tradition and of the authority of Petit, reinforced as the latter was by the great advance he had made over the practice of his predecessors, and perhaps to the insufficient publication of Pouteau's views. The paper from which the above quotations are made appears to have been written in 1749, but there is no evidence that it was published elsewhere than in the posthumous collection of 1783, which, consisting of disconnected essays upon various subjects, probably had only a limited circulation. Whatever the cause may have been, the result is beyond question ; surgeons continued to reduce dislocations of the hip by traction with the pulleys, the limb being only slightly flexed, and by pressure applied at the upper part of the thigh to move the head laterally into the cavity. Sir Astley Cooper habitually used only extension, followed by rotation of the thigh *inward*.

Prof. Nathan Smith, of New Haven, taught and practised a method of reduction by manipulation which was published in 1831 after his death, in his *Medical and Surgical Memoirs*, edited by his son, Nathan R. Smith, and this, Prof. Bigelow says, "covers the ground of priority of invention." See Chapter XXV., Treatment.

The next published recognition of the possibility of reducing a dislocation of the hip by manipulation alone was by Desprès, who, in 1835, communicated to the Société Anatomique of Paris[1] "a new method of reducing dislocations of the femur" by flexion and rotation outward. The only comment it excited at the time, according to the records of the society, was the mention a few months later by Pigné of the fact that the same method was described by Beach in a *Treatise on Medicine*, published in New York in 1833, and was there said, on the authority of Sweet, the "natural bone-setter," to have been practised by the savages of North America.[2] The Desprès incident is mainly noteworthy as showing how completely the previous suggestions had been forgotten or overlooked, even by Pouteau's own countrymen. It is now used by the French as a justification for speaking of the method by manipulation (at the hip) as the "*Méthode de Desprès.*"

In like manner, other surgeons sought to modify the practice as regarded the shoulder-joint, by advising that the traction should be made in different directions and combined with rotation of the limb. Of these the most noteworthy are Mothe and Lacour, since it is with their practice that the manipulative methods are generally thought to have begun.

The earlier manipulative methods were either empirical or based upon more or less incorrect notions of the nature of the obstacles to be overcome and of the mechanism by which the result was to be obtained, and it is only since the pathology of the different dislocations has been better understood, with reference especially to the position of the rent in the capsule and the influence of the portions which remain untorn, that the different procedures embraced under this method have been intelligently devised and executed. They differ so widely in their details that only

[1] Desprès : Bull. de la Soc. Anatomique, Sept. 1835, p. 4.

[2] Beach, like Sweet, appears to have been an irregular practitioner, and it is likely that his assertions, even when known, were not deemed worthy of serious consideration.

the most general description can be given here; they consist in giving to the limb successive different positions, by which the head of the bone is first brought opposite the opening in the capsule and then into its cavity, and by which the opening in the capsule is made to gape widely, or is actually enlarged if necessary. For the accomplishment of these ends the limb is used as a means of acting upon the capsule so far as it remains attached to the bone, and the head of the bone is made to take its successive positions by rotation of its shaft, or by using it as a lever which finds its fixed point either upon some adjoining prominence of bone or in the capsule, or by moving the entire limb in the direction of its long axis. Combined with these manipulations it is commonly necessary to employ a certain amount of traction either to overcome such resistance as is offered by the muscles or to lift the limb, as in a backward dislocation of the hip when the patient is lying on his back. The latter necessity is sometimes obviated by supporting the patient face downward, so that the weight of the dependent limb will aid reduction instead of opposing it.

It rests essentially upon an anatomical and pathological basis consisting of two parts, the position of the rent in the capsule and the resistance of the untorn portion, and depends for its knowledge, in any given case, of these two factors mainly upon the position occupied by the limb and the limitations of the movements. Resistance of the muscles, when present, is overcome by anæsthesia or by traction.

Such traction as is required is made by the hands of the surgeon or of an assistant, or, as above mentioned, by the weight of the dependent limb, or by the prolonged action of an elastic band or of a weight suspended over a pulley.

Continuous extension by India-rubber bands was practised by Legros and Onimus while internes in the Paris hospitals, 1863 to 1866, and advocated by them in a paper published in 1868.[1] They recognized that their object, the fatigue of the opposing muscles, could be equally well accomplished by weight and pulley or a steel spring, but they give the preference to India-rubber because of the ease with which it could be used. Their reported cases are dislocations of the shoulder and elbow. The method is so simple, so easily practised, so free from pain that it is well worthy of trial; its neglect of late, which has been almost complete, is doubtless due in great part to a preference for immediate resort to anæsthesia, and to failures due to lack of perseverance, or to faulty direction of the traction.

The method of application in dislocations forward of the shoulder, for example, is as follows: A loop is made fast to the lower part of the arm by turns of a roller bandage or by strips of adhesive plaster as in Buck's extension; then the patient is seated in a chair, counter-extension provided by a band passing around the chest under the axilla and over the opposite shoulder and made fast to some neighboring fixed point, the elbow gently raised to or nearly to the position of horizontal abduction, and extension made in the direction of its long axis by a rubber cord

[1] Legros and Ominus: Des tractions continues, et de leur application en chirurgie. Arch. Générales de Méd., January, 1868.

passed through the loop attached to the arm and around a fixed point established in an appropriate position. The traction should be about twenty or twenty-five pounds, and needs to be continued for from fifteen to thirty minutes; under its influence the muscles become relaxed and the patient experiences the sensation of great fatigue, the head of the bone gradually approaches the glenoid cavity, and either enters it spontaneously or is replaced by the pressure of the surgeon's fingers, or by a sudden pull upon the arm. Instead of the rubber, a weight and pulley may be conveniently used, and the direction of the traction changed when necessary by shifting the position of the pulley.

Evidence of the success of the effort to reduce is furnished by the sound commonly heard on the reëntrance of the head of the bone into the cavity of the joint, and by the restoration of the normal form of the region.

When the dislocation is no longer recent—that is, when a sufficient period has elapsed for subsidence of the inflammation, and for union of the lacerated tissues in their new relations, but while there is reason to think that reduction is still possible—manipulation alone will not suffice, but resort must be had to other measures, such as more forcible traction and rotation, to break up the adhesions, and thus restore to the displaced bone the mobility which it possessed when the injury was recent.

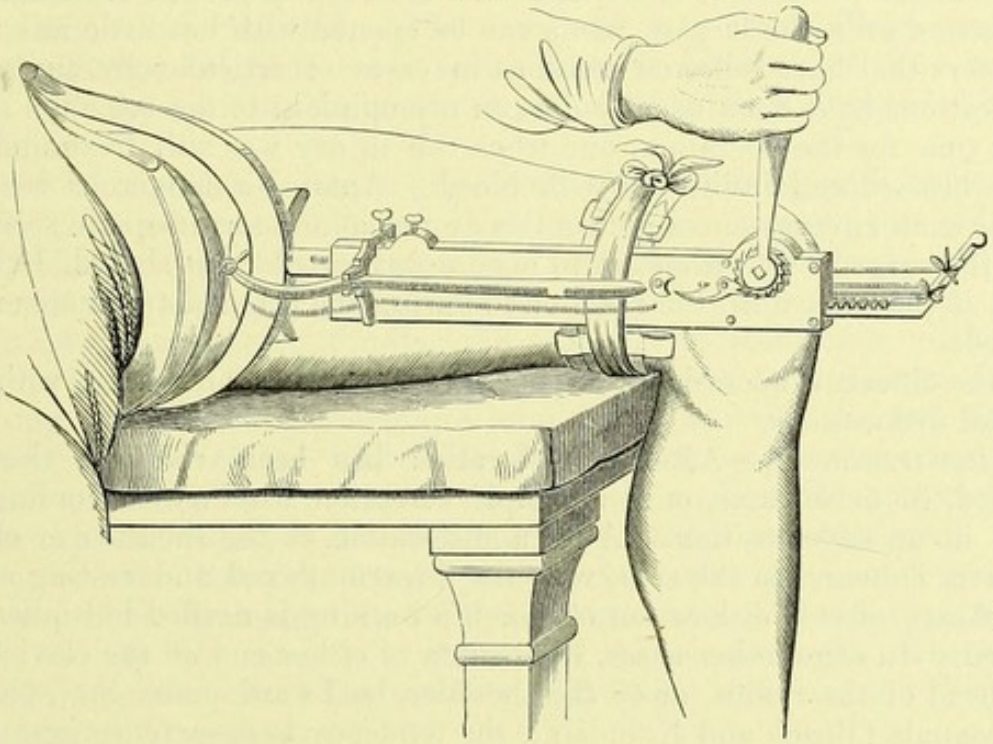
It is always a very difficult question, and one that cannot fail to cause the surgeon much anxiety, whether the attempt to reduce should be made, and how much force may properly be used in it. The length of time that has elapsed is not of itself sufficient to determine the answer to this question, for experience has shown the widest differences in this respect, some dislocations proving irreducible after two or three weeks, while others have been quite readily reduced after the lapse of several months. Some help may be got from consideration of the amount of inflammatory reaction immediately following the injury, from the position and mobility of the head of the bone, and possibly by recognition of the condition of the articular cavity; but, after all, a positive answer can only be obtained by making the attempt. It is hardly necessary to add that the attempt should be made with the utmost caution, and with constant attention to the dangers with which experience has shown it is surrounded, especially rupture of large adjoining vessels and nerves, and fracture of the bone. As has been already said, the difficulty lies not only in the adhesions which fix the bones in their new relations, but also in the possible closing of the rent in the capsule, and in the shutting off of the articular cavity by the formation of adhesions between its margin and the overlying capsule. When these conditions exist, reduction without a cutting operation is practically impossible.

The danger is by no means to be measured by the force employed in the attempt, for it is dependent also upon the changes undergone by the tissues in consequence of the dislocation, and upon their inability to accommodate themselves to the changing positions of the limb during manipulation. As dislocations of the shoulders are more common than all other dislocations taken together, and as rupture of the axillary vessels is not only the most dangerous, but also the most frequent accident during attempts at reduction; and as, moreover, a dislocated arm

may still be a very useful member, it is not surprising that surgeons, speaking under the sense of their responsibility as teachers, have often uttered strenuous warnings, like this of Hutchinson's,[1] who, after calling attention to the chance of accident in elderly patients, adds: "Let me beg of you not to allow any impulse of selfish vanity or the desire to vaunt an unusual success mislead your judgment into attempting that which is not really for your patient's advantage. Let him go elsewhere if he likes, and let another possibly obtain the credit of success; you will still be able to reply, with the celebrated general, that, despite the fact of victory, you still hold to your former judgment that the battle ought not to have been fought."

The same keen sense of the risk involved was shown by the late Professor Gross,[2] when he said, "I have never had charge of an old or neglected dislocation without a strong secret wish that it had fallen into other hands, such have, usually, been my disappointment and the anxiety attendant upon my efforts at reduction."

FIG. 8.



Jarvis's adjuster.

When it is sought to reduce a dislocation that is no longer recent, the first effort should be to liberate the displaced head by rotation of the shaft, with the view of thus breaking up the new adhesions, and then traction should be made with pulleys, or with a machine such as Jarvis's adjuster (Fig. 8), which consists essentially of two metal rods movable upon each other by a rack and pinion, one of which is made fast to the distal segment of the limb for extension, while the other makes counter-extension above. These instruments, as now made, are furnished with a

[1] Hutchinson: Med. Times and Gazette, 1866, i. p. 304.
[2] Gross's Surgery, sixth edition, vol. i. p. 1117.

dynamometer, which indicates the amount of force that is being exerted, and the same indicator may also be used with the pulleys. The machine has the advantage over the pulleys of allowing the position of the limb to be changed at will, and the disadvantage that the traction cannot be suddenly released. When pulleys are used, this sudden release is effected by interposing between them and the limb a specially devised catch, constructed like a pair of forceps, by pressure upon the handles of which the end is liberated.

Traction by the hands of several assistants is dangerous, because of the difficulty of regulating the force exerted by them, which, by a sudden, well combined effort, may become excessive. It seems probable that we shall see much less in the future than in the past of these repeated, prolonged, forcible efforts to reduce old fractures, and that surgeons will resort instead to arthrotomy to effect reduction, or to excision or fracture to improve the position of the limb. All three methods have yielded some good results already, at the shoulder, elbow, and hip.

The antiseptic method has earned the complete and well-founded confidence of the profession, and it has been abundantly proved that under its protection even the largest joints can be opened with but little risk; the disasters that have followed incisions in cases of articular fractures and dislocations have been usually due, in my opinion, to the selection of an unfit time for the operation, one when the injury was still fresh and the parts bruised and infiltrated with blood. Against a dangerous reaction under such circumstances antiseptics do not afford an adequate security, and the surgeon who proposes to open a dislocated joint should, I think, wait, if possible, until the reaction following the original traumatism has ceased.

The different operations will be described in connection with the special dislocations.

After-treatment.—After a dislocation has been reduced, there is needed, in most cases, only a simple retention bandage to confine the limb in an easy position. After a dislocation of the shoulder or elbow, the arm is bound to the side, with the forearm flexed and resting across the chest; after a dislocation of the hip nothing is needed but quiet rest in bed. In some other cases, dislocation of either end of the clavicle, of the head of the radius, or of the shoulder backward under the spine of the scapula (Busch and Krönlein), the tendency to recurrence is so great that special dressings are required. The joint should be kept quiet, certainly any movement that causes pain should be avoided, and if the inflammatory reaction threatens to be severe it must be opposed by the application of cold, or uniform gentle pressure if it can be borne. After the lapse of a week or two, passive motion within painless limits may be made, and the use of the limb gradually resumed. In making this passive motion or this use of the limb, those positions must be avoided in which the head of the bone would press upon the torn part of the capsule, or in which the sides of the rent would be again separated from each other.

If, as sometimes happens, the joint remains stiff, weak, and sensitive, but is cold rather than warm, and aches, and perhaps becomes puffy after use, it needs massage and rubbing, and to be actively moved, either by

the patient or by the physician. Its sensitiveness and immobility under such circumstances are due to the prolonged disuse, to retraction and loss of pliability in the periarticular tissues, and possibly to the presence of adhesions within the cavity itself. Sir James Paget[1] has written very wisely about cases of this class, and has pointed out that the temperature of the part may be taken as a safe guide in treatment. He says, "If the part be always overwarm, keep it quiet; if it be generally cold or cool, it needs, and will bear, exercise and freedom from the restraint of bandages, with friction and passive movements and other similar treatment of the reviving kind." In some cases it may be well forcibly to liberate the joint by free motion under anæsthesia.

Habitual Dislocation. — A marked tendency to recurrence may be combated by prolonged immobilization of the joint if the injury is comparatively recent, or by special treatment designed to thicken and shorten the capsular and periarticular tissues. Genzmer[2] has successfully employed in two cases of recurrent dislocation of the shoulder repeated injections into the joint of the pure tincture of iodine. The needle was introduced a finger-breadth below the coracoid process, and from seven to ten minims were injected. The arm was then immobilized, and the injections repeated from five to seven times at intervals of three or four days. He recommends the same treatment for habitual dislocation of the lower jaw.

Gerster[3] obtained a satisfactory result by arthrotomy with removal of a portion of the capsule. The patient was a girl, twenty years old, who had suffered a subcoracoid dislocation seven weeks previously. Reduction was very easy, but the weight of the limb was sufficient to cause immediate recurrence. Finding the tendency to recurrence unchanged after he had kept the limb in place for five weeks by a plaster-of-Paris dressing, Dr. Gerster opened the joint by an anterior incision and removed from the relaxed inner side of the capsule a piece one inch long by half an inch wide. A counter incision was made in the posterior part of the capsule for catgut drainage, and the anterior wound closed. High fever, six hours later, rendered it necessary to open the wound and substitute a rubber drainage tube for the catgut; the wound was then treated open, and the tube removed at the end of the second week. The wound healed in eight weeks. The mobility of the joint was fair, and there was no tendency to recurrence.

[1] Paget: Clinical Lectures and Essays, p. 84.
[2] Genzmer: Centralblatt für Chirurgie, 1883, p. 563.
[3] Gerster: N. Y. Surgical Soc., in N. Y. Medical Journal, April 5, 1884, p. 390.

CHAPTER VIII.

ACCIDENTS THAT MAY BE CAUSED BY ATTEMPTS TO REDUCE A DISLOCATION.

THE complications or accidents that may be caused by the attempt to reduce a dislocation may appear during the attempt, as the immediate consequence of the manœuvres employed, or subsequently as a more or less remote consequence of the changed conditions, the local injuries, or the inflammation produced by those manœuvres; and they may be localized at or near the dislocated joint, or may be the result of a local distant change or of a more diffused impression upon the organism. They may, therefore, be grouped as: 1st, primary local accidents; 2d, consecutive local accidents; 3d, cases of hemiplegia, syncope, and sudden death. The first group comprises injuries of the skin, cellular tissue, muscles, vessels, nerves, and bones; the second group includes suppuration in or about the joint, and œdema, gangrene, and paralysis consequent to injury to vessels or nerves. The third group includes those cases of shock or exhaustion, sometimes proving fatal, which have become exceedingly rare since the introduction of anæsthetics, and those others, that have come in their place, of death due to the anæsthetic itself.

Instances of these accidents and references to them in the writings of the older surgeons—that is, previous to the beginning of this century, are not very numerous, and they indicate that while the accidents themselves were not infrequent they were commonly attributed to the dislocation rather than to the effort to reduce. The most recent and complete work upon the subject is a *Thèse de concours*, by Dr. A. H. Marchand, *Des accidents qui peuvent compliquer la réduction des Luxations traumatiques*, published in Paris in 1875. Special articles upon the different kinds of injuries will be mentioned in the appropriate places.

It is noticeable, on comparison of the cases that have occurred at different periods, that while some varieties of the lesions are common to all times, with their varying methods of treatment, others are in a manner dependent upon the means by which the reduction has been attempted. Thus, violent traction is the sole cause of some; manœuvres, such as abduction and rotation of the arm, the principal cause of others; violent pressure at or near the head of the bone, prolongation of the effort, and anæsthetics, each of its own peculiar varieties. Notwithstanding these differences, certain points may be recognized as common to the greater number, such as the age of the patient and the length of time during which the dislocation has remained unreduced. Injuries of the vessels have been most frequent in the old and in dislocations of long standing, and all the other accidents have, in recent times at least, been rarely seen except in connection with dislocations that have long remained unreduced

or that have been complicated by much inflammatory reaction. The reasons for the greater liability to rupture of the arteries under these conditions are not obscure; the loss of elasticity because of atheromatous change in the vessels in the old, and the adhesion of the vessels to adjoining parts as a sequence of inflammation are a sufficient explanation, and the mechanical difficulties created by the contraction and readjustment of the torn tissues in old dislocations explain the others by the force that is required to overcome them.

Integument.—The skin may be bruised or lacerated at a distance from the joint by the pressure of the cords through which traction is made, or near the joint by the pressure of the hands or instruments acting upon the dislocated end of the bone, or it may be torn across if the traction is exerted upon it rather than upon the bone. These lesions are seldom serious, and the former may usually be avoided by protecting the surface with thick layers of cotton or flannel. Transverse rupture of the skin between the points of extension and counter-extension is due to a faulty application of the force, by which it is exerted upon the skin alone and not upon the underlying bone. The skin is elastic and tough, and when unaltered by disease will support a very considerable strain, one far in excess of that commonly needed to overcome the contraction of a muscle, but the traction may be so applied that it will act only upon the skin. Thus, if a broad band is strapped snugly about the middle of the arm and traction is made by a cord attached to it, it will draw the skin downward toward the elbow; and if at the same time the skin of the axilla and chest-wall is prevented by counter-extension from sharing in the movement, the intermediate portion is put upon the stretch and may tear, as in the following case reported by Mr. Hutchinson:[1]

"In a case not long ago, of a six weeks' dislocation, we were compelled to desist because the skin had torn across the axilla. This curious accident occurred whilst we were trying the heel in the axilla method, and without the application of any unusual force, nor was the operator's boot on. Suddenly the skin gave way from side to side, and a great transverse rent presented itself. The patient was a woman of fifty, of lax, flabby tissues. The wound healed quickly."

Similar cases have been reported in dislocations of the shoulder (Malgaigne,[2] Smith[3]), elbow (Marchand[4]), and of the terminal phalanx of the great toe.[5]

In connection with this, as representing a less degree of the same injury, may be mentioned an experience of Malgaigne's (loc. cit., p. 528) which he considered unique. He was attempting to reduce an intracoracoid dislocation in a very fat woman, and had increased the traction to 230 kilograms (about 500 pounds). The traction was made in the arm, the elbow being held at a right angle by an assistant. Just as Malgaigne changed the position of the limb in an effort to throw the bone into place the assistant loosed the forearm, and the bracelet slipped nearly to the wrist, dragging the skin along. The skin was not broken,

[1] Hutchinson: Lond. Med. Times and Gazette, 1866, i. p. 304.
[2] Malgaigne: Luxations, pp. 144, 501.
[3] Smith: Lancet, July 6, 1878.
[4] Loc. cit., p. 22.
[5] Gaz. Hebdomadaire, 1867, p. 398.

but the underlying cellular tissue was extensively torn, and gangrene, fortunately limited in extent, followed.

To guard against the occurrence of this accident the limb should be firmly grasped, if traction by the hands is used, at the enlarged distal end of the bone, so that the skin should not be drawn downward by the slipping of the hands, and the additional precaution may be taken to press the skin of the forearm (in the case of a shoulder dislocation) upward before the limb is grasped, and similar precautions suitable to the region should be taken at the point of counter-extension. If traction is made by a cord or band, it should be attached to the limb just above a bony prominence or enlargement which will prevent its slipping; it should not be made fast simply by enclosing its loop in circular turns of a bandage which maintain their hold upon the skin by friction. For the same reason, if the attachment is made by means of strips of adhesive plaster, the strips should not extend far up the limb, and the gliding of the skin should be guarded against by snug circular turns of the bandage above bony enlargements. As the maximum of distention will be suffered by the portion of skin which covers and immediately adjoins the dislocated joint, and as this distention will increase as the bone yields to the traction and moves toward its cavity, the effect upon the skin of the counter-extending measures should be carefully scrutinized, and the bearing changed from time to time, if possible, so as to take advantage of the elasticity and mobility of the adjoining portions of integument.

Sloughing of the skin, due to its compression against an underlying bone by direct pressure exerted to force the latter back into place, has been occasionally observed, in a dislocation of the astragalus,[1] and over the olecranon in an attempt made by a bonesetter to reduce a backward dislocation of the elbow.

Emphysema of the Cellular Tissue.—On the basis of two cases, in which the condition of the parts was not shown by direct examination, it has been asserted that a gaseous tumor may form in the cellular tissue under the skin as a result of efforts to reduce a dislocation. In each of these cases the dislocation was of the shoulder, and the explanation offered in one was that the emphysema was due to air that had escaped from the lung after its rupture during and by the struggles and cries of the patient. The first case was reported by Desault;[2] he reduced by violent and prolonged traction a dislocation of the shoulder of six weeks' standing, in a man sixty years old. At the moment of reduction a tumor formed suddenly under the pectoral muscle, and soon filled the axilla; the patient fainted, and the pulse was barely perceptible on the affected side. The tumor was well defined, elastic, not fluctuating; the overlying skin was not discolored, and percussion gave a "sort of sound" (espèce de bruit). On these symptoms rupture of the artery was excluded, and diagnosis of emphysema made. In two weeks the tumor had entirely disappeared, leaving in its place a large ecchymosis. Pelletan[3] had a similar case, made the same diagnosis, incised the tumor,

[1] Dauvé: Rec. de Mém. de Méd. et Chir. Milit., 1867, vol. xix. p. 143.
[2] Desault: Œuvres Chirurgicales, vol. i. p. 380.
[3] Pelletan: Clinique Chirurg., vol. ii. p. 95, quoted by Malgaigne.

and lost his patient by hemorrhage; the artery was found to have been ruptured. The only symptom in Desault's case which gives support to his diagnosis is an alleged resonance in percussion, and that, in which an error of observation might so easily be made, cannot be allowed to outweigh all the others which point so plainly to rupture of a vessel.

The third case cannot be so seriously criticised. Flaubert[1] reduced a dislocation of the shoulder of five weeks' standing in a woman seventy years old; the first attempt was unsuccessful; in the second traction was made by eight students, and the patient, who at first uttered vehement cries, seemed afterward to be upon the point of suffocating, and her face became purple and injected. An emphysema immediately appeared above the clavicle and spread over the shoulder to the middle of the back. She died on the eighteenth day, apparently in consequence of the tearing away of the lower four trunks of the brachial plexus at their attachment to the spinal cord.

Rupture of the Muscles.—Under this head only those lacerations of the muscles will be mentioned which are occasioned, especially in old dislocations, by violent traction or by forcible, exaggerated, and long-continued manipulation of the limb. The cases in which the injury has been confirmed by autopsy are few, only those in which death has promptly followed in consequence of associated lesions or of the inflammation to which the violence has given rise. Yet, in another of Flaubert's cases, quoted by Marchand,[2] there seems to be no doubt that not only the muscles but also the ligaments and other soft parts were extensively torn. The case was one of dislocation of the elbow backward, twenty-seven days old, in which traction was made upon the forearm by seven assistants; suddenly the parts seemed to yield and change their positions with a sound of tearing, and at the same moment a zone of narrowing or depression appeared at the level of the joint with a bony prominence above and below. It seemed to all present that the muscles and soft parts covering the joint had been ruptured, leaving a gap two inches long. An enormous fluctuating swelling promptly appeared, the radial pulse returned the next day, and the patient recovered.

In the cases confirmed by autopsy the dislocation has always been of the shoulder, and the muscles most frequently torn have been the pectoralis major and the subscapularis. In a case reported by Petit the long portion of the biceps was torn from its tendon, and in one examined by Sir Astley Cooper,[3] a woman, fifty years old, who had died apparently from the violence used in reduction, "the pectoralis major was found to have been slightly lacerated, and blood was effused among its fibres; . . . the supraspinatus was lacerated in several places; the infraspinatus and teres minor were torn, but not to the same extent as the former muscle. Some of the fibres of the deltoid muscle and a few of those of the coraco-brachialis had been torn, but none of the muscles had suffered so much injury as the supraspinatus."

In a case briefly mentioned by Callender[4] "a bonesetter employed

[1] Flaubert: Répertoire d'Anat. et de Phys., 1827, quoted by Malgaigne.
[2] Marchand: Loc. cit., p. 20, and Malgaigne, loc. cit., p. 149.
[3] Cooper: Disloc. and Fract., Am. ed., p. 320.
[4] Callender: St. Bartholomew's Hosp. Rep., 1866, vol. ii. p. 101.

twelve or sixteen men to pull at the arm of a man sixty years old, who was said to have dislocated his shoulder some time previously, and the following were the fatal results: the pectoral muscle was torn through, the plexus of nerves ruptured just below the clavicle, where also the artery was torn across. The bones of the forearm were dislocated at the elbow, and the bones of the arm and forearm fractured."

Avulsion of a portion of a limb is fortunately a very rare accident. Except for one or two cases of avulsion of the thumb, known only by tradition, the only instance of complete avulsion is that in which Alphonse Guérin tore away the forearm at the elbow in an attempt to reduce a subcoracoid dislocation of the shoulder. The following is an abstract of a full report of the case published in the *Bulletins de la Société de Chirurgie*, 2d Series, vol. 5, 1864, pp. 121 and 131. The patient was a woman of good health and constitution. The dislocation was not recognized until six weeks after its occurrence, when unsuccessful attempts were made to reduce it. All power of voluntary motion of the limb had been lost since shortly after the accident. At the time of admission to the hospital there was found a complete subcoracoid dislocation of the left humerus; the limb hung motionless beside the body, and only the fingers could be slightly moved; its cutaneous sensibility was dulled, temperature unchanged; there was œdema of the lower part of the forearm and especially of the hand; skin faintly purplish; sharp pains throughout the limb. Chloroform was given to complete resolution; a broad bandage was passed under the axilla for counter-extension, and another made fast to the wrist and confided to four assistants. During the first attempt the second bandage slipped; it was tightened, and traction again made, steadily and without much force. Suddenly, without warning, the limb separated at the elbow. The artery was tied, the lower two and a half inches of the humerus sawn off, and the stump trimmed.

The rupture had taken place mainly through the joint, a small portion of each condyle remaining attached to the muscles of the forearm, and a portion of the olecranon to the triceps, and through the substance of the biceps and brachialis anticus; the nerves had given way at distances above the elbow varying from five to seventeen inches, the latter being the musculo-cutaneous very much drawn out, and the brachial artery at three and a half inches. The muscles were softened and brown, especially the pronator quadratus which was pulpy; the nerves were injected, with nodes at intervals; the veins were dilated. The ends of the long bones were profoundly disorganized, with thinning of the compact shell and rarefaction of the spongy part; they broke under slight pressure and could be easily perforated with the scalpel. The radius and ulna had been broken about half an inch above their lower articular surfaces. Microscopical examination showed degeneration of the nerves, muscles, and bones.

The patient died on the thirteenth day, and the autopsy showed no change in the tissues of the other limbs; the muscles of the left shoulder were normal, except the deltoid, the fibres of which were pale and degenerated. The nerves were matted together in the axilla and firmly pressed against the head of the humerus; above the point of compression they were normal, contrasting strongly with the parts below.

It is evident that the accident was favored by great trophic changes in the limb due to pressure upon the nerves in the axilla.

Injuries of the Main Bloodvessels.—Although the earliest recorded cases of accidents of this class occurred at about the beginning of the eighteenth century, the subject did not receive the attention of systematic writers on surgery until after the publication, in 1827, of an article by Flaubert.[1] Malgaigne, in 1855, discussed the subject at length in his work on dislocations, mentioning sixteen cases of all kinds, certain and uncertain. Callender,[2] taking as a text his own fatal case, again collected and collated the known cases; and similar use was made of the material, and other cases added to the list by Le Fort,[3] Willard,[4] and Marchand.[5] In 1882, Körte[6] reported three personal cases, and wrote a very full and valuable paper on the subject, containing forty-four supposed (actually thirty-eight; see note below) cases of dislocation of the shoulder, in which the vessels had been seriously injured during the act of dislocation or of reduction; and in 1884 Cras[7] reported a personal case of injury of the axillary artery, and added a few others to Körte's list. Strictly speaking, several of these cases should not be here considered, since in them the vessel was injured at the moment of dislocation and not during reduction, and in many others it remains uncertain whether the same objection might not be made to them. They are retained because they serve equally well with the others to further the study of most features of the subject.[8]

[1] Flaubert: Mém. sur plusieus cas de luxations dans lesquels les efforts pour la réduction ont été suivis d'accidents graves, Répertoire d'anat. et de phys., 1827.

[2] Callender: loc. cit., p. 96.

[3] Le Fort: Dict. encyclopédique des sci. méd., article Axillaires.

[4] Willard: Phila. Med. Times, 1873, vol. iii. p. 721.

[5] Marchand: Des accidents qui peuvent compliquer la réduction des luxations traumatiques, Thèse de concours, Paris, 1875.

[6] Körte: Arch. für klinische Chirurgie, vol. xxvii. p. 631.

[7] Cras: Bull. de la société de Chirurgie, 1884, p. 739.

[8] Reference to the original accounts, so far as I have been able to obtain them, shows several errors in the lists given by the above-mentioned writers. Sir Astley Cooper's case must be excluded because it is the same as Gibson's first case, having been simply quoted by Cooper without acknowledgment.

Blackman's case must be excluded because it proved to be not a dislocation, but a fracture of the humerus. As it has been widely quoted, and is, indeed, given in detail as a dislocation by Dr. Hamilton (Fractures and Dislocations), an explanation of the manner in which the error arose may be of service. Blackman reported it as a dislocation in the Western Lancet, August, 1856, p. 469, and an abstract of this report was given in the Amer. Journal of the Med. Sciences, 1856, vol. xxxii. p. 571, and is quoted by most writers. But on page 508 of the same (August) number of the Western Lancet is a note by Blackman, which apparently had been overlooked by the maker of the abstract, giving the results of the autopsy, and showing the error in the diagnosis. The fracture was at the surgical neck, and the end of the shaft had been displaced upward, and lay in contact with the coracoid process; the head was still in the glenoid cavity, and had partly united with the shaft about an inch below its upper end.

In Segond's case not only does the artery appear to have been wounded by a piece of the dish the patient was carrying, but it is doubtful even if the limb was dislocated.

In Delpech's case it is recorded only that at the moment of reduction the patient grew pale, became unconscious, and died immediately, and there is nothing to show the cause of death.

In Fano's the artery may have been simply compressed. O'Reilly's is the same as Adams's. The latter admitted the case into the hospital, the former operated upon it.

A case which Callender quotes, a man treated by a "bone-setter," does not deserve

I have met with only two recorded cases in which a large bloodvessel has been injured in the reduction of any dislocation, except of the shoulder. These were both of the elbow, the cases of Flaubert and Michaux, quoted by Marchand and Malgaigne. The former has been already quoted under rupture of the muscles; in the latter the patient was ten years old, and the dislocation was of the elbow backward and outward, the swelling was considerable, the radial pulse was present. Reduction was attempted on the day after the accident, and on the next following day, but without success. The last attempt was immediately followed by swelling of the elbow and by arrest of pulsation in the radial and ulnar arteries; gangrene set in, and six days after the attempt the limb was amputated. The tendons of the biceps and brachialis anticus were found to have been forced by the manipulation around the external condyle to the posterior aspect of the humerus, accompanied by the ruptured brachial artery and median nerve.

The trustworthy recorded cases of injury to the larger vessels of the axilla in dislocation or reduction of dislocation of the shoulder are forty-seven in number.[1] Of these, the axillary vein alone was ruptured in three (Froriep, Price, Hailey), although I think the last one doubtful, and the artery and vein together in two (Platner, Baum).[2] In most of the others, the axillary artery or one of its branches was injured, but in some the source of the hemorrhage remains uncertain. In thirty-two cases death or amputation of the arm furnished the opportunity to examine the region and determine the character of the lesion; this, in some cases, was a complete or partial rupture of all the coats of the artery, or of the inner and middle coats alone, with subsequent formation of a circumscribed aneurism.[3] In other cases the vitality of the wall appears to have been diminished or destroyed by direct pressure, and this to have been followed, after the lapse of a few days, by rupture (Warren), or, still later, by the formation of an aneurism. In Gibson's second case an aneurism appears to have formed in consequence of the earlier attempts to reduce, and then itself to have been ruptured when Gibson effected reduction. Rupture always appears to have taken place quite high up, and usually at the point pressed upon by the head of the humerus. Callender found it necessary to divide the pectoralis minor to reach it. In the fatal cases of injury of the vein alone the vessel was torn completely, or almost completely, across. In Baum's case both artery and vein were partly torn by a broken piece of the new bony socket that had formed about the head of the humerus. The artery was tied above the origin of the long

to be grouped with those treated by professional surgeons, although the force employed—traction by twelve or eighteen assistants—was not much in excess of that recorded in some of the other cases, or of what I have myself seen employed. Not only the artery, but also the muscles were torn, and the humerus was broken.

Green's case (Lancet, 1825, vol. viii. pp. 189 and 283) is quoted as one of recovery after ligature of the subclavian, but the reports end on the eighteenth day with the ligature still in place, and after a free hemorrhage on the thirteenth day.

[1] For the references, see the list of cases at the end of this section, p. 88.

[2] Possibly to these may be added Volkmann's case of wound of the axillary vein, thought to have been caused by a splinter of bone. The wound was discovered during an operation to excise the head. (See Chapter XVIII.)

[3] It is possible that this rupture may be followed by obliteration of the artery at the wounded part. Scarpa held this opinion (Hodgson, Diseases of Arteries, p. 488).

thoracic, and a second ligature was subsequently placed on it at the level of the lower border of the pectoralis major.

In five cases (Callender, Desprès, and Körte's three) only a small (one-sixth of an inch) oval opening was found on the anterior wall of the artery, and was thought to have been produced by the tearing off of a branch, the subscapular or circumflex.

In Gärtner's case the opening in the artery is described as funnel-shaped, but the tumor was small, formed slowly, and presented the common signs of aneurism, so that it seems probable that what he describes as the opening included also the neck of the aneurismal sac. In other cases the subscapular (Lefeuvre) or the circumflex artery (von Pitha) was torn across at or near its origin. These last-named eight cases form a considerable proportion of the whole number, and are of great importance because they explain the persistence of the radial pulse noted in several of the histories. In Parker's the swelling was at the axillary border of the scapula behind, "near the situation of the dorsal scapular artery or the subscapular at the junction of the two."

Of thirty-one cases in which the age of the patients is given, in twenty they were more than forty years old. The youngest was twenty (Gärtner), the oldest eighty-six (Sands). In very few of the cases it is noted that the arteries were atheromatous, although the advanced age of many of the patients makes it probable that the elasticity of the vessels was diminished.

In more than half the cases the dislocation was recent—less than three weeks. In not more than one-third of them is it reasonably certain that the lesion was caused during reduction; in three cases it was certainly caused by the dislocation; in the remainder the cause is obscure. To these latter belong those cases in which the reduction was promptly effected, and without the use of much force or of exaggerated positions of the arm.

In many of the others the attempt to make reduction was greatly prolonged or several times repeated, and the force used was very great or improperly applied. This last criticism is probably applicable to the earliest four cases (Verduc, Petit, Platner, and Bell), about which nothing is known except that death was caused by hemorrhage. In one of them (Bell) the use of the ambi is mentioned, and it is probable that it or the method of the door or ladder was employed in all.

In some the injury was evidently caused by excessive traction (Gibson, traction by five or six assistants in one case, by pulleys for nearly two hours in the other; Leudet, eight assistants); in others by faulty manœuvres, such as extreme abduction or elevation of the arm, rotation, and circumduction; in others again apparently by direct compression of the vessel against the underlying bone, as by the booted heel in the axilla (Warren, Rivington), or possibly by the thumbs (Panas).

Leaving aside the earlier cases in which faulty methods no longer in use were employed, and those old dislocations in which the relations and connections had been permanently changed by fibrous or bony tissue of new formation, it becomes evident that in dislocation of the shoulder the accident is most to be apprehended when the elbow is raised in abduction to the height of the shoulder, or is carried, as in Callender's case, across the

chest and face in a wide movement of circumduction; and for this reason, that in these movements the dislocated head of the bone is turned downward into the axilla, and the vessels which lie upon its inner side are pressed down before it and forcibly put upon the stretch, while those branches which run almost directly outward, the subscapular and circumflex, and are fixed to the tissues amid which they branch, are directly and forcibly elongated. Even when the head of the humerus is in its socket the axillary vessels are put upon the stretch when the arm is widely abducted, as can be readily verified during an operation for the removal of the axillary glands, or, still more simply, by observing the arrest of the radial pulse when the arm is raised and carried backward; and there are several cases on record in which this movement alone has resulted in the formation of an axillary aneurism or in rupture of the axillary artery.[1] Although in dislocation inward the limb is shortened by being abducted, yet the artery is not thereby relaxed, but, on the contrary, is still further stretched around the head of the bone. Jössel,[2] in a recent case in which death was caused by associated injuries, found the "nerves of the brachial plexus, especially the circumflex nerve and the subscapular artery, greatly stretched by the head of the humerus;" and, according to Körte (loc. cit., p. 640), he found in another case of recent dislocation the subscapular artery torn.

In his remarks on the case at the Sheffield Infirmary[3] in which the artery was torn across during an unsuccessful attempt to reduce a dislocation of six weeks' standing, and an incision was made through which each end of the torn artery was tied, Mr. Jackson says: "One thing was noticed on cutting into the axilla: the extreme tension caused by the pressure of the head of the humerus on the vessels and nerves when the arm was raised above the shoulder." This patient died two days after the operation.

In some of the cases in which it is certain or probable that the injury to the vessel was inflicted at the moment of dislocation, it is noted that the latter was produced while the arm was widely abducted—that is, under circumstances in which the head of the humerus would be driven downward and inward.

If the dislocation is an old one, and especially if there has been much inflammatory reaction, and the vessels have become firmly adherent to the bone, or imbedded in unyielding cicatricial tissue, the liability to rupture is increased, because of the loss of elasticity occasioned by the latter condition, and because of the limitation of the strain to a shorter segment of the vessel in the former. If, in addition, the distensibility of the vessel has been further reduced by atheroma, the danger is still greater; and this last predisposing cause may properly be deemed sufficient to lead to the rupture, even when the traction is slight and the manœuvres are confined within a narrow range.

In Anger's case, fracture of the head (?) of the humerus coexisted; in

[1] Cases of Pelletan and Paget, and specimen in museum of St. George's Hospital; Callender, loc. cit., pp. 103 and 107.

[2] Deutsche Zeitschrift, 1880, vol. xiii. p. 177.

[3] British Med. Journal, Feb. 3, 1883, p. 207.

Mash's, two pieces had been chipped off the head of the humerus, and were lying in the glenoid cavity. In several others fracture of the greater tuberosity of the humerus or of the rim of the glenoid cavity is noted; the former of these two complications is common in inward dislocation of the humerus, and could have had no direct influence in causing the injury of the vessels; the latter, also, was probably without influence, since the vessels are pushed away from the scapula, and the fragment remains attached to it.

The *symptoms* at the beginning present two widely different forms; in one, the less common, a tumor presenting many of the signs of an encysted aneurism appears in the axilla a few days or weeks after the reduction, and increases in size rather rapidly; if not successfully treated, it soon involves the skin and ruptures externally. In the other form, the more common, a diffused fluctuating swelling, without bruit or pulsation, appears immediately, or within a few hours, in the axilla, raising the pectoral and deltoid muscles, or is, perhaps, most prominent posteriorly, and in most cases promptly reaches a large size, even that of the adult head (Lister); the radial pulse sometimes persists. The only exception to rapid growth among the recorded fatal cases is Körte's third case (loc. cit., p. 636), in which the extravasated blood disappeared slowly, leaving a firm, non-pulsating lump, as large as a walnut, in the course of the axillary artery, which a surgeon supposed to be a lymphatic gland, and undertook to extirpate nearly five months after the accident. It proved to be an aneurism containing much stratified clot; the axillary artery was tied above and below, and the patient died.

In several cases the patients died promptly after the accident, sometimes after profound syncope, sometimes (Gibson's first case) after a short period of apparent well-being, with symptoms of shock or acute anæmia. In two, which finally ended in recovery (Sands, Agnew), the patients were at first greatly prostrated, and death by syncope threatened. In another (Mash's) gangrenous emphysema developed in the arm, and the patient died forty hours after the reduction. In this case the inner and middle coats of the artery were torn across "just beyond the point of origin of the dorsal scapular branch." The radial pulse was at first perceptible, but had ceased the next morning.

In most of the others the swelling increased, and, in a longer or shorter time, ruptured spontaneously, or was threatening to rupture when operative interference (puncture, incision, or ligature of the subclavian) was resorted to. The longest period was in Bellamy's case, six months after reduction, and even in this case the first hemorrhage occurred five weeks after reduction.

In the cases that recovered without operation (Agnew, Sands, Malgaigne, Desault, Anger, Nélaton's second case[1]), the swelling subsided, and the ecchymosis was slowly absorbed. Agnew's patient was discharged in ten days, Anger's and Desault's in a fortnight, Malgaigne's was well on the twenty-second day, and Sands's, a woman eighty-six years old, made a slow recovery. In three of them (Nélaton's, Anger's, Sands's[2])

[1] Referred to by Anger and Le Fort, loc. cit.

[2] Dr. Sands's patient died in May, 1885. The injury proved to have been of the axillary artery, which was occluded at a point a quarter of an inch above the origin

the diagnosis of rupture of the axillary artery was made. Desault's diagnosis was "emphysema of the cellular tissue;" the case has been quoted above, under that head. Malgaigne and Agnew made the diagnosis of rupture of the axillary vein.

I think there is reason to doubt the correctness of the diagnosis in the last three cases, certainly in Desault's and Malgaigne's, for it was avowedly based on the persistence of the radial pulse, and, although it is not so stated in the report of Dr. Agnew's case, it seems fair to assume that the same persistence of the pulse which is noticed in the report was also the basis of his diagnosis. As has been already mentioned, rupture of the subscapular or circumflex artery has several times presented similar symptoms, and, as in Mash's case just quoted, the radial pulse may even persist after rupture of the inner and middle coats of the axillary artery itself. Pelletan had a case similar to Desault's, made the same diagnosis, and incised the tumor; the patient died of hemorrhage, and the artery was found to have been ruptured.

In the two cases in which rupture of the vein alone was demonstrated post-mortem (Froriep, Price), the patients died promptly, in an hour and a half and on the following day respectively. In the third case, Hailey's, in which this lesion is said to have been proved by the autopsy, the account of the examination is very unsatisfactory, and leaves it, I think, quite uncertain what the actual injury was. The patient was a man fifty-nine years old; the dislocation was caused by a fall from a wagon, and was very easily reduced. The symptoms were, first, pain in the wrist, then, after a few days, swelling of the shoulder and œdema of the arm; at the end of two months a tumor appeared between the acromion and coracoid (*sic*), and death by exhaustion a few days later. The tumor was blood-clot, more than two pounds being removed from the axilla.

In Dr. Morgan's case "it was impossible to detect the source of the hemorrhage" at the autopsy, and it was attributed to the rupture of many small veins. This explanation also, I think, may well be questioned, for in this case too the radial pulse persisted, and at that time no cases had yet been reported in which similar symptoms had been shown to be caused by rupture or avulsion of a branch of the main artery. If, as seems probable from the account, and in view of the ignorance of this fact, the examination was mainly directed to the condition of the veins, it is not unlikely that rupture of an arterial branch may have been overlooked, especially since the symptoms were not unlike those of some of the other cases in which this rupture was demonstrated (Desprès, Körte's second case). The symptoms and course of this case were, in brief, as follows:

The patient was a man fifty-four years old, the dislocation subcoracoid, the reduction immediate, under chloroform, with the heel in the axilla. During the first week "there was nothing to be noticed but the ordinary swelling attending such a dislocation. This swelling, instead of subsiding,

of the posterior circumflex. The specimen was presented at the meeting of the New York Surgical Society May 26, 1885, and a description of it will be found in the report of the proceedings. (N. Y. Med. Journal, and The Medical News, June 13, 1885.)

increased, and this somewhat rapidly toward the end of the first week. There was also some purple discoloration about the inner and posterior parts of the shoulder. Still there were no appearances which might not attend an ordinary bruise or laceration about the part. But, in the course of the following week, enormous swelling had come on, extending from the elbow up the arm, and over the chest to the level of the outer third of the clavicle, and over the scapula." The swelling was soft and fluctuating; the skin in places dark purple and thin; the radial pulse was natural. Fever, with slight shivering and one distinct chill. "About the third or fourth week an incision was made in the arm, and the hand passed up into the cavity, which contained an enormous amount of blood, chiefly coagulated, extending under the pectoral muscles, down the side of the chest, and behind over a great part of the scapula, and communicating with the shoulder-joint. The subclavian and axillary arteries could be felt." The man died with symptoms of septicæmia.

In Körte's second case (loc. cit., p. 635) the patient was fifty-two years old, the dislocation forward and inward. Several unsuccessful attempts to reduce were made during the sixth month, and the last was followed by the gradual appearance of a non-pulsating swelling under the pectoral muscle, œdema of the arm, and sharp neuralgic pain. Radial pulse. The patient became feverish, the tumor softer, the skin thin, and at the end of six weeks it ruptured spontaneously. The hemorrhage was arrested with a tampon, and the patient died shortly afterward. The autopsy showed a large cavity occupying all the space under the pectoralis major, and filled with large blood-clots. On the outer and front side of the artery, 4 centimetres below the clavicle, was a transverse opening measuring 0.4 by 0.3 centimetre (one-sixth by one-eighth inch), thought (loc. cit., p. 650) to have been produced by the tearing off of an arterial branch.

In Desprès's case there was the same swelling, slowly increasing and becoming fluctuating, œdema of the arm, and persistence of the radial pulse. In addition, a bruit was audible after the tenth day, and the swelling subsequently pulsated at times. An operation for ligature of the subclavian was done on the fifty-fifth day, and was followed by arrest of the pulsation, but, after the patient died, on the fifty-fourth day, it was found that the ligature had been placed upon a nerve immediately overlying the artery. The common trunk of the circumflex arteries was found to have been torn off at its origin.

On the other hand, in Körte's first case, in which the lesion proved, post-mortem, to be a similar opening upon the side of the axillary artery, and of almost exactly the same size, pulsation in the brachial and radial arteries was barely perceptible two months after the accident, when the patient first came under observation with an enormous pulsating swelling of the shoulder filling the axilla and extending up to the clavicle.

These histories show, and many of the others might be quoted in confirmation, that, although the diagnosis, so far as the general nature of the accident, rupture of a bloodvessel, is concerned, does not long remain obscure, the identity of the injured vessel cannot always be determined. If the tumor pulsates, the diagnosis of rupture of an artery may be made; and if, in addition, the radial pulse is present, it is extremely probable

that the injured vessel is not the main artery, but that one of its branches, probably the subscapular or circumflex, has been ruptured or torn off at its origin. Beyond this it does not seem at present possible to go with much certainty, although the great preponderance of arterial lesions in the known cases—26 out of 28, or, adding Hailey's and de Morgan's, out of 30, or, again, adding Platner's and Braun's, in which both artery and vein were torn, out of 32—makes it highly probable in any given case that an artery and not the axillary vein has been torn.

Of the remaining 15 cases, 6 recovered without operation (Desault, Malgaigne, Nélaton's second case,[1] Anger, Agnew, and Sands) and have been already discussed. Nélaton, Anger, and Sands made the diagnosis of rupture of an artery. In 8 (Warren, O'Reilly, Green, Volkmann, Létiévant, Cras, Archangelski, and Parker) the subclavian was tied; in 7 of them with success; in 1, Green's, the result is not known. In 1, Dickson, pulsation was arrested by digital pressure on the subclavian continued for eight hours; a year later the tumor was again pulsating, and digital pressure was again made, apparently for a week; three years later there was no trace of the tumor.

In the last 7, and in 3 of the first 6, it seems reasonably certain that an artery was injured, for pulsation of the swelling is noted in every account that is given in detail, and such was the opinion of the surgeons who treated them. The record, then, may be made as follows: Of 47 cases, an artery (the axillary or a large branch) was ruptured in 38, the artery and vein in 2, the vein alone in 2, in 2 dissection failed to reveal the source of the hemorrhage, and in 3, in which the patients recovered without operation, the symptoms do not justify a positive diagnosis.

The *terminations* were as follows: 15 recoveries, 31 deaths, and in 1 (Green's) the result is unknown; 20 received no operative treatment; of these 6 recovered and 14 died.[2] In 16 the subclavian was tied, with 6 recoveries, 8 deaths, and 1 unknown result. In 1 a cure was effected by digital pressure on the subclavian. In 6 an incision was made in the axilla, and the artery tied above and below the point of rupture; all died. In 4 the limb was articulated; 1 recovery, 3 deaths. The treatment in the cases that recovered without operation was simply compression of the swelling and immobilization of the arm, with the application of ice in Malgaigne's, and compression of the subclavian artery in Agnew's.

In drawing inferences from these results, it must be borne in mind that in many of the cases in which operations were undertaken non-operative treatment had previously been employed, and had resulted in a condition that made an operation necessary. Thus, using only those cases in which the record is sufficiently detailed, of the 17 cases of ligature or compression of the subclavian, in 10 the operation was done after the lapse of several weeks or even months, in 1 on the third day, in 1 on the tenth day, and in 5 the length of the interval is not known. Of the 4 disarticulations, in 1 the operation was at a late date, in 1 five days

[1] After rupture of the tumor without hemorrhage, and suppuration of the sac and shoulder-joint. See Körte, loc. cit., p. 655.

[2] Possibly Körte's second case should be included among the recoveries.

after the accident, and in 2 unknown. Of the 6 treated by incision and double ligature of the axillary artery, the operation was done promptly in 2, and after a long interval in 4. Consequently the results of non-operative treatment may be tabulated as follows: Of 35 patients, 6 recovered, 14 died, and 15 (with 10 deaths) subsequently underwent operation, either because death by hemorrhage threatened, or because of the existence of a growing aneurism.[1] A fair inference is that conservative treatment may properly be tried at first, but should not be prolonged if the symptoms do not promptly yield; and, secondly, that, in case of resort to operation, ligature of the subclavian artery or disarticulation at the shoulder is to be preferred to incision of the sac and double ligature of the artery.

Experience with arteries wounded under other conditions has shown that they will sometimes quite readily heal, or the opening made into them will close, under pressure accurately made at the point of injury, and it would therefore be proper to attempt to treat this injury by direct, limited pressure. Whether or not it would be possible to recognize the wounded point and make efficient pressure directly upon it cannot be said, since the attempt does not appear to have been made. In default of such limited pressure, general compression of the swelling in the axilla seems to be the only resource short of operation. The common treatment of ruptured artery, incision and double ligature of the vessel, was immediately resorted to in only two of these cases, Lister's and the one at the Sheffield Infirmary. Both were promptly fatal.

An important question arises from these facts in connection with the treatment of dislocation of the shoulder: How far does the possibility of the occurrence of this accident affect the choice of a method of reduction? and also concerning the propriety of attempting reduction in cases that are not recent.

In the reduction of recent dislocations, these accidents show that abduction of the arm especially should be avoided, as also circumduction, violent traction, and rough pressure in the axilla. Kocher's method by manipulation appears well adapted to avoid the danger. It is also to be remembered that the injury to the vessel may be caused by the dislocation itself, and its symptoms may be masked by the swelling commonly present during the first few days.

In old dislocations the probability of the occurrence of the accident is increased by the more forcible measures usually necessary to break up the adhesions that bind the bones in their new relations; and, while it may be proper in many cases to make the attempt to restore the limb to usefulness, the possibility creates another reason for abstention when the patient is old, the duration of the dislocation long, and the adhesions firm. Even a dislocated arm may be very useful, and the fatality of this accident, more than seventy per cent. of deaths, may well cause the surgeon to hesitate to incur the risk merely for the sake of ameliorating a condition which does not endanger life and is quite compatible with activity and usefulness.

[1] Körte's second case is an exception; an error in diagnosis led to an operation after the aneurism had apparently undergone spontaneous cure.

List of Cases.

A. *Fatal without Operation.*

1. Verduc (Malgaigne, Des luxations, p. 149); artery wounded; no treatment; death by hemorrhage.
2. Petit (Malgaigne, Des luxations, p. 149); artery wounded; no treatment; death by hemorrhage.
3. Pelletan (Malgaigne, Des luxations, p. 149); artery wounded; puncture; death by hemorrhage.
4. Platner (Malgaigne, Des luxations, p. 151); artery and vein; death by hemorrhage.
5. Leudet (Malgaigne Des luxations, p. 149); artery; 57 years. Dislocation 11 days.
6. Froriep (Malgaigne, Des luxations, p. 151); vein; 26 years. Dislocation 3 weeks.
7. Gibson, I., Surgery, i. p. 325; 50 years. Disloc. 2 months. Death in a few hours.
8. Price, quoted by Callender, p. 107; vein. Death on following day.
9. Körte, I., Arch. für klin. Chir., vol. xxvii. p. 631; artery; 25 years. Disloc. recent. Puncture.
10. Körte, III., Ibid.; artery; 52 years. Disloc. 5½ months. Rupture.
11. Mash (Carruthers), Brit. Med. Journ., 1872, i. p. 526; artery; 38 years. Disloc. recent.
12. Haily, Ibid., 1863, ii. p. 634; 59 years. Disloc. recent.
13. De Morgan, Ibid., 1872, i. p. 54; 54 years. Disloc. recent. Incision.

B. *Ligature of Subclavian.*

14. Green, Lancet, 1825, vol. viii. pp. 189 and 283; 33 years. Disloc. recent. Result unknown.
15. Warren, Med.-Chir. Trans, vol. xxix. p. 25; 30 years. Disloc. recent. Recovery.
16. Gibson, II., loc. cit., p. 334; 35 years. Disloc. 9 weeks. Death.
17. O'Reilly (Adams), Cyclop. of Anat. and Phys., vol. iv. p. 616; 50 years. Disloc. recent. Recovery.
18. Nélaton, I., Path. chir., ii. p. 368. Disloc. old. Death.
19. Rigaud, Dict. encyclop., art. Épaule; artery; 23 years; death.
20. Von Pitha (Körte, loc. cit., p. 649); artery; death.
21. Volkmann (Körte, loc. cit., p. 656). Recovery.
22. Panas (Marchand, p. 52); artery. Dislocation recent; death.
23. Desprès, Bull. de la Soc. de chirurgie, 1878, p. 116; artery; 40 years. Recent; death.
24. Gärtner, Schmidt's Jahrb., 1871, vol. cli. p. 304; artery; 20 years. Recent; death.
25. Létiévant, Bull. de la Soc. de chir., 1884, p. 748. Recent; recovery.
26. Lefeuvre, Ibid., p. 750; artery; 52 years. Recent; death.
27. Cras, Ibid., p. 739; 45 years. Recent; recovery.
28. Archangelski, Centralblatt für chirurgie, 1885, p. 383. Dislocation habitual; aneurism appeared after unsuccessful attempt on 4th day, and increased after a second attempt in 4th week. Subclavian tied below the clavicle; recovery.
29. Parker, Lancet, 1885, i. p. 704. F. 36 years. Disloc. 7th week. The ruptured artery was apparently the subscapular.

C. *Double Ligature—all Fatal.*

30. Callender, St. Barthol. Hosp. Rep., vol. ii. p. 96; artery; 61 years. Disloc. old.
31. Wutzer, Arch. für klin. Chir., vol. x. p. 308.
32. Körte, II., loc. cit.; artery; 29 years. Disloc. recent.
33. Lister, Edinb. Med. Journ., 1873, p. 829; artery; 58 years. Disloc. 8 weeks.
34. Rivington, Brit. Med. Journ., 1872, i. p. 420; artery; 71 years. Disloc. recent.

35. Sheffield Inf., Ibid., 1883, i. p. 207; artery; 62 years. Disloc. 6 weeks.
36. Baum, Deutsche Klinik, 1867, p. 431; artery and vein. Lig. of axillary (possibly double).

D. *Digital Pressure.*

37. Dickson, Keney, Philad. Med. and Surg. Reporter, 1882, vol. xlvii. p. 256. M. 24. Recent; recovery.

E. *Disarticulation at Shoulder.*

38. Jünken, Arch. für klin. Chir., vol. x. p. 313; artery. Unsuccessful attempt to apply double ligature; recovery.
39. Bell (Malgaigne and Callender). Death.
40. Ledentu, Bull. de la Soc. de chir., 1877, p. 187; artery. Disloc. recent; death.
41. Bellamy, Lancet, 1880, ii. p. 260; artery; 55 years. Disloc. 7 weeks; death.

F. *Recovery without Operation.*

42. Desault, Œuvres chirurgicales, vol. i. p. 380; 60 years. Disloc. 1½ month.
43. Malgaigne, loc. cit., p. 150; 44 years. Disloc. 2 months.
44. Anger, Bull. de la Soc. de chir., 1878, p. 122; 54 years
45. Nélaton, II., Ibid.
46. Agnew, Willard in Phila. Med. Times, 1873, p. 721; 60 years. Disloc. 6 weeks.
47. Sands, N. Y. Med. Record, 1880, p. 45; 84 years. Disloc. 7. weeks. Autopsy in the proceedings of the New York Surgical Society, May 26, 1885, in N. Y. Med. Journal and in The Medical News, June 13, 1885.

Injuries to Nerves.—These also have been far more frequently observed at the shoulder than elsewhere, and there is the same difficulty in many of the recorded cases in determining whether the injury was caused by the dislocation or by the manœuvres employed to effect a reduction.

The injury may consist in direct compression of the nerve against the bone, as in the attempted reduction by the method of the door or ladder or by the heel in the axilla, or in forcible elongation or complete rupture of the nerve by traction upon the limb, or such change in its position that the nerve is stretched around the head of the bone, or in avulsion of the nerve from the spinal cord. As the autopsies are few in number our knowledge of the lesions is mainly clinical. In a case quoted in the preceding section, one of rupture of the brachial artery near the elbow, the median nerve was also ruptured; and this double injury has been several times encountered in compound dislocation of the elbow.

In a case reported by Flaubert,[1] and mentioned above in the section on Emphysema, a dislocation of the left shoulder five weeks old in a very stout woman aged seventy years, reduction was accomplished with difficulty after prolonged traction upon the arm by eight assistants. Besides the emphysema extending over the neck and back, there were syncope lasting an hour, cloudiness of vision, paralysis of the right arm, and left hemiplegia with loss of sensibility in the left arm but with pain referred to it. Thirty-six hours later there was sharp pain in the back of the head and neck and in the ears; pain also in the left thigh, in which sensation was better than in the right; the left arm was insensitive, with-

[1] Marchand: Loc. cit., pp. 25 and 67.

out pain, and motionless; the right arm numb and somewhat weakened; pulse rapid, skin warm. The next day the pupils were dilated and did not respond to light. On the seventeenth day the respiration was embarrassed, the skin hot, pulse rapid, prostration great; and on the nineteenth day death. The autopsy showed the lower four pairs of the brachial plexus on the left side to have been torn away from the spinal cord; their torn ends plainly showed the delicate filaments by which they took their origin, and the ganglions on the posterior roots could be distinguished. The first pair had suffered no injury. The spinal dura mater was of a dark brown-red color, and the cord, at the point where the nerves had been torn away, was changed into a reddish-brown pulp in which the gray and white substances seemed mingled.

The two following cases recorded by Flaubert[1] bear a close resemblance clinically to this one.

In a man, fifty years old, with a dislocation of the shoulder dating from a fortnight before, traction by three assistants caused numbness and pain in the hand and wrist; a second attempt, with six assistants, instantly caused numbness in the corresponding leg, and the reduction was abandoned. The following night there was sharp pain in the lower cervical vertebræ, subsequently extending to the dorsal region. The arm remained almost completely paralyzed.

A dislocation of the shoulder seven weeks old in a woman sixty-four years of age was reduced by traction made by five assistants. At the moment of reduction the patient felt a sort of rupture at the wrist, followed by a quivering that extended to the lower third of the arm and by complete hemiplegia and great diminution of sensation on the same side, especially in the arm. The lower limb regained its power, but the arm remained paralyzed and atrophied.

Gerdy,[2] while trying to reduce a dislocation of the shoulder by forcible traction with pulleys, the arm being held at right angles with the body, observed a tense cord under the skin on the inner side of the arm. Thinking it was the median nerve, he abandoned the attempt and made two experiments upon cadavers to determine the effect of traction upon the nerves and vessels. In each he was able to make a similar cord manifest on the inner surface of the arm, and found on dissection that it was the median nerve much stretched and carried inward. The brachial artery was much less tense. The traction was then increased until the nerve broke; the other nerves, the brachial plexus, and the vessels remained uninjured.

In other cases the effects, as indicated by the symptoms, have been limited to the limb, arm or leg, or to portions of it.

Erichsen[3] quotes from Billroth a case of dislocation of the shoulder of nine months' standing which had been accompanied by partial paralysis of the arm and some atrophy. The reduction was followed by total paralysis. Le Bret[4] reported one which occupies a position intermediate between this class and the preceding: a soldier dislocated his right shoulder;

[1] Quoted by Malgaigne: Loc. cit., pp. 158, 159.
[2] Marchand: Loc. cit., p. 71.
[3] Erichsen: Surgery, Am. ed., vol. i. p. 415.
[4] Le Bret: Soc. de Biologie, 1854, p. 119. Quoted by Weir Mitchell.

reduction was immediately made by traction, and was followed by paralysis of motion in the entire arm, loss of sensation below the elbow and on the right side of the neck, and by ptosis and dimness of vision on the same side. In most of the more recent recorded cases the history leaves it in doubt whether the paralysis was caused by the dislocation or by the reduction. In the older cases, in which the rough method of the door, ladder, or ambi was employed for reduction, there can be little doubt that the paralysis was commonly caused by the reduction. Petit[1] says he has seen it several times, and La Motte[2] describes a striking instance. At the shoulder the nerve most frequently affected is the circumflex; Marchand thinks this nerve is commonly injured by the dislocation, the others by the reduction. Instances of injury in other dislocations than those of the shoulder are rare. Hutchinson[3] describes a case of ischiatic dislocation of the femur reduced by manipulation under ether, followed by complete anæsthesia of the limb below the knee except on the inner side of it and of the foot.

In a case of anomalous form quoted by Dr. Hamilton,[4] a recent dislocation downward and backward between the tuberosity and spine of the ischium received into the Pennsylvania Hospital in 1835, "on the following day, the muscles of the patient having been sufficiently relaxed by suitable means, the pulleys were applied; but after a second attempt, some of the bands having given way suddenly, the pulleys were removed, when it was found that the reduction had been accomplished, although neither the patient nor his attendants had noticed the return of the bone to its socket. For several days there was entire loss of sensibility and motion in the leg, owing, probably, to the pressure which had been made upon the sciatic nerve; but these symptoms gradually disappeared."

Here, too, it is uncertain whether the injury to the nerve was caused by the pressure upon it of the head of the femur or by its elongation during reduction.

Maclise[5] gives a plate of a dislocation of the femur backward in which the sciatic nerve is stretched over the neck of the bone; and he says: "In general (in dislocations into the sciatic notch) the great sciatic nerve is bent over the femur and put on the stretch." . . "I have seen it so situated in regard to the head of the femur that the reduction could not possibly (?) have been effected with safety to that nerve." The plate apparently represents a dislocation produced upon the cadaver, and it seems probable that the text refers to dislocations similarly produced. I know of only one clinical case in which such relations of the parts have been observed: Quain's, Chap. XXV., Fig. 127.

Fracture.—Fracture of the dislocated bone during reduction has occurred in dislocations of the shoulder, elbow, and hip, and not only when great force has been employed, but also during comparatively gentle manipulations to flex, abduct, or rotate the limb.

At the shoulder the recorded cases appear all to have been dislocations

[1] Petit: Maladies des Os. Edition of 1844, p. 52.
[2] La Motte: Traité de Chirurgie, vol. iv. p. 343.
[3] Hutchinson: Med. Times and Gazette, 1866, i. p. 194.
[4] Hamilton: Fracts. and Disloc., 1880, p. 789.
[5] Maclise: Dislocations and Fractures; Plate 25, Fig. 2.

of long standing in elderly people, and in most the accident was caused by forcible rotation during traction. Hamilton,[1] who had personal experience of such cases, found at the autopsy of one of them that the fracture was at the surgical neck, and thought it to be the same in the others. In Fano's case[2] the fracture was thought to be at the anatomical neck. In Richet's[3] the broken end of the shaft was brought into the glenoid cavity, with subsequent formation of a useful joint; and Agnew[4] obtained a similar and highly satisfactory result, after fracture of the surgical neck of the humerus during attempted reduction, by keeping up constant movements until a false joint had formed between the fragments.

Several authors assert that the ribs have been broken during reduction by the pressure of a firm axillary pad used as a fulcrum, and also say that the lip of the glenoid cavity may be broken during reduction.

At the elbow fracture of the olecranon has been frequently caused, either intentionally or by accident, in the reduction of old dislocations. There is but one recorded case of its fracture in a recent dislocation, and even in this there is some doubt whether the fracture had not taken place before the reduction was attempted (Daugier, in Malgaigne, loc. cit., p. 146).

Markoe[5] mentions a case, apparently unique, of fracture of the humerus in an attempt to reduce an old dislocation of the elbow. "While making extension, and at the same time trying to flex the forearm on the arm, the humerus gave way, and a very oblique fracture was found to have occurred about a hand's breadth above the joint."

In dislocations of the hip the femur has been broken, usually at the neck, but once at least at the lower end of the shaft; and it is asserted by some that the rim of the acetabulum also has been broken. In a case reported by Malgaigne, a dislocation backward of eight months' standing in a patient seventeen years old, traction to the amount of nearly five hundred pounds was first used unsuccessfully; it was then reduced to three hundred, and the limb slowly rotated outward; a crack was heard, and it was found that the femur had been broken three finger-breadths above the condyles. In all the other cases the accident was due not to traction, but to efforts made by the hands of the surgeon to change the position of the limb, rotation or abduction. Although the force thus applied is slight compared with that developed by the use of pulleys, it must be remembered that its effect is greatly increased by the leverage of the limb.

There is reason to believe that after long disuse a bone becomes weak, and this supposition is offered by Profs. Markoe and Bigelow in explanation of the accident in their cases. In that of the former the patient was forty-two years old, and the dislocation of seven weeks' standing; in that of the latter, twenty-three years old, and six months' standing. In the former the bone broke with a distinct snap; in the latter with a continued fine crepitation during slow flexion of the limb. The final result in Bigelow's case was good; the head of the bone was firmly attached to

[1] Hamilton: Loc. cit., p. 660. [2] Marchand: Loc. cit., p. 82.
[3] Richet: Gaz. des Hôpitaux, 1860, p. 159.
[4] Agnew: Surgery, vol. ii. p. 32. [5] Markoe: Dis. of the Bones, p. 18.

the back of the trochanter, the shortening was one and a half inches, the limb was in good position and moved freely in all directions except that of eversion. In a case quoted by Sir Astley Cooper (loc. cit., p. 45) an equally good result was obtained.

Inflammation, suppuration, gangrene.—The inflammatory reaction induced by a dislocation is usually moderate, and, as has been shown in Chapter III., rarely terminates in suppuration; and when excessive reaction does follow the reduction of a recent dislocation, it is not always possible to determine whether the original traumatism or the reduction is responsible for it. In dislocations of long standing this difficulty does not exist, for the primary reaction has completely subsided, or, if persistent, has become moderate and chronic before the reduction is attempted, and its renewal or exacerbation is plainly due to its interference.

The inflammation may be due to the direct pressure of the apparatus used for making extension, or to laceration of the parts about the affected joint; the latter is the more dangerous because of the probability that the inflammation and suppuration may extend to the cavity of the joint, but the former also has proved fatal, as in the following case quoted by Marchand from a report by Velpeau.[1] A dislocation of the elbow of six weeks' standing, in an elderly man. Two unsuccessful attempts to reduce, at a week's interval, without accident. In the third attempt counter-extension was made by bands attached to the upper part of the arm and passing under the axilla, and traction was made by pulleys. On the fourth day a diffuse phlegmon appeared in the axilla and spread slowly over the lateral wall of the chest; multiple incisions were made, erysipelas followed and terminated fatally in six days.

Of the other form, laceration of the parts about the affected joint, the following case is an example. It was under the care of Malgaigne, is briefly referred to by him (loc. cit., p. 168), and is reported in full by Parmentier.[2] A man, thirty-four years old, with an intracoracoid dislocation of six months' standing. Three attempts to reduce were made, the traction in the last amounting to more than four hundred pounds, and the head of the bone being brought almost back to its place, but an attempt to force it into place by lateral traction with a bandage failed and even lacerated the skin on the posterior margin of the axilla. On the fifth day after the last attempt the patient complained of pain in the axilla, and the following day became delirious, and a large quantity of pus escaped through the laceration of the skin; trismus and tetanus followed, and death two days later.

The autopsy showed abscesses under and behind both pectoral muscles, in the substance of the coraco-brachialis and along its under surface, and communicating with the new articular cavity through a rent in its capsule. The head of the humerus was prevented from returning to the glenoid cavity by adhesions to the new capsule and shortening of portions of the old one. The glenoid cavity had lost its cartilage and was overlaid with movable fibrous tissue having a serous surface, apparently the posterior portion of capsule drawn across it.

[1] Velpeau: Annales de la Chirurgie francaise et Etrangère, vol. i. p. 297.
[2] Parmentier: Bull. de la Soc. Anatomique, 1852, p. 302.

The following case, reported by Mr. Jonathan Hutchinson,[1] is even more striking. An elderly woman, drunk, was admitted with a dislocation into the axilla; an attempt to reduce failed. The next day she said the shoulder had been dislocated for several years, but she was not believed, and reduction was again attempted with the aid of chloroform by moderate manual extension directly outward and the knee in the axilla as a fulcrum; the attempt was continued for ten minutes. Great inflammation followed, the joint suppurated, and the patient died. The autopsy showed a new articular cavity formed below and in front of the glenoid cavity. The soft tissues of the joint were wholly destroyed by suppuration, and every trace of cartilage removed.

An experience of Broca's shows that an unfortunate, even fatal, result may follow an apparently judicious and moderate attempt at reduction.

The patient,[2] a coachman, thirty-nine years old, entered the hospital for treatment six months after he had dislocated his left hip. Traction to the amount of more than five hundred pounds was made with Mathieu's apparatus without success, and the attempt was not repeated. No ill result appearing, the patient was discharged at the end of a week. A fortnight later he was admitted to another hospital with considerable swelling of the hip and peritonitis, and died on the following day. The autopsy showed a collection of pus occupying the old and new articular cavities, filling the external iliac fossa, infiltrating the gluteus medius, and in contact with the entire surface of the internal and external obturators and with the obturator foramen; also a generalized peritonitis, much more marked in the true pelvis than elsewhere. The course of the lesion was thought to have been: inflammation of the new joint, extension to the old one, then to the obturator internus, and finally to the peritoneum. It was thought probable that the patient had resumed work immediately after leaving the hospital, and that this untimely use of the limb had provoked the suppuration.

In a few recorded cases the inflammatory reaction was so severe that the limb, or the affected segment thereof, became gangrenous. Dupuytren[3] reported a case in which, after reduction of a dislocation of the thumb by long and violent efforts, the thumb became gangrenous and separated at the metacarpo-phalangeal joint.

These cases are to be distinguished from those in which gangrene has been caused by injury to the vessels or nerves, as in the case of La Motte referred to in the section on Injury to Nerves, and probably in Delagarde's,[4] in which, after reduction of an old dislocation of the shoulder, abscesses and points of gangrene formed in the limb and rendered amputation at the shoulder necessary.

Persistent œdema of the limb, a condition resembling elephantiasis, has been observed in a few cases in which unsuccessful attempts had been made to reduce old dislocations, evidently the result of interference with the venous flow. In a case of Malgaigne's, quoted by Velpeau,[5] the

[1] Hutchinson: Med. Times and Gazette, 1866, i. p. 304.
[2] Reported by Tillaux in Bull. de la Soc. de la Chir., 1868, vol. ix. p. 266.
[3] Quoted by Marchand, loc. cit., p. 129.
[4] Delagarde: St. Barthol. Hosp. Rep. vol. iv. p. 89.
[5] Marchand: Loc. cit., p. 131.

œdema of the arm disappeared simultaneously with the development of numerous varicose veins in the arm and shoulder.

Syncope and sudden or early death; fat embolism.—Besides the numerous cases already quoted in this chapter which show the dangers to the life of the patient that may arise in the course of an attempt to reduce a recent or an old dislocation, there are still others which indicate that life may be seriously threatened, or even destroyed, by other accidents or complications than the rupture of important vessels or nerves or excessive reaction and suppuration. In some of the fatal cases the failure to make an autopsy leaves the cause of death obscure, but the symptoms point to rupture of a vessel as a possible cause. An example of this kind is the case of the mayor of Nîmes, operated on by Delpech[1] for a dislocation of the shoulder. Traction was made by ten assistants; at the moment of reduction the patient grew pale, became unconscious, and immediately died. This syncope seems to have differed only in its result from that accompanying rupture of a vessel or nerve in some cases (*e. g.*, Agnew, Sands, and Flaubert, quoted above).

Quite recently E. Bœckel[2] has reported a case the autopsy of which suggests another explanation, not only of some of the deaths by syncope, but also of some attributed to the anæsthetic.

The patient was a man fifty years of age, with a recent ilio-pubic dislocation, who was brought to the hospital after an unsuccessful attempt to reduce. Chloroform was given and reduction made in seven minutes; the patient grew pale, his respiration weakened and promptly stopped. The autopsy showed the heart to be atrophied, both pulmonary arteries plugged by non-adherent clots, rounded like emboli, in the medium-sized branches and those of the third and fourth order, and also *fat embolism* of the lungs very wide-spread and intense. The iliac and femoral veins were free, but there was a thrombus in the popliteal vein from which it was thought those in the pulmonary arteries had been broken off.

Before the use of anæsthetics, in the times when muscular resolution was sought to be obtained by measures which depressed and weakened the patient, and when the efforts to reduce were made with great violence and sometimes prolonged for hours, exhaustion of the patient habitually followed, and death was sometimes the consequence. Malgaigne refers briefly to several such cases and gives one in detail: an athletic man, forty years old, with an old dislocation of the humerus. After having made a free venesection, Lisfranc reduced the dislocation by traction on the fourth attempt. The patient returned unaided to his bed and seemed well, although pale; two hours later he called the nurse, said he felt ill, uttered a cry, and died. The autopsy showed the vessels, nerves, and spinal cord intact, the viscera in good condition, and only an excessive injection of the vessels of the pia mater and a serous effusion in its meshes.

[1] Malgaigne: Loc. cit , p. 152.

[2] Bœckel: Mort subite par embolies pulmonaires, simulant la mort par le chloroform après réduction d'une luxation de la cuisse. Rev. des Sciences Méd., Oct. 15, 1881, p. 637.

Death by the action of an anæsthetic, especially chloroform, is thought to occur in a larger proportion of cases of reduction of dislocation than in other operations, but no satisfactory explanation of the greater risk, if it actually exists, has been given. Of 134 cases of death by an anæsthetic collected by Marchand, in 17 the operation was the reduction of a dislocation; of these 11 were of the shoulder, 3 of the hip, and 1 each of the knee, elbow, and thumb.

PART II.

NON-TRAUMATIC DISLOCATIONS.

CHAPTER IX.

CONGENITAL[1] DISLOCATIONS.

UNDER the term *non-traumatic* may be included all dislocations which exist at birth (*congenital*), although it is claimed that some of them are due to violence inflicted upon the fœtus in utero, or even during delivery, and those which appear subsequent to birth as the result of non-traumatic changes in one or more of the constituent parts of the joint ("spontaneous," "symptomatic," "inflammatory," "paralytic," "myopathic," "chronic," "tardy," "dislocation by distention," "by relaxation," "by destruction," "by deformity"), and those which may be reproduced at will by the individual, "voluntary."

The existence of dislocations (at least of the hip) in the newborn child, and their non-traumatic character, have been recognized since the earliest times, but the accurate study of the subject may be said to have begun in 1818, with Schreger, who examined, post-mortem, two specimens in a girl two and a half years old and a woman of forty-eight. A few years later, 1826, Dupuytren brought the subject before the Académie des Sciences, and called attention especially to the facts that the affection was often inherited, and often bilateral. Since then the subject of congenital dislocation of the hip has been actively studied by many, and the similar but much rarer affections of other joints have received due attention.

Statistics.—Dislocations have been observed at birth in many joints, but not only do those of the hip far exceed all others in number, but the latter are actually, as well as relatively, so rare that their statistics have not much value. Next to that of the hip the most common dislocation is apparently of the shoulder, and then that of the head of the radius. Krönlein says that the records of Von Langenbeck's Polyclinic show 90 congenital dislocations of the hip, 5 of the shoulder, 2 of the head of the radius, and 1 of the knee. It is not exceptional to find several dislo-

[1] The use of the term *congenital* to classify certain dislocations is objectionable for several reasons, which will appear in the course of the discussion of the subject. It includes forms that radically differ in their etiology and pathology, but as these forms cannot well be distinguished from one another during life, a classification based upon other points cannot be realized in practice, but must be confined to the dead-house and museum.

cations present in an individual, or one or more dislocations associated with such congenital defects as spina bifida, club-foot, ventral hernia, encephalocele, and exstrophy of the bladder.

As will appear in studying the etiology of this affection, the statistics of congenital dislocation of the hip include cases widely different in their origin, and even some which are acquired and not congenital, that is, some which have been produced during the first few months of life, perhaps before the patient began to walk, by the unopposed action of certain groups of muscles after paralysis of others. It seems probable, however, that the error thus arising is not a large one, but still, for this and for other reasons, I shall here quote only the more recent statistics, believing them to be the most nearly correct. These are Drachmann's,[1] Pravaz's (quoted by Krönlein) and Krönlein's.[2]

TABLE VI.—CONGENITAL DISLOCATIONS.

	Period.	Cases.	Male.	Female.	Single.		?	Double.
					Left.	Right.		
Drachmann . . .	1865–1880	77	10	67	24	24	...	29
Pravaz	1863–1878	107	11	96	27	29	...	51
Krönlein	1875–1880	90	14	76	32	22	5	31
Total . . .	.....	274	35	239	83	75	5	111

Prahl's, quoted above in Chapter I., are not given in sufficient detail to be included in the table; they comprise 18 cases; 3 were males, 15 females, making with those in the table a total of 292, of which 38 were males, 13 per cent., and 254 females, 87 per cent. Angot[3] says that of about 20 cases observed by him at the Hôpital des Enfants malades in 1882, all were girls. Of 11 cases of congenital dislocation of the knee collected by Hibon,[4] 7 were girls, 3 boys, and in 1 the sex was not recorded; of these, 3, 1 girl and 2 boys, were stillborn, and presented other very marked deformities.

According to a remark made by Broca in a discussion on this subject in the *Société de Chirurgie*,[5] Parise, while interne at the Hôpital des Enfants trouvés, dissected the hips of all the children that died there during his term of service, 332 in number, and found single and double dislocations in 3. This would indicate a far greater frequency of the affection than clinical records do.

Etiology.—The discussion of this branch of the subject, which was taken up with much interest after the publication of Dupuytren's memoir, was not fruitful of positive results because of the lack of anatomical material and minute examination, and of the failure distinctly to dis-

[1] Drachmann: Schmidt's Jahrbuch, 1881, vol. clxl. p. 170.
[2] Krönlein: Deutsche Chirurgie, Lief. 26, p. 82.
[3] Angot: Luxations congénitales de la hanche. Thèse de Paris, 1883, p. 11.
[4] Hibon: Luxations congenitalés du tibia en avant. Thèse de Paris, 1881, p. 7.
[5] Broca: Bulletins de la Société de Chirurgie, 1866, vol. vii. p. 331.

criminate between different forms and between the original bony defects and the changes produced by long use of the deformed limb. Since the affection is one which often escapes recognition until the child begins to walk, it was sometimes confounded with dislocations resulting from infantile paralysis, and as it is one which does not destroy life, the opportunities for direct anatomical investigation were almost entirely restricted to two classes of cases, the stillborn and those that died shortly after birth in consequence of other important congenital defects, and those in which the original changes had been masked or supplemented by subsequent ones produced by the further displacement of the head of the femur and its abnormal relations to the adjoining parts. In the former, incorrect inferences were drawn from the associated defects, as when the irritation of an over-full urinary bladder, or the separation of the symphysis pubis, was deemed the immediate cause of the arrest of development of the acetabulum; and in the latter the attention was led far astray by prominent changes in the bones. The history of the theories advanced has not only an historical value, but it serves also to indicate certain varieties and prominent features of the affection, and therefore I append the following résumé made by Krönlein. It must be remembered that most of the theories deal exclusively with dislocations of the hip.

1. *The so-called congenital dislocation is traumatic*, and arises:

a, through *external violence* acting upon the fœtus in utero, or through the action of the muscles of the fœtus itself. Hippocrates and the early writers held that mechanical injuries of the belly of the mother could produce dislocation in the fœtus. Cruveilhier did not entirely reject this theory in some cases. Chatelain, Kleeberg, Zielewicz, even specify in their three cases the injury, a fall in the seventh month, which, in their opinion, had caused the dislocation. Chaussier claims even that a dislocation can be caused by the contraction of the muscles of the fœtus, and narrates in support the case of a young woman who, during the ninth month of pregnancy, felt on three occasions such violent movements of the child that she almost became unconscious. When delivery took place at term, the child had a complete dislocation of the left forearm.

b, *during delivery.*

Capuron (1834) held that some congenital dislocations of the hip had been produced during delivery, by traction with the finger on the groin in breech-presentations. Chelius and d'Outrepont (1839) maintained even that none of the so-called congenital dislocations of the hip were congenital in the sense that they were due to a faulty development of the acetabulum, but that all were caused by traction on the foot during delivery.

2. *Congenital dislocation* (*of the hip*) *is a spontaneous* dislocation, and is occasioned:

a, *by softening and laxity of the ligamentous portion* of the joint (Sédillot, 1836). This opinion was held in part by Stromeyer (1840).

b, *by fœtal hydrarthrosis* (Parise, 1842) or other joint affection, such as fungous synovitis with effusion (Verneuil and Broca), or caries and destruction of the capsule (Morel Lavallée, Albers, Von Ammon).

3. *Congenital dislocation* (*of the hip*) *is due to the peculiar position of the lower limbs of the fœtus in utero.*

a, it is possible that in the *strongly flexed position of the hip* the pressure of the head of the femur upon the posterior or lower portions of the capsule may, *when the latter is abnormally weak*, cause dislocation (Dupuytren, 1826).

b, congenital dislocation of the hip is due to *abnormal adduction of the thigh in utero*, to a compressed position of the fœtus due to deficiency in the amount of the amniotic liquid (Roser, 1864).

4. *Congenital dislocation of the hip*, like most congenital deformities of the joints, such as club-foot, wry neck, and spinal curvature, *is the result of primary muscular contraction*, which is itself to be regarded as the result of an affection of the central nervous system (J. Guérin, 1840, and, following him, Chaussier, Melicher, Mercer-Adam, Carnochan, Erichsen, and others).

5. *Congenital dislocation of the hip is often only the last stage of a paralysis and consequent atrophy of the pelvi-trochanteric muscles.* This fœtal paralysis leads gradually to relaxation of the ligaments, and this, often only after the lapse of time, and especially after the children have begun to walk, and by the action of the weight of the body, to dislocation (Verneuil, 1866). This theory has recently (1878) been brought forward again by some of Verneuil's pupils (Reclus, Dalby), and extended to congenital dislocations of the humerus (Kirmisson).

(Krönlein in this fails accurately to define the position of the supporters of this theory. Their contention is not so much that congenital dislocations are thus produced, but rather that some so-called congenital dislocations originate after birth in a paralysis, and are mistakenly thought to have been congenital. Reclus[1] formulates his conclusions as follows:

1. From the group of so-called *congenital* dislocations *paralytic* dislocations must henceforth be withdrawn.

2. These dislocations follow "amyotrophies," and may appear at any age, although they have rarely been seen except in infancy.

3. For their production two conditions are necessary—atrophy of a muscular group; integrity of its antagonists.

4. At the hip the iliac dislocation is the most common. It is due to the contraction of the adductors, which is unopposed because of the atrophy of the gluteal and pelvi-trochanteric muscles.)

6. *Congenital dislocation of the hip is due in most cases—and these should be regarded as typical—to a defect of formation or development*, which prevents the joint from assuming the normal shape. This very generally held theory was presented by Palletta, and then taken up and specially developed by Schreger, Dupuytren, Breschet, Von Ammon, and others.

Schreger emphasizes the fact that so-called congenital defects are not

[1] Revue Mensuelle Méd. et Chir., 1878, p. 88.

produced by an abnormal change in preëxisting, normally formed parts, but are due to defective formation or arrest of development, and that is especially true of congenital dislocations of the hip. Dupuytren and Breschet suggest a delayed development of the three pelvic bones forming the acetabulum. Since the vascular and nutritive supply of the pelvic organs and walls is independent of that of the lower limbs, it may happen, according to Breschet, that the growth of the pelvis is delayed, and fails to keep pace with that of the femora. The latter are then drawn back to the lowest point on the outer surface of the former, and rest in the external iliac fossa. Von Ammon,[1] in his remarkable work, expresses himself very clearly concerning congenital dislocations, which he terms *dysarthroses congenitæ*. "Even if their external appearance," he says, "corresponds somewhat with that of dislocations acquired after birth, yet in their method of formation they differ essentially from them, and they also have only the slightest resemblance to those secondary dislocations that follow joint disease. . . . In many cases there is in part the greatest certainty, and in part the greatest probability, that the affection depends upon an arrest of the constituent parts of the joint at an earlier fœtal stage of development." And further (loc. cit., p. 3): "If the term 'luxatio' is in general understood to mean the slipping of a movable bone out of its natural joint connections, it is applicable only with the greatest restrictions to the congenital dislocations in question. . . There are cases of so-called congenital dislocation in which the head of the bone has never left its corresponding joint surface—that is, has never been dislocated, but rather, on the contrary, has never been in normal and proper relations with it." According to Von Ammon, then, a congenital dislocation is an arrest of development. The acetabulum does not develop into the usual, symmetrically rounded, deep socket, but retains its earlier saucer-shape; while the head of the femur, continuing to grow, becomes too large for the small acetabulum, and no longer suitable to lodge in it. (Krönlein, loc. cit., p. 84.)

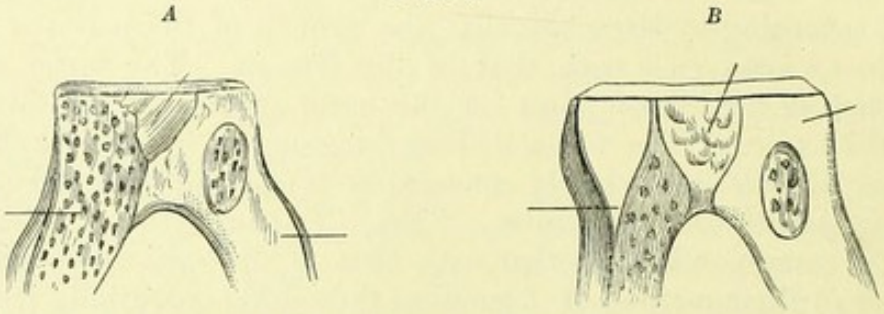
Von Ammon recognized not only this typical form of congenital dislocation but also the other varieties that had been described by other authors, and quoted cases and reproduced drawings in illustration of them. So far as the typical form is concerned, but little less has been added since his time to our knowledge of its pathogeny, and that little is contained in a paper published by Grawitz[2] in 1878, who, by microscopical examination of twelve specimens of congenital dislocation in seven newborn children, showed that the arrest of development consisted in a failure of the Y cartilage of the acetabulum to carry on the growth of one or all of the three segments of the os innominatum. He found, in his first case, for example, the acetabulum only as large as that of a fœtus of about the fifth month, and the Y cartilage broader than usual because of diminished ossification of the three adjoining bones, the pubis, ischium, and ilium (Fig. 9). The cartilage was hyaline and vascularized, and with normal, elongated cells containing one, two, or three nuclei.

[1] Von Ammon: Die angeborenen chirurgischen Krankheiten des Menschen, 1842, p. ix.

[2] Grawitz: Virchow's Arch., 1878, vol. 74, p. 1.

On comparison with sections of a normal pelvis of the same size, a striking difference appeared at the junction of the bone and cartilage. The formative zone in all three epiphyses was very imperfect, its cells scanty and widely separated, and the zone of cells arranged above one another

FIG. 9.



Section through the Y cartilage of the acetabulum into the obturator foramen. *A*, normal pelvis; *B*, pelvis of child with congenital dislocation of the hip. (GRAWITZ.)

in rows adjoining the line of ossification was not one-third as wide as it normally is, and the arrangement of its cells was irregular and broken. In two cases (Cases IV. and V.) the difference was even greater than in the first, for the zone of calcification was entirely lacking, and the cartilage cells contained no nuclei but only fat granules. In some of the cases the Y cartilage was centrally interrupted by an interposed wedge of embryonal adipose tissue. On the other hand, the appearances in the femur were those of normal growth, except in one case. In no case was there premature ossification of the Y cartilage, such as had been alleged shortly before by Dollinger[1] in explanation of the same affection.

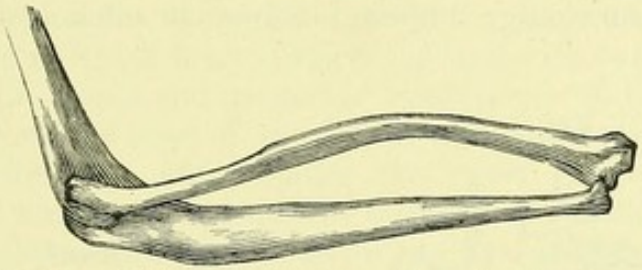
The conclusion, I think, cannot be avoided that while in a limited number of cases dislocations existing at birth, especially in joints other than the hip, may have been caused by traumatism, abnormal position of the limb, or paralysis in the manner alleged by various writers, yet in the great majority of congenital dislocations of the hip the cause is to be found exclusively in arrest of development of the acetabulum by deficient action or vitality of the cells of the Y cartilage. And to the testimony in support of this opinion furnished by anatomical examination of specimens may be added that drawn from clinical observation, such as the coexistence of other deformities due to arrest of development, the frequency of double and multiple dislocations, the inherited tendency to the affection, and its great predominance in females.

Many of the congenital dislocations of other joints than the hip must also be regarded as due to defective formation of the corresponding bones, but the defect is rather a malformation apparently, than the result of an arrest of the development of one of the bones constituting the joint. At the elbow, however, in dislocation of the head of the radius, this bone is sometimes found relatively, and even actually, longer than the ulna, so that the dislocation may be in part the result of an arrest of the growth of the ulna. In a specimen taken from an adult, pictured by Humphrey[2]

[1] Dollinger: Arch. für klin. chirurgie, 1877, vol. 20, p. 622.
[2] Humphrey: Med. Chirurg. Trans., vol. 45, p. 296.

(Fig. 10), of dislocation of the head of the radius forward and upward, there was ankylosis of the joint between the ulna and humerus, and the lower third of the ulna of the other arm was lacking.

FIG. 10.



Congenital dislocation of the head of the radius upward and forward, with exaggerated growth in length.

In some dislocations of the knee characterized by hyperextension of the leg upon the thigh the cause appears to have been muscular contraction.

Of the other etiological varieties that have been asserted to exist, one at least seems to have been proved by direct examination to exist, that in which the dislocation follows distention of the capsule and ligaments by dropsy of the joint during intrauterine life.

Pathology.—The opportunities for studying the pathology of congenital dislocations other than those of the hip have been so very rare, and the study of those that exist has been made so uncertain by the doubtfulness of the diagnosis in some and the difficulty in distinguishing between primary and later changes in others, that but little can be positively said concerning them. In studying specimens of dislocation of the hip it is necessary, as Gurlt pointed out, to distinguish between those obtained from very young children who have never walked, those from older children whose growth was not completed, and those from adults.

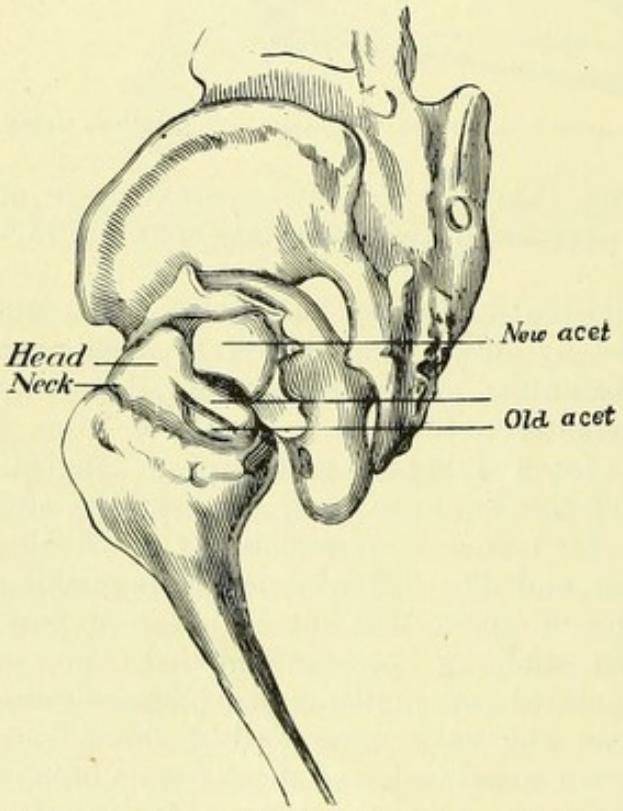
Hip.—The common form is dislocation upon the dorsum of the ilium; the only exceptions, and they are extremely rare, are upon the pubis and into the obturator foramen.

In the newborn child with a dislocation the acetabulum is smaller and flatter than normal, and is continuous by its flattened posterior border with another articular surface or new acetabulum lying above and behind the original one. Usually, too, the head of the femur is smaller than normal, although still too large for the acetabulum, and the neck short or almost absent (Fig. 12); sometimes the head and neck together have a conical, pointed form. The ligamentum teres is long and flattened, the capsule is complete and embraces both the old and the new acetabulum (Fig. 11). The microscopical changes have been described above.

The mechanism of the alteration seems plain; as the femur and its socket are originally developed out of one continuous strip of tissue they are at first in normal relations to each other, but as the development of the acetabulum goes on more slowly and imperfectly than that of the head of the femur the latter becomes relatively too large, and being no longer firmly held in place it is gradually drawn backward and upward by the continuous action of the attached muscles, the corresponding edge of the capsule is pressed away from the cotyloid border, and a new articular surface is

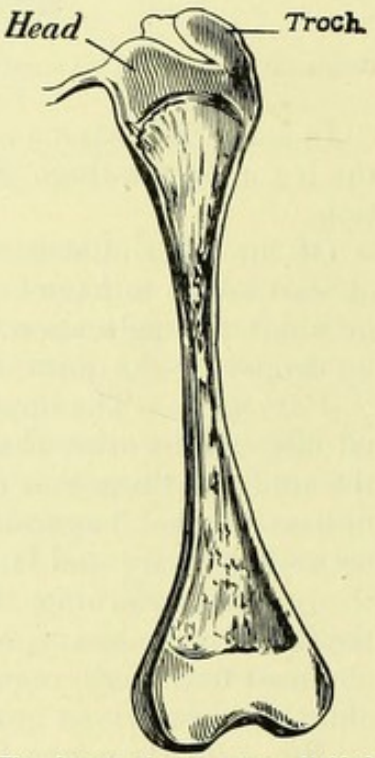
formed at the point where the head of the femur comes to rest. Meanwhile, the defective development of the original acetabulum persists, and its variation from the normal is probably still further increased by the absence from it of the femur. The remaining bones and the muscles not being put to sufficient use to feel the effect of the changed relations in the joint suffer no change unless involved in some associated defect of development.

FIG. 11.



Left hip of an eight months fœtus with double dislocation. (GRAWITZ.)

FIG 12.



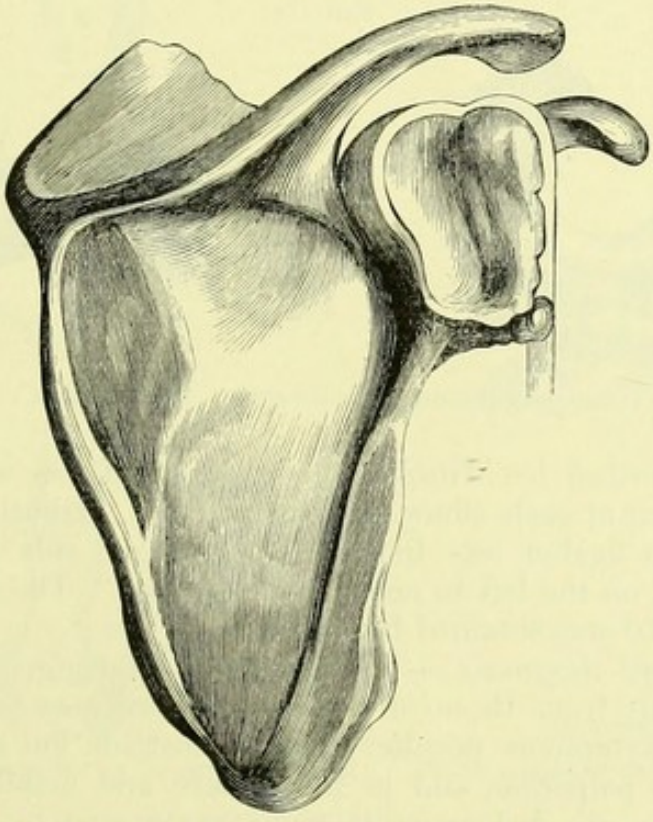
The femur of the same, divided longitudinally. (GRAWITZ.)

But as soon as the child begins to walk, this change in the relations of the bones and muscles to each other makes itself felt, and as the local developmental weakness persists, two factors are now at work to remove the condition of the parts still further from the normal. The acetabulum, by its continued failure to share equally in the growth of the pelvis, becomes relatively smaller and more deformed, the head of the femur is removed still further from it, and becomes deformed in consequence of its irregular bearings upon the surface of the ilium; the ligamentum teres becomes longer, flatter, and thinner, and the capsule thick and strong, and its cavity commonly larger than usual. As the individual advances in life, and after puberty has been reached, the ascent of the femur is finally arrested, partly by the formation of a socket, and partly by the resistance of the capsule and the muscles. The elements of support then resemble in a measure those sometimes found with ununited fracture of the neck of the femur, and the pelvis, instead of resting directly upon the femur, is suspended from it by the capsule, ligaments, some of the pelvi-trochanteric muscles, and even by the psoas-iliacus, the

tendon of which, instead of passing downward, curves around the brim of the pelvis and passes upward, outward, and backward to the lesser trochanter, which is now at a higher level than the acetabulum or even than the horizontal branch of the pubis.

The head of the femur may be separated from the ilium by the interposed capsule, so that the support is entirely by suspension, and there is no real joint, one in which bony surfaces covered with cartilage play upon each other; or the upper and posterior attachment of the capsule may still be found above the head of the femur, upon an overgrowth of bone springing from the ilium and forming the upper part of a new socket, the remainder of which is constituted by the body of the ilium. The latter bone sometimes shows at this point an overgrowth of bone, and sometimes a depression with a corresponding thickening on the opposite, inner surface. In the former of these two last-named conditions, it seems probable that the capsule has been for a time interposed between the femur and the ilium, and has finally disappeared at this point under pressure, the irritation of which has caused the outgrowth of bone before its periosteum has in turn disappeared; in the latter, it is probable that the attachment of the capsule has been pushed back step by step, leaving a bare surface of bone, which has worn away under the pressure of the femur, or by

FIG. 13.



Double congenital, subacromial dislocation. (R. W. SMITH.)

absorption; while the associated irritation has led to a conservative thickening on its other side. The old acetabulum is narrow and elongated, running upward and backward; the ligamentum teres perhaps destroyed by over-stretching.

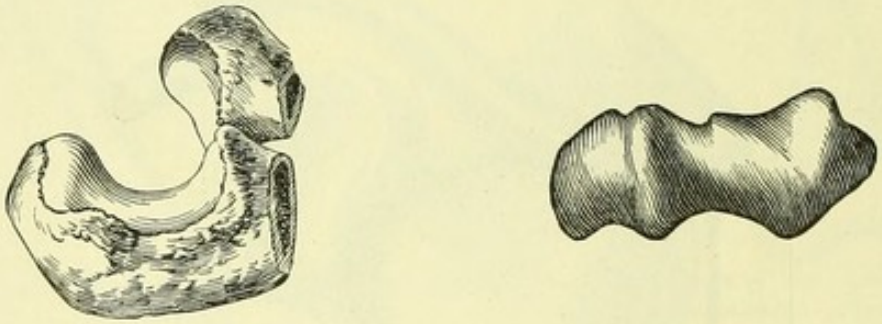
The entire pelvis is also changed in shape by the abnormal direction of the pressure to which it is subjected in walking. If the dislocation is unilateral, the crest of the ilium on the corresponding side is carried inward, and the tuberosity of the ischium outward, the horizontal branch of the pubis is elongated, and its direction from the symphysis is more upward and backward; the anterior superior spine of the ilium is displaced inward and backward, and, in short, the entire bone undergoes a change in shape which carries its centre upward and backward, and makes its lateral surface more vertical.

If the dislocation is double, the same changes are found on both sides, and the sacrum is more sharply curved.

Congenital dislocation of the shoulder may be either subcoracoid, subacromial, or subspinous. R. W. Smith,[1] who was the first to describe them, gives examples and plates of the first two forms. He found the original glenoid cavity lacking or rudimentary, and the new one well developed either immediately under the coracoid process or on the outer side of the scapula below the acromion (Fig. 13). For a description of the cases see Chapter XVIII.

At the elbow the head of the radius may be displaced upward along the anterior surface of the humerus, or backward, or inward so as partly to overlap the coronoid process of the ulna (Fig. 14). In a case of the

FIG. 14.



Congenital dislocation of the left elbow. (MITSCHERLICH.)

latter kind, described by Mitscherlich,[2] the patient was a girl six years old, with a defect at each elbow, and a club-foot; extension of the elbow was perfect, but flexion was limited on the right side to an angle of 70 degrees, and on the left to one of 110 degrees. The specimen represented in Fig. 20 was obtained by excision.

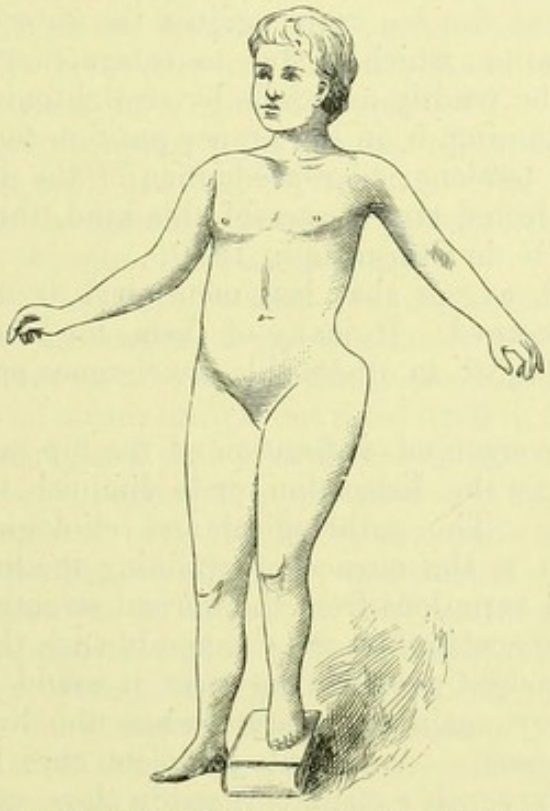
Symptoms and diagnosis.—The symptoms of congenital dislocations differ very widely from those of the traumatic variety, and not only by the absence of symptoms peculiar to a traumatism, but also in the signs recognizable by palpation, and in the posture and mobility of the limb. In general terms, the dislocation is to be recognized by an examination which determines the abnormal position and altered shape of the corresponding ends of the bones and the range of motion, and by consideration of the history of the case.

[1] R. W. Smith: Dublin Med. Journ., 1839, vol. xv. p. 261.
[2] Mitscherlich: Arch. f. klin. Chirurgie, vol. vi. p. 218.

In *dislocations of the hip* the changes are very likely to pass unnoticed until after the child has begun to walk, because during this first period they are usually too slight to attract attention, and because an examination for their detection is not likely to be made unless it is suggested by some special reason, such as coexisting malformations, or the history of similar defects in other members of the family. Even after the child has begun to walk, the defect may long remain unrecognized if both hips are affected, because the deformity of the regions and the shortening of the limbs being symmetrical, they do not attract much attention. Nevertheless, the changes are so characteristic that when an examination is made the diagnosis cannot well remain in doubt.

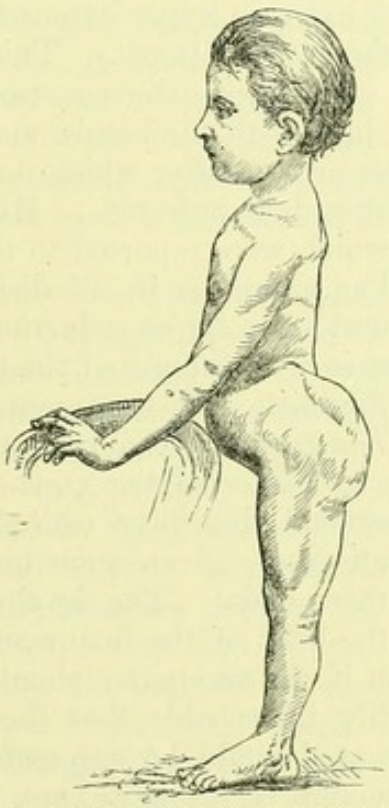
When the dislocation is unilateral and of the common dorsal variety, the patient limps because of the shortening of the affected limb; and for the same reason the spine shows a lateral curvature, which can be removed by supporting the foot at the proper height. Because of the passage of the head of the femur backward and upward upon the ilium, the pelvis is tilted so that its upper portion is directed forward, and a marked anterior curvature of the lower portion of the spinal column is produced, which disappears when the patient is recumbent.

FIG. 15.



Unilateral congenital dislocation of the hip. (KRÖNLEIN.)

FIG 16.



Double congenital dislocation of the hip.

Inspection and manipulation reveal the ascent of the trochanter, and the head of the femur may sometimes be distinctly recognized. Krönlein recommends that it should be sought for by placing the patient upon the opposite side, and flexing and adducting the affected limb. The shortening may be slight, moderate, or very great, and in the latter case can be diminished by traction upon the limb. In one case under my observa-

tion, a child less than two years old, the difference thus produced amounted to more than an inch. Usually the gluteal muscles and those of the thigh are less developed than those of the opposite limb. The movements of the joint are even more free than normal, except perhaps in abduction, but when voluntarily performed they are more or less lacking in precision and firmness.

When the dislocation is bilateral, the patient walks, not with a limp, but with a peculiar characteristic waddle, which sometimes amounts to a double limp and makes progression difficult and uncertain. The upper part of the pelvis is sharply inclined forward, producing the same anterior curvature of the lower portion of the spine that is found in unilateral dislocation, but without the lateral curvature unless there is a difference in the amount of the defect on the two sides. The arms appear unusually long, and are sometimes exceptionally muscular. The local changes have been described above.

At other joints, such as the shoulder, elbow, and knee, the position of the bones and the changes in their shape can be more easily made out, and the interference with the functions of the part, so far as it depends upon the relations of the bones to each other, appears usually to be less important than at the hip. A prominent exception to this is presented by one of the varieties of dislocation at the knee, dislocation forward, with extreme hyper-extension, so that the leg rests against the anterior surface of the thigh. This dislocation, which is due to contraction of the quadriceps extensor cruris, can be readily overcome by straightening the limb with the hands, and maintaining it in the proper position for a week or two, after which no further tendency to reproduction of the dislocation is manifested. Hibon[1] collected eight cases of this kind, three of which were reported to the Société de Chirurgie in 1880.

The *prognosis* in all dislocations, except that last mentioned, is unfavorable, so far as reduction is concerned. In many of them, the interference with the use of the limb is slight; in others this interference may be diminished by treatment.

Treatment.—The treatment of congenital dislocation of the hip may aim at either of two ends—to reduce the dislocation, or to diminish the functional disability caused by it. The pathological and etiological details above given show how slight is the chance of attaining the first of these ends. The developmental variations from the normal structure of the head of the femur and of the acetabulum are commonly such that even if the two parts should be brought properly together, it would be highly improbable that the tendency again to separate when the limb was used could be successfully opposed. A radical, complete cure by reduction is, therefore, not to be expected, except perhaps in those rare cases in which the development of the parts has been regular, and in which the dislocation has been produced by one of the exceptional causes, such as traumatism, hydrarthrosis, a faulty position of the limb during intrauterine life or paralysis; and even in such cases it can only be expected if the remedy is applied soon after the birth of the child, before changes have occurred to make reduction impossible.

[1] Hibon : Luxations congenitales du tibia en avant, Thèse de Paris, 1881.

Nevertheless, even in cases characterized by defective development, much can be gained by treatment begun at an early age, and faithfully carried out. Many cures of such cases have been claimed, especially by the two Pravaz, father and son, the former of whom claimed to have been the first to realize this result in practice. He claimed even more, that he had effected reduction, and he read an elaborate paper before the Academy of Medicine in 1838,[1] explaining his method of treatment and supported his claims by the presentation of one patient and the report of three additional cases. The committee to whom the paper was referred made a favorable report, and although the completeness of the reduction was disputed, the great amelioration of the patient's condition was established beyond question. Krönlein says that Pravaz subsequently reported to the same body seventeen cases, in fourteen of which he claimed to have effected complete reduction by means of prolonged traction. In a report made by a committee of the Société de Chirurgie[2] upon a case shown to the Society by Pravaz, Jr., in which the same treatment had been pursued for two years, the completeness of the reduction was denied, because the head of the femur could be distinctly felt behind the trochanter when the thigh was flexed; but it was admitted that the functions of the limb had been greatly benefited.

Quite recently, Dr. Buckminster Brown[3] has reported a remarkable success obtained by him by continuous traction and fixation maintained with great care and patience for thirteen months, in a case of double dislocation in a girl five years old. So far as can be judged from the accompanying photographs, the restoration of form was complete, and the walk had become normal. The original report should be consulted for the details. It seems probable that in such cases a new socket forms at the site of the acetabulum.

When the object has been to diminish the functional disability caused by the dislocation, it has commonly been sought by bringing the head of the femur as near as possible to the acetabulum, and retaining it there by artificial means until it has fixed itself in this position. Continuous traction by weight and pulley, or by the splints used in the treatment of hip-joint disease, is employed in old cases to bring the bone into position, and its retention has been sought by the same means, and by fixed plaster-of-Paris dressings, or specially constructed girdles and bands. Barwell[4] thinks time can be saved in this treatment by subcutaneous division of the muscles that have been shortened, the adductors, rectus, and glutei. In very young cases benefit has been got by fixing the limb for a long time in the abducted position. König[5] recommends a felt corset which shall include the pelvis, and, by preventing it from tilting, effectually oppose the displacement of the femur upward and backward. He says older children and adults have been well satisfied with the functional results thus obtained. Landerer[6] describes a corset which can be cheaply made of

[1] Bulletin de l'Acad. de Méd., Paris, vol. 3, p. 408.
[2] Bulletin de la Soc. de Chirurgie, 1864, p. 218.
[3] Brown: Boston Med. and Surg. Journal, June 4, 1885.
[4] Barwell: British Medical Journal, May 28, 1887.
[5] Lehrbuch der Speciellen Chirurgie, 1881, vol. iii. p. 287.
[6] Landerer: Archiv für klin. Chirur., 1885, vol. xxxii. p. 519.

alternate layers of bandages wet with silicate of soda and plaster of Paris, which is very durable, and has yielded excellent results. After it has been worn for some time, a year or more, the bone remains in place.

Of late years excision of the head of the femur has been done in old cases. Krönlein mentions a case by Roser, in 1874, and Heusner[1] reports a successful result in a girl twenty years old. In the latter case the dislocation was bilateral, and gave no special trouble until the age of seventeen, when the left hip became painful, and gradually grew so much worse that relief was sought in the hospital. The deformed head of the femur was removed, and the upper end of the femur fixed against the acetabulum, after the latter had been made deeper by chiselling.

Margary,[2] of Turin, reported at the Congress at Copenhagen, in 1884, a case in which he had deepened the cotyloid cavity by chiselling, replaced the head of the femur in it, and had made a new capsule out of portions of the old one and of the periosteum of the ilium. The patient died of pyæmia. According to Da Paoli,[3] Margary abandoned the method in favor of excision of the head. Paoli thought the results of the latter so defective that he again tried arthrotomy, with the addition of measures designed to increase the local reaction and thus favor a better development of a new acetabulum. He deepened the cotyloid cavity by chiselling, and diminished the size of the head, and fastened the latter in place by driving a nail from the outer aspect of the trochanter through the neck and head into the acetabulum, and left it in place twenty-five days. The operation was followed by fever and suppuration, but the patient recovered, and the shortening of nine and a half centimetres was permanently overcome. He thinks the most suitable age is between the eighth and twelfth years.

Congenital dislocations of other joints, except the knee, have rarely received any treatment. Malgaigne[4] mentions a case of infraspinous dislocation of the shoulder in a girl sixteen years old, treated by Gaillard by traction; the head of the humerus was brought to the glenoid cavity and finally, after two recurrences of the displacement, retained there.

In a case quoted above, Mitscherlich excised the elbow for the relief of the disability consequent upon a congenital dislocation of the upper end of the radius.

In dislocations of the tibia forward, with extreme hyper-extension of the knee, a complete cure has several times been effected by forcible straightening of the limb and retention for a short time by splints.

[1] Heusner: Centralblatt für Chirurgie, 1884, p. 751.
[2] Margary: quoted in Dict. Encyclopédique des Sciences Méd., art. Hanche, p. 219.
[3] Da Paoli: Centralblatt f. Chirur., 1887, p. 336.
[4] Malgaigne: Des Luxations, p. 569.

CHAPTER X.

SPONTANEOUS DISLOCATIONS.

THESE are dislocations which have occurred without the introduction of a recognizable traumatism. It is generally held that some of the constituent parts of the joint must have previously been so altered by disease as to facilitate the occurrence; but while this preliminary change does doubtless occur in the great majority of cases, yet there is reason to think that spontaneous dislocation may take place without it, through the continuous action of the muscles, when the limb has been long kept in a favorable position. Roser[1] says he has seen, in three cases, spontaneous dislocation of the hip produced by the reflex muscular contractions excited by pressure on the anterior portion of the spinal cord in patients affected with kyphosis and consequent paralysis. The dislocations occurred slowly, without pain or swelling of the region, and without a sign of coxitis.

The term "spontaneous," although not entirely free from objection, is in general use, and is usually preferred to the others that have been proposed, such as *pathological*, *symptomatic*, *inflammatory*, and *consecutive* or *secondary*. Volkmann[2] has classified them according to the primary changes which precede and facilitate their occurrence, as dislocations, 1st, by distention; 2d, by destruction; 3d, by deformity; including in the first those cases in which the joint has become loose through distention of its capsule and ligaments by an effusion within it, as in the eruptive fevers, rheumatic fever, pyæmia, and the puerperal state; in the second those in which the shape of the articular end of the bone has been changed by caries, as in hip-joint disease; and in the third those in which the shape has been changed by non-suppurative disease, as in arthritis deformans. To these may be added a 4th class, seen mainly in adolescents, in which the shape or growth of the bones has been so modified by the effects of pressure, muscular effort, or gravity that a permanent displacement takes place; and a 5th, "paralytic" or "myopathic," in which the dislocation is made possible by paralysis of some or all of the articular muscles, and is somtimes effected by the contraction of those which have not been paralyzed.

Although the propriety of applying the term dislocation to a change in the relations of two bones whose corresponding articular portions have already been destroyed has been questioned, and although the change of place does not come within the definition of dislocation previously given, and although the condition has but little in common with traumatic dislocations, either in symptoms or in treatment, yet the term has been

[1] Roser: Centralblatt f. Chirurgie, 1885, p. 569.
[2] Volkmann: Pitha and Billroth's Chirurgie, vol. ii. part 2, p. 658.

almost universally accepted and retained in preference to the proposed substitutes.

In all these varieties the immediate cause of the dislocation is the action of gravity or muscular contraction.

Dislocations by distention (Volkmann).—Concerning the pathology of this class but little is known by direct examination, because of the lack of autopsies, but the clinical history is well established. The joint by far the most frequently involved is the hip; a few cases have been observed at the shoulder and knee. In the most common form the course of the symptoms is as follows:[1] A patient is attacked by febrile articular rheumatism or acute mono-articular arthritis; the pain is great, the limb assumes a faulty position; after a few days the pain suddenly ceases, and on examination the region of the affected joint is found to present a deformity similar to that which characterizes a traumatic dislocation. If the condition is left without treatment, the inflammation comes to an end without leaving either osteitis or suppuration, but with persisting deformity; if, on the other hand, the dislocation is reduced, the deformity is thereby entirely removed, and in time complete recovery is obtained.

In other cases the dislocation takes place in the course of some of the eruptive fevers or other febrile condition, sometimes without previous notable pain in the joint and without the knowledge, at the time, of the patient. William Keen[2] collected forty-three cases of arthritis occurring as a complication of typhoid fever, in thirty of which dislocation took place, twenty-seven times at the hip, twice at the shoulder, and once at the knee.

It thus appears that these dislocations resemble those that are traumatic by their sudden occurrence, the absence of any lesion of the bones, and the possibility of immediate and permanent reduction with complete restoration of function.

The following cases taken from Verneuil's paper will show the details.

Obs. II. (loc. cit., p. 783). A young and healthy woman was attacked in 1845 by acute articular rheumatism after exposure to cold; the pain was severe, especially in the right hip, but she was at first able to walk, although with a marked limp. At the end of the second week the pain in the hip suddenly ceased almost entirely, and recovery was thought to be at hand. A few days later she left the bed, but limped so badly that she could scarcely take a step without crutches. Some time later Verneuil was led to examine the hip, and was astonished to find marked deformity of the region with displacement of the head of the femur. The dislocation was not reduced, and when the patient was last examined, ten years later, the head of the femur could be still more distinctly felt in the external iliac fossa thinly covered by the atrophied gluteal muscles.

Obs. I. (loc. cit., p. 782). A healthy girl, ten years old, had typhoid fever in July, 1883. During convalescence an attack of generalized rheumatism (or pseudo-rheumatism) occurred, ultimately localizing itself in the left foot and hip, with great pain, high fever, and considerable swelling of

[1] Verneuil, in Bull. de la Soc. de Chirurgie. 1883, p. 781.
[2] Keen: Toner Lectures, Smithsonian Institute, April, 1875.

the affected joints; very faulty attitude of the limbs and pelvis. On the 11th or 12th day the pains suddenly ceased, and the child, which until that time had remained lying on the right side with the body and all the joints of the lower limbs flexed, was able to sit up in bed and allowed an examination. This examination revealed considerable shortening of the left lower extremity. Verneuil, called in consultation, easily recognized a dislocation of the femur upon the dorsum of the ilium. On the 6th day after that in which the dislocation was presumed to have occurred, chloroform was given, the diagnosis confirmed, reduction easily made, and the child placed in a Bonnet gutter. At the end of another fortnight all swelling and sensitiveness had disappeared, and a complete recovery was effected.

Obs. VIII. (loc. cit., p. 787). A healthy young girl was attacked by very acute, generalized, articular rheumatism; both knees were affected, the left more than the right. Since flexion of the leg upon the thigh was the attitude that gave most relief, it was maintained by means of a large cushion placed transversely under the leg. One morning marked deformity of one of the knees was noticed, consisting in a subluxation characterized by considerable prominence of the femoral condyles and patella, and displacement of the head of the tibia upward and backward. There was also flexion of the joint at a right angle, marked tumefaction, great sensitiveness to pressure, tension of the skin, etc. The other knee was a little swollen and contained some liquid, but had preserved its form.

The patient declared that the displacement occurred suddenly during the preceding night, after a sudden start and energetic muscular contraction.

Verneuil recognized the tension of the flexor muscles, which contracted sharply at the slightest attempt to straighten the limb. He gave chloroform and easily reduced the displacement, noticing at the same time that all the femoro-tibial ligaments were very notably relaxed. The limb was placed in a splint in a position of almost complete extension, and afterward in an immovable dressing. The patient left the hospital cured of the rheumatism but walking with hesitation because of the weakness of the limb, although the knee had regained its natural size and shape.

The presence of a large effusion in the joint and the elongation of the ligaments have been assumed by all observers, and the actual presence of an effusion of some amount has been demonstrated in some of the exceptional cases, knee and shoulder, where such demonstration was possible. On the supposition of this effusion and of the relaxation of the ligaments produced by it, the production of the dislocation has been explained. Verneuil has further called attention especially to the unopposed contraction of certain muscles as the immediate cause. Some post-mortem observations have shown great distention of the capsule of the hip-joint in some cases (six ounces in Lerinser's case[1]), and great elongation of the ligamentum teres in others (Stanley,[2] Hutton), but the latter may well have been the effect of the dislocation rather than its cause, and it does

[1] Quoted by Volkmann, loc. cit.
[2] Stanley: Med. Chirurg. Trans., vol. 24, p. 123.

not appear in the histories that the dislocations occurred in the manner now in question. Theoretically speaking, a rapid effusion within the joint should serve rather to hold the bones more firmly together by making the capsule tense, unless the latter is loose enough to circumscribe a sphere whose diameter is greater than the distance between the fixed points of the capsule on the two bones, and it does not appear that this is the case in all positions of the hip-joint. Relaxation of the capsule and ligaments would then, on this theory, be a necessary preliminary to the dislocation.

Bonnet and Parise showed that by forcible injection of liquid into the cavity of the hip the articular surfaces could be separated for a distance of from three to six millimetres, one-eighth to one-quarter inch. The details of these experiments are not before me, but it seems probable that the separation existed only when the limb was flexed and the Y ligament thereby relaxed, for, according to Tillaux,[1] who repeated Parise's experiments, the injection causes the limb to become flexed. The flexed position relaxes the Y ligament, and if the capsule is filled with liquid the head of the femur can leave the cotyloid cavity without creating a vacuum, for the liquid takes its place, and thus a great obstacle to dislocation, atmospheric pressure, is removed. If it is remembered that these dislocations are always backward upon the dorsum of the ilium, and are preceded by the long maintenance of the limb in the position of flexion, adduction, and inward rotation which so greatly favors the occurrence of this dislocation, and that the muscles are stimulated to contraction by the pain of the arthritis, it does not appear improbable that this contraction is not only the immediate but also the preponderant cause of the accident, and that the arthritis favors it not by overstretching the ligaments but only by supplying an amount of liquid that removes the obstacle created by atmospheric pressure. These two conditions, pain and effusion, would explain why the dislocation does not also occur in the course of adynamic diseases in which the limb often remains for a long time in the flexed position.

Certainly the theory of the production of the dislocation by simple overdistention is incompatible with the easy reduction and maintenance of the reduction noted in several cases. It was unfortunate for some of the patients that their surgeons held to this theory, and were logical enough to refrain from attempting reduction and to leave the patients permanently crippled.

A few cases have been observed in which an acute purulent arthritis has been followed by dislocation; but in such cases it is always possible that the capsule has been in part destroyed by the suppuration.

Paralytic or "myopathic" dislocations, which are included by Krönlein in the preceding class, are observed especially at the shoulder. The humerus is held up and kept in contact with the glenoid cavity by the tonicity of the attached muscles, and when this tonicity fails the weight of the limb causes separation of the bones and subluxation or complete dislocation. The cavity of the joint, thus enlarged, is filled by

[1] Tillaux: Anatomie topographique, p. 1082.

an effusion, but this effusion is the consequence of the separation rather than a favoring, precedent, and causative condition, for it is presumably drawn from the surrounding tissues by suction, just as œdema appears under a dry cup.

At the hip they are produced by the unopposed contraction to those muscles which have not been paralyzed. In Roser's three cases of spinal caries, mentioned above, the dislocation was dorsal, and the immediate cause was the contraction of the adductors no longer opposed by the pelvi-trochanteric muscles. The opposite form, dislocation upon the pubis, due to paralysis of the adductors and the consequently unopposed contraction of the muscles on the outer side and back of the hip, has been reported by Bradford[1] and Reclus.[2]

Another variety may be mentioned, in which by the unequal growth of parallel bones, the tibia and fibula or the radius and ulna, one of them is slowly dislocated.

Voluntary dislocations, those which the individual can produce and reduce at will, may be mentioned in connection with this class. Those in which the peculiarity has originated in a previous traumatic dislocation are due to rupture of some of the ligaments or attached muscles and have been described among the consequences of traumatic dislocations; but a number of cases have been recorded in which this cause could not be invoked in explanation. (See Chapter II.) The only case I have seen was a man about thirty years of age who, a few years ago, frequented the medical schools of New York and added to his income by exhibiting his peculiar power before the classes.

Dislocations by destruction and *Dislocations by deformity* are of less practical interest to the surgeon because less amenable to treatment, and are to be regarded rather as incidents in, or symptoms of, other diseases than as morbid entities.

In the former, *dislocations by destruction*, Volkmann included those dislocations which occur in the course of chronic fungous or carious disease of joints or as a consequence of acute traumatic suppurative arthritis. Frequent examples are seen at the hip and knee.

In consequence of the destruction of the articular ligaments or of the bones themselves an abnormal mobility is created which allows the bones readily to be displaced by the action of gravity or by muscular contraction. At the hip this displacement is usually upward and backward; at the knee the well-known subluxation of the tibia backward or upward is produced by the contraction of the hamstring muscles, or, if the patient lies long upon one side and the destruction is well advanced, the displacement may be lateral to the distance of an inch or even more.

In the latter, *dislocations by deformity*, Volkmann included the dislocations which occur in the course of such affections as the *morbus coxæ senilis* and in the arthropathies of nervous origin, "Charcot's disease," in which the articular ends of the bones disappear by absorption without suppuration.

The remaining form has been specially studied, so far as I know, only

[1] Bradford: Boston Med. and Surg. Journal, 1883, vol. 108, p. 73.
[2] Reclus: Revue de Méd. et de chir., 1878, p. 176.

by Madelung,[1] and only at the wrist; the dislocation was always of the carpus forward, and was accompanied by marked changes in the shape of the radius of the bones of the first row of the carpus. The cause appeared to be overexertion, or, rather, prolonged and frequently repeated exertion in patients who, presumably, were predisposed to the change by defective vitality of the bones. Volkmann includes such cases under the general head of *disturbances of growth of joints*, loc. cit., p. 692.

[1] Madelung: Deutsche Gesellschaft für Chirurgie, 1878, p. 259, and Arch. für klin. chir., vol. 23.

PART III.

SPECIAL DISLOCATIONS.

CHAPTER XI.

DISLOCATIONS OF THE LOWER JAW.

Dislocations of the lower jaw are infrequent, constituting about four per cent. of all dislocations, according to Table III., Chapter I. They may be *bilateral* or *unilateral*, the former being the more common, in the proportion of about 5 to 2 according to Malgaigne, who found 54 bilateral in a total of 76 cases which he collected. Of these 54, 31 were in women, and this greater frequency in the female sex is universally recognized. The injury is rare in infancy and old age because, it is thought, the rami of the bone are not so nearly at right angles with its body as in adult life. It has been observed in patients eighteen and seventy-two years old, and has been caused in the newborn child by obstetric manipulations.

In the great majority of cases the dislocation is forward, the condyle of the jaw passing in front of the articular eminence at the root of the zygoma. A few instances have been reported of double or single dislocation backward with fracture of the wall separating the articular cavity from the external auditory meatus, of dislocation upward into the cavity of the cranium, and of unilateral dislocation outward with, or perhaps without, fracture of the body of the jaw. These are, however, entirely exceptional and may be briefly described before proceeding to the consideration of the common form.

Dislocation backward with fracture of the posterior wall of the articular cavity is caused by great violence received upon the chin and acting from before backward. One or both condyles may be driven through the wall into the external auditory canal, breaking the bone and lacerating or pushing backward the outer cartilaginous portion. The production of the lesion is probably easier when the molar teeth are lacking from the upper or lower jaw, or if the mouth is partly open when the blow is received. The symptoms are pain in, and bleeding from, the ear, immobility of the jaw, the mouth being held partly open, and displacement backward, as shown by the relations of the front teeth to each other. The absence of the condyle from its normal position can be recognized by the touch, and the auditory canal is seen to be obstructed by the displacement of its anterior wall.

A case described by Croker King[1] as one of dislocation backward and outward of one condyle was probably such as above described. The patient was a boy eight years old, the lower incisor teeth were one inch behind the upper, the left lower molars just outside the upper ones, and the chin deviated to the left. The reporter accounts for the supposed unilateral dislocation on the left side by the springiness of the jaw in the median line, but as this springiness was not detected until after he had inferred that some such condition ought to exist to explain the production of the dislocation, as no mention is made of recognition of the position of the condyle, and as the boy bled from the ear immediately after the accident, it seems probable that the dislocation was backward through at least the outer part of the auditory canal.

Le Fèvre[2] reported an interesting and very exceptional case in which the injury was caused by a fall from the second story of a building, the blow being received upon the chin. The jaw was displaced slightly backward and to the left, the teeth were close together, and the mouth could not be opened. Slight bleeding from the left ear. The diagnosis of fracture of the condyle was made. The patient was dismissed in the fourth week still experiencing difficulty in mastication and deglutition. Subsequently he suffered from violent headache, had several attacks of convulsions, and died about six months after the receipt of the injury. The autopsy showed that the roof of the glenoid cavity had been fractured, the condyle had passed into the cranium between the fragments, the neck of the condyle was in part destroyed, the dura mater was extensively inflamed and thickened, and there was a large abscess in the middle lobe of the brain.

Robert[3] received at the hôpital Beaujon a patient who had been injured by the passage of the wheel of a cart across the right side of his face. The chin was deviated to the right, and the mouth was held open. The left condyle of the lower jaw could be distinctly felt under the skin above the root of the zygoma. Greatly surprised at this displacement Robert sought for and found a vertical fracture of the body of the bone on the right side just in front of the ramus. The left coracoid process remained under the temporal fossa, the sigmoid notch crossing and embracing the zygoma. Reduction was made by pressing the left ramus outward until the condyle was freed from its contact with the upper surface of the zygoma, and then drawing it downward and inward to its place.

Neis[4] had an opportunity to observe a case in which the left condyle was dislocated in the same manner upward and outward, but apparently without fracture either of the jaw or of the temporal bone. The patient was a lad sixteen years old who received the injury by having his head caught between two boats, the pressure being upon the chin and occiput. The lower teeth were displaced backward, the mouth could not be opened, and there was slight oozing of blood from the left ear. Thirteen days

[1] King: Monthly Journal of Medicine, 1855, p. 265.
[2] Le Fèvre: Journal Hebdomadaire, 1834, vol. 3, p. 333.
[3] Robert: Archives générales de Méd. 1845, vol. 7, p. 44.
[4] Neis: Luxation du Maxillaire inf. en haut ou dans la fosse temporale. Thèse de Paris, 1879, No. 252.

after the accident, when he first came under observation, he was still unable to open the mouth or take solid food. The lower incisor teeth were nearly half an inch behind the upper ones, the jaws could be only slightly separated and could not be brought entirely together. The left condyle could be seen and felt above and in front of the auditory canal in the temporal fossa; it moved with the jaw; there was slight deafness on that side, and a small blood-clot in the canal. No fracture could be found. Reduction was effected with difficulty under chloroform by forcing wooden wedges between the molars. Neis thought the dislocation could be accounted for by the peculiar shape of the face and jaw, the face being short and broad, the chin flat, and the rami of the jaw very divergent upward.

Several other interesting cases are quoted in Neis's thesis.

Dislocation of the jaw forward, the common form, is usually caused by muscular action, as in laughing, scolding, yawning, or vomiting, or exceptionally by violence in widely opening the mouth to introduce some large object, such as an apple or the fist, or in drawing a tooth, or by a blow upon the jaw. Morris[1] reported a case in which dislocation took place during sleep, the patient being a girl fifteen years old who had long had the habit of sucking her thumb.

In order to understand this mechanism it is necessary to recall the construction and normal action of the joint. The lower jaw is attached to the skull by a synovial capsule which is strong on its outer side (the external lateral ligament), by an internal lateral ligament not in immediate relations with the joint but extending from the spinous process of the sphenoid bone to the margin of the inferior dental foramen, and by the stylo-maxillary ligament, a strong band extending from the styloid process of the temporal bone to the posterior border of the ramus of the jaw. The joint is occupied by an interarticular cartilage or meniscus which overlies the upper surface of the condyle and accompanies it in its normal movement forward from the glenoid cavity to the eminentia articularis when the mouth is opened. In front of the point to which the condyle thus moves forward the surface of the eminentia articularis is inclined slightly upward to become continuous with the much narrower under surface of the zygoma. The fibres of the muscles attached to the ramus which close the mouth run upward and forward, and only those belonging to the deep posterior portion of the masseter are vertical or inclined backward.

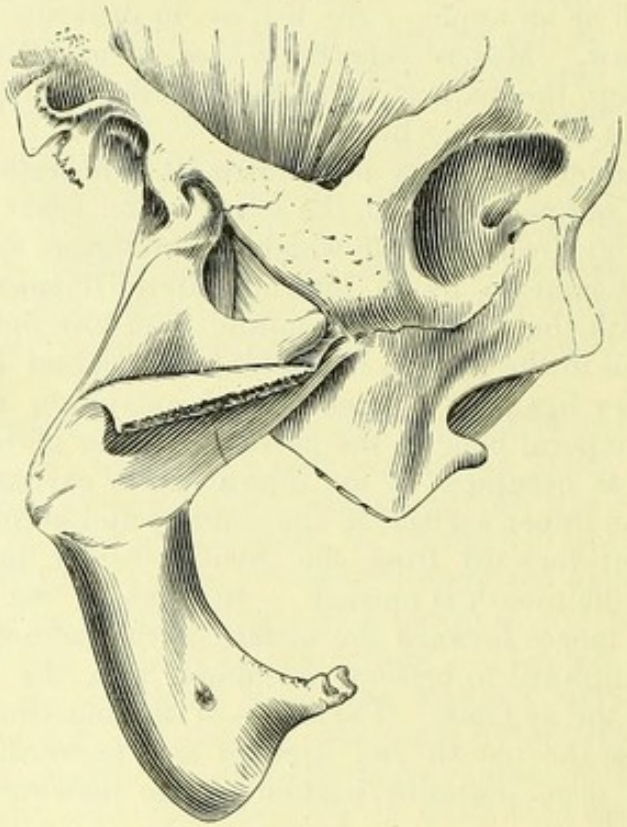
Since the condyle moves forward when the chin descends, the centre of motion of the jaw is not in the condyle, but at a point below it at or near the dental foramen, and as the angle of the jaw is at the same time moved backward the axis of the ramus changes its relations to the direction of the fibres of the masseter much more than it would if the centre of motion was in the joint, and it may become so far inclined forward that the posterior fibres of this muscle lie behind it in such a position that their contraction would tend still further to raise the angle of the jaw and thrust the condyle forward, thus exaggerating the effect of the action of the external pterygoid, which is to draw the condyle forward

[1] Morris: British Medical Journal, 1872, II., p. 242.

upon the articular eminence. Still, as the masseter is relaxed in opening the mouth, the contraction of these fibres cannot be invoked as a cause of dislocation, although it was offered by Petit in explanation of the fixity of the dislocated jaw; but the cause, when muscular, is rather to be found in the excessive action of the external pterygoid, aided by relaxation of the external lateral ligament, which latter condition is produced by the wide opening of the mouth, as will be explained more fully in the following section.

Pathology.—The opportunities directly to examine cases of dislocation of the jaw have been very few, and experiments upon the cadaver cannot entirely take their place, but it appears to be established that Malgaigne's opinion that the condyle did not advance more than one or two millimetres beyond the point on the articular eminence which it normally reaches is not correct, but that the advance is considerably greater. In

FIG. 17.



Nélaton's specimen of dislocation of the lower jaw in which the coronoid process was caught below the malar bone. (MALGAIGNE.)

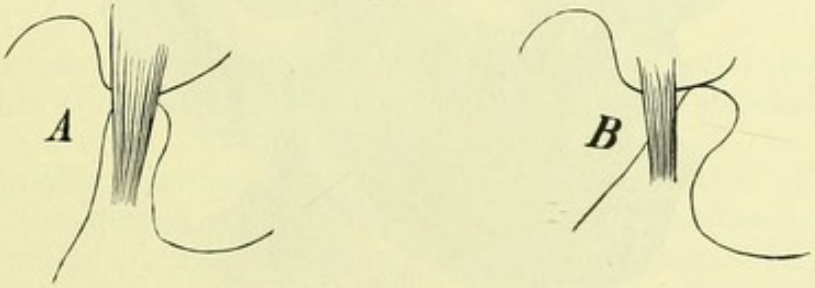
an autopsy made by Demarquay in a case of recurrent dislocation the condyle was displaced four centimetres forward from the glenoid cavity and was in front of the transverse part of the zygoma; the interarticular disk was behind it. It also appears that the rupture of the capsule, when it occurs, takes place in front between the meniscus and the condyle, but sometimes the meniscus accompanies the condyle without rupture of the capsule. This makes the persistence of the dislocation, and especially the fixation of the jaw, difficult to explain. The earliest theory, that of Petit above referred to, the contraction of the posterior fibres of the masseter, is generally rejected as inadequate. Another, also advanced by

the earlier writers and recently brought forward again by Nélaton and accepted by Malgaigne, and supported by at least one specimen, which is figured in Malgaigne's *Atlas*, Plate 17, Fig. 1 (Fig. 17), is that the coronoid process becomes engaged under the malar bone. That this may be an occasional adjuvant cause must be admitted on the facts presented, but that it is not the sole cause, and probably not even a frequent one, is proved by experiments upon the cadaver which have shown the fixation to persist after removal of the coronoid process, and by the fact that in Nélaton's specimen the process is unusually long.

The slightly upward inclination of the anterior surface of the eminentia articularis against which the displaced condyle rests is not of itself sufficient, and the most recent theory, suggested by Demarquay[1] and thoroughly studied by Mathieu,[2] that the return of the condyle is opposed by the meniscus beyond which it has passed, seems to be open to the objections that the meniscus is so freely movable backward that it would be readily pushed back into the glenoid cavity by the returning condyle, and that in some cases it accompanies the condyle in its excursion. An autopsy reported by Perier[3] of a case of recurrent dislocation showed absence of the anterior portion of the meniscus and lodgement of the remainder behind the condyle after reduction. It proves, therefore, not that the meniscus is the cause of the fixation, but that it may prevent complete reduction.

The cause must be found, I think, in the ligaments, the external lateral and perhaps the posterior portion of the capsule, and this opinion is supported by the tenseness of the lateral ligament observed by Weber[4] and Maisonneuve[5] upon the cadaver, and by the anatomical relations of the parts. The mechanism of its action I conceive to be as follows: The

FIG. 18.



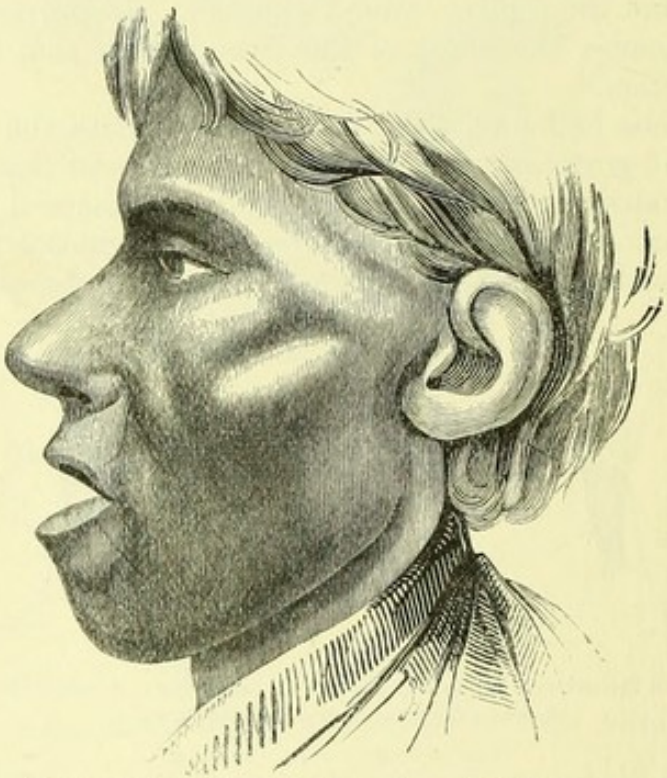
Diagrammatic of the external lateral ligament of the lower jaw. *A*, when the mouth is open. *B*, when the condyle is dislocated forward.

external lateral ligament, forming the anterior part of the outer portion of the capsule, extends from the articular eminence downward and backward to the neck of the condyle, its attachment to the eminence being posterior to the point at which the under surface of the latter begins to incline upward. This ligament (Fig. 18) is too short to allow the jaw to take such a position when the condyle is dislocated forward that the long

[1] Demarquay: Bull. de la Soc. de Chirurgie, 1863, vol. iv. p. 119.
[2] Mathieu: Arch. gén. de Méd., 1868, ii. p. 129.
[3] Perier: Bull. de la Soc. de Chir., 1878, p. 222.
[4] Weber: Handbuch de Allg. and Spec. Chir., vol. iii. Abt. 1. p. 288.
[5] Maisonneuve: Comptes rendus, Acad. des Sciences, 1862, p. 654.

axis of the neck shall coincide with that of the ligament. When the mouth is widely opened the ligament is relaxed by the approximation of its points of attachment, and the condyle passes forward; then, as the mouth is partly closed, the ligament becomes tense before the condyle has moved back past it, and thus its further movement backward is prevented, and while it remains thus displaced any force that tends to close the mouth increases the obstacle to replacement by making the ligament more tense and pressing the bones more firmly together. Such a force is naturally and constantly exerted by the powerful muscles of mastication, stimulated to contraction as they are by their forcible elongation and the pain and anxiety of the patient. The practical inference to be drawn from this explanation, if it is correct, is that reduction should be sought, not by crowding the body of the jaw downward and backward by pressure upon the molar teeth, but by first depressing the chin if possible, opening the mouth wider, so as to relax the ligament, and then pressing the condyle backward and closing the mouth as it passes the articular eminence on its way back.

FIG. 19.



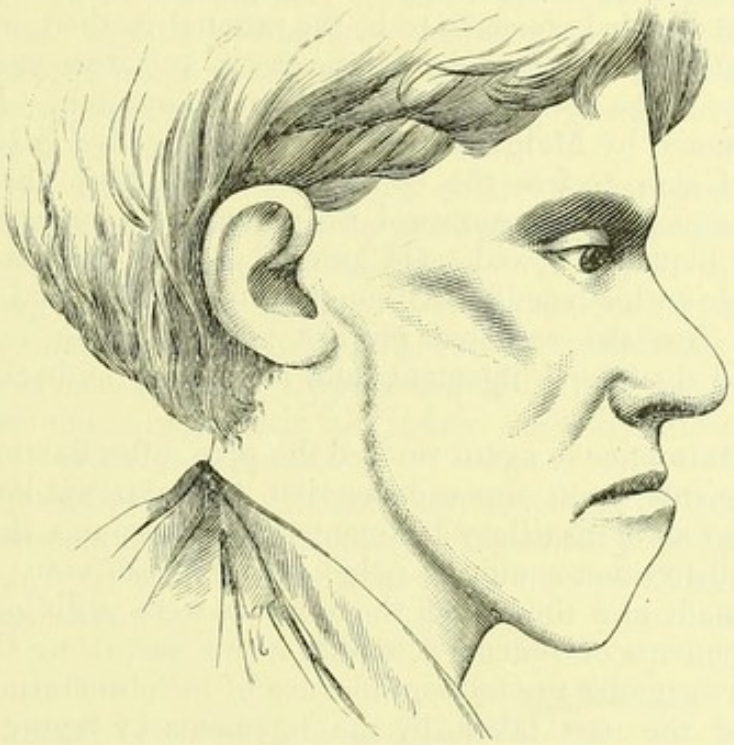
Bilateral dislocation of the lower jaw. (R. W. SMITH.)

The *symptoms* of bilateral dislocation forward are that the mouth is held open, the lower jaw immovable and projected somewhat forward; exceptionally, only the projection is present, and the mouth can be closed.[1] Speech is indistinct, swallowing difficult, and chewing impossible. The condyle can be felt in the temporal fossa in advance of its

[1] Some authors say that not only is the jaw protruded, but its angle is nearer the sterno-cleido-mastoid, a combination which cannot be explained, except by flexion of the head upon the neck. It seems more probable that it is an error of observation.

usual position; there is a prominence above the zygoma due to the raising of the posterior fibres of the temporal muscle, and a depression marking the empty glenoid cavity can be felt in front of the ear. The cheeks are flattened, and the saliva escapes from the mouth. The masseter and temporal muscles are usually tense, and the upper anterior portion of the former raised by the coronoid process.

FIG. 20.



Dislocation of the jaw of long standing. (R. W. SMITH.)

If the dislocation is unilateral the physical signs are found upon only one side, the chin is turned to the opposite side, and the functional disability is less.

The *prognosis* is favorable both as regards the reduction of the dislocation and the degree of disability if it remains unreduced, but somewhat unfavorable in that recurrence is quite probable. If it remains unreduced the parts appear slowly to adjust themselves to their new relations and finally to permit more or less satisfactory approximation of the jaws and restoration of the functions.

Treatment.—The dislocation is one which, as a rule, can be easily reduced, one indeed in which, as has been already said, reduction has often occurred spontaneously. The methods employed have, perhaps in consequence of this fact, been numerous, and have varied greatly in the objects aimed at, if not in the actual mechanism by which they have accomplished the reduction. It can be shown, I think, that many of the methods and procedures have been successful not because they met the ideas of their originators concerning the obstacle to be overcome, but because they overcame or avoided another obstacle which had not been recognized. With few exceptions the aim of the different methods has been directly to depress the condyle and then to press it backward, and

this aim has been accomplished by direct pressure downward upon the molars, or indirectly by raising the chin after having placed a wedge between the back teeth. Those who found the obstacle in the hooking of the coronoid process under the malar bone sought to disengage the process by opening the mouth more widely, and then pressed the jaw backward; while others, again, pressed the bone directly backward by placing the thumb and forefinger of one hand against the coronoid processes and then elevated the chin by a slight blow upon it from beneath. It is noteworthy that some of the gentlest methods, some which approach most closely to that which I conceive to be the rational method, were employed by the earliest surgeons, even by Hippocrates, and were again and again resumed only to be as often neglected and forgotten. Hippocrates's method, as quoted by Malgaigne, was to lower the chin a little in order, according to Galen, to free the coronoid process from the malar bone, and then to press the jaw backward, the patient being meanwhile encouraged to relax his muscles and yield himself as completely as possible to the effort made in his behalf. Although the intention and the supposed effect was to free the coronoid process, yet the wider opening of the mouth relaxed the lateral ligaments and facilitated the backward propulsion.

In 1862 Maisonneuve again revived the plan, after having observed in many experiments upon the cadaver that the external lateral, sphenomaxillary, and stylo-maxillary ligaments were tense and that after their division the dislocation could be reduced with great ease. His experiments were made at a time when the muscles were still looked upon as the great opponents of reduction, and it is not surprising that he should have failed to recognize the full significance of his observations and should have obscured the part taken by the ligaments by laying equal if not greater stress upon the action of the muscles. He ascribed the fixation to the pressure of the condyle against the zygoma, a pressure "maintained by the combination of the passive resistance of the ligaments and the energetic contraction of the elevator muscles," and proposed to reduce by direct backward propulsion after diminishing the pressure by opening the mouth more widely. His proposal, notwithstanding his high authority, does not appear to have been favorably received, possibly because the manœuvre which would diminish the tension of the ligaments would at the same time increase that of the muscles and thus leave the pressure as great as it was before, and his views, when mentioned by subsequent writers, are classed with those which attribute the obstacle to the contraction of the muscles.

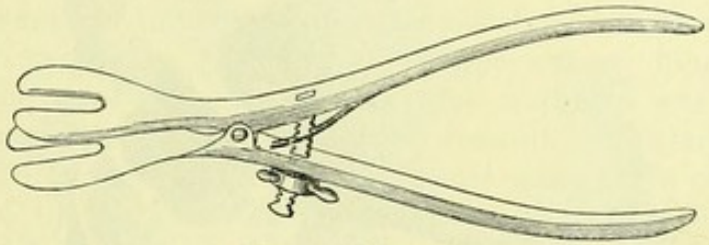
It is unquestionable that in this, as in most other dislocations, the obstacles to reduction are multiple, and that contraction of the muscles is one of them, and that it especially opposes reduction because it directly resists the attempt to place the bones in the most favorable position. It is also true that methods of reduction are habitually successful which are not based upon correct anatomical principles, but nevertheless those principles exist and are the same as in other dislocations; the opposing ligaments must be relaxed, and the bone should follow in returning to its socket the route by which it escaped from it. In the great majority of cases, as has been said, dislocation takes place while the mouth is widely

open and the ramus is inclined upward and forward. Theoretically, then, the same position should be given to it as a preliminary to reduction, and although the opposition of the muscles may create practical difficulties in the way of accomplishing this which will prevent its universal use and cause other methods to be preferred in the simple cases, yet in all difficult cases and whenever this opposition has been annulled by anæsthesia this method should be employed, the mouth should be widely opened and the jaw should be pressed backward, or backward and slightly downward. This pressure may be conveniently made by the thumbs placed inside or outside the mouth against the anterior edges of the ascending rami, the head of the patient being solidly supported behind. Possibly the expedient of reducing each side separately would prove as advantageous in this method as it has in others.

In the method by forcible depression of the posterior portion of the jaw the thumbs may be used alone by placing them upon the lower molar teeth and pressing downward and backward. It is well to guard them against bruising by covering them with cloths or leather, and when the reduction is accomplished they should be rapidly withdrawn or slipped to the outer side of the teeth to escape being bitten, an accident that has happened to several surgeons and has indeed been the cause which led to the invention of other procedures.

Instead of direct pressure with the thumbs, wedges of wood have been used, as have also hinged instruments, taking their bearings upon both sets of molars. Of the latter, Stromeyer's forceps (Fig. 21) are the simplest and best known.

FIG. 21.



Stromeyer's forceps.

In cases of long standing in which adhesions have formed and must be ruptured before reduction can be made, these forcible measures are necessary, for the jaw cannot otherwise be moved through a range sufficient to accomplish the object. Reduction has been obtained as late as the ninety-eighth day after the occurrence of the dislocation.

Mazzoni treated an irreducible bilateral dislocation of eight months' standing in a woman twenty-seven years old by excision of both condyles, with an excellent functional result.

After reduction the mouth should be kept closed by a bandage and the patient fed on soft food for two or three weeks. It is not unlikely that the marked tendency to recurrence so commonly observed is the result of inopportune use of the jaw, perhaps also, in part, of the favorite method of reduction which tends to elongate or rupture the lateral ligaments.

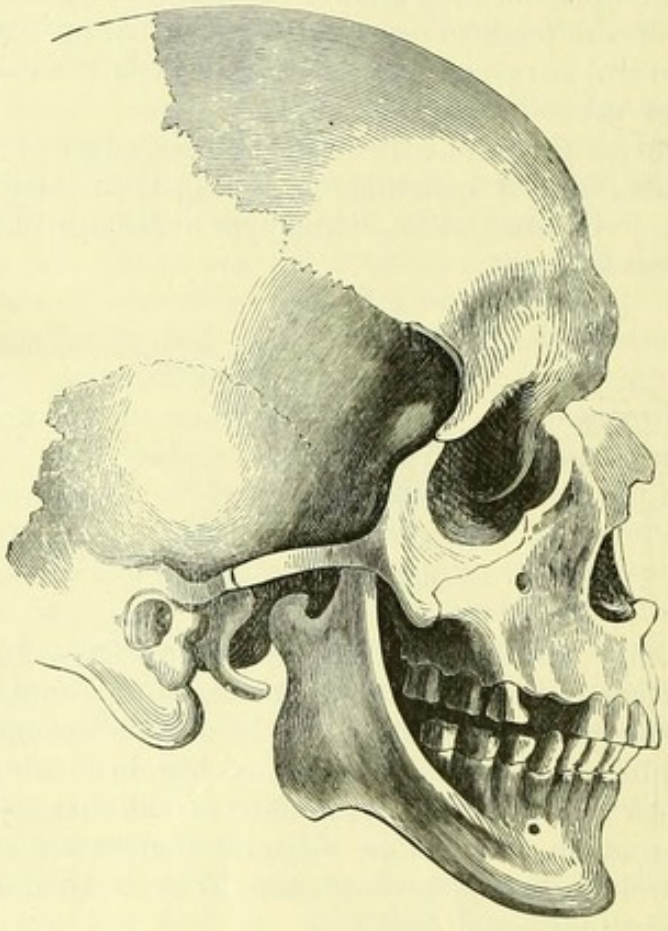
Genzmer[1] has proposed to treat the tendency to recurrence by injec-

[1] Genzmer: Centralblatt für chirurgie, 1883, p. 563.

tions of pure tincture of iodine into the joint, a method which he has successfully employed in the similar condition at the shoulder. The joint is sought in front of the tragus of the ear at the lower border of the zygoma, and the injection should be repeated several times at intervals of three or four days. It does not appear from the abstract of the paper in which the method is set forth whether it has been employed at the jaw or not.

Annandale[1] has recently treated two cases successfully by opening the joint and suturing the meniscus to the periosteum. "An incision, slightly curved, about three-quarters of an inch in length, is made over the posterior margin of the external lateral ligament of the joint, and is carried down to its capsule. Any small bleeding vessels having been secured, the capsule is divided, and the interarticular cartilage is seized, drawn into position, and secured to the periosteum and other tissues at the outer margin of the articulation by a catgut suture."

FIG. 22.



Congenital dislocation of the lower jaw. (R. W. SMITH.)

Pathological or consecutive dislocations are uncommon, and only in a few cases[2] has the condyle, eroded and deformed by antecedent inflamma-

[1] Annandale: Lancet, 1887, I. p. 411.
[2] Gurlt: Path. Anat. der Gelenkkrankheiten, p. 109, Cases 5, 11, 15.

tion, been found outside its cavity and sometimes united by bony union to the skull.

Congenital Dislocations.—The only example of this condition of which I have found mention, if a fœtal monster reported by Guérin be excepted, is one described by R. W. Smith[1] (Fig. 22). The patient was a congenital idiot who died at the age of thirty-eight years. The dislocation existed upon the right side and was the result of defective development of the constituent parts of the joint. "When the mouth was closed the external lateral ligament of the lower jaw, instead of being directed backward, was seen descending obliquely forward, to be attached to a very imperfectly developed condyle, which was not in contact with that portion of the temporal bone which, in the natural state, corresponds to the glenoid cavity, being separated from it by an interval of at least a quarter of an inch. There was neither an interarticulate cartilage nor cartilage of incrustation, the osseous surfaces of the joint being invested by thick periosteum alone."

"The right side of the inferior maxillary bone was considerably smaller than the left, the atrophy extending nearly to the symphysis and affecting the bone as to its length, breadth, and thickness, the ramus being half an inch less in its transverse diameter, and its parotideal margin half an inch shorter than upon the opposite side. . . . The parotideal margin, thin, concave at its upper part, and forming nearly a right angle with the body of the bone, terminated above in a small curved process directed nearly horizontally inward. . . . This process, which in form somewhat resembled the coracoid process of the scapula, was the only vestige of the existence of a condyle, and was destitute of cartilage."

"The deformity of the temporal bone consisted in an arrest of development of the zygomatic process. The superior or longitudinal root existed, but the transverse root or articular eminence was absent, there being in its place merely a flat surface destitute of cartilage. At the point where the two roots meet in the normal state, or, in other words, at the tubercle of the zygoma, the temporal was joined to the malar bone, the suture which connected them being distant only half an inch from the circumference of the external auditory canal, while upon the opposite side the interval was one inch and a half."

The right superior maxilla and right half of the sphenoid were also smaller than those of the left side.

[1] R. W. Smith: Fractures and Dislocations, p. 273.

CHAPTER XII.

DISLOCATIONS OF THE VERTEBRÆ AND OF THE OCCIPUT FROM THE ATLAS.

The study of dislocations of the vertebræ is closely associated with that of fractures of the same bones, because in many cases the differential diagnosis between a fracture and a dislocation cannot by made with certainty, and because the associated lesions and consequences are the same. For some of the latter, therefore, the reader is referred to the chapter on Fractures of the Vertebræ.

Concerning the frequency of dislocations of the vertebræ widely different opinions have been held; some (Delpech) denying even the possibility of dislocation without fracture, others thinking them extremely rare, and others, again, claiming that they are quite common. The most notable member of the last group is Porta, who, according to Blasius, observed no less than twenty-seven cases in thirty years. By far the most valuable contribution to the settlement of this question, and indeed to the whole subject, is the monograph of Blasius,[1] who collected 294 reported cases, of which 185 were dislocations, 37 diastases, and in 72 it remained undetermined to which of these two classes the lesion belonged. Although an autopsical examination was made in 174, yet in 38 of these the account is so defective that the variety and seat of the injury cannot be determined; and in only 172 of the 294 cases can these details be said to have been established. By far the most common seat is the cervical region, then the dorsal, and last the lumbar region, in which only a very few cases have been observed.

This difference in the frequency of occurrence in the several regions has been habitually referred to alleged corresponding differences in their normal mobility; but the explanation is somewhat lacking in precision. The mobility of the different parts of the spinal column, as described by Weber,[2] and most later anatomists, is as follows: Antero-posterior flexion and extension is slight, or almost absent, between the second and third cervical vertebræ, is most marked from there to the fifth or seventh, is less between the sixth and seventh, and still less between the seventh and the first dorsal. It is very slight between the upper seven dorsal, somewhat greater in the lower ones, and very distinct between the last two dorsal and the first two lumbar, and between the fourth and fifth lumbar and the fifth lumbar and the sacrum. Lateral mobility is greatest in the first six cervical, less between the seventh cervical and the first dorsal, very slight in the first six or seven dorsal, and then usually increases downward through the lumbar region. Rotation is most marked in the

[1] Blasius: Die traumatische Wirbelverrenkungen, in Vierteljahrschrift für prakt. Heilkünde, 1869, vols. cii. ciii.

[2] Meckel's Archiv für Anat. und Physiol., 1827, p. 240.

cervical, is slight in the upper dorsal, becomes again very marked from the eighth to the eleventh dorsal, is then less to the first lumbar, and is practically absent in the remaining lumbar vertebræ. It appears, therefore, that while the greatly preponderating frequency of dislocations of the cervical vertebræ corresponds with greater normal mobility of that region, yet dislocations of the less movable dorsal are much more frequent than those of the more movable lumbar vertebræ.

Blasius gives the following table of the actual frequency at different ages:

TABLE VII.—DISLOCATIONS OF THE VERTEBRÆ.

Age.	Cases.		Age.	Cases.	
	Certain.	Doubtful.		Certain.	Doubtful.
1 to 5 years . . .	1	3	41 to 50 years . . .	14	4
6 " 10 " . . .	6	4	51 " 60 " . . .	6	1
11 " 15 " . . .	9	2	60 ..... " . . .	1	1
16 " 20 " . . .	8	2	"Child"	1	...
21 " 30 " . . .	25	10	"Adult"	9	6
31 " 40 " . . .	18	8			

Of 40 cases collected by Richet,[1] the age in only 11 was more than forty years, and in only 3 more than fifty years. This greater frequency in those of middle life must be referred to the greater exposure to the accidents that are apt to produce the lesion incident to their occupation, an explanation which is corroborated by the much greater frequency of the injury in males than in females: according to Blasius, 4 to 1 in the cervical region, and 12 to 1 in the dorsal.

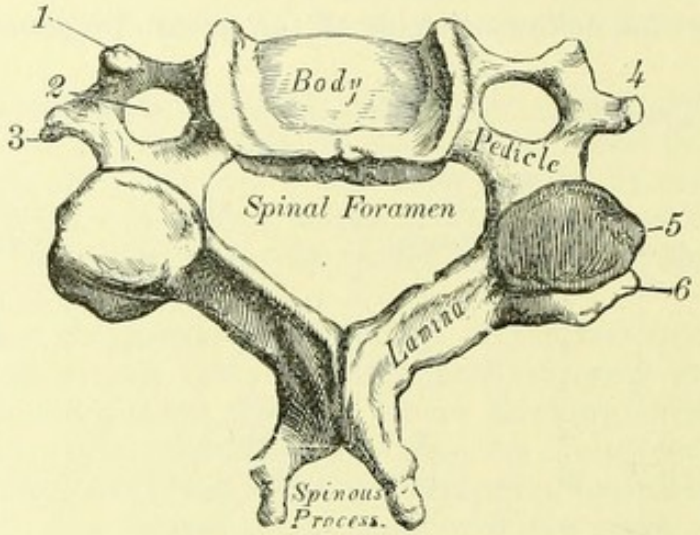
The difference of opinion above mentioned regarding the frequency of the occurrence of the injury in general, doubtless depends in part upon the definitions which the different authors have adopted, since some accept as dislocations only those cases which are not complicated by fracture, while others accept also those in which an associated fracture can be rightly deemed unessential to the production of the dislocation. The latter view is in harmony with the classification of other dislocations, and will be adopted here; a dislocation of a vertebra being defined as an injury in which the adjoining articular processes on one or both sides have been partly or completely separated from each other, with or without avulsion of portions of the body of either vertebra or fracture of one or more processes. The term *diastasis* is applied to those dislocations in which, the intervertebral disks and other ligaments having been torn, the vertebræ are longitudinally separated from each other in front or behind, but have not also been so horizontally displaced that the articular surfaces on either side have been put out of line with each other.

The terminology employed to indicate the seat and variety of the displacement has also varied with the different writers, some speaking of the upper, others of the lower, vertebra as the one that is dislocated,

[1] Richet: Anatomie Médico-Chirurg., p. 247.

while others have sought to avoid misunderstanding, by using such a phrase as "dislocation of the fifth upon the sixth." The latter form can be advantageously employed in the report of cases, or whenever any doubt might arise as to the meaning, but it will be convenient here to follow the more general practice, and speak of the upper vertebra as the

FIG. 23.

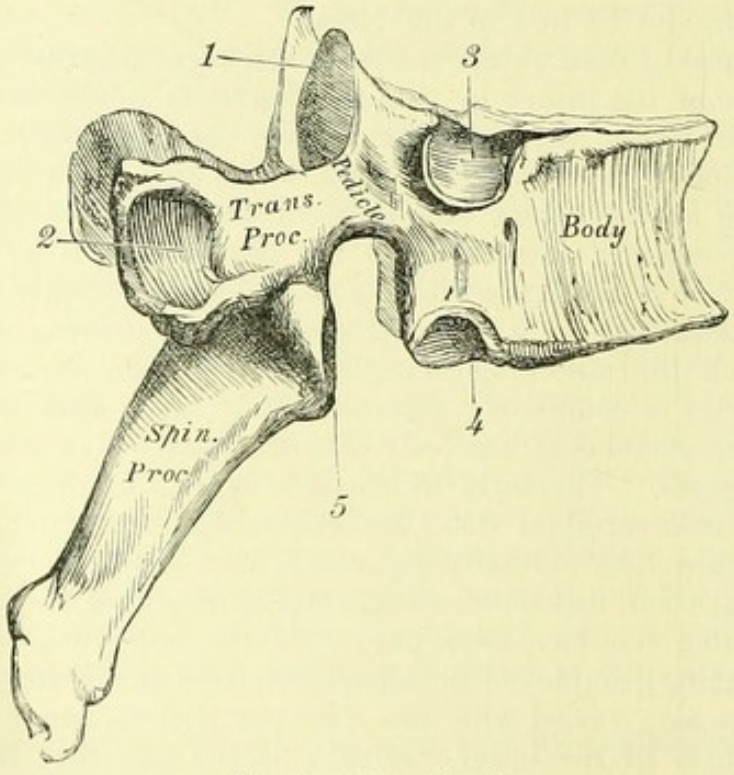


Cervical vertebra. (GRAY.)

1. Anterior tubercle of transverse process. 2. Foramen for vertebral artery. 3. Posterior tubercle of transverse process. 4. Transverse process. 5. Superior articular process. 6. Inferior articular process.

one that is dislocated, and of the direction and character of its displacement, as those of the dislocation.

FIG. 24.



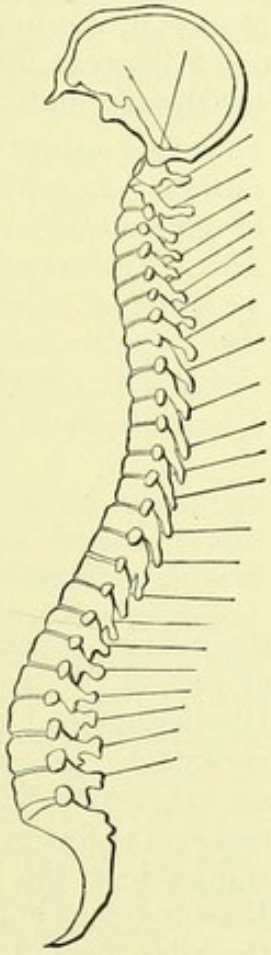
Dorsal vertebra. (GRAY.)

1. Superior articular process. 2. Facet for tubercle of rib. 3. Demi-facet for head of rib. 4. Demi-facet for head of rib. 5. Inferior articular process.

Classification and Pathology.—The relations of the vertebræ to each other are so complex, and the combinations of different directions which the displacements may present are so variable and numerous, that a classification of the varieties based upon these directions is not only very complicated, but it also fails to offer comparative advantages sufficient to compensate for its complexity. The classification made by Hueter, according to the character of the movement or the direction of the force which produces the dislocation, is simple, and at the same time indicates the main features of the displacement and suggests the proper method of reduction. It fails, however, to distinguish between the varieties; and, therefore, while adopting it, it has appeared desirable also to use in connection with it other terms indicative of special features.

The provisions for normal motion between adjoining vertebræ consist in the elasticity and compressibility of the intervertebral disks between the bodies, and in the articulations placed just behind those upon the arches. The normal range of motion, though varying in the different portions of the column, is at best slight, and can be referred in the main to two axes for each pair, one of which lies in the median plane and passes through the centre of the disk from behind forward, with an inclination downward of its anterior end which is slight in the lumbar and lower dorsal regions, more marked in the upper dorsal, and greatest in the cervical regions (Fig. 25). The other axis is a horizontal transverse one, passing through the posterior part of the disk. Motion about the first axis produces a lateral bending of the column, and, in the cases in which the axis is inclined downward and forward, with this motion must be associated a rotation of the upper vertebra, by which the anterior surface of its body is turned to the side toward which the column is inclined; and the greater the inclination of the axis, the more marked is this associated rotation.[1] The movement is arrested by the contact of the margins of the adjoining articular surfaces with their bases on the concave side, and if it persists beyond this point dislocation is produced, the opposite inferior articular surface of the upper vertebra being raised above the one with which it articulates by the lateral bending, and being carried forward by the rotation. To these dislocations Hueter gives the name *dislocations by abduction* or *rotation*.

FIG. 25.



Direction of the median axis in the different sections of the spinal column. (HENKE.)

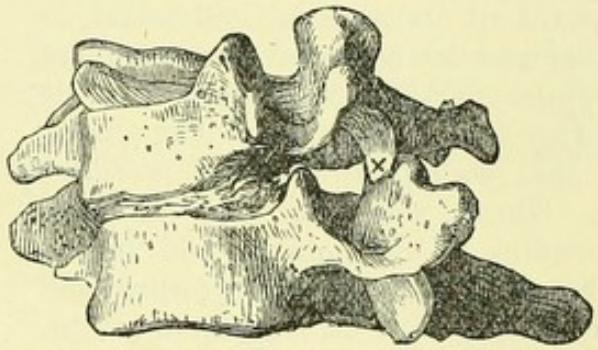
Motion about the other, transverse, axis produces a bending forward (or, to a less degree, backward) of the column, during which the ante-

[1] This normal rotation toward the concave side should not be confounded with the pathological rotation toward the convex side observed in scoliosis; the latter is, in part at least, produced by a progressive asymmetry of the vertebra itself, the shortening of the pedicle upon the convex side.

rior portion of the disk is compressed, the posterior portion stretched, and both inferior articular surfaces of the upper vertebra moved upward and forward along the superior articular surfaces of the underlying vertebra. The movement is checked, when its normal limit is reached, by the ligaments of the joints and arches, and, if these yield, a dislocation is produced, in which the inferior articular processes of the upper vertebra pass forward and in front of those with which they articulate—*dislocation by flexion.*

Under the first head, *dislocations by abduction*, are to be included the complete or incomplete unilateral dislocations forward or backward, and the bilateral dislocations in opposite directions, described as distinct forms under these names by Blasius, all of which, with one exception (the unilateral dislocation backward), represent only different degrees of the same displacement. Instead of being entirely separated from each other, the articular surfaces may remain in contact at their edges (incomplete dislocation). If the displacement is somewhat greater, the inferior process of the upper vertebra passes further forward, and sinks into the notch between the body and the superior articular process of the lower vertebra (complete unilateral dislocation) (Fig. 26), and at the same time

FIG. 26.



Complete unilateral dislocation by rotation or abduction; cervical vertebra. (KÖNIG.)

the inferior process on the opposite side may be carried backward by the movement of rotation (bilateral dislocation in opposite directions). Blasius quotes four cases in which the latter variety was observed and verified by post-mortem examination; the dislocated vertebræ were the second, fourth, and fifth cervical, and the eleventh dorsal, and the dislocation was forward on the left side in the first three, and forward on the right side in the last one. The unilateral dislocation backward, of which Blasius refers to a few examples exclusive of those of the occiput upon the atlas, may, I think, be attributed to the same mechanism, the displacement being effected in consequence of the yielding of the ligaments of the joint on the side toward which the body is bent, instead of on the opposite side as in the other cases. In a case observed by Cloquet, and briefly mentioned by Blasius, the second lumbar vertebra was dislocated in this manner, the dislocation being complicated, but unessentially, by fracture of the body and arch of the vertebra; all the processes were uninjured. The patient survived several years, and the condition of the parts was determined by autopsical examination. Under the second head, *dislocations by flexion*, are included bilateral dislocations forward

or backward. The force continuing to act after the normal limit of forward flexion of the column has been reached, the ligamenta subflava are ruptured, and the posterior portion of the intervertebral disk is torn or separated from the vertebra with or without avulsion of a portion of the bone, the articular processes of the upper vertebra lodge in front of those of the lower in the notches. Sometimes the processes do not pass entirely beyond each other, but remain in contact at their extremities; and sometimes, the movement being accompanied by slight rotation of the vertebræ upon each other, one articular process is displaced further forward than the other. The lumen of the vertebral canal may be seriously encroached upon in this dislocation, and its contents injured by compression against the upper edge of the body of the lower vertebra.

The mechanism of the double dislocation backward, of which a few cases have been accurately observed, has not been demonstrated, but the possibility of its production by extreme dorsal flexion of the column is such that it may, provisionally at least, be placed in this class. Its comparative rarity is to be explained by the infrequency with which the trunk is exposed to this movement, and by the greater resistance to dislocation which arises from the relations of the bones. The motion is arrested by bony contact at the arches, and by the intervertebral disks, the efficiency of whose resistance is increased by their greater distance from the fulcrum about which the rupturing movement must turn. It is interesting to note that in a case reported by Stanley,[1] dislocation backward of the fifth cervical vertebra, the upper five vertebræ were firmly united together by bony fusion. The displacement was so great that the body of the fifth rested upon the laminæ and spinous processes of the sixth. The additional leverage created by this ankylosis may be invoked as an argument in favor of the theory of production by dorsal flexion.

Transverse dislocation has been diagnosticated in several cases, but the only one in which sufficient anatomical proof has been obtained is one mentioned by Charles Bell.[2] A child was run over by a stage coach and died of croup thirteen months later. The last dorsal vertebra was found completely displaced to the left side of the first lumbar with slight chipping of the bone. The articulation between these vertebræ is of such a character that this form of dislocation would seem impossible without fracture of the articular processes, and probably it may still properly be deemed so except in a child. The same anatomical conditions exist in the lumbar vertebræ, but in the dorsal and cervical regions the articular surfaces look backward and forward or are only slightly inclined to one side, consequently this form of dislocation must then be regarded as possible.

In the greater part of the dorsal region it would necessarily be associated with dislocation of the vertebral end of the corresponding rib.

Bell's case and another involving the same vertebra reported by Mohrenheim are quoted by Blasius but rejected on the ground that the primary dislocation was probably bilateral backward or forward, and the transverse displacement secondary. There is nothing in the original report of Bell's case to warrant this assumption, which must therefore rest on

[1] Stanley: Edinburgh Med. and Surg. Journ., October, 1841, p. 404.
[2] Bell: Injuries to the Spine and Thigh Bone, 1824, p. 25.

theoretical considerations alone. In all the clinical cases quoted by Blasius, with one exception, the cervical vertebræ were concerned, and he says that the correctness of the diagnosis is very doubtful in all.

The main groups and varieties, then, are as follows:

Dislocations by flexion, ventral or dorsal.
- Bilateral forward.
- Bilateral backward.

Dislocations by abduction or rotation.
- Unilateral forward } complete or
- Unilateral backward } incomplete.
- Bilateral in opposite directions.
- Transverse (?).

The *associated lesions* comprise rupture of the various ligaments, muscles, bloodvessels, and nerves, fracture of the bones, and injuries of the spinal cord and its membranes, and those later changes which may be induced by the primary ones.

The *intervertebral disk* is always ruptured or torn away from one or the other vertebra, and this rupture or separation is almost invariably complete, the exceptions having been found in a few of the slighter forms or in diastasis. The line of separation may run entirely within the substance of the disk or between it and the body of the vertebra, but usually it combines the two forms and is accompanied by the avulsion of larger or smaller fragments of the bone. In one or two cases the disk appears to have been crushed.

The *capsular ligament*, on one or both sides according to the character of the displacement, is always torn. The *anterior* and *posterior ligaments* are either torn, wholly or in part, or stripped from their attachments to the bodies of the vertebræ, sometimes bringing with them in the latter case portions of the bone. The *ligaments* between the *laminæ* and the *spinous processes* are either torn or put upon the stretch, and those between the *transverse processes* were torn in the only reported case found by Blasius in which their condition was mentioned. Instead of rupture of the ligaments *fracture* of the processes to which they are attached may occur, and various other fractures of the adjoining processes or of more distant parts are frequently observed.

The surrounding and the attached *muscles* may be torn by the displacement or by the direct action upon them of the dislocating violence.

Bloodvessels.—The veins coming from the bodies of the vertebræ and those of the meninges of the cord are so large and their relations with the bones and ligaments are so close that hemorrhage is always free and sometimes very profuse. In Robert's case[1] of backward dislocation of the fifth dorsal vertebra the blood escaped into the mediastinum and through the torn pleura into the pleural cavities; in it also, as in many others, the adjoining muscles were extensively infiltrated with blood.

In dislocations of the cervical vertebræ the vertebral arteries so commonly escape injury that the possibility of their rupture has been denied, but in a case received into St. Thomas's Hospital[2] the vertebral artery

[1] Robert: Bull. de la Soc. de Chirurgie, September 21, 1853.
[2] Med. Chirurg. Rev., 1831, vol. 14 (18 of analyt. series), p. 227.

was found to have been torn and a large amount of blood to have escaped into the vertebral canal and among the muscles. Blasius admits this case into his list although all the processes of the fourth vertebra were broken.

The *nerve trunks* at their point of emergence through the intervertebral foramina may be compressed or torn on one or both sides between the articular process of one vertebra and the body or pedicle of the other; and in the lumbar or lower dorsal regions the nerves constituting the cauda equina have repeatedly been found torn across or compressed between the body and laminæ of the adjoining vertebræ.

The *spinal cord and its membranes* may entirely escape injury, and, if injured, the lesion may present any grade between simple compression and complete rupture. The injury may be caused by pressure of the bone against the cord or by the direct elongation of the latter. All the lining membranes may be torn, entirely across or only in part, or one of them alone may be ruptured. Their rupture is necessarily accompanied by the extravasation of blood, usually profuse, between the dura and the bone and amid the meninges. Occasionally an extravasation of blood has been found within the cord itself; thus, in a case reported by Martini,[1] one of diastasis between the fourth and fifth cervical vertebræ, in which there was complete rupture of all the ligaments and separation to such an extent that the finger could be passed between the bones, the meninges were not torn, and the only lesion found in the cord was a clot three centimetres long in its centre and involving also the cortical substance. A similar case has recently been reported by Quénu.[2] It is worthy of note that in three reported cases[3] in which extensive paralysis was present the autopsy failed to show any lesion of the cord, and that in others there has appeared to be no fixed relation between the extent of the paralyses and the anatomical lesions found in the cord. In other cases the cord has been found torn while the ligaments have been only slightly injured; in one[4] of slight diastasis between the sixth and seventh cervical vertebræ produced by hanging, the pedunculi cerebri were found completely torn across.

The analysis made by Blasius to determine the relative frequency and severity of injury to the cord in the different forms and at the different seats of dislocation shows that the danger is greatest in dislocation of the lower cervical vertebræ, the fifth and especially the sixth, although even there the cord may entirely escape injury. In the variety which he terms "unilateral forward" (dislocation by abduction or rotation) the danger is less than in the "bilateral forward" or "backward" (disocation by flexion); in 7 autopsies the cord was found injured in 6, and of 45 cases observed clinically, all of the neck, in 9 there was evidence of injury or compression of the cord, which disappeared in 5 and was followed in 4 by inflammatory and softening processes in the cord. The variety which

[1] Martini: Schmidt's Jahrbücher, 1861, vol. 110, p. 195.

[2] Quénu: Le Progrès Médical, Feb. 27, 1887.

[3] Colborne: Provinc. Med. and Surg. Journ., vol. 2, p. 50; Hafner: Zeitschrift für Wundärzte und Geburtshelfer, 1856, vol. 9, p. 249; and Porta: Della lussazioni della vertebre, 1864, quoted by Blasius.

[4] Guérin: Gazette Médicale, 1853, p. 275.

he terms "bilateral in opposite directions" appears particularly free from this danger; in the few cases he collected paralysis was exceptional and temporary. Of 8 cases of bilateral dislocation backward examined post-mortem, the cord was uninjured in 2, and more or less severely injured in 6; of 6 clinical cases, in 3 there was no paralysis, and in 3 the paralysis was temporary. Of 52 cases of bilateral dislocation forward, the cord was uninjured in 17, and was injured seriously and irreparably in 11; in the remaining 24, either recovery followed or a distinction cannot be made between the effects of the mechanical violence inflicted upon the cord by the dislocation and those of the later inflammatory and nutritive changes. It must be remembered that in most of the clinical cases our knowledge of the exact character of the lesion of the skeleton is defective.

Blasius (loc. cit., p. 130) summarizes the analysis as follows: in no form of dislocation is injury of the spinal cord a necessary consequence; such injury is less to be expected in unilateral dislocation, and in unilateral dislocation forward of the cervical vertebræ it is always, or almost always, only a simple compression without crushing; in bilateral dislocation backward or forward, either of the dorsal or cervical vertebræ, the cord is exposed to more serious lesions and seldom escapes entirely uninjured, and when the displacement is forward the cord is mechanically affected in most cases, but the cases of severe injury are fewer than those in which all injury is escaped; finally, the danger is least in bilateral dislocation in opposite directions.

Secondary changes.—When the patients survive for a sufficient length of time the signs of a more or less acute inflammatory reaction appear. There is reason to believe that this reaction in the meninges and cord is not so frequent or severe as that which follows injury to the skull, but yet in a number of cases pus has been found in the meninges and even in the centre of the cord itself, as in a case mentioned in a paper by Coliny,[1] one of diastasis between the seventh cervical and first dorsal vertebræ with rupture of the ligaments of the articular processes, in which the cord at the level of the diastasis was found almost diffluent and containing in its centre a small focus of greenish-brown pus, which extended up to the level of the fourth cervical vertebra. The cord may be slightly softened and changed in color, or it may be reduced to pulp, and this change may involve only the portion corresponding to the dislocated vertebra or it may extend to a greater or less distance above and below, as in a case reported by Bryant[2] of dislocation of the eleventh dorsal vertebra in which it involved the entire length of the cord below the fourth dorsal. It is probable also that other changes observed after fracture of the vertebræ, such as extensive suppuration within the pia and the substitution of fibrous tissue for the nervous elements of the cord, may take place, for the conditions are practically the same.

The intervertebral disk seems habitually to disappear by softening and absorption; and the ligaments undergo changes similar to those observed in other ligaments—that is, their torn portions reunite by cicatricial tissue or they contract new attachments in the evolution of the process of

[1] Coliny: Archives Gén. de Méd., 1836, 2d ser., vol. 10, p. 200.
[2] Bryant: Guy's Hosp. Rep., 1859, vol. 5, p. 80, case 45.

repair, and they may even become ossified. The tendency of the reparative process to end in suppuration, which has been observed to be exceptionally marked after fracture of the vertebræ, has been manifested also after dislocation, although possibly only in cases complicated by fracture. In some of the reported cases it seems probable that the suppuration was primary (caries of the body of a vertebra), and that the dislocation was the consequence of the changes produced by it in the bones and the ligaments.

Etiology.—The causes have been habitually described as direct and indirect violence and muscular action, and to these Blasius adds "counter-stroke," as in a fall upon the buttocks with the trunk strongly flexed. The distinction between direct and indirect violence is made by classifying under the latter those cases in which the force has acted upon the column at some distance from the point of dislocation to bend it in one or another direction, and under the former those in which the force has acted directly upon the dislocated vertebra. But the mechanism—in most, if not in all cases—is certainly the same; the column is forcibly bent, and the dislocation is produced by this forcible bending, just as a rod may be bent or broken by grasping and approximating its two ends with or without the aid of direct pressure against its centre. It seems highly probable also that in the cases attributed to "counter-stroke" the mechanism is the same; the motion of the lower part of the column is arrested by impact against the ground, while the upper portion continues its descent, and thus the flexion is increased to the necessary degree, exactly as if the column had been bent by a force applied to its upper portion. In the cases of dislocation by muscular action the cervical vertebræ alone have been involved, and the movement has been that of exaggerated rotation.

Symptoms and Diagnosis.—Most of the symptoms of dislocation are the same as those of fracture of the vertebræ. There is usually the same history of violence acting upon the spinal column, either directly or indirectly, to bend it beyond the limit of its normal range of motion, localized pain increased by movement or manipulation, inability to stand, partial or complete paralysis below the point of injury, diminution or exaggeration of the normal mobility of the affected part with or without reflex muscular rigidity of the upper segment of the column, and deformity recognizable by sight or touch. The symptoms which are thought to be of most service in establishing the differential diagnosis between these two injuries are crepitation and abnormal mobility at the point of injury in fracture, and their absence in dislocation. Unfortunately, crepitation is not always obtainable in fracture by such manipulations as are permissible, and it may be present in dislocation accompanied by fracture—that is, in a condition in which the dislocation is the important injury, and the fracture a comparatively unimportant addition. Rigidity of the column at the injured point is common but not constant in dislocation, and it may be caused in fracture, or even in contusion or sprain, by muscular contraction. But while a positive differential diagnosis may not often be possible, a probable diagnosis may frequently be made, at least when the injury is in the cervical region, by attention to the attitude and rigidity of the neck, by recognition of the change in the relations of the transverse processes, or of the bodies of the vertebræ so far as they

are accessible to examination in the pharynx, or of the lower spinous processes, and by the impossibility of correcting the displacement by lateral pressure.

On the other hand, muscular contraction and pain due simply to bruising of muscles or nerves or to inflammation of the vertebral joints may produce an attitude and rigidity closely resembling those of dislocation.

The *deformity* consists in displacement of the spinous or transverse processes forward or backward or to one side, and is to be recognized by palpation. The displacement of the transverse processes, unless very great, can be recognized by touch only in the neck, that of the spinous processes everywhere except in the upper cervical region unless the patient is very fat. The body of the displaced vertebra is accessible to examination only in the pharynx and occasionally, as in a case reported by Dupuytren, by deep pressure through the anterior abdominal wall.

Pain, although sometimes absent, is commonly present, and is provoked or increased by movements of the body or by direct pressure upon the injured region. It has its origin in the bruising or laceration of the adjoining soft parts and in pressure upon the nerves within the canal or at their point of exit through the intervertebral foramina. In some cases it is referred only to the point of injury, in others it is radiated along the course and over the region of distribution of the affected nerves.

Paralysis, entirely absent in some cases, may be partial or complete within the affected region; usually the two sides of the body are similarly affected (paraplegia), and limitation to a lateral half of the body (hemiplegia) is unknown except where the paralysis has been only partial. Motor paralysis is, as a rule, more marked and extensive than sensory paralysis, and in a few cases the autopsy has shown anatomical differences in the extent of the injury to the different portions of the spinal cord corresponding to the differences in the extent of the motor and sensory paralyses observed during life. As a rule, paralysis of either kind is less marked in dislocation than in fracture.

Paralysis is observed in the muscles of the column adjoining the point of injury (and this fact has been offered in explanation of the exaggerated mobility sometimes observed), in some or all of the parts of the body below the point of injury, and occasionally in those lying above it. This last mentioned extension is to be explained by mechanical injury to the cord at a higher point than the dislocation, as by over-stretching in diastasis, or by extravasation of blood, or by the extension of inflammatory processes set up by the injury.

Instead of paralysis, or in association with it, may be observed muscular contractions, neuralgic pains, and hyperæsthesia, presumably dependent upon inflammatory changes in the cord and meninges. In a few cases there have been general convulsions, promptly followed by death, and in one,[1] diastasis between the seventh cervical and first dorsal vertebræ, convulsions appeared at the end of the first week and were followed in rapid succession by trismus, renewed convulsions, mania, and finally, after

[1] Charles Bell: Inj. to the Spine and Thigh Bone, 1824, p. 9.

disappearance of the former symptoms, by motor paralysis of the extremities.

The implications of the muscles of the trunk in the paralysis may have the most serious consequences, since it deprives the patient of control over the escape of urine and feces and of their voluntary evacuation, and also of the power of bringing into action the accessory muscles of expiration. If the injury is situated at a high point the action of all the muscles of inspiration except the diaphragm may be abolished, and if it is situated at or above the third cervical the latter muscle also may be paralyzed and the patient immediately dies asphyxiated.

In addition to these symptoms of injury of the cerebro-spinal nerves and centres are others of widely different character and involving many different tissues and organs, which, as Hutchinson[1] has pointed out in a valuable and very interesting paper, may be referred to changes in the sympathetic, especially the vaso-motor system. Thus, sudden rises of temperature, general or local and of longer or shorter duration, may be observed, sometimes associated with pallor of the surface or with marked pulsation in the arteries. If the injury is in the cervical region the heart-beat becomes slow but does not also show the intermissions that commonly accompany the slow pulse of injury to the brain.

Immobility of one or both pupils, with a slight degree of contraction, has been noted; in other cases immobility with dilatation.

Priapism frequently accompanies injury of the lower cervical and upper and middle dorsal regions when it is sufficient to cause paraplegia. Blasius found it most frequent in dislocations of the lower four cervical vertebræ, once in dislocation of the occiput from the atlas, only once in dislocations of the dorsal vertebræ (twelfth), and in none of the lumbar dislocations. Hutchinson says it is constant and well marked in dislocations of the upper and middle dorsal regions, but, as Blasius points out, this statement is too broad and is not borne out by the statistics. Its frequency, compared with all cases in males, was found by Blasius to be 1 to 5 at the fourth cervical, 1 to 3.6 at the fifth, 1 to 2.7 at the sixth, and 1 to 2.5 at the seventh. He adds that it was present in fourteen out of twenty-five cases of fracture of the sixth cervical vertebra. The condition of the member appears, however, not to be that of normal physiological erection, but rather of simple engorgement, the member remaining comparatively flaccid although swollen. In a few cases the priapism has been provoked only by the additional application of a local irritant, as the passage of a catheter.

The rapid formation of bedsores has also been attributed to vaso-motor or trophic changes, but while it is possible that such changes may act as a predisposing cause, yet the immediate, determining cause appears to be rather the prolonged, unrelieved pressure to which the parts are subjected in consequence of the paralysis. (See Fractures, p. 273.)

The occurrence of cystitis and ammoniacal decomposition of the urine within the bladder has also been explained in the same manner, but it seems rather to be the consequence of over-distention of the bladder and of the use of the catheter. The later consequences of this cystitis are

[1] Hutchinson: London Hospital Report, 1866, vol. 3, p. 357.

extremely serious and may hasten, or be the immediate cause of death. (See Fractures, p. 272.)

Injury to or change in the vaso-motor nerves has been thought to be the cause also of changes sometimes observed in the lungs. In two cases elsewhere mentioned[1] I have known fracture of the cervical vertebræ to be followed by expectoration of blood coming from the lungs, and Blasius (following Moritz) describes a pulmonary congestion appearing promptly, marked at first by increased secretion, and rapidly causing death by œdema of the lungs, usually on the second or third day.

Prognosis.—The injury is commonly deemed, and with good reason, one that places the life of the patient in great danger. Of the cases collected by Blasius the termination is noted in 278, and of these the injury caused death in 176 and was more or less completely recovered from in 102. These statistics, however, cannot properly be taken to indicate the actual percentage of mortality in such cases, because they are made up not from integral records but from published cases, and, as is well known, cases that survive are more frequently published than those that terminate fatally. Furthermore, as Blasius points out, the diagnosis is by no means certain in all of the recoveries, and in some of the fatal cases death may have been due to associated injuries. From these 278 cases Blasius took 159 in which the diagnosis was certain; of these 36 recovered and 123 died, a proportion of 22.6 per cent. of recoveries, or 1 in 4.4, which corresponds quite closely with that established by Gurlt, 19.6 per cent., for fractures of the vertebræ (see Fractures, p. 254). It is well worthy of note, also, that of these 36 recoveries the dislocation was completely reduced in 27 and partly reduced in 2, and that all these 29 and 5 of the remaining 7 were dislocations of the cervical vertebræ.

In the fatal cases death usually followed promptly upon the receipt of the injury. Of 113 authentic cases 21 died within the first twenty-four hours, 31 on the second and third days, 17 between the fourth and seventh days, 14 in the second week, 5 in the third, 6 in the fourth, 3 in the fifth, 2 in the sixth week, and the remainder at periods varying from two and a half to five months. Death, especially in the cases in which it occurs promptly, is usually the consequence of the injury to the cord or of the inflammatory processes set up in it by the injury; but when this injury is situated in the lower portion of the cord life may be indefinitely prolonged, as in the case quoted above from Charles Bell, in which by complete lateral dislocation of the twelfth dorsal vertebra the cord was completely divided, and the patient, a child, died of croup thirteen months later. Simple compression of the cord involves less danger to life than its complete or partial division or crushing, and relief of the compression may be followed by restoration of function. If the compression takes place gradually, even to a very marked degree and at the upper end of the cord, as in several reported cases of cervical spinal caries, prolongation of life is still possible, and even marked and permanent compression at the level of the atlas and axis has, in two reported cases, not proved

[1] Fractures, p, 262.

immediately fatal. In one[1] of these, dislocation of the atlas forward from both the occiput and the axis with fracture of the odontoid process, the canal was reduced to a triangular slit two millimetres wide on one side and five on the other; the patient survived five months, being completely paralyzed during most of the time. In the other case,[2] incomplete dislocation of the occiput from the atlas due to caries, the patient survived three months and died of tubercle of the brain.

If the dislocation remains unreduced the irregularities in the form and function of the column of course persist, and the irritation of the traumatism may lead to such ossification of the ligaments and bony ankylosis of adjoining vertebræ as will still further diminish the mobility of the column and increase the chance of the occurrence of fracture, as in a case mentioned by Ollivier d'Angers.[3]

If the dislocation is reduced the symptoms usually disappear promptly, but the paralysis may persist in whole or in part, and the case may even terminate fatally in consequence of the injury done to the cord or its envelopes.

Treatment.—This must be directed to the reduction of the dislocation, the prevention of its recurrence, and if reduction is impossible to the relief of the consequences of the displacement. The propriety of attempting reduction has been earnestly questioned, and many judicious surgeons have recommended that the attempt should be abstained from because of the possibility that it may add to the injury of the cord. Some (Nélaton) have suggested that the attempt should not be made unless the injury or its consequences have already placed the patient's life in imminent danger; while others (Porta) have sought to restrict the attempt to those cases in which the cord has not been injured and the existing dislocation can be borne without serious trouble or disability. The reason for the last advice probably lay in the belief that if the cord were already so injured by the traumatism as to give rise to noteworthy symptoms no good could be expected from reduction, a belief that is not in harmony with observed facts. The postponement of reduction until after the appearance of later symptoms due to the persistence of the irritating conditions is as unwise, as fatal, as similar temporization in the treatment of fractures of the skull. If anything is to be done it should be done promptly, and yet it must be added that reduction has been successfully made in several cases as late as the eighth or ninth day after the accident, and in one after the lapse of two months, and was followed by the prompt or gradual disappearance of the paralysis.

The attempt to discriminate, with reference to the question of attempting reduction, between cases in which the paralysis is due to simple compression of the cord and those in which it is due to its laceration or the effusion of blood within the canal is impracticable because of the impossibility of making a positive differential diagnosis between those conditions.

The possibility that the attempt may cause the instant death of the

[1] Costes: Schmidt's Jahrbuch, vol. 79, p. 208.
[2] Darriste: Bull. de la Soc. Anatomique, 1838, vol. 13, p. 144.
[3] Traité des Maladies de la Moelle épinière, 3d ed. vol. 1, p. 276.

patient, especially when the dislocation is in the upper part of the cervical spine, is a weighty factor in the problem but should not, in my judgment, deter the surgeon if the patient or his friends accept the risk. It should only stimulate him to make the most accurate possible diagnosis as regards the seat, direction, and mode of production of the dislocation, and most cautiously to select and execute the necessary manœuvres. The urgency of the symptoms may leave him but scant time for observation and reflection, and the history of the case may throw no light upon the mode of production, so that the general rule to return the dislocated part along the path by which it escaped from its position cannot be knowingly and deliberately followed. Under such circumstances the surgeon must trust to traction aided by such flexion and rotation of the column as his best scrutiny of the displacement and knowledge of the relations of the articular processes may suggest. Anæsthesia should be employed unless contraindicated by the condition of the heart or respiration.

The return of the bone to its place is usually indicated by a distinct sound, and the rigidity which is usually present gives place to normal mobility.

If the dislocation is comparatively slight, moderate lateral pressure may effect reduction, as in a remarkable case reported to Blasius[1] by Richter. A lad, eleven or twelve years old, consulted Richter because of deformity and stiffness of the neck caused by a fall. He found the spinous process of the third cervical vertebra slightly displaced to one side, and that pressure upon it caused pain. No paralysis. An attempt to reduce the dislocation by traction on the head failed, and the child was sent home to await another attempt. On the way, the child, who had heard and comprehended the diagnosis, stopped by a wall, leaned his head and shoulder against it, and pressed forcibly with his thumb against the opposite, convex side of his neck, and instantly reduced the dislocation. The story was confirmed by the child's companions, and the surgeon found at his visit the neck straight, normally movable, and free from pain.

In another case quoted by Blasius a dislocation of the third cervical vertebra had remained unreduced in spite of several attempts; on the ninth day the patient fell out of bed, and reduction took place with an audible snap.

After reduction has been made no other retentive measures than rest in bed are ordinarily required, but if there is reason to fear recurrence the parts may be immobilized by gypsum bandages or padded wire splints that embrace the entire trunk if the injury is situated below the shoulders, and the head and chest if it is in the cervical region.

If reduction cannot be made immobilization is still necessary to favor the formation of firm adhesions and the solidification of the bones in their new relations; and in addition measures may be needed to combat the inflammatory processes set up by the traumatism and to meet the indications of other symptoms. Of the latter the most urgent is the acute hyperæmia of the lungs that has occasionally been observed, and this is most promptly and satisfactorily met by free venesection. The

[1] Blasius: Loc. cit., vol. 104, p. 114.

necessity of attention to the urinary bladder must not be overlooked, and although Hutchinson, in the paper above quoted, expresses the opinion that the disadvantages arising from the use of the catheter are greater than those following retention and relief by overflow, the contrary opinion is very generally held. Possibly it would be well to remove the urine by aspiration above the pubes twice a day for the first two or three days rather than by catheterization, in the hope of the early restoration of control. M. D. Harrison[1] speaks highly of the value of permanent antiseptic drainage of the bladder through a perineal incision in the treatment of "fracture-dislocations of the spine." Under its use he has seen not only the cystitis disappear, but also the bedsores heal and the paralysis diminish.

Dislocations of the Occiput and Cervical Vertebræ.

Dislocations are far more frequent in this region than in others, a fact that is to be explained by its greater exposure to dislocating violence, by the anatomical relations which permit greater freedom of motion, and by the relative weakness of the connecting ligaments. The fifth cervical vetebra is the one most frequently dislocated. The anatomical differences between the articulations of the atlas with the occiput and axis and those of the other vertebræ are such that a separate description of the injury at the upper end of this region is necessary.

Dislocations of the Occiput (from the Atlas).

The articulations between the occiput and the condyles of the occipital bone are formed on each side by a long, oval articular surface on the atlas, which is concave both from before backward and from side to side; the long axis of which runs from in front outward and backward and the outer margin of each is higher than the inner margin, so that each articular surface looks upward, inward, and backward, and together they constitute a cup-shaped socket into which the rounded condyles of the occipital bone fit, and upon which they have a motion only of flexion and extension. In addition to the ligaments uniting the two bones there are other and strong ones within the canal which directly unite the posterior surface and apex of the odontoid process with the occipital bone and thus aid in opposing the separation of the atlas from the latter.

The dislocation was formerly deemed quite a common one, and to this opinion succeeded another more in harmony with the anatomical conditions of the joint but still erroneous, namely, that it had never occurred. There are, however, three observations which positively demonstrate the occurrence of the injury, those of Costes,[2] Bouisson,[3] and Milner.[4]

[1] Harrison: Liverpool Med. Chir. Journ., July, 1887.

[2] Costes: Schmidt's Jahrbuch, vol. 79, p. 208, and Malgaigne: Des Luxations, p. 329. Both these accounts are abstracts of the original report in the Journal de Bordeaux, August, 1852, and they differ materially from each other in some points. In the account here given I have in the main followed the former, since Malgaigne's appears to have been taken from an abstract, not from the original paper.

[3] Bouisson: Schmidt's Jahrbuch, vol. 82, p. 216, from Revue Méd. Chirurg. de Paris, vol. 2, p. 355.

[4] Milner: St. Bartholomew Hosp. Rep., vol. 10, p. 314.

In the former a lad fifteen years old was thrown down and beaten upon the back of the neck, by which the atlas was displaced forward from its articulations with both the occipital bone and the axis, and the odontoid process of the latter was broken off. The patient's head remained inclined forward, and movements of the neck were difficult. A few days later hyperæsthesia and paralysis of motion appeared, and persisted, without treatment, for four months; then the right arm and leg became painful and he was taken to the hospital. The pulse was feeble and slightly quickened; at the posterior part of the neck was a firm swelling projecting a little on the right side which subsequently proved to be the posterior part of the axis, and the chin was turned to the left and so depressed as almost to touch the chest. He died thirty-six days after admission to the hospital.

At the autopsy the skull was found dislocated backward from the atlas, the articular surfaces being completely separated on the right side, while on the left the anterior and inner part of the articular surface of the condyle was still in contact with the posterior part of that of the atlas. At the same time the atlas was tilted forward, rotated to the left in front and to the right behind, and displaced forward upon the axis; the odontoid process was broken off at the base and reunited by fibrous tissue in an almost horizontal position with the body of the axis. The posterior arch of the atlas was so closely approximated to the body of the axis that the interval between them was reduced to a triangular slit five mm. wide on the left side and two mm. on the right.

In the second case, Bouisson's, a lad sixteen years old was thrown down upon his face and instantly killed by the fall of a heavily laden cart, the edge of which pressed upon the upper part of the back of his neck. The right condyle of the occipital bone was displaced backward from the corresponding articular surface of the atlas for a distance of two centimetres, with rupture of the capsular ligaments; on the left side the ligaments were torn but the articular surfaces were not displaced from each other. The posterior occipito-atlantoid and the right alar and occipito-odontoid ligaments were torn, and the muscles of the neck were extensively lacerated and contused. A large extravasation of blood extended upward from the spinal canal between the dura mater and cerebellum, and the medulla was greatly compressed but not torn.

In Milner's case a man thirty-eight years old fell from a height of seventy feet and was taken up dead. The head was freely movable, and capable of being so displaced to either side that the top of the spinal column would form a projecting tumor in the neck. There was found "complete dislocation of the occipital bone from the atlas and axis, all the ligaments on both sides which connected them with the occiput were completely torn across." The posterior arch of the atlas was broken off transversely where it joins the lateral masses. The odontoid process was cracked longitudinally, but there was no displacement between the atlas and the axis. The medulla oblongata and the vertebral arteries were divided.

In connection with these may be mentioned several other cases of which the histories are so defective that the exact nature of the lesion remains in doubt. Some of them are given in the article by Bouisson

from which the above account of his case is taken. In three of them, Ludwig, Lassus, and Schneider, there appears to have been at the most a diastasis; the same is all that can be said, and with even less certainty, of Palletta's; and those of Lazaretto, Pyl, and Harrison are worthless because of the lack of anatomical demonstration and even of symptoms upon which a diagnosis could be made. Darriste's case is erroneously quoted from a very brief note in the *Archives Générales;* the original report (quoted above, p. 141) shows that it was a case of caries with subluxation. A case recently reported by Cole[1] of supposed occipito-atlantoid dislocation by muscular action, a sudden turning of the head, followed by reduction and recovery, was, I think, probably a dislocation of one of the lower vertebræ.

The rarity of the occurrence is readily explained by the extent of the articular surfaces, the strength of the ligaments, and the extra-articular checks to the movement of the skull upon the atlas, the effect of which is to cause exaggerated movements of lateral or antero-posterior flexion of the head to be transmitted to the lower vertebræ. In the last of the three cases mentioned above (Milner's) the violence was very great, a fall from a height of seventy feet, and the mode of production of the dislocation is not known; in the other two it was clearly a force acting from behind directly upon the atlas while the head was pressed backward, and in one of them, Bouisson's, the greater extent of the dislocation on one side than on the other was probably due to obliquity of the direction in which the force was exerted.

In respect of the *symptomatology* and *diagnosis* nothing can be added to that found in the histories of these few cases, unless possibly the account given by Celsus may be accepted as having been based upon actual observation. To the sinking of the chin upon the chest, as noticed in Costes's case, he adds difficulty in swallowing and speaking (the former probably due to narrowing of the pharynx), and involuntary emissions. Possibly digital exploration of the pharynx would disclose the change in the relations of the occipital bone and atlas.

If *treatment* is called for, the attempt to reduce should be made by steady traction on the head combined with such coaptative pressure upon it and the vertebræ as would be suggested by the character of the displacement.

Dislocation of the Atlas (from the Axis).

The articulation between the atlas and axis is composed not only of the two lateral articulations as in the other vertebræ, but also of that between the odontoid process and the anterior arch of the atlas. This process, which, genetically, is the separated body of the atlas that has united with the axis, is placed vertically behind the anterior arch of the atlas, and is firmly held in place by the strong transverse ligament of the atlas, by the two alar or cheek ligaments which pass from the base of the process to the occipital bone at the margin of the foramen magnum, and by the vertical band of the transverse ligament, the suspensory

[1] Cole: New York Medical Record, March 15, 1884.

ligament, and the posterior occipito-axial ligament which overlies the others.

Dislocation forward or backward is possible only after fracture of the odontoid process or rupture of the transverse ligament, or by the slipping of the process beneath the ligament. The number of cases of the injury demonstrated by autopsy is fairly large and contains examples of all three forms. In most of the reported cases the injury was a diastasis or incomplete separation of the articular surfaces, the atlas being displaced forward, and usually so inclined that its anterior arch lay in front of the body of the axis. If, in this change of place, the odontoid process is broken off and accompanies the atlas, the probability of dangerous compression of the cord is somewhat lessened. The other forms that have been demonstrated are dislocations forward and backward of both articular surfaces; dislocation forward on one side only (unilateral dislocation forward) has been observed only clinically. There is some reason to think that some of the obscure reported cases that ended in recovery may have been of the kind designated as "bilateral dislocation in opposite directions," that in which one articular surface is displaced forward and the opposite one backward, for experiment shows that this displacement can exist without causing compression of the medulla. A case observed by Sédillot probably was of this kind. (*Vide infra.*)

The following are examples of the rarer forms:

Dislocation forward without rupture of the transverse ligament.—A man[1] sixty years old fell from a height of four or five metres, striking upon his head, and survived ten hours. The head was held in moderate dorsal flexion, but was freely movable. The odontoid process had passed under the transverse ligament, and compressed the medulla. The right alar ligament was torn, the left untorn. The articular surfaces of the atlas had moved forward upon, but had not entirely left, those of the axis. There was no fracture.

A similar case is reported by Orton,[2] in which all the ligaments uniting the axis to the atlas and occipital bone were torn, but the transverse ligament was uninjured, and the odontoid process lay behind it compressing the cord. The injury was caused by a blow of the fist received obliquely from behind, on the angle of the jaw. Death was instantaneous. These two are the only positive examples of this injury.

Dislocation backward.—A woman[3] sixty-eight years of age fell while descending a ladder, struck upon her forehead, and died instantly. The atlas was dislocated backward on both sides, the anterior ligament detached, the capsular ligaments in front torn, the odontoid process broken at its base, and the posterior arch of the atlas broken on each side near the transverse process. The fracture of the atlas was thought to have been caused by its impact against the spinous process of the axis.

There is no other reported case in which this variety has been demonstrated, post-mortem, but Malgaigne quotes from Ehrlich a supposed case which ended in recovery. The head was thrown backward and was very

[1] Journal de Chirurgie de Malgaigne, 1844, p. 370.
[2] Orton: Lancet, 1876, i. p. 853.
[3] Melchiori, quoted by Malgaigne, loc. cit., p. 333.

movable, and a firm prominence which was thought to be the axis, could be felt on the right side of the neck in front. There was loss of consciousness, and general paralysis. Reduction, accompanied by a distinct sound, was effected by traction upon the head, and pressure by the thumbs upon the prominence in the neck, while the fingers grasped the occiput. The head at once regained its solidity, and the paralysis disappeared.

Bilateral dislocation in opposite directions.—Sédillot[1] reported the case of a girl who had suffered for some time with stiffness of the neck and deviation of the head to the left, although it could be turned to the right. The injury had been caused by a man who seized her by the head from behind and forcibly twisted it to the side toward which it remained deviated. She died seven weeks later, with increasing paralysis. The autopsy revealed a "dislocation of the atlas," the details of which are not given. The front of the odontoid process was rough, and the odontoid ligaments were torn and partly destroyed, but there was no pus. Only the anterior portion of the cord was softened. Blasius describes this case as one of bilateral dislocation in opposite directions; although it was probably such, the description does not prove it.

In the commoner forms of *diastasis* with inclination and displacement of the atlas forward, and in *complete forward dislocation* the transverse ligament is ruptured, or the odontoid process is broken off and accompanies the atlas. In diastasis all the ligaments uniting the atlas to the axis are ruptured; in dislocation forward the ligaments of the posterior arch are sometimes untorn. In a case reported by Phillips,[2] the posterior arch of the atlas was broken off on each side and remained in place, while the anterior portion, including the articular surfaces and carrying with it the fractured odontoid process, was displaced so far forward and downward that it lay entirely in front of, and became united to the body of the axis. The patient survived forty-seven weeks and died of hydrothorax. The injury gave rise to no marked symptoms except persistent stiffness and pain in the neck, which were attributed during life to a strumous arthritis set up by the injury and treated by leeching and issues.

I have met with no mention of injury to the vertebral arteries or veins.

The spinal cord may be torn across in part or entirely, or crushed, or simply compressed. In double dislocation forward, it is most likely to escape injury if the odontoid process is broken off. On theoretical grounds, it is also thought not to be greatly endangered in bilateral dislocation in opposite directions.

The *cause* has usually been a fall or blow upon the head. In forward dislocation, and in complete diastasis, the force has probably always been so exerted as to bend the head toward the breast; in partial diastasis, with rupture of the ligaments of only one side, the inclination must have been toward the opposite side. In two cases of suicide by hanging, in which complete diastasis was found, direct traction was probably aided by lateral flexion of the head. The cases in which the odontoid process has slipped

[1] Sédillot: Gazette Médicale, 1842, p. 776.
[2] Phillips: Méd. Chirurgie Trans., vol. xx. p. 78.

backward under the untorn transverse ligament can be explained only on the supposition of forced flexion of the head and atlas forward and to one side. This supposition is supported in Orton's case by the direction and nature of the violence that caused the injury.

Unilateral dislocation or bilateral dislocation in opposite directions may be produced by exaggerated rotation of the head, as in Sédillot's case. The alleged efficiency of muscular action to produce these forms has not been demonstrated, and the comparatively frequent production of these forms of dislocation at lower points in the cervical spine in this manner suggests the probability of an error of diagnosis in the cases reported as occurring at this point, or between the atlas and skull, and ending in recovery.

Symptoms.—In simple diastasis without displacement, and without injury of the cord, there may be no symptoms except pain and exaggerated mobility of the head, and even the latter may be lacking because of spasmodic contraction of the muscles. If the diastasis is combined with displacement, and especially with fracture of the odontoid process, it cannot be distinguished from pure dislocation. In the latter the head may be very movable or rigidly fixed, and the movements of rotation which take place in the joints between the atlas and axis are abolished. In the common form, dislocation forward, the chin is depressed upon the chest, and a prominence may be felt at the back of the neck, below the occiput, formed by the spinous process of the axis. In the pharynx may be seen or felt the projecting anterior arch of the atlas. Pain is always present, and usually severe. Phillips's case, above quoted, is a marked exception in respect of pain, disability, and deformity. The nervous symptoms vary with the degree of injury to the cord.

The *prognosis*, even accepting the cases of doubtful diagnosis followed by recovery, is very bad. Death may be caused immediately, or suddenly at a later period by the shifting of the loosened bones and the consequent compression of the cord, or by the progress of the changes induced by the primary traumatism.

Treatment.—Immediate reduction of the displacement and the prevention of its recurrence are imperative, if the former can be accomplished without such violence as would in itself endanger the life of the patient. Although Phillips's case furnishes proof that the persistence of the displacement is not necessarily incompatible with the prolongation of life and activity, and although this proof is supported by the survival in fair condition of several other patients who have received injuries at the upper part of the cervical spine, the exact nature of which was in doubt, but which were followed by permanent rigidity and deformity of the part, yet there can be no question, I think, of the propriety of making, or even of the obligation to make, cautious, well-considered attempts to correct the displacement. Even if dangerous pressure upon the cord has not at the time taken place, yet it is certain that the condition is full of the gravest risk. The displacement may gradually increase, as in Dubreuil's case, in which the chin did not touch the chest until the tenth or eleventh day, and death occurred suddenly on the seventeenth, or the fatal increment of displacement may be suddenly added by the relaxation of the spasmodically contracted muscles, or by an incautious movement

of the patient, or even of his attendants. This latter has occurred even after complete reduction, as in the following case which I quote in some detail because it will illustrate many of the prominent features of the injury:

A man[1] fifty-eight years of age fell down a hill-side and remained all night upon the ground unconscious. In the morning he tried to walk and found himself "unsteady." Help came, and he was taken home. When seen by the reporter he was seated in a chair, his chin resting on his sternum, his head and neck rigidly fixed. He was conscious, not paralyzed, and complained of great pain in the neck. There was a marked prominence at the back of the neck below the occiput.

By steady traction upon the sides of the head the displacement was completely reduced with a distinct snap and crepitus, and the pain was relieved. A week later he sat up in bed, and immediately fell back dead, with reproduction of the original deformity.

The autopsy showed that the odontoid process had been broken off with a portion of the body of the axis, and displaced forward with the atlas (the transverse ligament remaining intact) so far that the lateral articular surfaces were almost entirely separated.

As it seems probable from the shape of the bones that complete dislocation forward, except in cases that are immediately fatal, is very rare, the traction upon the head should be directed somewhat backward, as well as upward, so as to avoid increase of the displacement, and may be combined with counter-pressure against the back of the neck.

After reduction has been effected, and in cases of diastasis without displacement, the head and neck must be made immovable by suitable dressings. Certainly it would not be safe, even with the most tractable patients, to trust to simple rest in bed. In some cases a stiff leather collar has been sufficient, but I should prefer a plaster-of-Paris dressing, one that should envelop the head above the ears, the neck, or at least its posterior half, and the upper part of the chest, and that should be strengthened by strips of iron moulded to fit the parts, and included between its layers.

Dislocations of the Lower Six Cervical Vertebræ.

These are by far the most common of the dislocations of the spine, and the articulations between the fourth and fifth and between the fifth and sixth are the most frequently affected. The varieties that have been observed and verified are diastasis, bilateral dislocation forward, backward, and in opposite directions, and unilateral forward. Of these the bilateral forward and backward may be classed as dislocations by flexion, and the bilateral in opposite directions and the unilateral forward as dislocations by abduction and rotation. The bilateral forward and the unilateral forward are the most common. The statistics of Blasius show that of 108 cases in which the exact nature of the injury was ascertained 23 were diastases, 41 bilateral dislocations forward, 37 unilateral forward, 4 bilateral in opposite directions, and 3 bilateral backward; to the latter

[1] Dr. Gibson: Lancet, 1885, ii. p. 429.

to the latter may perhaps be added 8 others in which the diagnosis was not entirely beyond question.

The positively demonstrated cases of *bilateral dislocation backward* are two reported by Porta and one by Stanley. The latter of the fifth cervical, in which the upper five vertebræ were firmly united to one another by bony fusion has been quoted above, p. 133. The dislocation was complete, the body of the fifth vertebra resting upon the laminæ and spinous process of the sixth. The injury was caused by a fall backward upon the head and back. Theoretically, it may be assumed that hyperflexion forward of a vertebra, combined with direct pressure backward upon it, would produce this form of dislocation, for by the flexion a diastasis would be effected in which the posterior and capsular ligaments would be torn, and then the direct pressure backward would rupture the intervertebral disk and produce the displacement. That the injury is rare notwithstanding the frequency of the occasions in which the head is bent forcibly forward is to be explained by the normal freedom of motion in this direction which allows the chin to be depressed upon the breast. In Stanley's case the ankylosis of the overlying vertebræ restricted this range, and in the movement forward the normal limit of movement of the fifth vertebra upon the sixth was promptly reached and the dislocating action begun.

Of the four cases of *bilateral dislocation in opposite directions* I have not been able to examine the original reports in any. Possibly the one attributed to Malgaigne (*Revue Méd. Chirurg.*, 1853) is the same as the case described in his *Luxations*, p. 371, as unilateral forward; if so, and if it is retained in the list, it would seem proper also to add Martellière's case mentioned by Malgaigne upon the following page, 372, as resembling his own in the associated slight displacement backward of the opposite inferior articular process with rupture of the capsule. In Malgaigne's case there was also chipping of the lower border of the articular surface of the dislocated vertebra on the side of the principal dislocation with the production of a notch in which the upper edge of the underlying process was engaged. Similar chipping of the same border was found in Martellière's case, but the articular process had passed completely beyond the underlying one and had descended in front of it to a distance of nearly one-quarter of an inch. This form is an exaggeration of the unilateral dislocation forward, and their causes and mode of production will therefore be considered together.

In *bilateral dislocation forward* both inferior articular surfaces of the dislocated vertebra are carried forward beyond the anterior borders of the underlying ones, and the fixation is effected either by the dropping of the processes into the notches in front of the latter, or, if the movement forward is combined with anterior flexion, by the interlocking of the body of the upper vertebra with the projecting lateral borders of the upper surface of the under one. Blasius claims that this is effected almost as frequently by posterior as by anterior flexion, an opinion which it is not easy to accept. Flexion backward (hyperextension) of the neck is arrested, so far at least as the lower five vertebræ are concerned, by the contact with one another of the spinous processes, and, if continued upon these as a fulcrum and not modified by fracture, it would simply separate

the bodies of the vertebræ vertically (diastasis) and would require the aid of another force acting backward or forward directly upon the vertebræ to dislocate them. Such a combination of forces would be furnished by violence acting upon a limited point on the back of the neck from behind forward, and instances of such are to be found in the records, as a fall in which the back of the neck strikes against a sharp corner.

In hyperflexion forward the fulcrum is found at the anterior border of the body of the vertebra, and the first effect, in like manner, is to produce diastasis with rupture of the posterior and capsular ligaments, and then as the projecting lip on the inferior anterior border of the body of the upper vertebra engages in front of the upper border of the lower one, and the force continues to act, not simply to flex but also to crowd the head directly down toward the chest, the body of the upper vertebra slips downward and forward, by which movement the articular surfaces are separated antero-posteriorly. Then if the neck is straightened the body of the vertebra may be raised to its original level, and yet the dislocation will be maintained by the interlocking of the articular processes. Under such circumstances there would be no angle in the direction of the neck, but only a depression in the nape and a projection in the pharynx corresponding to the body of the dislocated vertebra.

FIG. 27.



Dislocation of the neck by flexion; median section.

Occasionally the spinous process with more or less of the adjoining laminæ is broken off. The intervertebral disk is always torn, and so are usually the ligamenta flava and the interspinous ligament; the longitudinal (anterior and posterior) ligaments are less frequently torn, often only stripped off, and thus by connecting the contiguous vertebræ they affect the posture of the head and neck. The spinal cord may be compressed or crushed, or may escape injury.

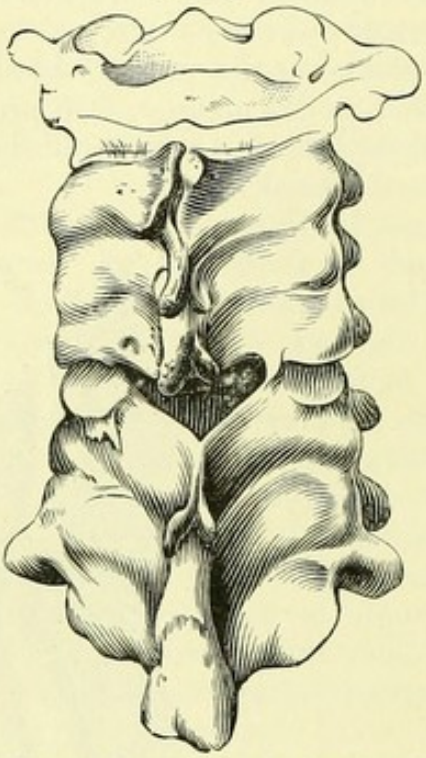
As the articular surfaces are in some cases almost horizontal, the anterior borders being but slightly higher than the posterior ones, it is conceivable that the dislocation may be produced by direct violence acting upon the bone from behind forward, without the aid of either flexion or extension of the column.

In *unilateral dislocation forward*[1] (dislocation by abduction and rotation) the articular surface on one side of the upper vertebra is carried upward and forward until its posterior edge has passed the anterior edge of the one with which it articulates. At the same time the spinous process moves from the median line toward the side of the dislocation, and the anterior surface of the body projects slightly in front of that of the underlying one. In short, the movement is one of rotation and abduction about the opposite articular surface as a centre, and by it the vertebral canal is but slightly narrowed, and but little or no violence is

[1] Blasius (loc. cit., vol. 104, p. 82) found only one case of unilateral dislocation *backward*—of the sixth cervical—and even in it there was also fracture of the lamina and body of the seventh vertebra on the side of the dislocation.

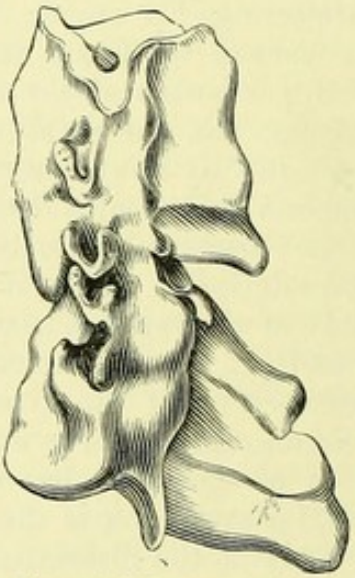
done to the cord. The segment of the column above the dislocation is abducted, and forms with the lower part an angle or curve, the convexity of which is on the dislocated side.

FIG. 28



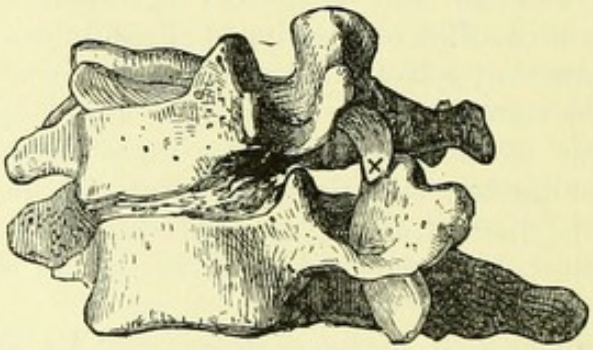
Bilateral dislocation by flexion; fourth cervical vertebra; from behind. (MALGAIGNE.)

FIG. 29.



Bilateral dislocation by flexion; fourth cervical vertebra; from the left side. (MALGAIGNE.)

FIG. 30.



Complete unilateral dislocation by rotation or abduction.

The normal motion possible in the articulations of this region, is one in which rotation and abduction are combined in nearly equal proportions; neither can take place without the other. The dislocation is produced by carrying the movement beyond its normal limits; in other words, it is produced by any force which over-abducts or over-rotates the upper part of the column. This force may be an external one, or one developed by the muscles attached to the head. Of these dislocations by muscular action, Völker[1] collected fourteen more or less certain cases, and

[1] Völker: Deutsche Zeitschrift für Chir., 1876, vol. vi. p. 424.

made them the basis of a careful study of the subject. Additional cases have since been reported. The movement which produces the lesion is a sudden turn of the head to one side, in which the action of the sterno-cleido-mastoid far outweighs that of the rotators of the vertebræ themselves, which are much too weak to rupture the ligaments that are found torn in this dislocation. If this movement is violent, ill regulated, if its momentum is unchecked by the antagonistic muscles, it carries the head beyond its normal limit, and produces the dislocation in exactly the same manner as if an external force had been applied to the head to turn it in the same direction.

In *diastasis* the lesion consists essentially of more or less extensive rupture of the ligaments. It is the same in its forms, nature, and etiology as the other varieties, with the exception of the displacement of the bones and of the persistent change in the relations of the articular surfaces to each other; the displacement is either entirely absent or is slight. It seems probable that in many of the cases described as diastases actual dislocation had been present at first, but had subsequently been reduced in the handling of the patient either before or after death, for the rupture of the ligaments is described as so extensive that the bones could be freely displaced upon each other in any direction. A singular instance of the production of a diastasis by muscular action is reported by Lasalle:[1] a crazy man, confined in a strait-jacket in a chair, jerked his head violently backward and forward, became at once paralyzed, and died a few hours later. The autopsy disclosed a separation between the fifth and sixth cervical vertebræ, with rupture of the posterior ligament, the interspinous muscles, the ligamenta flava, and the intervertebral disk.

Symptoms.— Unilateral dislocation forward. The posture of the head has varied so greatly in the reported cases that it is of no value as a symptom. Not only may the abduction of the upper segment of the column, which is necessary to the production of the dislocation, be almost entirely corrected by the sinking back of the articular process of the upper vertebra into the notch of the lower one, but even if it persists it may be so far compensated for or obscured by flexion in the occipito-atloid and rotation in the atlanto-axial articulation, that it will not be recognized. The face is, however, usually turned away from the side on which the dislocation has taken place. A painful prominence, swelling, or rounding, can be recognized on the dislocated side; it is due, according to Völker, to the angle created in the column, the slight projection of the transverse process, and the contracted condition of the muscles. Observers differ as to the condition of the muscles on the opposite side, some reporting them relaxed, others contracted. The deviation of the spinous process of the dislocated vertebra to the side of the dislocation, is a valuable sign when it can be recognized, but the depth at which the third, fourth, and fifth spinous processes are placed is such that their position cannot usually be determined, and while that of the second can always be felt, its deviation may be unrecognizable, because the position of the underlying ones with which it must be compared remains unknown.

[1] Lasalle: Gaz. Médicale, 1841, p. 763.

The projection of the body of the vertebra in the pharynx is sometimes recognizable by the finger introduced through the mouth.

The last named three signs are diagnostic if fracture can be excluded, but as the last two are unrecognizable in many cases, the first, the existence of a painful prominence on the side of the neck, is the one upon which the surgeon will usually have to depend. The differential diagnosis, at least in cases due to muscular action, is with muscular contraction (muscular caput obstipum); the following tabulation of the differential points is taken from Vogt.[1] Its statements must be accepted as true of only the majority of cases, not of all.

Caput obstipum, muscular. Right-sided contraction.	*Dislocation by rotation. Right side.*
Head abducted to the right. Face turned to the right.	Face turned to the left. Head abducted to the right only in complete dislocation with sinking of the articular process of the upper vertebra deeply into the notch of the lower one. Otherwise, the abduction is variable.
No change in the line of the spinous processes.	Spinous process of the dislocated vertebra deviated to the right.
Muscles variously contracted on the sides of the neck. No prominence to be felt.	On the left, the muscles prominent and contracted, especially the trapezius(?). On the right, by deep pressure through the contracted muscles a prominence can be felt.
Abduction to the right easily increased; to the left, impossible. Rotation to the left can be increased; to the right, impossible.	Abduction to the left possible, but painful; to the right, impossible(?). Rotation to the right impossible(?).
No pain on pressure at any particular point of the neck.	Much pain produced by pressure on the prominence on the right side; sometimes also on the left at the same level, and at the spinous process.
No change in the pharynx recognizable by palpation; no difficulty in swallowing.	Sometimes a recognizable prominence on the posterior wall of the pharynx; sometimes difficulty in swallowing.

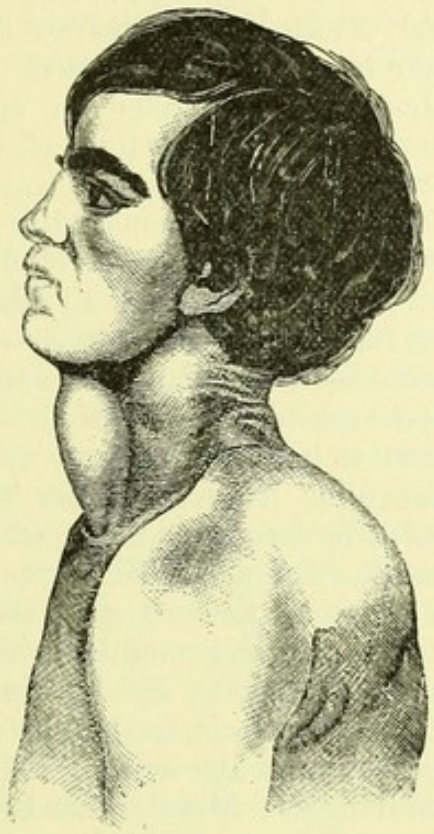
Cases may occur, as they have occurred, in which the symptoms are so obscure that a diagnosis between dislocation by muscular action and muscular rheumatism cannot be positively made. Under such circumstances the manipulations that would reduce a dislocation if it were present should be carefully made. If they reduce the deformity and relieve the symptoms they both establish the diagnosis and cure the patient.

In *bilateral dislocation forward* the symptoms vary greatly. The head may be bent far forward toward the chest with marked prominence in the nape of the neck of the spinous process of the vertebra next below the dislocated one, or it may be bent backward or backward and to one side, with marked projection of the trachea and perhaps larynx, and irregu-

[1] Vogt: Moderne Orthopœdik, 2d ed., 1883, p. 77.

larity in the outline of the front of the column recognizable by palpation through the soft parts. The head may be rigidly fixed, or, more rarely, freely movable. These differences depend partly on the position of the dislocated bone, the presence or absence of associated fracture, and the extent of the injury to the connecting ligaments, partly on the direction and character of the dislocating force, and partly on the contraction or relaxation of the muscles which control the position taken by the unaffected joints above the seat of injury. In the majority of cases the head is bent forward, and an angle with its apex directed backward is formed by the two segments above and below the dislocation. Attempts to move the head and pressure at the seat of injury are very painful. In these patients the irregularity in the line of the transverse processes may also be recognized by the touch; and if the dislocation is not too low the projection of the body of the vertebra may be felt in the pharynx.

FIG. 31.



Ayre's case of bilateral dislocation forward of the fifth cervical vertebra.

Of the symptoms of *bilateral dislocation backward* nothing positive can be said. In most of the supposed cases the head has been bent backward, the face directed somewhat upward, the tissues of the front of the neck tense, and respiration and deglutition somewhat interfered with.

Paralysis, partial or complete, is frequently observed. Its immediate importance, its urgency, as a symptom varies accordingly as the dislocated joint is above or below the point of exit of the phrenic nerve. The fourth cervical nerve, from which the phrenic mainly arises, though it receives a branch also from the third or fifth, leaves the vertebral canal through the foramen between the third and fourth vertebræ, but leaves the side of the cord at a somewhat higher point. A dislocation below the third cervical vertebra may cause paralysis of all the accessory muscles of respiration that act by raising the ribs, but, the diaphragm continuing to act, prolongation of life is possible. If, on the other hand, the dislocation is at a higher point, and the trunks going to form the phrenic nerve are injured or the cord is so compressed or torn that the integrity of the corresponding fibres within it is destroyed, or they are all cut off from the respiratory centre, then the diaphragm also, being no longer innervated by these nerves, immediately ceases to act, and the individual dies asphyxiated. In a few cases the threatening symptoms have been instantly relieved by changing the position of the patient or by systematic reduction of the dislocation. In all such threatening

cases and in those that have been immediately fatal the injury is, as a rule, at one of the upper joints. In the exceptions there have been associated injuries to which the death is to be attributed.

If the paralysis is due to compression or laceration of the cord it may be complete of both motion and sensation below the point of injury, or it may involve only the motor nerves. It seems probable that the partial paralyses are due to pressure not upon the cord but upon a nerve trunk in the intervertebral foramen.

Loss of control over the sphincters, incontinence of urine, and the other secondary symptoms of injury to the cord have been already considered.

Prognosis.—The mortality of dislocations of the lower six cervical vertebræ, excluding cases of diastasis, is, according to Blasius, fifty-six per cent., or, excluding all doubtful cases, sixty-six per cent. This estimate is open to the serious objection that it rests upon a principle of selection which views with suspicion every diagnosis that is not verified by post-mortem examination. Since there is good ground for this suspicion in many cases and no better alternative method of selection is practicable, it seems better to assume that the percentage cannot at present be determined. According to the same statistics the mortality is greatest, 88.4 per cent., in the double dislocation forward, while that of the unilateral forward sinks to 34.9 per cent. In the fatal cases death, as a rule, comes promptly, within the first week. Suppuration has been observed about the seat of injury in cases that remained unreduced.

Treatment.—In *unilateral dislocation forward*, at least in those produced by muscular action, Völker says reduction is usually easy and free from danger. Mention has been made above of the case in which a boy reduced his own dislocation by resting his head and shoulder against a wall and pressing upon the prominence in the neck with his thumb.

Simple traction upon the head, the counter-extension being made by the weight of the body, followed by rotation of the face toward the dislocated side has proved successful, but it seems better and is generally recommended that the articular process should be freed by still further abducting the head and upper segment of the column (away from the side of the dislocation), and then, when freed, should be rotated backward into place. If traction is used it should be made in the direction of the long axis of the upper segment, not in that of the lower one, for in the latter case the strain would come wholly or mainly upon the untorn connections on the non-dislocated side and rather tend to depress the dislocated articular process still further in front of the corresponding lower one than to raise it above it.

Bilateral dislocations in opposite directions are to be classed with the preceding as dislocations by abduction and rotation, and treated in the same manner. Probably the differential diagnosis could not be made clinically.

In *bilateral dislocations forward* it has been recommended by Hueter that the reduction should be made first on one side and then on the other by abduction and rotation, as if dealing with two unilateral dislocations forward.

The methods that have been employed with success have combined

traction upon the head, either in the sitting or recumbent posture, with pressure upon the front and back of the neck at suitable points.

After reduction the patient should be kept quiet for some time, and if reproduction of the dislocation is feared a retentive dressing should be applied. It must be rigid enough to prevent any flexion of the neck forward or back, and, after unilateral dislocation, should include the head so as to prevent rotation. Such a dressing might be conveniently made with plaster-of-Paris.

Dislocations of the Dorsal Vertebræ.

The cartilaginous surfaces of the articular processes in the dorsal region are placed more nearly in a vertical plane than those of the cervical vertebræ; the superior ones look backward and slightly upward and outward, the inferior ones, with the exception of those of the twelfth, look forward and slightly downward and inward; the inferior ones of the twelfth are placed like those of the lumbar vertebræ and look outward and somewhat forward. This disposition does not in itself make dislocation to either side by rotation or direct dislocation backward with fracture difficult; dislocation forward is made possible by flexion sufficient to raise the inferior articular processes of the upper vertebræ above the superior ones of the lower. Dislocation between the twelfth dorsal and first lumbar vertebræ seems to be much less favored by the relations of the processes, and yet this is the point in the combined dorsal and lumbar regions where dislocation is by far most common. Blasius (loc. cit., vol. 103, p. 46), collected twenty-two cases in which the character of the dislocation was demonstrated by autopsy; of these one was of the third dorsal vertebræ, three of the fifth, one of the sixth, one of the ninth, three of the tenth, two of the eleventh, and eleven of the twelfth; of the doubtful cases ten were of the twelfth, four of the eleventh, and one each of the fifth, eighth, and tenth. This greater frequency at the twelfth has been attributed to the greater normal mobility of this joint, but as the mobility is equally great, or even greater, between the lumbar vertebræ where dislocation is much more rare, this explanation is not sufficient. The explanation given by Chas. Bell[1] of the greater frequency of fractures at the same point seems equally applicable to dislocations; it rests upon the combination of rigid and flexible segments in the column and finds the greatest frequency at the junction of such segments. This is supported by the experiments of Bonnet, who found that forced flexion of the dorso-lumbar column had its maximum effect between the eleventh dorsal and second lumbar, and especially at the first lumbar. Motion between the dorsal vertebræ is limited not only by their relations to each other but also by the attached ribs.

The observed varieties are the bilateral forward and backward with about equal frequency, the bilateral in opposite directions, and the lateral. Of the latter there are only two demonstrated cases, Bell and Mohrenstein, twelfth dorsal, and even in these Blasius thinks the injury was primarily a unilateral dislocation forward or backward, which was

[1] Quoted in Fractures, p. 261.

followed by bodily lateral displacement. In the few cases in which the condition of the adjoining ribs is noted, these have been found sometimes dislocated and sometimes fractured not far from the column. The degree of injury to the cord varies with the character and extent of the displacement. Other pathological conditions have been considered above.

The *causes* have been forcible flexion of the trunk forward and the direct action of great violence upon the back or side of the spinal column, as in the fall of a heavy object, or the passage of the wheel of a wagon across the body.

The *symptoms* of the dislocation are found in recognizable changes in the position and relations of the dislocated vertebræ, especially in the prominence of its spinous process or of the underlying one, or in its lateral displacement, and in a deviation of the column which creates an angle at the seat of the dislocation, the apex of which is usually directed backward. In some cases it is noted that the articular processes of one or the other of the two adjoining vertebræ form prominences under the skin.

Excessive mobility at the seat of dislocation has also been observed in most cases.

Paralysis appears to be more common and more complete in the forward than in the backward dislocations, and in a few cases has disappeared after reduction.

The symptoms resemble so closely those of fracture that the differential diagnosis, in the absence of post-mortem examination, can rarely be made with certainty. The failure to obtain crepitation is no proof of the absence of fracture, and when present it may be due to the presence of an associated unimportant fracture. Reduction and the absence of a tendency to reproduction of the deformity are the best obtainable evidence that the injury was a dislocation.

The *prognosis*, as regards either the preservation of life or the full restoration of function, is not favorable. The uncertainty of the diagnosis in most cases of survival and the comparative fewness of the cases deprive the percentages of value, and it can only be said that the injury seems more likely to prove fatal when it is situated in the upper part of the region than when in the lower, and that in quite a number of cases more or less complete recovery has followed. In one that has been under my observation for two years the patient, a girl fourteen years old, has been in good health although she remains completely paralyzed below the level of the breasts; the injury appears to have been a diastasis at the fourth or fifth dorsal vertebra, and was caused by a fall down the narrow air-shaft of a tenement house from a height of about sixty feet. Such prolongation of life has, however, seldom been reported. In other cases there has been a permanent deformity or an abnormal mobility at the injured point.

Treatment.—Reduction, by extension and counter-extension at the hips and shoulders, has been tried, and sometimes with success. If it is obtained the patient must be kept absolutely recumbent for several weeks, and preferably with the trunk enveloped in a plaster-of-Paris dressing, and the same measures should be employed even when reduction has not

been effected, in order to favor the consolidation of the bones in their new positions.

It seems not improbable that the knife may yet be resorted to with advantage to expose the dislocated bone and enable the surgeon to act with better knowledge of the actual displacement and of the difficulties to be overcome. I believe, however, that such an operation should not be done until after the soft parts have had time to recover from the laceration of the original traumatism.

Dislocations of the Lumbar Vertebræ.

The possibility of the occurrence of pure dislocation of the lumbar vertebræ, which has been long in doubt because of the close interlocking of the processes and the strength of the ligaments, is proved by two cases collected by Blasius and also, it may be said, by two others in which there was present associated but unimportant fracture of some of the processes. The first two cases are those of Curling[1] and Porta.[2]

Curling presented a specimen preserved in the London Hospital Museum: the intervertebral disk between the third and fourth lumbar vertebræ was destroyed, with slight splintering of the edge of the bone at one or two places; the body of the third projected nearly half an inch in front of that of the fourth, and the articular processes of the two bones were separated to the same distance; the ligaments connecting the laminæ and the spinous processes were stretched but not materially torn.

The other two cases are those of Keig[3] and Cloquet.[4] In the former a sailor twenty-three years old was crushed under a heavy iron cylinder which fell across his back. The second lumbar vertebra was displaced backward seven lines, the upper articular process of the third becoming lodged in the notch of the second; the tip of the right lower articular process of the second was broken off but not separated from the rest; the left transverse processes of the first and second vertebræ were broken off (by muscular action, it was thought), and the spinous processes of the ninth, tenth, and eleventh dorsal vertebræ and the left eleventh and twelfth ribs were broken. The right sacro-lumbalis muscle was completely divided transversely, and the liver and spleen ruptured.

In another case Porta found at the autopsy a pure diastasis between the third and fourth lumbar vertebræ, the bones being separated a few lines without lateral or antero-posterior displacement, and all the ligaments being torn; the spinous process of the third was broken at its base.

The conditions which so effectually oppose dislocation with or without fracture are the great breadth, thickness, and elasticity of the intervertebral disks, the large masses of muscle that lie on each side of the spinous processes, and the arrangement of the articular processes by which those of each upper vertebra are received between those of the next lower and

[1] Curling: London Hospital Reports, vol. 3, p. 355.
[2] Quoted by Blasius: Loc. cit., vol. 103, p. 55.
[3] Keig: Schmidt's Jahrbuch, vol. 107, p. 69. (Blasius writes the name Keli.)
[4] Blasius: Loc. cit., from Journal des Difformités, vol. 1, p. 453.

are thus absolutely prevented from moving laterally or from being separated by lateral flexion without fracture of one or the other.

In the eighteen cases collected by Blasius the dislocation was most frequently of the first vertebra, next of the second, and then of the third; the fourth and fifth were each dislocated once.

In the cases uncomplicated by fracture the only varieties observed were dislocations forward and backward (dislocation by flexion); in the others there were examples also of the unilateral and bilateral (dislocation by rotation).

The *symptoms* are irregularity in the line of the spinous processes, local pain, disability, and more or less complete paralysis of the parts below. As the spinal cord is replaced throughout the greater part of this section by nerve trunks, the cauda equina, which less completely fill the canal, the paralysis is less likely to be complete than when the injury is at a higher point, and it is also more easily recovered from if the displacement is corrected. The extreme attitudes described in some of the cases, as in Larrey's, in which the head rested on the knees, must be ascribed either to associated fracture or, more probably, to general muscular relaxation. Abnormal mobility or immobility of the entire column or at the injured point is dependent upon conditions already discussed in connection with dislocations at other points.

The *prognosis* is more favorable than in dislocations of the dorsal or cervical regions, presumably because of the usual absence of injury to the cord, and the less extent of the paralysis; and, while many of the cases have proved promptly fatal, death has usually been due to associated injuries.

Treatment.—In backward dislocation reduction appears not to have been difficult; it has been obtained by pressure upon the projecting spinous process, with or without forcible extension of the column. In a case reported by Harrison,[1] dislocation backward of the third lumbar vertebra, reduction was obtained with the aid of anæsthesia by extension and counter-extension, combined with moderate pressure upon the spinous process, while the patient was lying upon his back. The paralysis began to diminish on the following day, and complete recovery followed, although a slight projection in the line of the column persisted. A plaster-of-Paris jacket was worn for four and a half months.

Possibly the plan recommended by some of the older surgeons of combining flexion forward with extension, would be necessary or useful in some cases. It could be effected by placing the patient on his belly across the side of a barrel, or by raising him on a cloth passed under his belly.

[1] Harrison: Lancet, 1885, ii. p. 114

CHAPTER XIII.

DISLOCATIONS OF THE STERNUM.

UNDER this title are included only dislocations of the normal divisions of the sternum from one another, not those of the sternum from the clavicles or from the cartilages of the ribs; they are those of the body from the manubrium, and of the ensiform process from the body.

Dislocations of the body from the manubrium.—The manubrium, constituting nearly the upper third of the sternum, is united to the second piece, the body, by a layer of interposed cartilage, sometimes hyaline, sometimes more or less distinctly fibrous, and sometimes containing a central synovial sac of variable size. Henle speaks of this central sac as of rare occurrence; Maisonneuve and Brinton found it in about two-thirds of the cases examined. Ossification of the band occasionally takes place in advanced life; the earliest age at which it has been observed is thirty-four years.

The second costal cartilage articulates with both these segments of the sternum at their junction. Although this division of the sternum into segments was described by the anatomists, no account thereof appears to have been taken by surgeons until, in 1842, Maisonneuve[1] read before the Académie de Médecine in Paris, a paper in which he called attention to the anatomical divisions of this bone, and reported two cases of dislocation of the body from the manubrium which had come under his observation, and in which he had made the autopsies. Earlier records show several cases which were doubtless dislocations, but Maisonneuve was the first to separate them from the class of fractures and apply this name to them.

The injury is not a common one, even if allowance is made for the probable description of some as fractures. Malgaigne, in 1855, could collect only ten examples, although he included in the list several of the older cases reported as fractures; Ancelet[2] collected sixteen cases of all kinds, Brinton[3] thirteen of dislocation forward, and added one of his own. Gurlt,[4] in his table of fractures and diastases of the sternum, has twenty-nine cases classified as diastasis between the first and second pieces, and three between the second and third. Adding to these those quoted by Ancelet, Brinton, and Servier,[5] the list is increased to more than forty. Only one of the patients was a woman, and the ages ranged from thirteen to more than sixty-five years.

In sixteen the body was completely dislocated forward and upward

[1] Maisonneuve: Arch. gén. de Méd., 1843, vol. 14, p. 249.
[2] Ancelet: Gazette des Hôpitaux, 1863, p. 257.
[3] Brinton: Amer. Journ. of Med. Sci., July, 1867, p. 39.
[4] Gurlt: Die Knochenbrüche, 1862, vol. 2, p. 31.
[5] Servier: Dict. Encyclopédique, 1883, art. Sternum.

upon the manubrium, in three or four backward; in two the dislocation was incomplete forward, and in one the two segments were separated longitudinally.

Causes.—The injury has been produced by direct and indirect violence, and, possibly, in one or two cases, by muscular action. Guines,[1] in the report of a case of tetanus in a boy thirteen years old, states that on the seventh day he found the breast elevated, all the false ribs displaced and carried upward, the sternum bent at the junction of the first and second pieces, and forming with the ensiform process an eminence three inches high. The pectoral muscles were forcibly contracted, while those of the abdomen were, if not in their natural condition, at least much relaxed (compared with their previous condition). On the eighteenth day, the tetanus having ceased, it is noted that the deformity of the breast persisted. I understand this to mean that there was an angular displacement at the junction of the first and second pieces, the apex being directed backward, and the ensiform process distant three inches further than usual from the spine.

In two other cases muscular action may possibly have been the determining cause, but the mode of production is obscure; in one of them (Drache, quoted by Malgaigne), a young man fell into a cellar with some falling timber, which rested upon his chest; while striving to free himself he felt a snap in the region of the sternum, and the dislocation was thought to have been then produced. In the other (Ancelet), a boy thirteen years old was exercising on parallel bars with his chest bent forward; his feet unexpectedly touched the ground, and a forward dislocation, complete on only the left side, was produced.

In the case of longitudinal separation (Aurran and David), the patient fell from a height of fifty feet, striking on his back across a low wall so that his head was on one side and his legs on the other. He received at the same time a fracture of the spinous processes of the last two dorsal vertebræ, and the dislocation (a diastasis) seems therefore to have been produced by hyper-dorsal flexion of the spinal column, by which the two segments of the sternum were pulled apart. The case seems, to some extent, to confirm the theory of the possibility of dislocation by muscular action. The patient recovered.

In three cases a forward dislocation was caused by violence received directly upon the front of the chest, presumably upon the manubrium. One patient (Aurran) fell with a ladder, striking his chest against one of the rungs; another (Malgaigne) fell against the gunwale of a boat; the third (Frémey[2]) was struck and killed by the pole of a wagon. Drache's case also is sometimes quoted as an example of direct violence, and so perhaps may be Richet's,[3] in which some boxes of soap fell upon a man, and caused a dislocation backward of the body upon the manubrium. Reid's patient was kicked by a mule; the direction of the displacement is not mentioned.

In Duverney's[4] patient the injury was compound, and was caused by

[1] Guines: Arch. gén. de Méd., 1829, vol. 19, p. 396.
[2] Frémey: Bull. de la Soc. Anatomique, 1868, vol. xiii. p. 419.
[3] Richet, reported by Siredy in Bull. de la Soc. Anat., 1857, vol. ii. p. 305.
[4] Duverney: Maladies des Os, 1751, vol. i. p. 235.

the forcible compression of the sides of the chest by a falling stone, the second piece being thrust forward (see Fractures, p. 300); and in Pitha's[1] it was caused by similar lateral compression between the buffers of two railway cars.

In most of the others the injury was caused by a fall from a height, by which the trunk was probably bent forcibly forward, as shown in several of them by associated fracture of the cervical or dorsal vertebræ. The mode of production in these cases appears to be similar to that by lateral compression of the ribs; the first and second ribs being shorter and more rigid than the others, the manubrium remains fixed, while the second piece is pushed forward and upward by the other ribs that articulate with it and which are themselves pressed forward by the flexion of the spine. Servier demonstrated this action upon the cadaver by exposing the sternum and costal cartilages, dividing the third, fourth, and fifth of the latter, and then throwing the body backward from a sitting position so as to strike upon its shoulders on the floor; the ends of the ribs could be seen to spring forward and inward.

Pathology.—In the common form, dislocation of the second piece forward and upward, the bones override, sometimes as much as an inch; the anterior fibrous layer lining the bone is torn, the posterior one stripped from the second piece. In Brinton's case the body was twisted somewhat obliquely downward toward the right side. The upper end of the body may also be so inclined forward that it is separated from the anterior surface of the manubrium and rests only against its upper edge. The second costal cartilages almost invariably remain in contact with the manubrium. Sometimes the third and fourth have been broken.

In two cases the dislocation has been incomplete, Nélaton's and the boy reported by Ancelet who received his injury while exercising on parallel bars; in the latter the body was turned about its longitudinal axis so that its left upper corner was elevated above the manubrium and the second costal cartilage to a distance fully equal to the thickness of the bone, while its right upper corner remained in place. In one case (Duverney) the dislocation was compound.

The dislocations of the body backward furnish two autopsies. Sabatier's patient[2] was an elderly man who, after having been beaten with the fists, was thrown into a ditch thirty feet deep; he survived for a week. The body of the sternum was displaced 2.8 cm. upward behind the manubrium; there was a large extravasation of blood under the skin and in the substance of the right lung, which was extensively bound down by old adhesions.

Richet's patient, twenty-seven years old, was thrown down upon his back by some heavy boxes that fell from a wagon upon his chest and caused many associated injuries; he died of pyæmia on the twenty-second day. The body of the sternum was displaced backward and slightly upward behind the manubrium; the second costal cartilage on the left side remained attached to the body, that of the right side was separated from both body and manubrium, and its end was free in an abscess that bathed the dislocation. There was a complete transverse fracture of the

[1] Gurlt: Loc. cit., p. 225.

[2] Gurlt: Loc. cit., p. 275.

manubrium half an inch above its lower end, and a fracture of the body without displacement at the level of the articulation of the fourth costal cartilages. There was a compound fracture of the left leg, and simple fractures of the left third and fourth ribs and of the right radius.

The complications have been numerous and varied: fractures of the cervical and dorsal vertebræ, of the ribs, costal cartilages, pelvis, thighs, and legs, rupture of the adherent lung, rupture of the lungs and heart (Duverney).

Symptoms.—In the severe cases—those complicated by other injuries, especially of the spinal column and thoracic viscera—the general symptoms due to the dislocation may be masked or increased by those of the other lesions; in general terms, the rational symptoms in forward dislocation are more or less transient oppression of breathing and sharp pain at the seat of injury, increased by pressure or by movements of the body or head.

The neck and trunk are bent forward, the lower ribs appear prominent, and the upper ones depressed. The anterior surface of the sternum presents a well-marked elevation at the level of or just below the first intercostal space, which has a sharp, well-defined upper margin rising directly from the manubrium and is continuous below with the body of the sternum. The absence of the second costal cartilages from the upper corners of the body makes it possible to recognize with the finger the shallow, saucer-like depression at these points with which they articulate. The recognition of these depressions, or the distance of the upper edge of the projection from the line of the third ribs, will enable the surgeon to distinguish a dislocation from a fracture of the body; and the presence of the second costal cartilages below the upper edge of the projection will indicate a fracture of the manubrium.

The *prognosis* is grave; more than half the patients have died of their injuries, though doubtless the fatal result is to be attributed in most of the cases to the associated lesions. In the cases that have survived a failure to effect reduction has not led to any disability; one of the patients in the list had borne his unreduced dislocation for fifteen years without inconvenience. Stetter[1] mentions, without giving the reference, a case observed by Audic of habitual dislocation backward (or of the manubrium forward) which recurred every time the patient rose from the recumbent posture without supporting his head.

Treatment.—Reduction is to be made by bending the trunk backward and making pressure upon the projecting piece of the sternum. The patient should be placed upon his back on a firm cushion or on a table with his head and shoulders projecting beyond its end, and then the head and neck should be drawn backward, and counter-extension made on the pelvis It is recommended also that in dislocation backward the patient should be encouraged to make full inspirations.

After reduction is made a body bandage, or, better, a broad strip of adhesive plaster should be placed around the chest.

In case of failure to reduce by these or other simple means, resort

[1] Stetter: Compend von den Luxationen, 1886, p. 19.

should not be had to cutting operations unless grave indications due to pressure upon the thoracic organs should exist.

Pathological dislocations.—To the three examples of this kind quoted by Malgaigne, Servier has added a fourth. They are, in brief, as follows:

1. Beauchêne. A medical student twenty-three years old, who suffered from almost continuous pain at the middle of the sternum and from osteocopic pains in the lower limbs, had acquired the habit of pressing frequently and forcibly with his hand upon the sternum; as a result, the first two pieces of the bone became partly displaced and flexed upon each other so as to form a very marked projection forward. When the patient rotated his thorax to one side or the other the two pieces moved upon each other with pain and crepitation. Anti-syphilitic remedies relieved the pains in the limbs, but those in the sternum persisted. Malgaigne thought the affection was a simple arthritis of the joint, and says he had himself several times suffered in like manner, and had found relief in pressure upon the sternum which prevented it from moving during inspiration.

2. A watchmaker, who worked seated and bent forward, found that the position caused a disagreeable sensation at the upper part of the sternum and some difficulty in breathing, and he noticed when he straightened himself a singular creaking at this point which appeared to be caused by the sliding of the manubrium in front of the body of the bone. He abandoned his occupation and the subluxation gradually disappeared. Ten years later, when he was thirty-eight years old, it suddenly reappeared, but had not since recurred.

3. Graves. A medical student nineteen years old, who some years before had often suffered from serious inflammation of the chest, but whose health was completely reëstablished, could push backward with his hand the body of the sternum and the corresponding costal cartilages to a depth of two inches. The upper margin of the depression was two inches below the upper border of the sternum; the latter margins corresponded to the line of union between the ribs and their cartilages. The movable piece was much softened.

4. Bourneville[1] observed in a patient nineteen years old suffering from generalized tubercular disease a fluctuating prominence at the level of the junction of the first two pieces of the sternum, the body appearing to be subluxated forward; reduction was accompanied by slight crepitation. The autopsy showed a separation between the two pieces of one centimetre, with distention of the anterior ligament due to thick yellow pus that filled the joint between the two pieces and the second costal cartilages.

Dislocation of the Ensiform Process.

Of this injury, referred to by many of the earlier writers as a possibility, only five or six more or less well authenticated cases are on record. They are those of Martin and Billard, quoted by Malgaigne,

[1] Bull. de la Soc. Anatomique, 1869, vol. 14, p. 56.

Polaillon,[1] Gallez quoted by Servier, and Hamilton.[2] In addition may be mentioned the reference made by Malgaigne to an example observed in a newborn child by Seger, and that to one similar to Polaillon's (as quoted by Mauriceau) in the discussion on his case.

Polaillon's patient was a woman thirty-five years old, and her injury was caused apparently by tight lacing to conceal the enlargement of pregnancy; all the others were males, and their injuries were caused by blows received upon the epigastrium; their ages were eighteen, nineteen, twenty-eight, and fifty-three years.

No autopsy was had in any case, and in Polaillon's alone is the condition described with sufficient detail to make it reasonably certain that the separation took place at the line of union between the process and the body of the sternum; the others may have been fractures of the process itself. In Polaillon's the base of the process was displaced backward, and the point looked directly forward. In Hamilton's, first seen by him twelve years after the accident, the cartilage was "bent at right angles with the sternum, pointing directly toward the spine." In the other cases the character of the displacement is not fully described, but apparently the apex of the process was directed backward in most.

In three cases the most prominent symptom was persistent vomiting, which in one (Hamilton's) recurred every five or six days for two years and then ceased spontaneously, in another (Martin) was relieved by grasping the process with the fingers and drawing it forward into place, and in a third (Billard), after it had lasted a month and threatened to prove fatal, was relieved by drawing the process forward by means of a blunt hook introduced below it through an incision. Polaillon's patient suffered sharp pain, which was excited by the pressure of the clothing and the ingestion of food, and was extremely severe during delivery; reduction was impossible, and after a time the inconvenience caused by it ceased. In Gallez's case the prominence could be reduced and reproduced with a click by manipulation; the patient suffered only local pain and was promptly cured by reduction maintained by the aid of a small compress fixed over the process by means of adhesive plaster.

[1] Polaillon: Bull. de la Soc. de Chirurgie, 1877, p. 9.

[2] Hamilton: Fractures and Dislocations, 6th ed., p. 182. The account leaves it uncertain whether this was deemed a fracture or a dislocation.

CHAPTER XIV.

DISLOCATIONS OF THE RIBS AND THE COSTAL CARTILAGES.

UNDER this title are included dislocations of the ribs at their juncture with the vertebræ, of the ribs from the costal cartilages, of the cartilages from the sternum, and of the cartilages of some of the lower ribs from one another.

The head of each rib articulates with the bodies of one or two vertebræ by a true joint containing one or two synovial sacs and strengthened by firm ligaments; the tubercle and neck of each rib, except the eleventh and twelfth, are united to the transverse process of the corresponding vertebra by a synovial joint and ligaments and to the transverse process of the vertebra next above by a longer ligament. The union between each rib and its costal cartilage is direct, without a synovial sac, and is strengthened on the anterior surface by the periosteum. The articulations between the costal cartilages and the sternum are, with the exception of the first, true synovial joints, sometimes double, surrounded by a capsule which is strengthened in front and behind to form the anterior and posterior ligaments. The seventh rib is the lowest that articulates with the sternum. The fifth, sixth, seventh, eighth, and ninth costal cartilages are united with one another for a short distance on their contiguous margins by true synovial joints formed by slight projections on their margins and surrounded by capsules which are strengthened by fibres derived from the anterior intercostal aponeuroses.

DISLOCATION OF THE HEAD OF THE RIB. (LUXATIO COSTO-VERTEBRALIS.)

The earlier writers described three forms of dislocation of the head of the rib as possible, upward, downward, and inward, but their descriptions appear to have been based exclusively upon their notions of what was anatomically possible, and not to have been supported by knowledge of the actual occurrence of any of the forms. The first recorded case, and that a doubtful one, was reported in 1753 to the Académie de Chirurgie by Buttet. His patient was a man fifty-five years old who had been run over by a wagon; he was so fat, and the swelling was so great that the outlines of the ribs could not be traced, and the diagnosis was based on the fact that when pressure was made upon the front of the chest the sixth rib on the right side could be felt to move with a very distinct, audible click which, moreover, was reproduced whenever the patient made a movement of his trunk.

The next case was Hankel's[1] in 1834: a young man fell into a clay-

[1] Hankel: Gazette Médicale, 1834, p. 187.

pit and received an injury in the lower dorsal region; he died on the fifteenth day, and the autopsy showed fractures of the eleventh dorsal vertebra and of the twelfth rib on each side and a dislocation of the eleventh left rib.

During the next following six years six additional cases were reported, and the list has not since been added to except by Webster's case, the date of occurrence of which is not known but is probably earlier than that of the others.

M. Webster,[1] when examining the body of a patient who had died of fever, found the head of the seventh rib thrown upon the front part of the corresponding vertebra and there ankylosed. He learned that the individual, several years before, had been thrown from his horse across a gate and was supposed to have broken a rib.

Boudet,[2] in 1839, reported the case of a man thirty-two years old who had been instantly killed by a fall from a height of ninety feet. The head of the fourth rib on the left side had been dislocated, without fracture, forward and inward through the pleura and into the lung; the corresponding transverse process was broken.

Alcock[3] reported the case of a man who by a fall from a roof received injuries of which he died on the fifteenth day. The laminæ of the sixth and seventh dorsal vertebræ were broken, and the spinous processes driven into the vertebral canal; the sixth, the seventh, and eighth ribs were fractured, and "two of them had their heads dislocated from their articulation with the transverse processes." The case is quoted by Malgaigne and subsequent writers from an abstract in the Gazette des Hôpitaux, and their description reads "their heads were entirely expelled from their articular cavities."

On the page (586) in the *London Medical Gazette* preceding that in which the original account is found, Alcock reports another case not mentioned by Malgaigne or those who have followed him: a soldier received a gunshot wound in the back, the ball entering three inches from the spinous processes and lodging in the body of the twelfth dorsal vertebra. The eleventh rib was found to have been fractured between the neck and the angle, and "the head of the twelfth rib was dislocated on the body of the succeeding vertebra."

Finally, three cases were published in February and March, 1841, in the *Dublin Medical Press*, those of Kennedy, Dunne, and Finnecane.[4] *Kennedy's* patient was a man twenty years old who fell from a falling platform at a horse race; he complained especially of pain in the lumbar region which was the seat of a large ecchymosis. On examination the surgeons found a distinct depression at the site of the heads of the eleventh and twelfth ribs, and pressure made upon their anterior ends caused the other ends distinctly to move without crepitation. The patient recovered in three weeks. The diagnosis was dislocation of the last two ribs downward and forward.

[1] Webster: Cooper on Dislocations and Fractures, Am. Ed., 1844, p. 450.
[2] Boudet: Bull. de la Soc. Anatomique, 1839, vol. 14, p 104.
[3] Alcock: London Med. Gazette, 1838–39, vol. 2, p. 587.
[4] Abstracts in the Gazette Médicale, 1841, p. 410.

Dunne's patient was a lad eleven years old who received a blow upon the back; he became paraplegic on the seventh day and was brought to the hospital on the ninth, when a swelling one inch broad and three-quarters inch high was found extending along the left of the spinal column in a position corresponding to the heads and necks of the last three or four ribs; the tenth and eleventh ribs appeared to be depressed. An abscess formed and was opened, and the boy died on the sixteenth day. The tenth and eleventh ribs were found to be dislocated forward, the former completely, the latter incompletely. The costo-transverse ligaments of the tenth rib were completely ruptured, and the displacement was such that the finger could be passed between the head of the rib and the corresponding articular surface on the body of the vertebra.

Finnecane's case was that of a girl fifteen years old who was killed by the fall of the roof of a burning house in which she was lying ill of a fever. She was found dead on her knees beside the bed, one beam having fallen upon her head, and another across her loins. The last two ribs on the left side were found dislocated forward on the bodies of the vertebræ, and the costo-vertebral and costo-transverse ligaments ruptured.

It appears from these scanty records that the lower ribs, especially the last two, are the ones most exposed to be dislocated, and that the cause is direct violence received from behind. The only form verified by autopsy is dislocation forward, and in only one case (Kennedy) was it thought that the rib was dislocated downward as well as forward.

The great mortality in the cases, six out of nine, is of course to be attributed to the associated lesions; there is no reason to think that the simple dislocation of the head of the rib would of itself be dangerous unless in its displacement it should injure adjoining important parts, as it did indeed in Boudet's case, in which it perforated the lung.

The treatment employed in the cases that recovered was very simple, a body bandage with, in one case, a compress over the anterior ends of the ribs, an addition which it is permitted to suppose was not of importance.

Separation of the Ribs from the Costal Cartilages. (Luxatio Chondro-costalis.)

Of this injury there are only five, possibly six, examples on record, and in only one of these was the condition demonstrated by autopsy. Three of the cases are described by Malgaigne, and the fourth, of which he quotes a brief mention by Samuel Cooper, is in all probability the well-known case of Charles Bell. Of the fifth case our only knowledge is through the description of the specimen presented without history to the Société Anatomique by Carbonell.[1] It showed a separation of the second, third, and fourth cartilages from the ribs, with fracture of the ossified union between the first rib and the sternum and of the fifth costal cartilage one centimetre from its outer end; all five ribs were also broken at their angles, and the right bronchus was torn away from the trachea.

Chaussier's[2] patient was an officer forty-eight years old who had long

[1] Carbonell: Bull. de la Soc. Anatomique, 1865, p. 17.
[2] Chaussier: Bull. de la Faculté, 1814, p. 50, quoted by Malgaigne.

suffered with a cough and had thereby produced a hernia of the lung between the eighth and ninth ribs on the left side and another between the seventh and eighth ribs on the right side at the level of their junction with the cartilages, accompanied by a separation between the seventh rib and its cartilage on the right, and between the eighth and its cartilage on the left; at each of these points the rib was movable with crepitation.

Bouisson's and Chas. Bell's cases have been quoted in the volume on Fractures, p. 321. In the remaining case, De Kimpe,[1] the patient was thrown from his horse, and struck his chest against a milestone; the fifth costal cartilage on the left side was depressed so that the rib overrode it and projected under the skin. The displacement could be corrected by a full inspiration, but recurred on expiration. A tight starch bandage was worn for three weeks, and then union was found to have taken place with a displacement backward of the cartilage equal to about one-third its thickness.

The possible sixth case is Monteggia's,[2] a separation of the second and third costal cartilages in a very emaciated man seventy years old, in consequence of a violent attack of coughing. Gurlt says: "Monteggia declares expressly that it was not a fracture of the cartilage but a separation of the epiphysis," by which, of course, is meant a separation at the costo-chondral junction.

The injury is so closely allied to fracture of the cartilages that the reader is referred for other details to Chapter XVIII. of the volume on Fractures.

Dislocation of the Costal Cartilages from the Sternum. (Luxatio Chondro-sternalis.)

Of this injury there are twelve recorded examples: Ravaton, Manzotti, Monteggia, and Bell, quoted by Malgaigne; Cooper,[3] Flagg,[4] Wolfenstein,[5] Gross,[6] Bennett,[7] Mulvany,[8] and Blodgett, two cases.[9] There are, in addition, one or two cases, elsewhere referred to (see Chap. XIII.), in which separation of the first and second pieces of the sternum has been accompanied by complete separation of the second costal cartilage from the sternum on one or both sides.

In three of the cases (Bell, Cooper, and Blodgett's second) the cause appears to have been traction exerted through the pectoralis major, in swinging dumb-bells, kneading bread, and exercising on parallel bars; and possibly the cause was the same in Blodgett's first case, in which a man while carrying a piano made a violent effort to prevent its fall. In three others the cause was a fall; in the remainder it is unrecorded or obscure.

[1] De Kimpe: Gaz. des Hôpitaux, 1852, p. 18.
[2] Gurlt: Loc. cit., vol. 2, p. 250.
[3] Cooper: Loc. cit., p. 451.
[4] Flagg: Northwestern Med. and Surg. Journal, August, 1871, quoted by Hamilton.
[5] Wolfenstein: Allg. Wiener Med. Ztg., 1873, No. 44, quoted by Poinsot.
[6] Gross: Surgery, 6th ed., vol. I., p. 1132.
[7] Bennett: Dublin Journal Med. Sc., 1879, I. p. 441.
[8] Mulvany: Lancet. 1882, I. p. 432.
[9] Blodgett: N. Y. Med. Journ, 1883, vol. 38, p. 34.

The fourth cartilage was displaced singly forward in three cases, forward in combination with the fifth and sixth in two, and backward with the second and third in one; the third singly, the fifth and sixth together, and the fifth, sixth, and seventh together were each displaced forward in one case, and the first and second were together displaced forward and outward once (Blodgett's first). In two cases it is not stated which cartilage was displaced, nor in what direction.

The only autopsy was in Bennett's case. The patient was a woman about fifty-six years old who had been run over by a cart and died a few days later of pleurisy and pneumonia. The third cartilage on the left side was displaced forward, and there was also fracture of the second, third, fourth, and fifth ribs on the same side, and of the second to the ninth ribs on the right side. The perichondrium with the attached ligaments was stripped clean off. The dislocation was reduced by direct pressure and did not recur; it must be remembered, however, in connection with this, that the corresponding rib was broken.

In the single case of backward dislocation (Mulvany) the patient was a boy fifteen years old, who while steering a ship in a heavy storm was thrown violently across the deck by a wave and struck upon the back of his left shoulder against the deck-house. The second, third, and fourth left cartilages were displaced backward behind the sternum, and the sternal end of the right clavicle was dislocated forward. Reduction could be effected by drawing the shoulders backward, but the displacement immediately recurred when the traction ceased. The patient was kept upon his back for eighteen days, and the deformity was then found to have been much diminished. In two months he was again at work.

Usually there has been sharp local pain at the moment of the accident, subsequently excited by movements of the thorax and by local pressure. In one case (Mulvany) there was slight recurrent hemoptysis.

The recognition of the injury appears always to have been easy, by attention to the difference in level between the cartilage and the sternum. In only one case (Wolfenstein) was it mistaken for a local inflammation.

Reduction of the forward dislocations was in every case easily effected by direct pressure, but the tendency to recurrence was marked.

The best treatment would appear to be the application over the displaced cartilage and around the chest of a broad strip of adhesive plaster, as in fracture of a rib, making special local pressure, if necessary, with a compress. Possibly a truss could be used with advantage.

Dislocation of one Cartilage upon Another. (Luxatio Chondro-Chondralis.)

To our knowledge of this subject nothing has been added since Malgaigne wrote upon it; he collected three cases, one of which came under his own observation. They are, in brief, as follows:

Martin. A man seventy years old, while trying to rise from a strained semi-recumbent posture, felt a very painful snap in his chest. Notwithstanding the swelling of the soft parts, an elevation of the cartilages of the last three true ribs (fifth, sixth, and seventh), on the right side, which made this side much more prominent than the other, could be dis-

tinctly seen, and the hand could be readily passed under them. He was treated by the application of compresses and a body bandage for a month. The elevation persisted, but was smaller than at first.

Boyer. Of this case Malgaigne says only "Boyer, who saw a similar case under analogous circumstances, was also struck by the prominence of the upper cartilage, but recognized that it was the lower one that was dislocated backward."

Malgaigne. A man, while pressing a lever forcibly down with his left hand, his body being inclined to that side, felt under his left breast a snap with a sharp pain which for the moment prevented him from straightening himself. Nine years later the deformity attracted the attention of Dr. Séger, who brought him to Malgaigne. The cartilages of the seventh, eighth, and ninth ribs were depressed below the level of the sixth and tenth, which thus formed the borders of a groove at the bottom of which the intermediate ones lay. The skin formed a marked fold in this groove. The three depressed ribs were approximated to and imbricated upon one another, their intercostal spaces being almost obliterated in front. The dilatation of the chest during inspiration was less on the left than on the right side, the patient's gait was a little uneven, and the trunk inclined forward on the left.

CHAPTER XV.

DISLOCATIONS OF THE CLAVICLE.

THE percentages of the frequency of dislocations of the clavicle in the different tables of statistics that have been published vary greatly from one another (see Chapter I.). Thus, of 400 cases of recent traumatic dislocations collated by Krönlein 6 were of the sternal end of the clavicle and 11 of the acromial end, 1.5 and 2.7 per cent. respectively; of 420 collated by Prahl the corresponding numbers were 10 and 3, or 2.38 and 0.73 per cent. In Table III., Chapter I., a total of 1432 dislocations gives 45, or 3.1 per cent., of the sterno-clavicular joint, and 14, or 0.9 per cent., of the acromio-clavicular, while another of 964 cases treated in hospital gives 68, or 7 per cent., of the sterno-clavicular joint and none of the acromial. Polaillon[1] says that of 967 cases of dislocation treated in the Paris hospitals during four years, 1861–64, 87, or 9 per cent., were of the clavicle. During the same period 609 fractures of the clavicle were treated. Of the 87, 84 were in men, 3 in women; 85 were adults, and 2 were aged. Of 97 reported cases collected by him from medical books and journals, 77 were in men, and 17 in women; in 3 the sex was not stated. He gives the following table of 66 cases classified according to sex and age:

TABLE VIII.—DISLOCATIONS OF THE CLAVICLE; SEX AND AGE.

	Male.	Female.	Total.
Under 10 years	1	2	3
10 to 15 "	2	0	2
15 " 20 "	2	4	6
20 " 30 "	8	2	10
30 " 40 "	13	2	15
40 " 50 "	15	0	15
50 " 60 "	6	2	8
Above 60 "	5	2	7
	52	14	66

And the following of 97 classified according to the variety:

TABLE IX.—DISLOCATIONS OF THE CLAVICLE; VARIETIES.

			Male.	Female.	?
Acromial end,	50	38 upward	32	3	3
		6 downward	5	1	0
		6 subcoracoid	4	2	0
Sternal end,	44	19 forward	14	5	0
		16 backward	13	3	0
		9 upward	7	2	0
Both ends,	3	.....	2	1	0

[1] Polaillon: Dict. Encyclopédique des Sciences Méd. Article, Clavicule, p. 717. (1875.)

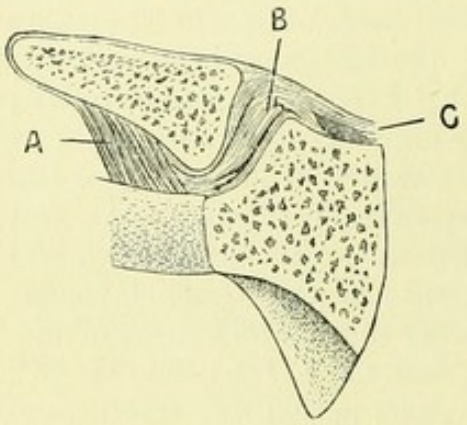
Of 50 cases observed by Hamilton, 9 were of the sternal and 41 of the acromial end.

The dislocation may be of either end or of both, and occasionally both clavicles have been simultaneously dislocated.

A. Dislocations of the Sternal End of the Clavicle.

Anatomy.—The sternal end of the clavicle is so much larger than the clavicular notch of the sternum with which it articulates that it projects above it and in front and behind. The articular surfaces are separated from each other by an interposed fibro-cartilaginous disk, or meniscus, of varying thickness, which fills the gaps created by the unsymmetrical irregularities of the two surfaces and by their inclination to each other, and extends below the lower edge of the clavicle, separating it also from the cartilage of the first rib. This meniscus is most strongly attached above to the upper edge of the end of the clavicle, and below to the cartilage of the first rib. On each side of it is a synovial cavity. The ligaments of the joint are the interclavicular, costo-clavicular, and the anterior and posterior sterno-clavicular. The inter-clavicular ligament extends across from the upper edge of the end of one clavicle to that of the other above the inter-clavicular notch of the sternum, sending bundles of fibres into the meniscus and to the top of the sternum. The costo-clavicular ligament extends from the sternal end of the first rib upward and outward to the under surface of the clavicle as far as to the subclavian vein, partly surrounding the inner end of the subclavius muscle but lying mainly behind it. It sometimes contains within itself a bursa of considerable size. The anterior and posterior sterno-clavicular ligaments cover in the joint in front and behind respectively, mainly constituting its capsule. They are short and quite tense.

Fig. 32.



Frontal section through the sterno-clavicular joint. *A*, rhomboid or costo-clavicular ligament; *B*, meniscus; *C*, interclavicular ligament. (Henle.)

Motion is possible about all the axes, but only to a comparatively limited extent, the extreme opposite limits being distant about 60° from each other; that is, the acromial end of the bone can be made to describe a circle which is the base of a cone having an angle of 60° at its apex in the joint. Movement of the shoulder downward or downward and backward is arrested by contact of the clavicle with the first rib, and if then continued this point of contact becomes the centre of motion, or the fulcrum, and the sternal end of the clavicle is forced upward or forward out of its place, and a dislocation is produced.

Varieties.—The dislocation may be complete or incomplete, upward, forward, or backward; and when complete it is usually also inward, toward the median line, and when complete forward or backward, it is usually also downward. Possibly a separate class of dislocations, upward

and outward, should be made of such cases as those of Stokes (*vide infra*) in which the cause is the prolonged action of the sterno-cleido-mastoid muscle in forced inspiration.

Dislocation Forward. (Luxatio Claviculæ Præsternalis.)

This is the most common form, and is usually caused by the shoulder being forced backward, or backward and downward. The means by which this movement has been produced are various; in some cases it has been a fall upon the point of the shoulder or upon the extended hand; in others, the pressure of some heavy object upon the front of the shoulder when the body was supine, as the wheel of a wagon or the foot of a horse; in others, again, by the sudden slipping of a heavy burden carried upon the back by straps passing around the shoulders. Richerand[1] reported a case in which it was caused in a girl twenty years old by the forcible approximation of her elbows behind her back, and Boyer another in which the shoulders were drawn back to give the patient, a young girl, a more erect and graceful carriage. In like manner, it has been caused by the voluntary throwing back of the shoulders, as in soldiers at drill, and in one case, Bardenheuer,[2] by the involuntary effort made to prevent the fall of a burden carried upon the head.

In all of these the mechanism is the same; the outer end of the clavicle is carried back to the limit of the normal range of motion, and then it either finds a new centre of motion at the point at which it comes into contact with the first rib, in consequence of which the inner end is carried forward if the movement is prolonged, or, as claimed by Morel-Lavallée, the limit of the normal range is reached without such contact with the rib, the anterior sterno-clavicular ligament is put upon the stretch and ruptured, and then dislocation takes place. The latter explanation fails, I think, to account for the displacement of the bone, since even after the anterior ligament has been torn by the angular movement backward, direct propulsion forward is necessary to overcome the resistance of the posterior one, and unless another suitable force is superadded this can be effected only by such change of motion as would be produced by the interposition of the new fulcrum assumed in the first explanation.

Other cases in which the mode of action is not entirely clear, although possibly the same as the above, are Melier's, in which the dislocation was caused in a child by grasping its arm to save it from falling from a carriage, and Holden's,[3] in which it was caused by violent exercise in a gymnasium.

Holden's case is of interest also for other reasons: the dislocation was readily reduced, and the bone remained in place for six months; then, while the patient was putting on his coat the dislocation was reproduced, and again, a few days later, while doing the same thing, the sternal end of each clavicle was dislocated, "and from that time the phenomenon recurred frequently until the inconvenience had become unbearable." Even raising the hands to the face would reproduce it. The dislocation

[1] Bardenheuer, Deutsche Chirurgie, Lief. 63, a, p. 57.
[2] Richerand: quoted by Polaillon: Loc. cit., p. 729.
[3] Holden: N. Y. Medical Journal, 1873, vol. 18, p. 622.

was upward and forward, and "equal to the diameter of the end of the bone."

It was successfully treated by the prolonged wearing of an artificial sternum of leather with a prolongation or horn at each upper corner. This was moulded to the parts while wet, the horns being pressed down over the clavicles, and, when dry, was lined with buckskin and supplied with a strap and buckle at the end of each horn and its lower extremity. By means of these straps it was made fast to a broad belt about the waist.

In a few cases the dislocation has been caused by the pressure of an aneurism at the root of the neck, and in others[1] by prolonged, forced, inspiratory efforts. In the latter (two cases) the dislocations appear to have been primarily upward, and the displacement forward to have been the consequence of the elongation of the ligaments. In one of them both clavicles were dislocated.

Cazin[2] reported a case in which the dislocation was gradually produced in a boy eleven years old who was suffering from Pott's disease of the dorsal spine with angular deformity and retraction of the corresponding side of the chest, and who had the habit of resting on his elbows in bed. Cazin thought the displacement was due to the diminution of the size of the upper part of the chest, not to the force exerted through the arm.

In a case reported by Heusinger[3] the sternal end of each clavicle in a boy fifteen years old could be readily displaced forward, upward, or backward simply by the movements of the arms. The condition had never been noticed by the boy or his parents, and is spoken of by the reporter as congenital. The condition of the parts was characterized by great laxity of the ligaments between the sternum and the meniscus, the latter remaining closely attached to the clavicle and sharing in its movements.

Age.—According to Bardenheuer, Fergusson met with a case in which the dislocation was produced in a child during delivery. The next earliest age at which the injury has been reported is ten months; it was caused by a fall from bed.[4]

Pathology.—The dislocation may be complete or incomplete; in the latter form the posterior portion of the articular surface of the clavicle remains in contact with that of the sternum, and the anterior sterno-clavicular ligament alone is ruptured. In the former the articular surfaces are completely separated, and the posterior edge of that of the clavicle rests upon the front of the sternum; ordinarily it lies nearer the median line and at a lower level than that of its normal position, the greatest recorded displacements being one mentioned by Richerand, three inches downward, another reported by Jousset[5] in which the end of the clavicle lay upon the second rib. This displacement inward or downward or in both directions must be secondary and due to the action of the weight of the corresponding limb and to the contraction of the muscles which draw the shoulder inward, downward, and forward when it is

[1] Stokes: Dublin Med. Journ., 1852, vol. 13, p. 459.
[2] Cazin: Gaz. de Hôpitaux, 1874, vol 47, p. 507.
[3] Heusinger: Arch. für path. anat., 1867, vol. 39, p. 339.
[4] T. R. Wright: Boston Medical and Surgical Journal, 1880, vol. 102, p. 333.
[5] Jousset: Gaz. Médicale, 1833, p. 217.

deprived of its normal support, in the same manner and for the same reasons as after fracture of the clavicle. (Fractures, p. 337.) The opportunities for post-mortem examination have been so few that a positive account of the condition of the ligaments cannot be given. That the anterior one is ruptured cannot be doubted, and it is probable that the posterior one also is torn, although in some cases it may only be torn from its attachment and left continuous with the stripped-up periosteum of the posterior surface of the clavicle. In one case[1] all the ligaments except the anterior sterno-clavicular are described as intact; the meniscus accompanied the clavicle and was partly torn. In a case reported by Cloquet[2] there was found at the autopsy instead of rupture of the posterior ligament a fracture that split the end of the clavicle into two parts, the posterior one of which remained in place, while the anterior one, continuous with the shaft of the bone and capped by the meniscus, was dislocated forward. Whether or not the meniscus habitually accompanies the end of the clavicle in its displacement is not known.

In the cases in which the dislocation has been slowly produced, Stokes's and probably Heusinger's, the ligaments were found greatly elongated but not torn. Stokes does not mention the position of the meniscus: in Heusinger's case it accompanied the clavicle.

Occasionally a portion of the edge of the articular surface of the sternum or of the clavicle has been broken off. The sternal portion of the sterno-cleido-mastoid may be pushed aside or even torn away from the sternum, perhaps bringing with it a scale of bone.

Simultaneous dislocation of the acromial end (*vide infra*) and fracture of the shaft have been observed as complications.

Symptoms.—The principal physical sign is the projection of the end of the clavicle and, if the dislocation is complete, its displacement toward the median line or downward. If the dislocation is incomplete the projection can be made to disappear by pressing it backward, but it is likely to reappear when the pressure is removed. In the complete dislocations the extent and direction of the displacement vary with the extent to which the ligaments have been torn and with the character of the dislocating force and the influences to which the limb has been subjected since the accident. The weight of the limb, if unsupported, tends to bring the shoulder nearer the thorax and thus forces the end of the clavicle inward or downward. If the head and neck are maintained erect the clavicle is kept at or near its normal level by the clavicular portion of the sterno-cleido-mastoid and the cervical fascia, but if, as seems to be usually the case, the head is inclined toward the injured side to relieve the pain, this support is lost and the bone is left free to descend to a lower level.

The other symptoms are sharp local pain, which is greatly abated in a day or two, depression of the shoulder, inclination of the head toward the injured side, and inability to raise the arm.

The local swelling may be so great as to mask the position of the bone, and if crepitation should be present the injury may be, as it has

[1] Bull. de la Soc. Anatomique, 1879, p. 809.

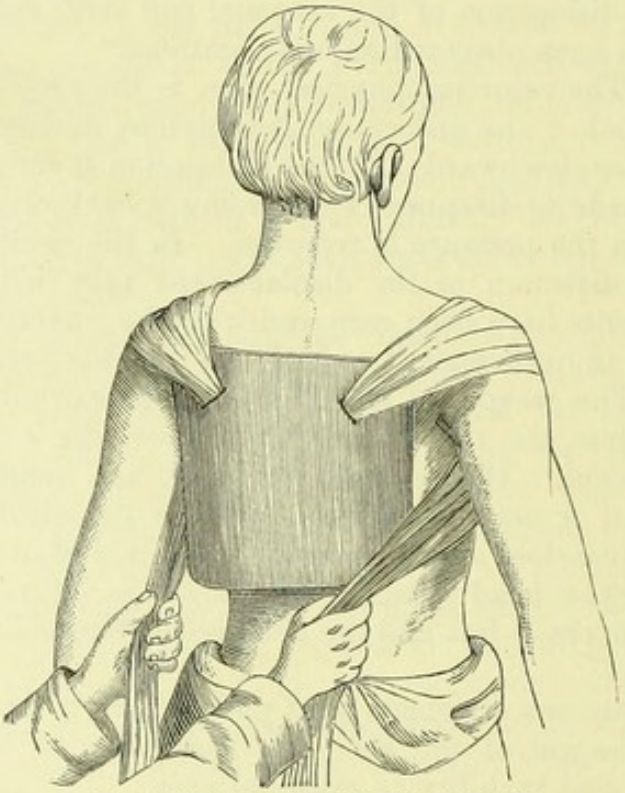
[2] Cloquet: Nouveau Journ. de Méd. 1820, vol. 7, page 248, quoted by Polaillon.

been, mistaken for fracture. Another error of diagnosis has been to mistake the dislocated end for an exostosis; and, conversely, hypertrophy of the bone has been mistaken for a dislocation.

The *prognosis* is unfavorable as regards the complete correction of the deformity, but favorable in respect to the restoration of function. In almost all the reported cases projection of the end of the bone, to a greater or less extent, has persisted, but the patients have been able to use the arm freely and with no sense of loss of power, even when the dislocation has remained complete. Holden's case, above quoted, is exceptional in both respects. The inconvenience of the displacement is spoken of as "unbearable," and the permanent reduction appears to have been complete.

Treatment.—Reduction is effected by drawing the shoulder outward and slightly backward and making pressure backward on the dislocated end after it has been thus brought opposite the joint. Hamilton failed in two cases to effect reduction, but I have met with no other reported failures. The reduction is, however, the least part of the treatment; the difficulty is to keep the bone in its place. Many methods, including most of those that have been used in fracture of the clavicle, have been tried, and often in combination with direct pressure upon the end of the bone. Velpeau and Malgaigne recommended that the shoulder should be kept drawn forward, a recommendation that seems justified on

FIG. 33.



Récamier's dressing for fractured clavicle.

anatomical grounds but has not yielded good results in practice; probably the failure is due to the same cause that has rendered the posterior position of the shoulder inefficient, the difficulty of maintaining it.

A simple method that has yielded fairly good results is a figure-of-8 bandage around the shoulders, the turns crossing over a pad on the back. Or the bandage may be attached to the pad as in the dressing recommended by Récamier for fracture of the clavicle (Fig. 33).

Direct pressure, usually in conjunction with fixation of the shoulder, has been applied in a great variety of ways, of which the simplest, which may serve also as the type, was that employed by Nélaton. He used an ordinary spring-truss, placing one of its pads upon the sternal end of the clavicle and the other between the shoulder-blades, and carrying the spring under the axilla of the uninjured side. The objection to the use of pressure arises from the probability of irritating the skin or even causing a slough at the point at which it is applied. Combined with rest in bed upon the back and a good position of the shoulder, the maintenance of the pressure for a week has proved sufficient to prevent recurrence although not entirely to overcome the projection.

Demarquay proposed to mould a leather cape accurately to fit the bust of the patient, and to reinforce its pressure by a spring and pad fitted over the end of the bone. An objection to the dressing arises from its expensiveness. Probably an efficient substitute could be made of plaster-of-Paris, and the fixation of the shoulder could be assured by enveloping the chest and the upper arm in the plaster and connecting them by means of iron braces. Such a dressing could be made to leave the inner end of the clavicle open to inspection, and would furnish a support for the attachment of a compressing pad, if that should be necessary.

Le Fort[1] obtained excellent results in two cases by moulding a piece of gutta-percha over the lower part of the neck and upper part of the chest so as to cover both sterno-clavicular joints and about two-thirds of the dislocated clavicle, and keeping it in place by straps or a truss.

Possibly the dressing employed by Holden (ut supra) would be entirely efficient to keep the bone in place. The brief account of his case leaves it somewhat uncertain whether or not the reduction was complete.

In a case in which the total correction of the displacement should be important, the patient should be kept in bed upon the back, in order to diminish the tendency to reproduction of the deformity created by the weight of the shoulder when the body is erect, and frequent inspection should be made to determine the efficiency of the measures. Should all other means fail, digital pressure should be maintained for a week or ten days. The dressings should be worn for at least a month.

Dislocation Backward. (Luxatio Claviculæ Retro-sternalis.)

This dislocation, the second in order of frequency of those of the sternal end, may be produced *directly*, by a force acting from before backward upon the end of the bone, or *indirectly*, by a force that presses the shoulder forward and inward. The latter is the more frequent. In the few recorded cases of dislocation by direct violence the cause has been such as the fall of the patient forward, striking upon the clavicle,

[1] Le Fort: Gaz. des Hôpitaux, 1885, p. 369.

or the fall upon him of a stone, or the passage across his chest of the wheel of a wagon, and in one case the point of a pickaxe was driven through the skin over the cartilage of the second rib by the caving-in of a bank of earth, and then, passing upward, forced the clavicle out of place. In the dislocations by indirect violence the patient has commonly been caught between two bodies, as the pole of a wagon and a wall, or the side of a railway car and a wall, or between two boats, in such a way that the shoulder has been pressed forward and inward.

A case mentioned by Sir Astley Cooper[1] is frequently quoted as one in which the dislocation was caused by progressive distortion (scoliosis) of the spine. It appears, however, that the dislocation was due to an accident, and that the subsequent change in the shape of the spine only increased the unreduced displacement until it seriously interfered with deglutition. The end of the clavicle was then removed by operation.

The dislocation may be complete or incomplete.

Pathology.—Until quite recently the only recorded case in which a direct examination of the parts had been made was the one of compound dislocation mentioned above in which the injury was caused by the point of a pickaxe. It was reported by Tyrrell.[2] The pectoralis major was freely torn from its attachment to the clavicle, but in all probability this was mainly, if not entirely, the result of a direct action upon it of the point of the pickaxe, and is not a common feature of the dislocation. The meniscus remained attached to the sternum, and the end of the clavicle could be easily felt by the finger in the wound.

A second case was reported by Bennett[3] in 1881; the patient was caught between a wall and a railway car and rolled along for some distance. The sternal end of the right clavicle, accompanied by the meniscus, was dislocated backward, and the cartilages of the first, second, third, and fourth ribs of the same side were broken.

The end of the bone is displaced inward or inward and downward, and it is generally stated that it lies between the trachea and the sterno-hyoid and sterno-thyroid muscles, but, in the absence of direct proof of this, I am disposed to believe that it may rather lie between the latter muscle and the sternum, and below the former, for, it will be remembered, the sterno-hyoid arises in part from the posterior ligament of the joint and frequently from the clavicle itself, and the sterno-thyroid lies behind the other and has its origin as low even as the cartilage of the second rib. Possibly the difference noted in the direction of the displacement, inward in some, inward and downward in others, may depend upon varying relations between the bone and these muscles.

Whatever the relations between these parts may be, the end of the bone frequently presses upon the trachea and thereby causes more or less dyspnœa, or upon the œsophagus and causes dysphagia. Of sixteen cases analyzed by Polaillon dyspnœa was present in six, and dysphagia in three. The venous congestion of the face and neck coexisting with the dyspnœa has been sometimes attributed to pressure upon the brachio-

[1] Cooper: Disloc. and Fractures, Am. ed., 1844, p. 309
[2] Tyrrell: St. Thomas Hosp. Reports, 1836, vol. i. p. 261.
[3] Bennett: Dublin Journ. Med. Sci., 1881, vol. 71, p. 444.

cephalic vein, but although the region into which the end of the bone is displaced is occupied by most important vessels and nerves, the recorded histories do not show that they have ever been seriously pressed upon. Some authors, quoting other accounts of Cooper's case, say that pulsation was arrested in the radial artery on the corresponding side; if this was so, it was probably due to compression of the subclavian artery between the clavicle and the first rib.

Beside the complication of fracture of the cartilages of the first four ribs in Bennett's case mentioned above, fracture of the first rib has been noted in a case reported by Dr. N. C. Morse:[1] the patient was a girl eight years old who had been run over by a wagon and had received a dislocation backward of the sternal end of the left clavicle, with fracture of the first rib, and a dislocation "outward" (forward?) of the sternal end of the right clavicle. Apparently the wheel had crossed the left clavicle and chest. There was great dyspnœa and marked venous congestion of the face and neck which disappeared on reduction of the dislocation. The child recovered.

Symptoms.—The absence of the end of the clavicle from its articulation, and its position behind the sternum are recognizable by inspection and palpation, the course of the bone can be seen and felt to pass inward behind its normal position, and the cavity and border of the articular surface of the sternum can be traced with the finger. Morel-Lavallée called attention to the marked projection forward of the acromial end of the clavicle and claimed that this was a characteristic sign. Its value, which at the best is so much less than that of the recognition of the position of the sternal end, is still further diminished by the normal differences in the prominence of the acromial end.

The shoulder hangs a little forward and nearer the chest; sharp pain, increased by movements of the arm or head, is felt at the seat of injury, but usually is prompt to disappear. These voluntary movements are restricted or abolished by the pain.

Disturbance of respiration by compression of the trachea has been noted in only about one-third of the cases, and may be slight or so severe as to threaten suffocation. Ordinarily it lasts for only a short time, even if the dislocation remains unreduced.

Difficulty in swallowing has been less frequently noted than dyspnœa (three times in sixteen cases).

The *prognosis* is favorable as regards the reëstablishment of function even if the dislocation is not reduced, and reduction is, as a rule, easy, and retention more complete than after dislocation forward.

Treatment.—Reduction can commonly be effected by drawing the shoulder outward and backward, and this seldom requires more force than the surgeon himself can exert without assistance. In one case Lenoir was obliged to provide counter-extension by a bandage carried around the chest and made fast to the wall, and extension by another bandage passed around the upper part of the arm and drawn upon by two assistants while a third held the elbow near the side. In another of his cases one assistant placed his knee against the patient's back and drew his

[1] Morse: Cincinnati Med. News, 1877, vol. 6, p. 819.

shoulder backward while a second assistant held up the chin, and Lenoir passed his fingers down behind the end of the clavicle and pressed it forward. Reduction took place promptly and with a distinct snap.

Recurrence of the displacement should be opposed by dressings that hold the shoulder back and down. Arnaud aided this by keeping the forearm behind the back, an efficient measure but one that might prove very irksome. The necessity exists as in dislocation forward to examine the joint frequently with the object of promptly detecting and correcting any faulty position, and to wear the dressings for several weeks.

Dislocation Upward. (Luxatio Claviculæ Suprasternalis.)

The first recorded case of this form of dislocation was published by Duverney[1] in 1751, the next was observed by Sédillot[2] in 1835, and Malgaigne in 1855 could collect only five cases. The number is now increased to about twenty,[3] with two autopsies, Duverney's and R. W. Smith's.[4] Morel-Lavallée thought the displacement was always secondary to a dislocation backward, an opinion which has not been accepted by others. For reasons given above I am inclined to believe that the essential difference between the two forms is to be found in the relations of the displaced end of the bone to the sterno-hyoid muscle, that in the backward dislocation it lies below or possibly behind it, and in the upward dislocation in front of it. In like manner it differs from the forward dislocation in that the bone lies behind the sternal portion of the sterno-cleido-mastoid muscle instead of in front of and below it.

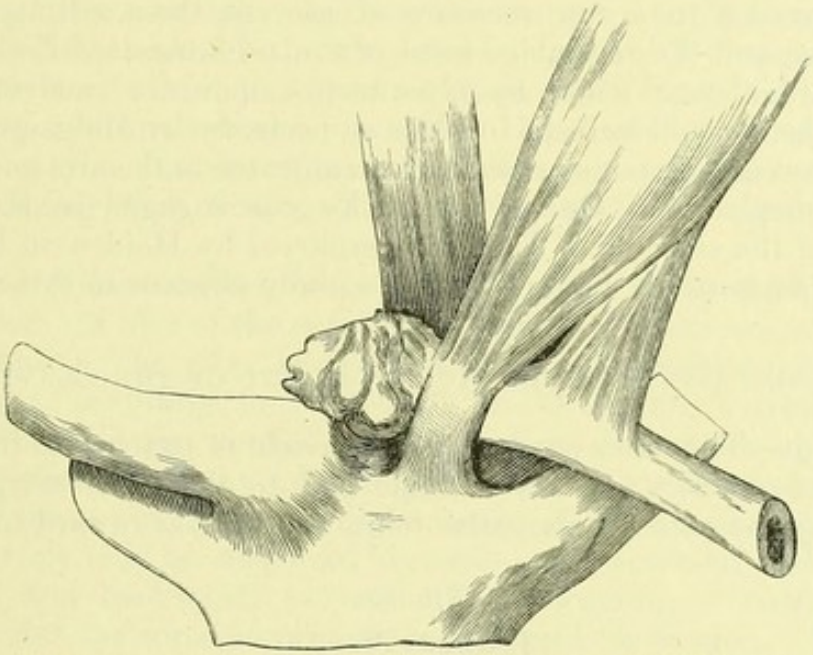
The cause in the sudden, traumatic cases, is the forcible depression of the shoulder and the acromial end of the clavicle, by which the upper portion of the capsule is torn and the end of the bone lifted out of the joint; then, the force continuing to act and pressing the shoulder inward toward the chest, the bone is forced inward to or beyond the median line and sometimes upward so far even as to rest upon the anterior surface of the larynx. A unique mode of production was reported by Dr. A. N. Blodgett.[5] The patient was carrying one end of a piano when the two men who were carrying the other end allowed it to fall. The patient felt sharp pain at the root of the neck and front of the chest, and it was found that the sternal end of the right clavicle had been dislocated upward and inward and that the first and second costal cartilages of the same side had been dislocated from the sternum forward and outward.

In Duverney's case all the ligaments were torn and the periosteum was stripped from the end of the clavicle; doubtless, therefore, the meniscus remained attached to the sternum. In R. W. Smith's case (Fig. 34), the end of the left clavicle rested on the upper border of the sternum in contact with the right sterno-cleido-mastoid, having passed behind the sternal portion of the left sterno-cleido-mastoid and in front

[1] Duverney: Traité des Maladies des Os, vol. i. p. 201.
[2] Sédillot: Contributions à la Chirurgie, 1868, vol. i. p. 261.
[3] For the bibliography see Malgaigne, Hamilton, and Polaillon, and cases here mentioned *passim*.
[4] R. W. Smith: Dublin Journ. Med. Sci., 1872, ii. p. 450.
[5] Blodgett: New York Medical Journal, 1883, vol. 38, p. 44.

of the sterno-hyoids. The clavicular portion of the left sterno-cleido-mastoid was relaxed, its sternal portion tense. The anterior and posterior sterno-clavicular ligaments and the costo-clavicular were torn; the meniscus accompanied the clavicle. The subclavius muscle was relaxed but not torn. There was dyspnœa and dysphagia; death was the result of associated injuries.

FIG. 34.



Dislocation upward of the sternal end of the clavicle. (R. W. SMITH.)

In a case reported by Stokes[1], and mentioned above, the dislocation is described as forward and upward, and the joints as being so loose that the sternal end of each clavicle could be easily moved in any direction; this condition had been produced by the "powerful action of the sterno-cleido-mastoid muscles" in forced inspiratory efforts provoked by great dyspnœa due to ascites. At the autopsy the ligaments were found to be greatly stretched, the sterno-clavicular being half as long again as natural and the rhomboids (costo-clavicular) also elongated. The relations of the end of the clavicle to the sternal portion of the sterno-cleido-mastoid are not stated, and it remains uncertain, therefore, whether the case properly belongs in the class of dislocations upward.

Symptoms.—If the dislocation is *incomplete* the only symptoms are the projection of the end of the clavicle above its normal position, and the local pain increased by movements of the head and arms.

The symptoms of the *complete* form are the recognizable displacement of the end of the bone inward and upward to a variable distance, its position behind the sternal portion of the sterno-cleido-mastoid of the same side, the tension of this portion of the muscle, the depression of the shoulder, and its approximation to the chest; local pain, sometimes dyspnœa and dysphagia, inhibition of voluntary movements of the shoulder and head because of pain, and sometimes the impossibility of passively raising the shoulder. The supra- and infraclavicular fossæ are altered,

[1] Stokes: Dublin Med. Journal, 1852, vol. 13, p. 459.

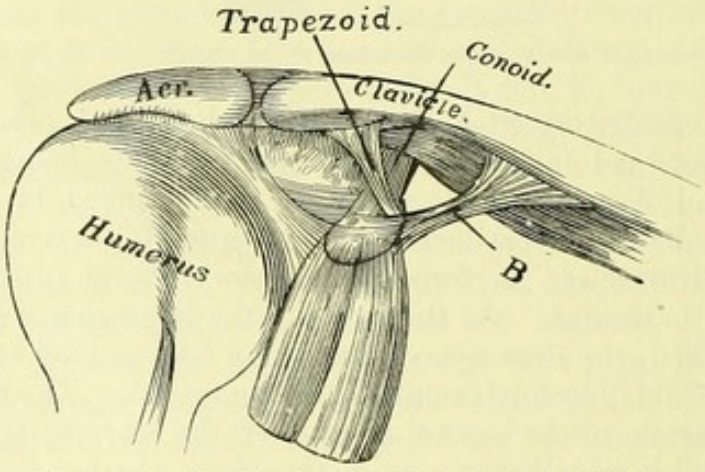
and the emptiness of the clavicular notch of the sternum may perhaps be recognized by palpation.

Treatment.—Reduction is effected by drawing the shoulder outward and making direct pressure downward and outward upon the sternal end of the clavicle, but here again the chief difficulty is to prevent recurrence. Fixation of the shoulder by various dressings, and the recumbent position to avoid the depression of the shoulder by the action of gravity, have been employed with a fair measure of success, the resulting deformity being slight, and the reëstablishment of the usefulness of the arm complete. Bardenheuer[1] found by experiments upon the cadaver that the dislocated bone could be kept in place so perfectly by Malgaigne's hooks that the most extensive movements communicated to the arm and shoulder would not displace it. One of the hooks was engaged in the clavicle, the other in the sternum. The plan employed by Holden in his case of dislocation forward (p. 176), might be equally efficient in this form.

B. Dislocations of the Acromial End of the Clavicle.

Anatomy.—The outer portion of the clavicle is attached to the scapula at two points, namely: at its extreme end to the inner margin of the acromion by the acromio-clavicular joint, and further inward to the cora-

Fig. 35.



Ligaments uniting the clavicle to the scapula. (Henle)

coid process by the coraco-clavicular ligaments. The articular surfaces forming the acromio-clavicular joint are flat and oval in shape, the long axis being antero-posterior, and the upper edge of the end of the clavicle rises to a variable distance above the upper surface of the acromion. The articular surfaces are separated in part, sometimes completely, by an interposed meniscus of fibrous tissue, wedge-shaped, with its base directed upward and attached to the broad, strong *superior ligament;* the *inferior ligament*, usually much thinner than the superior, closes the joint below. The coraco-clavicular ligament is composed of two portions, the postero-internal, or *conoid*, and the antero-external, or *trapezoid.* The conoid ligament, broad above and narrow below, arises from the inner part of

[1] Loc. cit., p. 63.

the upper surface of the coracoid process near its root, and passes upward and backward to be attached to the broad conoid tubercle on the under surface of the clavicle; the trapezoid ligament arises from the upper surface of the coracoid process in front of the conoid and passes upward, backward, and outward to be attached to the trapezoid line which extends outward from the conoid tubercle along the under surface of the clavicle. Between the two ligaments there is frequently a synovial bursa. The conoid ligament especially opposes the displacement backward of the clavicle on the acromion; the trapezoid opposes its displacement upward and outward. A thin, flat band of fibres runs from the back of the coracoid process upward and inward to the clavicle, and is sometimes described as the anterior coraco-clavicular ligament, the conoid and trapezoid being then distinguished as the posterior coraco-clavicular ligament.

Complete dislocation involves not only rupture of the ligaments of the joint proper, but also of the conoid and trapezoid ligaments to a greater or less extent. The joint allows motion in all directions, the extreme ranges being, according to Albert, 20° to 30° in the horizontal plane, and 60° to 70° in the vertical plane; and its dislocation appears to be commonly effected, not by extending the movement of the joint beyond its normal limit, but by direct displacement of one bone upon the other.

The clavicle may be displaced upward, supra-acromial dislocation, or downward and backward, sub-acromial dislocation, or downward and forward under the coracoid process, subcoracoid dislocation. The first is by far the most common; the last has been observed by only two surgeons, one of whom reported five cases.

Some authors, following the system of nomenclature used in the dislocations of other joints, term them dislocations of the scapula, but the innovation has not made its way.

Supra-acromial Dislocation. (Luxatio Claviculæ Supra-acromialis.)

The dislocation may be complete or incomplete; in the latter the clavicle is displaced upward to a distance equal or nearly equal to the vertical diameter of its articular surface; in the former the separation of the articular surfaces is complete, and there is an additional displacement outward over the acromion, or outward and backward, or to a greater distance upward.

The cause is usually a blow received upon the point of the shoulder and directed downward with an inclination inward, forward, or backward. The vigorous contraction of the trapezius by which the clavicle is prevented from accompanying the acromion in its descent seems to be an important, perhaps an essential, factor in the production of the lesion, the alternative factor that has been suggested, arrest of the descent of the clavicle by contact with the first rib, seems more likely to produce dislocation of the sternal end of the bone. Malgaigne found in one case marked tenderness of the trapezius and sterno-cleido-mastoid muscles, and cites the fact as proof of the correctness of this theory in some cases. The absence of such tenderness in other cases should not,

I think, be deemed opposing evidence, for an efficient contraction not followed by injury of the muscle is easily conceivable. A case reported by Cloquet[1] and sometimes quoted as an example of dislocation by direct violence, seems clearly to indicate the important part played by muscular action: A man who was carrying a beam upon his shoulder made a violent effort to keep it from falling, and found he had thereby produced a dislocation. Polaillon[2] mentions a case communicated to him by Dolbeau in which the dislocation was caused in a woman by an attempt to strike a child. In such a case the momentum of the arm presumably takes the place of the more common external violence received upon the shoulder.

A unique case in which the dislocation was caused by a blow received upon the clavicle from below upward is reported by Hamilton;[3] a bolt three-quarters of an inch in diameter was driven through the skin on the anterior margin of the left axilla, breaking the first rib, severing the coraco-clavicular ligaments, and forcing the clavicle upward from its place.

Malgaigne reports a case in which the injury was apparently caused by a fall upon the elbow.

Pathology.—Our knowledge of the character and extent of the laceration of the ligaments is derived almost exclusively from clinical observation and experiments upon the cadaver, for there is only one reported autopsy and one museum specimen. The autopsy, reported by Malgaigne,[4] was in a case of incomplete dislocation and showed that the articular facet of the clavicle had not entirely left that of the acromion; the superior acromio-clavicular ligament was only stretched or perhaps slightly torn away from the acromion, and the inferior one was in great part ruptured; on the other hand, the strong coraco-clavicular ligaments were torn entirely across. There were other and more serious associated lesions, for example, a comminuted fracture of the body of the scapula on the same side.

The museum specimen is one preserved in St. Thomas Hospital and mentioned by Sir Astley Cooper.[5] The patient was a man sixty years old who died of pulmonary disease seven weeks after the receipt of the injury. The account from which I quote states only that "the clavicle was found dislocated at its scapular extremity, and projected considerably over the spine of that bone. The acromion process, just where the clavicle is united with it, was broken off." Malgaigne, quoting apparently from some other account, says that Cooper supposed that all the acromial and coracoid ligaments must have been torn. He adds that this is what experiments upon the cadaver indicate, but that it is melancholy to limit one's self to conjectures when the specimen itself can be examined. Cooper (loc. cit., p. 312) gives also a drawing of a specimen of an old dislocation in which the conoid ligament had become ossified.

Experiments upon the cadaver have yielded results that are not entirely in accord with one another. Malgaigne found that even in incomplete

[1] Cloquet: Journal Hebdomadaire, 1830, vol. 7, p. 400, quoted by Malgaigne.
[2] Polaillon: Dict. Encyclopédique des Sciences Médicales, art. Clavicule, p. 719.
[3] Hamilton: Fractures and Dislocations, 1880, p. 626.
[4] Loc. cit., p. 432.
[5] Cooper: Dislocations and Fractures, Am. ed., p. 313.

dislocation the capsular ligaments were completely, and the coraco-clavicular partly, ruptured. Bouisson and Ader found that incomplete dislocation could be easily produced after division of the acromial ligaments and without injury to the coracoidal, and even to such a degree that the articular surfaces were completely separated vertically from each other. Ader further showed that after division of the coracoidal ligaments a complete dislocation could be readily produced and the end of the clavicle removed to a distance of two centimetres from the acromion.

Instead of rupture of the upper acromial ligament avulsion of the edge of bone on either side to which it is attached has been observed clinically.

Among the recorded complications are simultaneous dislocation of the sternal end of the same or of the other clavicle, fracture of the clavicle, of a rib, of the acromion process, of the coracoid process, of the body of the scapula, and subcoracoid dislocation of the shoulder of the same side.

Symptoms.—In incomplete dislocation the deformity consists in the elevation of the end of the clavicle to a variable distance, not greater, however, than the thickness of the bone, above the level of the acromion, and this elevation can be readily recognized by palpation, and can generally be reduced by moderate pressure.

In complete dislocation the elevation is greater, more than an inch in some cases, or is combined with displacement outward, backward, or forward. The displacement outward is, of course, due to the approximation of the acromion to the chest, and it is greater when the displacement upward is also greater. The explanation of this latter fact is to be found in the presumably more extensive laceration of the ligaments uniting the two bones. The greatest recorded overriding is one inch (Malgaigne). It has been observed also in some cases that the scapula has undergone a movement of rotation by which its inferior angle is carried backward toward the spine, and the anterior, upper angle is lowered, a movement that is attributed to the action of the weight of the arm; it has been observed only when the displacement inward of the scapula toward the chest has not been very marked.

The clavicle may occupy a position that is symmetrical with that of the opposite one, or may be inclined either forward or backward, and is then more or less prominent, respectively, under the skin. In a case observed by Malgaigne it had undergone rotation about its long axis by which its posterior border was raised and its anterior border depressed. Its outer end can often be moved quite freely forward and backward along the scapula, but it is sometimes fixed by the rigidity of the trapezius, and then the outer portion of this muscle shows prominently under the skin.

There is local pain, more or less severe, persisting for a variable length of time, and increased by pressure or by voluntary movements of the shoulder or arm. The attitude resembles that of fracture of the clavicle, the head being inclined toward the injured side, and the arm supported by the other hand. In the incomplete cases this is sometimes less marked, or even absent. The interference with voluntary movements of the limb varies greatly, and corresponds measurably with the pain and

the extent of the displacement; some patients are completely disabled, others can use the limb quite freely.

The *diagnosis* is to be made by recognition of the changed relations of the bones, which is easy in the cases of complete dislocation, and seldom difficult in the incomplete. In the latter case the local pain and the possibility of reducing the bony prominence by pressure, together with its immediate reappearance on the removal of the pressure, will give the clew. The question will then lie between dislocation and fracture of the clavicle near its end, and this may be answered by the aid of comparative measurements of the two clavicles and consideration of the presence or absence of signs peculiar to fracture. The error of mistaking the injury for a dislocation of the shoulder appears to have been quite frequently made, although it is difficult to understand how it could happen unless the soft parts were so swollen that the head of the humerus and the outer and anterior borders of the acromion could not be felt. The difference in the attitude of the arm is in itself almost sufficient for the differential diagnosis, for abduction of the elbow, which is the rule in dislocation of the shoulder, has been observed in only one reported case (Hamilton) of dislocation of the clavicle.

FIG. 36.



Complete supra-acromial dislocation of the clavicle.

A contusion or sprain of a joint in which the end of the clavicle stood abnormally high might easily be mistaken for a recent dislocation, since it would present all the signs of one, but the error would be of slight importance and would cause no harm to the patient beyond perhaps a needlessly prolonged confinement of the limb.

The *prognosis* in the incomplete form is good, for although the displacement has commonly persisted in some measure, the resulting deformity is slight. In the complete form, with marked displacement, there is, in addition to the common imperfect maintenance of the reduction an occasional inability even to make reduction. In such cases the functions of the limb may or may not be seriously interfered with by the persistence of the displacement. In the unique case quoted above from Hamilton, of dislocation by direct violence acting upon the clavicle from below upward, the bone remained displaced two inches upward, yet the patient could use the arm as freely and strongly as the other; and in one of Malgaigne's cases the patient, who would not accept any treatment, used his arm quite freely after the sixth day. On the other hand, in one of Bardenheuer's cases, in which the displacement persisted, the diminution of function was considerable, and the power of abduction of the arm was almost entirely lost.

Treatment.—In most cases the reduction of even the complete dislocations can be readily effected by drawing the shoulder either directly upward, or upward and outward, or backward, and at the same time pressing the clavicle directly toward its place. The only opposition that ordinarily needs to be overcome is the weight of the arm, which draws

the shoulder downward and inward away from the clavicle; with this is sometimes associated reflex contraction of the trapezius which draws the clavicle upward, and in a few cases the end of the clavicle has passed through the trapezius in such a way that the interposed fibres of the muscle have constituted a serious obstacle to reduction. To overcome this latter obstacle Moutet[1] subcutaneously divided the clavicular portion of the trapezius close to its insertion and was then able easily to restore the bone to its place and keep it there by a bandage.

In making reduction the arm should be kept near the side and pressed directly upward; if it is abducted the clavicular portion of the deltoid is made tense, and thus may oppose the outward movement of the scapula; and, in like manner, traction made upon the abducted arm is inappropriate, although sometimes successful, because the production of the desired effect is opposed by the deltoid and pectoralis major. If the shoulder needs to be drawn directly outward, this should be done by the hand introduced into the axilla, or by grasping the upper part of the arm with both hands, the fingers resting in the axilla, and the thumbs against the projecting articular surface of the clavicle, and thus drawing the shoulder outward while pressing the clavicle inward. Malgaigne narrates a number of cases in which varying positions of the arm modified the ease with which reduction could be obtained, but the results were contradictory, and do not indicate any principle of general application.

In short, reduction is to be effected by forcing the acromion upward, and outward, forward, or backward, as may be indicated by the direction of the displacement, by pressure exerted upon it through the humerus, by pressing the end of the clavicle in the opposite direction. If the clavicle is held high up by the contracted trapezius, either it must be lowered by inclining the head toward that side, or the acromion must be raised to its level. If the fibres of the trapezius are interposed between the bones, and cannot otherwise be got out of the way, they must be divided subcutaneously close to their insertion upon the clavicle.

In incomplete dislocation simple pressure downward upon the end of the clavicle will return it to its place.

The maintenance of the reduction is more difficult. The weight of the arm and the contraction of the trapezius constantly tend to reproduce the deformity, to carry the shoulder downward, and the clavicle upward. A great variety of methods of treatment have been employed, including most of the dressings used in the treatment of fracture of the clavicle. Most of the special ones seek to raise the acromion by pressure applied to the elbow while the forearm is flexed, and to hold down the clavicle by pressure applied to its upper surface. Simple bandages passing under the elbow and over the shoulder, immovable dressings made with dextrine or plaster of Paris, pads, straps, and buckles in various combinations, India-rubber bands, and even the common Petit tourniquet, all have been tried, and have given good results, and all have met with more or less of failure.

A simple dressing, which can be readily applied, does not slip or require renewal, and has given me satisfactory results in these cases, is

[1] Moutet: Montpellier Médical, 1861, vol. 6, p. 219, quoted by Polaillon.

the following: A strip of stout adhesive plaster, preferably "moleskin plaster," about four feet long, and two or three inches wide, is placed with its centre under the elbow, the forearm being flexed at or within a right angle, and its two ends are carried upward, one behind, the other in front, of the arm, and crossed over the shoulder at a point corresponding to the end of the clavicle, and then fastened to the front and back of the chest respectively. While applying it, the surgeon must press the elbow firmly upward, and the clavicle downward. The eye or finger can readily detect through the plaster any recurrence of the displacement. The dressing should be worn for three or four weeks.

This dressing has, as has been said, given me good results in all the cases, three in number, in which I have used it. I do not say perfect results, for in two of the three I thought there was still left a slight projection. The patients were laboring men, and the other clavicle was also prominent; possibly the projection was no greater than before the accident. However that may have been, the result would, I think, have been satisfactory, even if the patients had been ladies accustomed to expose their shoulders.

It may well be thought that a more extended trial will yield some failures, but, nevertheless, the dressing meets the indications more perfectly and with less inconvenience to the patient and surgeon than any other I know of.

The India-rubber bandage employed in a similar manner, as first proposed by Delens, has often given good results, but has sometimes caused sloughing of the skin. Dr. W. T. Bull reported to the New York Surgical Society in 1886 that he had employed it in four cases, getting sloughs in the last two, and that he had then abandoned it. It seems to me that elasticity is not only not required in the dressing, but is actually objectionable; it allows the bone to be displaced whenever the displacing force becomes greater than the strain exerted by the bandage, and at the same time it is constantly pressing upon the skin, even when pressure is not required, and is thus more likely to cause a slough than adhesive plaster, which, being inextensible, opposes displacement more effectively, and exerts its pressure upon the skin only at the time when, and to the degree that, displacement threatens.

The tourniquet, which appears to have had a larger measure of success than any other method that seeks to meet the indication in this way, is used as follows: The skin near the outer end of the clavicle and under the elbow is protected by pads of cotton or wool, over each of which is placed a plate of card-board or metal to equalize the pressure; then the pad of the tourniquet is placed upon the upper one, and its strap carried around under the elbow and made fast to the buckle, and finally, the screw of the tourniquet is turned until the desired pressure is obtained. A body-bandage immobilizes the arm and supports the forearm, and protects the strap from being displaced. By carefully graduating the pressure to be used, and shifting it from time to time if necessary, the formation of sloughs may be avoided.

Wiring of the clavicle to the acromion has been practised a few times in recent and in old dislocations, but is not generally approved.

W. Baum[1] reports good results in three cases of difficult retention obtained by suturing together through the skin the ends of the acromio-clavicular ligaments, as in Volkmann's method of treatment of fracture of the patella by sutures passed through the tendons. A silk ligature was passed through the skin and each stump of the ligament and tied in a loop, and then the two loops were drawn together over a pad of gauze by another thread. The shoulder was enveloped in a simple antiseptic dressing, and the arm fixed by a splint. In all three cases the recovery was complete in three weeks.

Subacromial Dislocation. (Luxatio Claviculæ Subacromialis.)

This dislocation, of which Petit was the first to make mention, is so rare that Polaillon in 1875 could collect only six recorded cases; the list has now been increased to eleven, or, adding Newman's, to twelve. The first four, quoted by Malgaigne,[2] are those of Melle, 1765, Fleury, 1816, Tournel, 1837, and Baraduc, 1842. The others are two observed and reported by Morel-Lavallée,[3] one by Dr. W. B. Chase,[4] one by Dr. J. X. Allen,[5] and one by Dr. Eaton.[6] Kœnig[7] refers to one that was observed in Bruns's clinic, and Bardenheuer[8] makes several quotations from the report of a case by Uhde but does not give the reference. He speaks also of a case reported by Gosselin in 1881, but I have been able to find only a clinical lecture by Gosselin on a case of supra-acromial dislocation. To these may be added Newman's case of simultaneous dislocation of both ends of the clavicle (*vide infra*), in which the outer end was displaced under the acromion.

The cause in these cases was direct violence exerted upon the upper surface of the outer end of the clavicle (Melle, Tournel, Chase), a fall upon the shoulder in three (Fleury, Morel-Lavallée's two), and muscular effort in one (Allen). In Baraduc's case the patient, a washerwoman, felt while at work a sharp pain in her right elbow; the next morning the pain was in the right shoulder, and the bone was said to be movable and prominent; two and a half months later when she entered the hospital the arm was without strength, the hand could not be raised to the head, and the trapezius, rhomboid, and serratus magnus were atrophied. The vertebral border of the scapula was very prominent, its inferior angle was carried backward and inward, and the anterior angle downward and forward. The end of the clavicle was displaced backward under the acromion.

Allen's patient, a stout muscular girl sixteen or seventeen years old,

[1] Fortschritte der Medizin, 1886, vol. iv., p. 189.

[2] Malgaigne: Loc. cit. p. 448 and 452. Malgaigne thinks Baraduc's case was probably pathological, not traumatic. The reference he gives for Tournel is incorrect; it should be 1837, not 1847.

[3] Morel-Lavalleé: Bull. de la Soe. de Chir., 1863, vol. 4, p. 51 and 240.

[4] Chase: Trans. Med. Soc. State of New York, 1879, p. 170.

[5] Allen: New York Med. Record, 1881, vol. 19, p. 206.

[6] Eaton: New York Med. Record, 1881, vol. 20, p. 734.

[7] Kœnig: Speciel. Chirurgie, 3d ed., vol. 3, p. 16.

[8] Bardenheuer: Deutsche Chir., Lief. 63, a, p. 89.

was chopping wood, and at the moment she had the axe raised and was about to deliver the blow she felt a sharp pain in the shoulder, and the arm fell powerless by her side. When seen six weeks later there was a marked depression on the top of the shoulder, much discoloration in the axilla, and the inferior angle of the scapula was thrown prominently outward. There was complete loss of voluntary motion of the arm and hand, and numbness of the entire limb. Reduction was easily effected by drawing the shoulder outward and backward.

Chase's case may be taken as a type of direct violence. A boy eight years old fell head foremost from a height of twelve or fifteen feet and struck with the top of his shoulder against the rung of a ladder. An ecchymosis over the outer end of the clavicle showed where the blow had been received. The acromial end of the clavicle was dislocated downward and somewhat backward, the shoulder was flattened in front, and the acromion very prominent. Reduction, under anæsthesia, was easily effected by drawing the shoulder outward and backward and pressing the clavicle in the opposite direction. There was no tendency to recurrence, and recovery was complete in five weeks.

Of the other two cases of direct violence, in one, Tournel's, the injury was caused by a horse stepping upon the front of the patient's shoulder as he lay on the ground; in the other, Melle's, the patient, who was a Russian soldier, attributed the injury to an effort he made when six years old to lift, with the aid of another child, a keg of water by means of a stick resting on his shoulder. He had also a dislocation of the corresponding humerus, which apparently had been received at the same time.

Morel-Lavallée explains the escape of the coracoid process from fracture by supposing that the scapula is so inclined by the contraction of the trapezius and the pressure of the clavicle upon the coracoid process, acting in opposite directions, that its inferior angle is abducted, the coracoid depressed, and the acromion elevated and drawn inward over the outer end of the clavicle.

The autopsy in Melle's case and experiments upon the cadaver show that the ligaments uniting the acromion and coracoid to the clavicle are completely ruptured; the clinical facts show that the displacement of the clavicle is not only downward and outward under the acromion but also backward to an extent that leaves the acromial facet entirely in front of the clavicle. This is perhaps to be accounted for by the presence of the head of the humerus, which opposes a displacement directly downward; and the same anatomical fact may explain the coincident dislocation of the humerus in Melle's case. The only other complications observed clinically are fracture of the surgical neck of the humerus, in one of Morel-Lavallée's cases, and simultaneous dislocation of the other end of the clavicle, in Newman's; but in experiments upon the cadaver fractures of the acromion and of the clavicle have been met with. In Melle's case the meniscus accompanied the clavicle.

Symptoms.—The pain at the moment of the accident may be severe or slight; voluntary movements of the arm are interfered with, and sometimes entirely prevented; and in one case (Allen) there was persistent numbness and tingling in the arm and hand, indicative of pressure upon the brachial plexus. The appearance of the shoulder is affected by the

sinking of the acromion and rising of the inferior angle of the scapula so that it appears to be inclined forward. The shoulder is usually approximated to the side of the head, but may be on a lower level than the opposite one because of the inclination of the trunk. The central portion of the clavicle may be depressed below the level of the soft parts in front and behind; its sternal end projects sharply forward, and its acromial end can be traced with the finger to the point where it engages under the acromion a little behind the articular facet on the latter. An obscure part of the description of Tournel's case, which Malgaigne found unintelligible, may possibly mean that the end of the clavicle passed entirely under the acromion and projected beyond its outer border.[1] The outline of the acromion and its empty articular facet can usually be traced with the finger, although in one case the swelling of the soft parts was very great.

The *prognosis* is favorable; in Tournel's case, in which reduction was not attempted, the patient had good use of the limb; in Melle's a new joint had formed between the under surface of the acromion and the upper surface of the clavicle, but the effect upon the functions of the limb cannot be known, for a dislocation of the humerus coexisted. In all the other cases in which the record is sufficiently complete reduction was easily effected with or without the aid of anæsthesia, and there appears to have been no tendency to recurrence except in one case.

Treatment.—Reduction is made by drawing the shoulder outward and backward, the arm being kept parallel to the trunk, and counter-extension being made by a bandage passed around the chest. Morel-Lavellée made traction from the wrist or elbow with the arm abducted, but this position of the limb is less favorable. Tournel reduced by placing his knee between the shoulders and drawing them forcibly backward; and Uhde did likewise, at the same time pressing the clavicle forward. The arm should be fixed against the trunk, and the forearm supported by a body bandage and sling.

Subcoracoid Dislocation. (Luxatio Claviculæ Subcoracoidea.)

Authority for the belief that this singular displacement has ever been clinically observed rests upon the statements of two surgeons, Godemer and Pinjon. Godemer met with his first case in 1833 and with four others in the following five years; Pinjon reported a sixth example in 1842. Godemer's cases were reported to the Société médicale d'Indre et Loire, and published in 1843; his paper was republished by Malgaigne in the *Revue médico-chirugicale de Paris*, 1847, vol. 2, p. 155; Pinjon's case was reported in the *Journal de médecine de Lyon*, 1842, vol. 3, p. 58. All systematic writers upon the subject are agreed in viewing these reports with much suspicion because of their remarkable similarity in detail and of the great anatomical obstacles to the production and maintenance of the displacement.

The features, as described by Malgaigne, are as follows: Four of the

[1] The phrase is: "L'épaule présentait en outre deux saillies; une interne et supérieure formée par l'acromion, l'autre externe et inférieure formée par l'extrémité externe de la clavicule."

six patients were between the ages of sixty-seven and seventy-one years; the remaining two are described as adults. In every case the injury was caused by a fall upon the shoulder.

The symptoms were: 1st. More or less pain and a large ecchymosis in the coraco-acromial region.

2d. A depression at the normal position of the clavicle; this bone was found to be inclined downward and outward, and its acromial end lodged in the axilla.

3d. The coracoid and acromion processes were prominent under the skin.

4th. The shoulder was inclined downward and forward; the inferior angle and posterior border of the scapula formed posteriorly a projection which disappeared when the shoulder was carried upward and backward.

5th. The arm was dependent, but could be easily moved in any direction except upward and inward.

Godemer made reduction in three cases by grasping the clavicle and disengaging it from under the coracoid process, while an assistant forced the shoulder backward and outward. In his other two cases the swelling prevented reduction before the third day. Pinjon failed to reduce because of the fainting of his assistant; the next day reduction was made by a "bone-setter."

C. Simultaneous Dislocation of both Ends of the Clavicle. (Total Dislocation.)

The recorded cases of this injury are now ten in number: Richerand,[1] Morel-Lavellée,[2] North,[3] Hutchinson,[4] Haynes,[5] Col,[6] Lund,[7] Rombeau, Hulke,[9] and Newman.[10] Seven of the patients were males, three females; their ages ranged between thirteen and forty years.

Haynes's patient, a weakly girl, thirteen years old, produced the dislocation while washing the back of her neck with the hand of the affected side; there was a complete dislocation forward of the sternal end, and an incomplete dislocation upward of the acromial end of the clavicle.

In all the other cases the cause was external violence, usually very great. The mode of production is varied, the most common form appearing to be force exerted along the transverse axis of the shoulders, and pressing forward the one that suffers the injury. Thus, Col's patient, a muscular girl, seventeen years old, while engaged in unloading a dray was caught between its shaft and a wall, the pressure being received upon the two shoulders, with a movement of torsion of the left one forward; the left clavicle was dislocated, its sternal end resting on

[1] Richerand: Arch. gén. de Méd., 1831, vol. 25, p. 108; reported by Porral, his interne.
[2] Morel-Lavallée: Bull. de la Soc. de Chir., 1859, vol. 9, p. 361.
[3] North: N. Y. Med. Record, 1866, vol. i. p. 79.
[4] Hutchinson: Lancet, 1871, ii. p. 711.
[5] Haynes: British Med. Journal, 1872, i. p. 99.
[6] Col: Gaz. des Hôpitaux, 1872, p. 893.
[7] Lund: British Med Journal, 1874, i. p. 106.
[8] Rombeau: Bull. Gén de Thérapeutique, 1874, vol. 86, p. 537; reported by Gros.
[9] Hulke: Lancet, 1885, ii. p. 245.
[10] Newman: Ibid., p. 524.

the front of the sternum, and its outer end on the acromion. Hutchinson's patient was caught and rolled along between a locomotive and a platform; Morel-Lavallée's had his shoulder caught between the wheel of a cart and a pile of lumber; Lund's, while resting his left shoulder against a gate, was struck by the end of the shaft of his wagon upon the back of the right shoulder, and the right clavicle was dislocated. North's patient fell backward from a stool, striking on the shoulder; in this case the outer end of the clavicle was dislocated forward. Rombeau's patient was struck on the back by a locomotive; Richerand's patient fell from the third story of a building, striking upon the top of his shoulder; Newman's fell with a falling building, and Hulke's was knocked down by a horse.

The sternal end has always been displaced forward, and the only additional change in position that is mentioned is, in Morel-Lavallée's case, that it had moved rather upward than downward. The acromial end was displaced backward in four cases (once to a distance of three finger-breadths), upward and outward twice, and once each forward and outward, downward, and incompletely upward. In Hutchinson's case the displacement is not described further than by saying that "when pressure was made on either end of the dislocated bone the other extremity rose perceptibly and protruded the skin."

In six of the cases reduction of both dislocations was effected and maintained, and the patients recovered with good use of the limb and but little deformity; in some of them mention is made of more or less persistent projection of the sternal end. Morel-Lavallée was unable to reduce the dislocation of the outer end, although he made direct traction upon it with a hook introduced through the skin. Lund, with the aid of chloroform, could only bring the bone "into fair position;" at the end of ten days the ends were found "fixed in their new position." In Newman's case, dislocation of the outer end under the acromion, reduction was impossible; the patient withdrew from the hospital on the tenth day, and remained disabled. The result in Hutchinson's case is not recorded.

Treatment—Reduction has usually been effected by drawing the shoulder outward and backward, and recurrence prevented by immobilizing it in a suitable position by means similar to those employed when the dislocation involves either end alone. Hulke used a gutta-percha splint moulded over the clavicle and bound down by a bandage that crossed the shoulders and was made fast in front and behind to another about the waist.

CHAPTER XVI.

DISLOCATIONS OF THE SHOULDER.

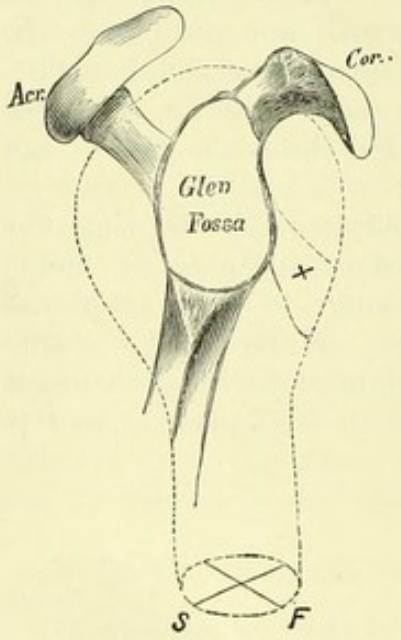
ANTERIOR DISLOCATIONS; SUBCORACOID, INTRACORACOID.

Anterior Dislocations.

Anatomy.—The bony surfaces which enter directly into the composition of the shoulder-joint are the glenoid cavity of the scapula and the postero-internal half of the globular head of the humerus. The former is of irregularly oval shape, the more pointed end above and the broader one below, and is slightly concave, being deepened by a low fibro-cartilaginous rim, which is continuous throughout with the capsule, and above also with the tendon of the long head of the biceps. The cavity looks outward and forward in a direction nearly midway between the sagittal and frontal planes of the body when the scapula occupies its usual position, and changes its direction as the scapula is moved forward or backward around the chest, or is drawn upward or downward, or is rotated.

Against this shallow surface the head of the humerus rests, being held in place by atmospheric pressure, the tonicity of the muscles, and the tension of thickened portions of the capsule in different positions of the limb. On the outer and anterior portion of the upper end of the humerus is the greater tuberosity, bounded internally in front by the bicipital groove which lodges the long tendon of the biceps in its passage downward and has upon its inner side the lesser tuberosity. Between the upper margins of these tuberosities and the globular articular head is a shallow groove, the anatomical neck.

Fig. 37.



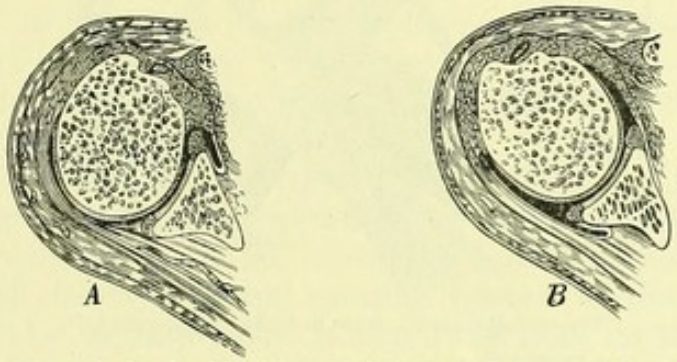
To show the relations of the humerus and scapula. ×, the lesser tuberosity. *F* and *S* indicate the frontal and sagittal planes.

The acromion and coracoid processes lie above, the one on the outer, the other on the inner side, and the strong coraco-acromial ligament uniting them closes in the upper part of the joint, but is separated from its cavity, as are also the two processes, by the interposed capsule and the tendon of the supraspinatus.

The surface of the head of the humerus that is covered by articular cartilage is about one-third of that of a sphere, and the axis passing through its centre meets the long axis of the shaft at an angle of about 130°. The linear extent of the glenoid fossa, including

its fibro-cartilaginous rim, on a horizontal section is less than half as great as that of the head of the humerus; on a vertical section it is about two-thirds as great. The head of the humerus, therefore, simply rests against the fossa, and its displacement is but slightly opposed by the conditions of contact between them. The muscles which are most closely associated with the joint are the supraspinatus, infraspinatus, and teres minor, attached to the greater tuberosity in the order named from above downward, and the subscapularis, which, arising from almost the whole of the costal surface of the scapula, passes forward, broadly covering the inner side of the joint with its fibres and tendon, to be

FIG. 38.



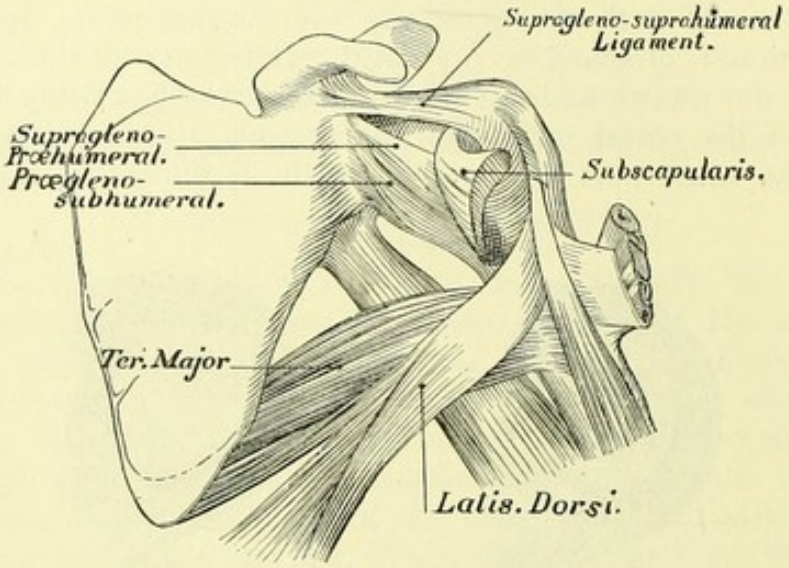
Horizontal section through the shoulder-joint; *A*, in inward, *B*, in outward rotation. (HENLE.)

attached to the lesser tuberosity. The tendon of the long head of the biceps, starting from the upper margin of the glenoid cavity, passes upward and forward over the head of the humerus and then down the bicipital groove, carrying with it a prolongation of the synovial membrane of the joint. The deltoid, from its broad origin on the spine of the scapula, the acromion, and the clavicle, covers the joint superficially on its posterior, external, and anterior aspects; and the coraco-brachialis, the short head of the biceps, and the great vessels and nerves lie upon its inner side.

The capsule extends from the free margin of the fibro-cartilaginous rim of the glenoid fossa, or from the surface of bone immediately outside of it, to the anatomical neck of the humerus. At the upper part its scapular insertion is at the base of the coracoid process and separated from the glenoid fossa by the tendon of the biceps; on the posterior and inner portion of the humerus it extends somewhat beyond the cartilaginous surface along the projection upon which the head rests. Between the two tuberosities the synovial membrane by which it is lined is prolonged down the bicipital groove, and is reflected over the long tendon of the biceps. The capsule is reinforced at some points by thickenings of itself which are known as ligaments and by the tendons of the scapular muscles; on the inner side it is perforated by the tendon of the subscapularis, and there shows a gap through which the cavity of the joint communicates with the subscapular bursa, a large pouch lying against the inner side of the neck of the scapula and the root of the coracoid process, between them and the upper part of the subscapularis. This opening lies just in front of the upper part of the anterior (inner) margin of the glenoid fossa, has the form of a slit or crescent, and is usually large enough to

admit the end of the finger. When the synovial membrane has been dissected away the gap has the form shown in Figs. 39 and 40, and is partly occupied by the tendon of the subscapularis. The portion of the

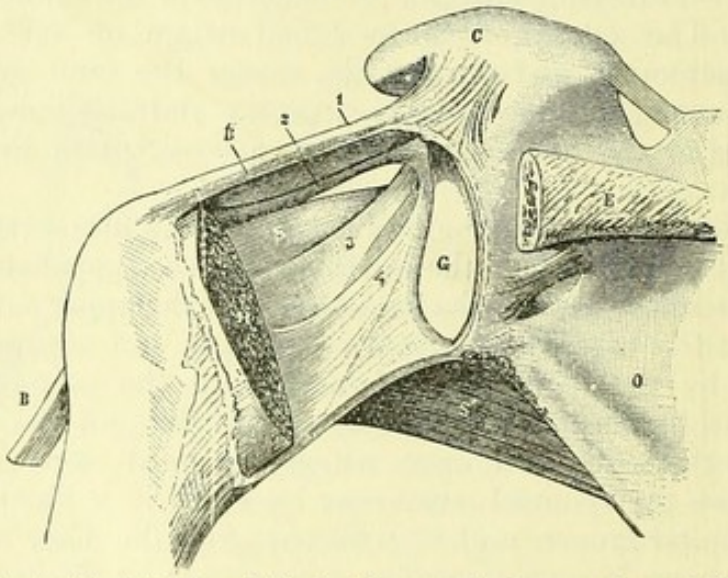
FIG. 39.



The shoulder-joint; from in front. (FARABEUF.)

capsule which forms its upper margin is called the gleno-humeral ligament, or, to adopt the subdivisions described by Farabeuf,[1] the supragleno-suprahumeral, the portion forming the lower margin is the supra-

FIG. 40.



The interior of the shoulder-joint from behind. (FARABEUF.) 1, coraco-humeral ligament. 2, supragleno-suprahumeral ligament. 3, supragleno-præhumeral ligaments. 4, prægleno-subhumeral ligament. 5, upper edge of the tendon of the subscapularis; 5′, its lower part. *B*, biceps tendon. *C*, coracoid. *E*, spine of scapula. *G*, glenoid fossa.

gleno-præhumeral, and the portion immediately below the latter is the prægleno-subhumeral. These different portions are shown in Figs. 39 and 40, which are copied from Farabeuf's paper. Of them the one

[1] Farabeuf: Bull. de la Soc. de Chirurgie, 1885, p. 391.

that forms the lower margin of the gap, the supragleno-præhumeral, is often of slight strength and underlies and is intimately adherent to the tendon of the subscapularis.

The coraco-humeral ligament is a strong wide band extending from the root and outer border of the coracoid process over the top of the joint to the neck of the humerus above the greater tuberosity, and is intimately connected with the capsule and the tendon of the supraspinatus. It is thought to play an important part in determining the position taken by the limb when dislocated, and the manœuvres by which the dislocation can be reduced.

The tendon of the supraspinatus passes between the acromion and the head of the humerus and is attached to the upper part of the greater tuberosity; it is blended with the capsule and is separated from the acromion by a bursa. Below it come the tendons of the infraspinatus and teres minor, passing to the lower and middle facets respectively and also blended with the capsule.

Outside the capsule is a loose layer of connective tissue which separates it and the tendons of the outer muscles from the under surface of the deltoid; within the layer is the subdeltoid bursa, extending under the acromion, which deserves special mention because of the fact that when the tendon of the supraspinatus is torn away from its attachment in a dislocation and retracts under the acromion with the adherent capsule, this bursa is thereby opened and placed in communication with the cavity of the joint, and the upper portion of the capsule is thus greatly lengthened. The influence of these new conditions in favoring recurrence of dislocation has been discussed in Chapter III.

With respect to the nerves and arteries it is only necessary to speak of the circumflex nerve and of the arterial branches which pass outward, the two circumflex and the subscapular. The circumflex nerve winds around behind the neck of the humerus to its outer side, to be distributed to the deltoid muscle and to the integument covering it. It may be so injured in a dislocation that the deltoid will be paralyzed, perhaps permanently.

The circumflex and subscapular arteries pass outward to be distributed among the muscles of the scapula and upper part of the arm; when in a dislocation the head of the humerus presses the axillary artery inward, those branches are put upon the stretch because they are prevented by the attachment of their branches to the tissues from moving inward as freely as the main trunk does, and consequently they may be ruptured or torn away from the side of the main artery. This accident may be the consequence of the dislocation itself, or of the efforts to reduce it.

The movements of the joint are not only very free but they are also effected by the gliding of one surface over the other, not by simple rolling, and consequently the capsule is loose and is thrown into folds on the side toward which the limb is moved. Above and on each side these folds are drawn back by the attached muscles in the line of their contraction and thus are kept from being caught between the articular surfaces; meanwhile, on the opposite side of the joint the capsule is made tense not only by the separation of its scapular and humeral points

of attachment, but also by the pressure against its inner surface of the head of the humerus around which it is stretched.

The movements which are most frequently concerned in the production of a dislocation are outward rotation and abduction. In the latter the elbow is raised directly outward or outward and forward from the side of the body by the action of the deltoid, the plane in which it moves being more or less exactly that which would be represented by the prolongation of the broad surface of the shoulder-blade. As the movement is made, the head slides downward on the glenoid fossa, the long head of the triceps, the lower part of the subscapularis, and the lower and inner portion of the capsule are made tense, and the movement is arrested when the top of the greater tuberosity comes into contact with the upper margin of the glenoid fossa, and the side of the shaft close below the tuberosity touches the acromion. If the movement is now continued, and the arm raised to the side of the head, it is effected by the rotation of the scapula and the elevation of its outer portion. If, on the other hand, the movement is continued while the scapula is kept stationary, the centre of motion is transferred to the point of contact between the humerus and the edge of the acromion, and the head of the bone is forced downward against the already tense capsule and ruptures it at its lower and inner portion, there where it presses directly against it.

In outward rotation when the arm is hanging by the side or is but slightly abducted the movement is arrested by the tension of the capsule on the inner side, and at the same time the lower and outer part of the greater tuberosity comes into contact with the outer lip of the glenoid fossa; if the movement is then continued the capsule yields, but the head does not become dislocated unless some other force intervenes to press it inward through the rent that has thus been made.

In all the other movements similar conditions are found, and dislocations following them are less frequent only because the movements are themselves less frequently carried beyond the limits set by the structure of the joint. Thus, adduction and rotation inward are checked by contact of the arm with the body before the capsule is put upon the stretch, and extension of the arm behind the axillary line must be carried very far before a new fulcrum is found, and is also a movement that is rarely produced or exaggerated by external violence.

Statistics.—The great frequency of dislocation of the shoulder is fully explained by the structure of the joint and by its exposure to the dislocating action of direct and indirect violence. This frequency is so great that dislocations of the shoulder are about as numerous as all the other dislocations of the body combined. The table of statistics given in Chapter I. show percentages varying from 46 to 60 of all dislocations. Malgaigne's statistics of 489 cases contain 321 of the humerus, more than 65 per cent.; Gurlt's collection of 907 cases in the hospitals of Berlin, Paris, and Philadelphia contain 563 of the shoulder, 58 per cent.; Bardenheuer[1] saw 20 in a total of 37 cases treated in one year, 54 per cent. Krönlein's statistics, which are especially valuable because they are made up from both hospital and polyclinic records, give a total of 207 dislocations

[1] Bardenheuer: Deutsche Chirurgie, Lief. 63 a, p. 279.

of the shoulder, of which 184 were in males and only 23 in females; of Malgaigne's 370 cases 97 were in women; classified according to age and sex they are as follows:

TABLE X.—DISLOCATIONS OF THE SHOULDER.

Malgaigne.

Age.	Hôtel Dieu.		St. Louis.		Total.
	Male.	Female.	Male.	Female.	
5 to 15 years	2	1	...	1	4
15 " 25 "	31	2	3	...	36
25 " 45 "	60	21	15	1	97
45 " 60 "	80	27	13	4	124
61 " 70 "	44	23	7	4	78
70..... "	17	13	1	...	31

Krönlein.

Age.	
11 to 20	2
21 " 30	55
31 " 40	45
41 " 50	48
51 " 60	36
61 " 70	19
71 " 80	2

Both show that the injury is rare in youth and old age, is most frequent in middle life, and is much more frequent in men than in women. The relative frequency at the different ages, established by taking into account the percentages of the total population belonging to those ages, differs somewhat from the actual frequency, the maximum being found above the age of fifty years. The proportions calculated from Krönlein's statistics with the aid of the relative numbers of the population at the different ages, as given in Table V., Chapter I., are 5, 9, 11, and 12 respectively for the decades from 31 to 70. This relatively greater frequency in advanced years is much more marked in women than in men, a fact which is to be explained by the greater exposure to violence incident to the occupations and habits of men in middle life. It indicates, I think, that a much larger proportion of the dislocations in advanced life are due to falls while walking than in middle life, since that is an accident to which both sexes are more equally exposed than they are to others.

The relations pointed out by Krönlein as existing between dislocations of the shoulder and those of the elbow and fractures of the clavicle are interesting. His statistics show that during the first two decades of life, a period in which dislocations of the shoulder are rare, dislocations of the elbow and fractures of the clavicle are most frequent. Thus, of 109 dislocations of the elbow contained in his table, 80 of the patients were under twenty years of age, and of 100 cases of fracture of the clavicle collected by him 70 of the patients were under ten years of age; while of 207 dislocations of the shoulder none of the patients was less than ten, and only 2 less than twenty years old. He thinks fractures of the clavicle are in childhood the equivalent injury of dislocations

of the shoulder by direct violence in middle life, and dislocations of the elbow the equivalent injury of dislocations of the shoulder by indirect violence. He further quotes investigations made by Küstner as showing that separation of the epiphysis in early life, and especially when produced by obstetrical manipulations, is the equivalent of dislocation at other ages, since it is caused by the same mechanism, the forcing of the limb beyond the range of normal motion; the epiphysis separates more easily than the capsule ruptures.

Classification.—The head of the humerus in leaving the joint may pass at first upward or downward, backward or forward, and may come to rest in any one of a great number of positions. The classification of the varieties is beset with much difficulty, because of their number, because of the frequency and importance of the secondary displacements, and, last though not least, because of the number of classifications that have already been made and are more or less current. The confusion has been further increased by the application of the same or very similar terms to different varieties by different authors. With the rare dislocations backward, and the still rarer ones upward, there is no difficulty; the uncertainty arises in connection with those in which the head of the humerus has passed across the anterior lip of the glenoid fossa. A brief account of some of the classifications and terms heretofore and still in use will show their differences and resemblances, and may serve as a convenient introduction and preparation for the classification that must follow.

Sir Astley Cooper's classification, upon which those now in use in England and America have been in the main constructed, recognized four kinds of dislocations: 1. Downward and inward into the axilla; 2. Forward, the head of the humerus lying under the clavicle on the sternal side of the coracoid process; 3. Backward; 4. Partial inward, the head resting against the outer side of the coracoid process. It is apparent, from his description, that the first and fourth included the common, frequent cases, those which are now generally termed "subglenoid," or "into the axilla," and "subcoracoid," respectively.

A few years later Malgaigne followed, also with four principal forms, but only one of them the same as Cooper's. His grouping is as follows:

Dislocations into the axilla.	1. Subcoracoid, complete; quite common. 2. Subcoracoid, incomplete; rare. 3. Subglenoid; rare.
Dislocations inward.	4. Intracoracoid; most common of all. 5. Subclavicular; rare.
Dislocations backward.	6. Subacromial; rare. 7. Subspinous; very rare.
Dislocations upward	8. Supracoracoid; only two cases known.

All these titles are now in general use; but while the last four, and perhaps the second also, are still used to designate the forms which he designated by them, the others have been used with different, sometimes with widely different, meanings. The first form, the complete subcoracoid, was "characterized by the projection of the head of the humerus in the axilla, and its position exactly below the coracoid process;" it would be included in Cooper's first group, dislocation downward into the axilla.

His second subdivision, incomplete subcoracoid, was the same as Cooper's fourth, partial dislocation inward. His third, subglenoid, was one concerning which he seems to have been far from having very precise notions; he had seen only one case, and had been able to collect only eleven others, and of these the symptoms differed widely, the head of the humerus being described as raising the anterior wall of the axilla in one case, and the posterior in another, as resting against the second intercostal space in one, and against the third in another, and even as having perforated the wall of the chest and lodged within it. The one feature which they had in common, and which he gives as pathognomonic, was that the head of the humerus was not immediately below and in contact with the beak of the coracoid process, but was separated from it by a greater or less interval. Apparently the class was created simply to collect together the odds and ends, the irregular cases that were not subcoracoid; and the idea which suggested the name given to it was that the primary displacement took place more directly downward than in the preceding varieties. It will be seen that the name has since been applied to a very much larger proportion of cases.

His second main division embraced two varieties, the intracoracoid and the subclavicular. Concerning the latter there is no misconception; the term has remained in use, and with the same meaning. The group is made up of those cases in which the head of the humerus has passed entirely to the inner side of the coracoid process, and lies below the clavicle. But the other term, intracoracoid, is generally employed in a much more restricted sense than by Malgaigne. By it he designated the greatest number of dislocations, more than two-thirds of those he saw at the Hôpital St. Louis; he applied it to those in which the head of the humerus, while still remaining under the coracoid process, overlapped it on the inner side by more than half its own diameter. Most of such cases are now termed subcoracoid, and only those in which the head has passed almost, if not entirely, to the inner side of the process are called intracoracoid.

The tendency of the more recent French and German writers is to make a single group of all the dislocations in which the humerus passes to the anterior side of the scapula, containing four or more subdivisions or varieties, two of which, the subclavicular and intracoracoid, in the narrower sense, are accepted by all. Of the remaining two principal ones, the subcoracoid and the subglenoid, the former is made to include the great majority, and the subglenoid is either closely and distinctly restricted to the very rare cases in which the head of the humerus is displaced directly downward upon the tendon of the long head of the triceps, or Malgaigne's grouping is accepted with all its diversities and vagueness. In the former case the group is removed from the principal division of "anterior" or "præglenoidal" dislocations, and made to form by itself another principal division, termed "dislocations downward."

The English and American writers, as a rule, divide the same cases into subglenoid and subcoracoid, basing the distinction between them upon the clinical feature of the greater or less facility with which the head of the humerus can be felt in the axilla; those in which it is more prominent in the axilla are "subglenoid," those in which it is more prominent

behind the anterior wall of the axilla, close beneath the coracoid process, are "subcoracoid." The objections to this grouping are that it does not sufficiently distinguish between primary and secondary displacements, and that the clinical features upon which it rests present a complete series of intermediate forms, most of which might be as properly placed in one group as in the other. The arbitrariness and uncertainty of the decision are well shown by a comparison of clinical and pathological statistics. Thus, Hamilton and Bryant say that the subglenoid is of more frequent occurrence than the subcoracoid, and Erichsen says that this is the opinion of most English surgeons; while, on the other hand, Flower,[1] who made an examination of all the specimens contained in the London museums, 41 in number, found that in 32 the dislocation was subcoracoid, and he adds, that of 50 cases recently observed by him in living patients the same was true of "a large majority;"[2] he calls attention to the fact that "the great frequency of subcoracoid dislocation observed in this series [of specimens] does not accord with the descriptions of this injury generally given in the standard surgical works of the country." A few years later, in the article on Injuries of the Upper Extremity which he prepared in connection with Mr. Hulke for Holmes's *System of Surgery*, Mr. Flower made a classification in which the influence of this important investigation is apparent. It is as follows:

1. SUBCORACOID. Forward and slightly downward. On to the neck of the scapula, in front of the glenoid fossa, and immediately below the coracoid process. *Common.*

2. SUBGLENOID. Downward and forward. Head of the humerus in front of the inferior costa [border] of the scapula, below the glenoid fossa. *Rare.*

His remaining three divisions are *Subclavicular*, *Supracoracoid*, and *Subspinous*, the latter including Malgaigne's sixth and seventh.

Turning now to the pathological data, to the recorded results of post-mortem examinations and experiments upon the cadaver, and confining our attention for the moment to the forms mainly in dispute, the dislocations forward (or inward) and downward, and to the points that affect the position of the head of the humerus, the following facts appear:

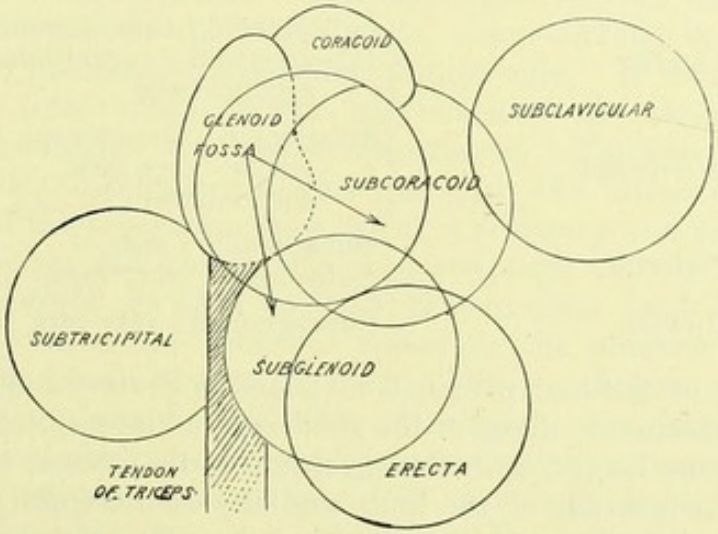
The head of the humerus, when it passes across the anterior edge of the glenoid cavity, must, as a glance at Fig. 37 shows, move somewhat downward so as to get below the beak of the coracoid process; the position of the limb that most favors the production of dislocation is abduction with or without external rotation. The inner and lower portion of the capsule, being pressed upon by the head of the humerus, tears between the tendon of the subscapularis and the triceps, the rent being small or large and varying greatly in extent and direction in the different cases, but it is always on the anterior and inner side, and the head passes more or less completely through it. If the movement is more directly forward and inward and to a less degree downward, as in dislocations by direct violence received on the outer side of the shoulder, the head of the bone

[1] Flower: Trans. London Path. Soc., 1861, vol. 12, p. 179.

[2] The number is given as 44 in his article on Injuries of the Upper Extremity in Holmes's System of Surgery.

pushes the subscapularis muscle before it and lodges close under the coracoid process and between that muscle and the edge of the glenoid cavity. In this case no secondary displacement ensues, and the form would be classed as *subcoracoid* by all. If the movement is forcible and prolonged the subscapularis may be torn entirely across and the head may pass through it and come to rest on the side of the thorax under the clavicle; or, as in a case quoted by Malgaigne, it may pass over the upper border of the subscapularis and come to rest at the same point. If, on the other hand, the primary movement downward has been more marked, as in dislocations effected by hyper-abduction of the arm, the head either passes below the subscapularis or tears its lower portion, and then, as the elbow is lowered the head rises, pressing the subscapularis or its untorn portion upward and remaining separated by it from the coracoid process. The extent and direction of this movement of the head are determined largely by the resistance of the untorn portions of the capsule, notably the outer and anterior part, which, by preventing the further descent of that part of the humerus to which they are attached, compel the head to move upward as the elbow descends. Other factors are found in the muscles; if the head lies under an untorn subscapularis its distance below the coracoid process will be greater than when it lies under only the upper portion of the muscle, and if in addition it has passed under the teres major or downward as far as the lower border of the pectoralis major the arm will remain widely abducted or even with the elbow above the head (luxatio erecta). Or, departing still further from what is usual, it may perhaps even turn backward after it has left its socket and pass under the long head of the triceps to lodge behind the glenoid cavity, the alleged subtricipital dislocation.

FIG. 41.



To show the range of positions that may be taken by the head of the humerus after primary displacement forward or downward in any of the directions between the arrows.

The head of the humerus rests against the inner side of the head or neck of the scapula at any point between its junction with the broad axillary border, or inferior costa, and the middle of the anterior lip of the glenoid fossa, and it may lie either directly against the edge of this lip or further back on the side, as is clearly shown by the specimens of old,

unreduced dislocations preserved in the museums. And according as it occupies one or the other position it will be more or less prominent in the axilla or more or less clearly seen and felt behind the pectoralis major beneath the coracoid process. The diagram in Fig. 41 shows the range of positions that may be taken by the head after primary displacement forward or downward.

It is evident, then, that the position in which the head of the bone is found bears only a limited relation to the point at which it left the joint, and that a classification which is sharply made upon this position is not only arbitrary and uncertain for a large number of cases, but also invites inattention to points that have an important bearing upon a safe and easy reduction.

It is desirable that a classification should not deal minutely with unimportant variations, and that instead of multiplying divisions it should rather gather into few groups those varieties that have characteristic and important features in common; and yet, as some forms differ widely in their symptoms from others with which they are on other grounds closely related, it is equally desirable to recognize and note such differences. The distinction made by Professor Bigelow between "regular" and "irregular" dislocations at the hip can also be made at the shoulder, taking for the dislocations downward and forward the integrity or the rupture of the antero-external portions of the capsule as the determining feature, but it has not the same importance in treatment. The following classification is, in the main, the same as that of Mr. Flower, above mentioned, and the later French and German writers. It differs from that of the majority of the English and American writers in restricting the group of the "subglenoid" and correspondingly enlarging that of the "subcoracoid" dislocations.

Anterior . . .	Subcoracoid; very common. Intracoracoid; exceptional. subclavicular.
Downward . . .	Subglenoid; uncommon. erecta; very rare. subtricipital (?).
Posterior . . .	Subacromial; rare. Subspinous; very rare.
Upward . . .	Supraglenoid; very rare.

The names of the four principal divisions indicate the direction of the primary displacement; those of the subdivisions the position in which the head of the bone lodges, with the exception of the *erecta*, which takes its name from the attitude of the limb, and the *subtricipital*, which rather indicates the route traversed by the head than the position finally taken by it. Between the anterior and the downward the division cannot be sharply made, and in many of the cases included among the first the primary displacement has more of the downward than of the anterior feature, but it is believed that by enlarging the subcoracoid class so that it will include all but the lowest of the lower forms, by extending its range so that it will distinctly include the lower as well as the higher primary displacements, the necessity of abducting the arm to effect reduc-

tion in those cases in which the secondary displacement upward is marked and might otherwise lead into error will be less liable to be overlooked. The difficulty of distinguishing between the subglenoid and the lowest of the subcoracoid will arise in only a very limited number of cases and will be without practical importance; at the most it will be merely a question of nomenclature.

Anterior (and Downward) Dislocations.

1. Subcoracoid.
2. Intracoracoid, subclavicular.

In these dislocations the head of the humerus passes across the anterior lip of the glenoid fossa, taking at first a direction that is forward and inward and more or less downward; it may subsequently move upward or further inward. The class includes two subdivisions, the *subcoracoid* and the *intracoracoid*, of which the latter is here made to include also the more marked dislocation inward known as the *subclavicular*.

The class embraces the subcoracoid, partial and complete, of all authors, most of the subglenoid of most English and American authors, and the intracoracoid and subclavicular of all. The terms "axillary dislocations" and "dislocations into the axilla" are applied by some to cases that are here called subcoracoid, and the term "pectoral" to the intracoracoid.

I. Subcoracoid Dislocations.

In this form, which includes a large majority of all cases, the head of the humerus lies under and in close proximity to the beak of the coracoid process, or at a distance below it that may equal or even exceed a finger breadth. The centre of the head may be either directly below the beak of the coracoid process or on its outer or inner side. If more than three-fourths of the transverse diameter has passed to the inner side of the coracoid the dislocation is termed *intracoracoid*. The class, therefore, is continuous with the subglenoid below and with the intracoracoid on the inner side, and the separation from them is arbitrary and artificial but is justified by custom and convenience in description.

Malgaigne showed, as early as 1835, that in some cases the articular surface of the head of the humerus rested on the anterior edge of the glenoid fossa, and such he termed "incomplete." Subsequently, in his volume on dislocations, he was able to reinforce his demonstration by additional clinical observations and by an autopsy in a recent case. The formation of a separate class composed of such cases seems unnecessary and even undesirable, for they differ from the complete ones only in degree, and the difference is both slight and without practical importance; the symptoms are like those of complete dislocation, the bone is fixed in its new position, and aid is required to replace it in the joint. Moreover, in some the diagnosis (differential, between complete and incomplete) can only be made at the autopsy. This was true even of one of Malgaigne's cases.

The injury may be produced by direct or indirect violence, a blow upon

the outer and upper part of the shoulder or hyperabduction of the arm, or by muscular action. When produced by direct violence the displacement is usually in a direction that is only sufficiently inclined downward to enable the head to pass below the coracoid process; in a unique case reported by Krönlein[1] the blow was received from above upon the acromion and only dislocated the humerus after it had broken that process. The extent of the displacement inward is affected partly by the force of the blow and the extent of the laceration of the capsule, and partly by the contraction of the muscles that adduct the limb.

Dislocations by indirect violence are the most common, the force acting to produce hyperabduction of the limb. The elbow can be raised to the height of the shoulder, while the scapula remains fixed in its habitual position, the movement taking place solely in the shoulder-joint, but extension of the movement can be normally effected only by a change in the position of the scapula by which its articular surface, the glenoid fossa, is directed upward. The hyperabduction which produces the dislocation takes place in the shoulder-joint, and consequently if the scapula is fixed in a low position the dislocation may take place even when the movement carries the elbow but little, if at all, higher than the shoulder. On the other hand, if the scapula moves freely the elbow may, as all know, be safely brought as high as the head. In short, hyperabduction of the joint sufficient to cause dislocation can exist while the elbow is at or even below the level of the shoulder. The auxiliary fixation of the scapula is commonly effected by the contraction of the muscles in an effort to control or prevent the elevation of the arm, and it can take place not only when the scapula is at any point between that which it occupies when the limb is at rest and dependent and that of extreme elevation of the limb, but also when its anterior portion is depressed below the position of rest. This is the explanation, in part, of some cases in which the dislocation has occurred while the elbow was lower than the shoulder; the associated factor is the contraction of the muscles.

Hyperabduction acts, as has been already described, by bringing the outer side of the upper end of the humerus into contact with the edge of the acromion and thus creating a new centre of motion for the continued movement, the effect of which is to cause the head of the humerus to descend and rupture the capsule in its inner and lower portion. After this rupture has taken place and the upward movement of the elbow has ceased, the contraction of the muscles, the deltoid, pectoralis major, and latissimus dorsi, draws the head of the humerus inward past the anterior lip of the glenoid fossa, and then when the elbow is lowered the head rises along the inner side of the joint, for the untorn outer and anterior portion of the capsule is made tense and, by thus preventing the descent of the portion of the bone to which it is attached, compels the movement to take place about this portion as a centre. As the first new centre of motion at the edge of the acromion determines, in connection with the muscles, the primary displacement, so the second new centre at the outer and anterior attachment of the capsule determines the secondary displace-

[1] Krönlein: Deutsche Chirurgie, Lief. 26, p. 14.

ment and the final position of the head of the bone and the attitude of the limb.

Muscular action, the contraction of the muscles of the individual himself, can produce a dislocation either by drawing the head of the bone directly out of its socket, or, much more commonly, by creating conditions of leverage and momentum similar to those existing in the production of dislocations by indirect violence. In many of the reported cases it is difficult to recognize the mechanism of the injury. The least questionable examples of dislocation effected by the direct traction of the muscles are those in which the injury has occurred during a convulsion. A considerable number of such have been reported. The examples of the other kind are numerous and varied, and the explanation is usually simple. A painter raises his arm to work upon a ceiling, an artilleryman to throw a shot, a patient lying in bed to free its curtain caught under the pillow, a woman to grasp an object hanging on the wall; in such cases hyperabduction of the joint seems to be the probable cause. In others hyperabduction can only be invoked on the supposition that the contraction of the deltoid has lowered the acromion, the arm being fixed in a position below the shoulder, as in Bichat's case of the notary who dislocated his shoulder in an attempt to raise a heavy book from the floor, or in Volkmann's of a woman who tried to lift a heavy pot from a shelf at the height of her shoulder, or Malgaigne's athlete who tried suddenly to lift a man kneeling in front of him, or Duplay's very muscular patient who stumbled while descending a staircase and threw out his arm to save himself from falling but touched no object with it.

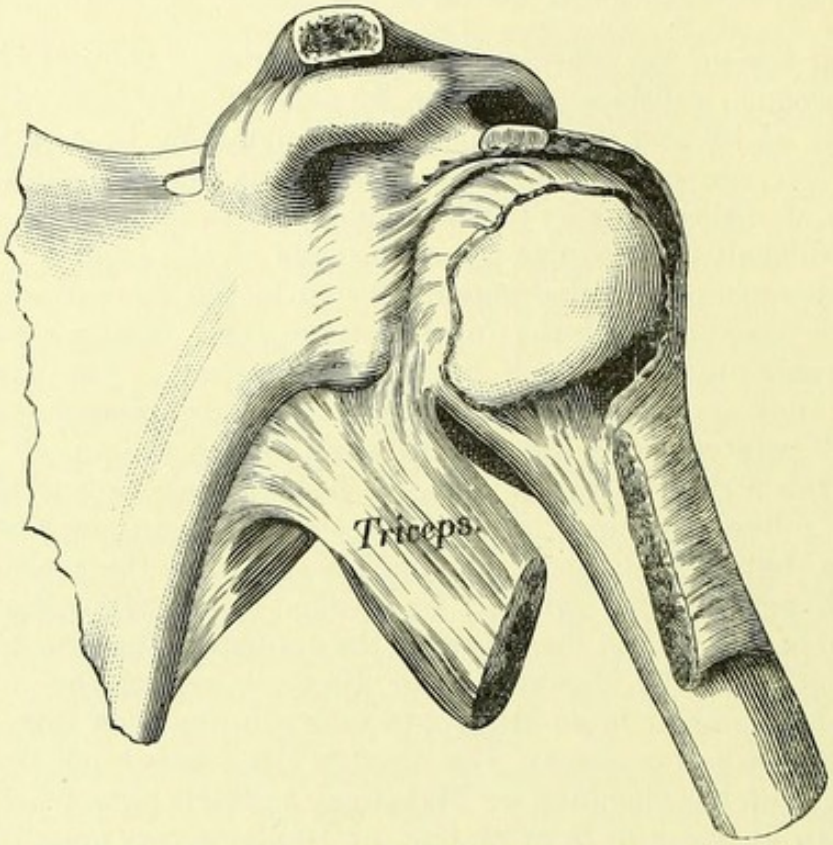
In other cases the influence of muscular action is entirely indirect. Thus, Rickert[1] tells of a very muscular man twenty-five years old who received a subclavicular dislocation by resting his hand against a wall over his head and sneezing. Bardenheuer mentions a similar case observed by Saponi. In such a case the mechanism is essentially the same as in that, for example, in which a man supported himself with his arms outstretched against a wagon to receive a sack of grain which another threw down upon his back and thereby dislocated both shoulders.

Even in the common cases of indirect violence, such as falls upon the outstretched hand or elbow, it is probable that muscular action frequently aids to overcome the resistance of the capsule as well as to draw the bone inward after this resistance has been overcome. When the arm is abducted and thrown back the pectoralis major and deltoid act with full force, undiminished by unfavorable conditions of leverage, to draw the head of the humerus obliquely across the glenoid fossa, and their combined force cannot be much inferior to that of many blows which have proved competent to dislocate.

The results of experiments upon the cadaver show that external rotation of the arm is in itself competent to effect rupture of the capsule, and several authors, following Sédillot in this, claim that external rotation is an important, perhaps an essential, adjunct in the production of most dislocations by direct impulsion. They explain its agency by assuming that in a fall upon the side the forearm is flexed and the elbow is thrown

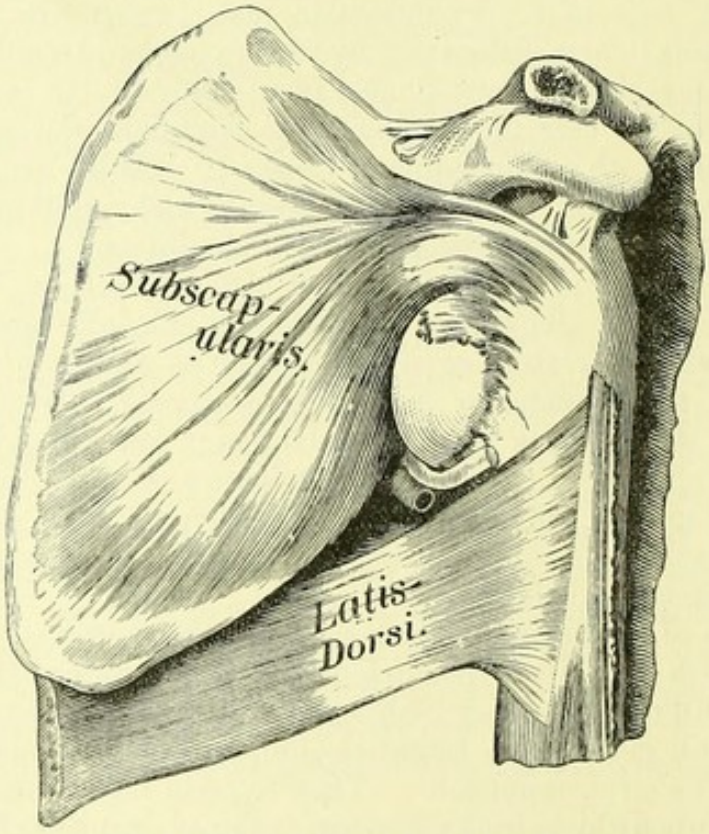
[1] Rickert: Maryland Medical Journal, 1883–84, vol. 10, p. 339.

FIG. 42.



Subcoracoid dislocation, reduced; in cadaver; the humerus has been rotated outward to show the rent in the capsule. (B. ANGER.)

FIG. 43.



Subcoracoid dislocation on a cadaver; showing rupture of lower part of the subscapularis. (B. ANGER.)

backward, and that thus the elbow is pressed toward the spine, outward rotation of the arm. It is impossible in most cases to determine the exact position and attitude of the limb at the moment the dislocation occurs, and the relative parts taken by abduction, rotation, muscular action, and direct impulsion in its production. At present it can only be said that every one of the four has proved sufficient by itself, and that they have been found to coöperate in varying degrees.

Pathology.—The results of experiments upon the cadaver are in harmony with those of post-mortem examination in recent and in old cases. The capsule is torn at its inner and lower portion between the tendon of the subscapularis and the triceps, and the rent extends usually along the inner and lower border of the glenoid fossa for half, sometimes even two-thirds, of the entire periphery. In other cases the rent extends outward and backward, rather than upward, and near the insertion of the capsule upon the humerus. Exceptionally, the rent is very small, or may even be entirely lacking. Eve[1] reported a case of subcoracoid dislocation in a man thirty-six years old, who had been knocked down by a railway train and died a few hours afterward. The capsule was untorn but was separated from the anterior border of the glenoid fossa, remaining continuous with the periosteum which was stripped up from the costal surface of the scapula. On the posterior surface of the head of the humerus was a deep vertical indentation made by impact against the anterior margin of the glenoid fossa. In 1880 I presented to the New York Surgical Society the shoulder-joint of an old man who had died of pneumonia a week after he had dislocated the shoulder by falling from the fourth story of a building. The dislocation was well marked, the shoulder was flattened, the head of the humerus could he distinctly felt in the axilla, and reduction was effected with the aid of ether. The joint was opened from behind, and the capsule was found untorn ; the tendon of the subscapularis was partly detached at its insertion, but at no point throughout its entire thickness, and the upper facet of the greater tuberosity was broken off in several pieces but not widely separated. Such cases of slight or no injury to the capsule are classed by some writers as "incomplete" dislocations.

The outer and upper portion of the capsule, when untorn, is drawn tightly across the glenoid fossa.

The subscapularis muscle is sometimes simply pressed inward and separated from the scapula by the interposed head of the humerus, but in most cases it is torn more or less widely from its lower border upward, and its upper portion may lie upon the head of the humerus and separate it from the coracoid process. Occasionally, instead of being ruptured the muscle is torn away from its attachment to the humerus, perhaps bringing with it the lesser tuberosity.

The supraspinatus is sometimes, probably often, torn from its attachment to the humerus, and the same is true in a less degree of the infraspinatus, and occasionally even of the teres minor.

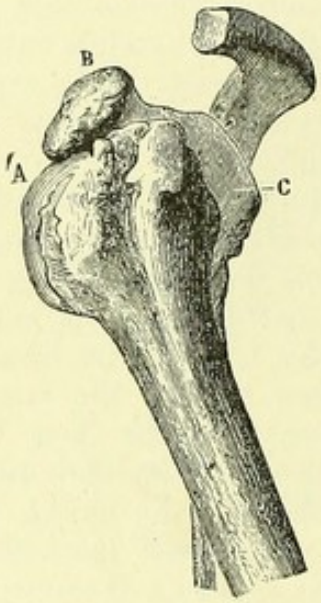
The teres major is sometimes slightly torn, apparently by the partial passage of the head of the humerus between it and the subscapularis.

[1] Eve : Trans. Path. Soc. of London, 1880, vol. 63, p. 317.

The anterior edge of the glenoid fossa is occasionally broken off; the acromion and coracoid process have both been found broken, but such injury appears to have been purely incidental and should be classed as a complication.

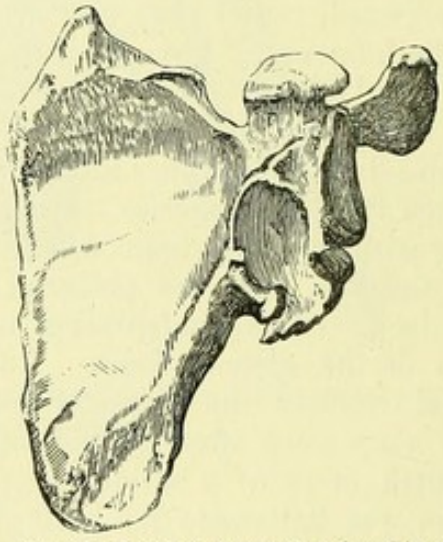
The head of the humerus lies against the edge of the glenoid fossa, or further back against the side of the neck of the scapula, and either close up against the beak of the coracoid process behind the coracobrachialis and the short head of the biceps, or lower down at a distance determined by its relations to the subscapularis and by the tension of the

Fig. 44.



Subcoracoid dislocation. B, coracoid; C, glenoid fossa. (Malgaigne.)

Fig. 45.

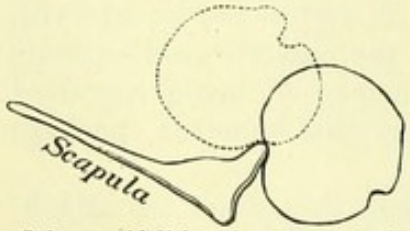


Scapula showing new socket found in an old unreduced subcoracoid dislocation. (Cooper.)

untorn portion of the capsule. It may lie on the outer side of the coracoid process, "incomplete dislocation," or immediately below it, or it may pass entirely to its inner side (intracoracoid dislocation), and it may be in outward or inward rotation (Fig. 46) or in any intermediate attitude.

As has been already said, avulsion of the tuberosities may take the place of laceration of the muscles attached to them; this has been rarely noted of the lesser tuberosity, but frequently of the greater, and especially of its upper and middle facets. Von Thaden,[1] who made a study of this feature, found that the upper and middle facets were each sometimes torn off separately, but the lower one only in connection with the other two. The complication is of importance because of the consequent loss of the control of the attached muscles over the humerus and the consequent exposure to recurrence of the dislocation (see Chapter III.), and because it opens the way for the escape of the long tendon of the biceps from its groove and its inter-

Fig. 46.

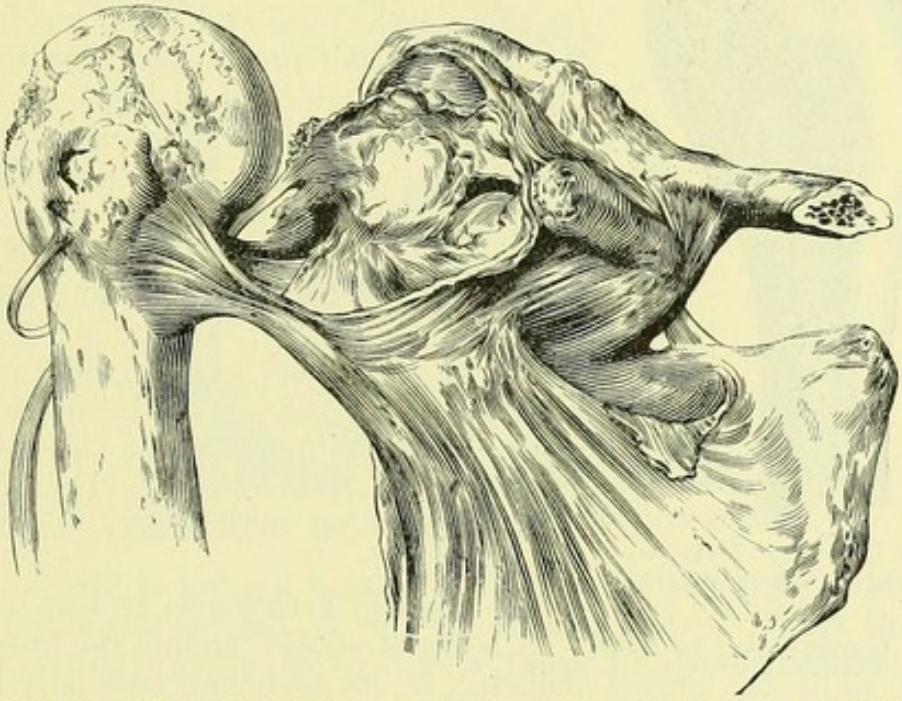


Subcoracoid dislocation; to show the different degrees of rotation of the humerus in different positions.

[1] Von Thaden: Arch. für klin. Chir., vol. 6, p. 67.

position between the humerus and its socket in such a way as to constitute a serious obstacle to reduction. In the specimens Von Thaden examined he found the tendon thus interposed three times. Körte[1] reported a similar case in which the tendon had slipped entirely out of its groove and was wound around the outer and posterior side of the head. He adds that Stromeyer quotes from Curling a case in which the tendon had to be lifted back over the head with a spatula before reduction could be made.

FIG. 47.



Old unreduced dislocation of the right humerus, with interposition of the capsule. At the inner side of the head of the humerus is the rent in the capsule through which it passed, and above the rent is the greater tuberosity which had been torn off. At the outer side of the coracoid process is an opening in the capsule which had been produced by the pressure of the humerus; through it the glenoid fossa is seen. (HILTON.)

When the tuberosity or a portion of it is thus broken off, the fragment lies over or in the glenoid fossa, and the broken surface of the humerus rests against the inner surface of the neck of the scapula or engages the edge of the fossa. The upper and outer portion of the capsule thus separated from the humerus may remain interposed between the head of the humerus and its socket and prevent reduction. After reduction of the dislocation the tuberosity reunites with the humerus with more or less irregularity and deformity.

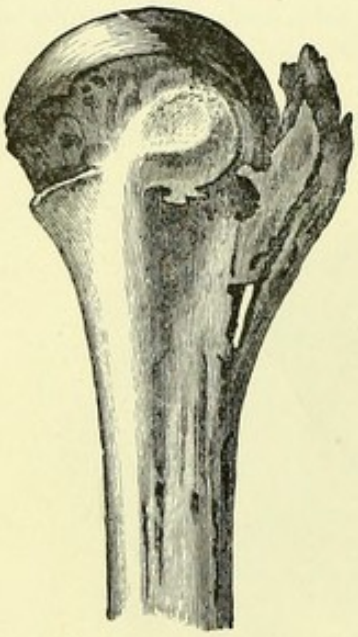
Except in connection with fracture of one or the other tuberosity the long tendon of the biceps is rarely dislocated, but it is sometimes torn away from its insertion or ruptured.

In some specimens of old unreduced dislocation a vertical groove has been found on the articular surface of the head of the humerus which was thought to have been caused by prolonged contact with the edge of the glenoid fossa. Malgaigne, who took a special interest in the specimens

[1] Körte: Arch. für klin. Chir., vol. 27, p. 747.

as supposed examples of incomplete dislocation, suggested that the groove might have been caused at the time the injury was received by the forcible impact of one bone against the other. It is interesting to find that this suggestion has been recently confirmed by the autopsy in Eve's case mentioned above and by two specimens of recent dislocation preserved in the Museum of the University of Edinburgh and reported in an interesting and valuable paper by Caird;[1] the indentation lay wholly or in part along the junction of the head and shaft, was from one to one and a half inches long, and from one-quarter to one-half an inch deep. The indentations accurately fitted the inner lip of the glenoid fossa, and the latter was bruised or chipped. The suggestion that the causation of fracture of the anatomical neck may be referred to the same mechanism seems very plausible.

FIG. 48.



Reunited fracture of the greater tuberosity of the humerus. (GURLT.)

The large axillary vessels and nerves are pressed inward and are rarely injured. Examples of the injuries that may be done them have been given in Chapter III., and the subject has been more freely discussed in Chapter VIII.

The axillary artery may be torn across in part or completely, probably by being stretched around the head of the humerus while the arm is abducted, or its branches, especially the subscapular and circumflex, ruptured or torn away at their origin. In Körte's case, just mentioned, the anterior circumflex was ruptured half an inch from its origin. The main nerves also may be compressed or stretched, and it is not uncommon to find the circumflex more or less disabled, as shown by loss of sensation in the cutaneous region supplied by it.

SYMPTOMS AND DIAGNOSIS.

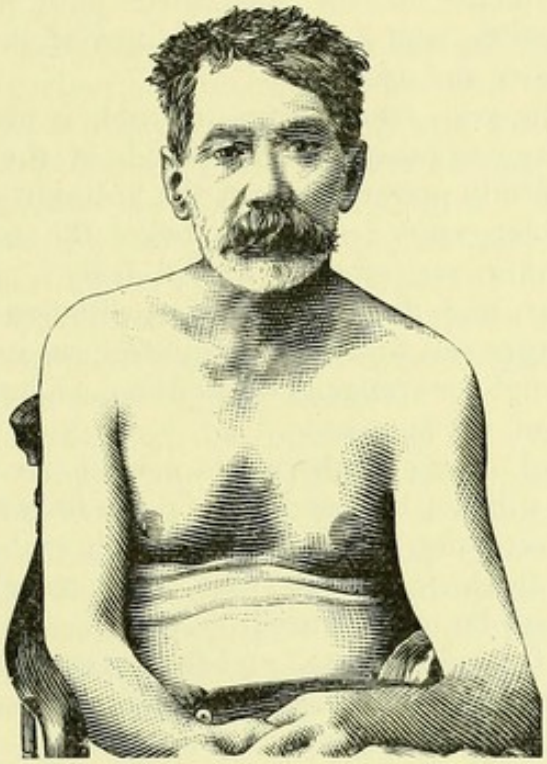
The description of the symptoms will be made simpler by limiting it at first to those commonly found in the medium displacements, and subsequently indicating the differences or modifications peculiar to the exceptional grades and conditions.

The patient sits with his head and trunk inclined toward the injured side, and supports the forearm with the other hand. The shoulder is flattened on the outer side so that the line of the deltoid runs straight down from the acromion and makes a more marked angle with the arm at its insertion than is usual. The anterior fold of the axilla lies lower, further from the clavicle than its fellow of the opposite side, and its creases appear deeper, as if the arm were applied more closely against the chest, and the outer part of the subclavicular fossa appears more full.

The elbow stands a little away from the side and can be easily abducted,

[1] Caird: Edinburgh Med. Journ., Feb. 1887.

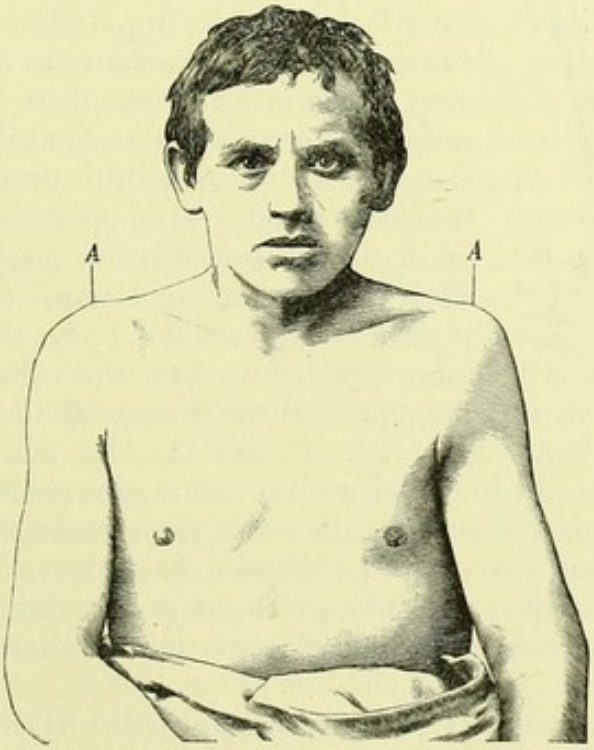
FIG. 49.



Subcoracoid dislocation of the left shoulder. (From a photograph.)

but any attempt to bring it nearer the side causes pain and is resisted; it may be in the axillary line, or in front of or behind it. When the elbow is flexed at a right angle the forearm is directed forward and inward; its

FIG. 50.



Subcoracoid dislocation (from a photograph.) A points to the acromio-clavicular joint.

direction can be passively changed to either side, but not freely. The hand cannot be brought to the opposite shoulder.

Voluntary movements of the dislocated joint are declared by the patient to be impossible, and pain is complained of in the shoulder, sometimes extending down the arm.

If the axis of the arm, viewed from in front, is prolonged upward by the eye it will be seen to pass to the inner side of the glenoid cavity, and if the fingers are firmly pressed against the anterior wall of the axilla in the line of this prolongation and a little below the coracoid process they will encounter the firm resistance of a solid body; palpation shows this body to be globular, and if it can be grasped between the thumb and finger, or if the finger can find some projection on its surface, it will be found to share in slight movements of rotation communicated to the arm by the other hand of the surgeon.

If now the head of the humerus is sought for by palpation in its normal position it will not be found there; the fingers can be pressed in deeply under the acromion from the outer side or behind, and perhaps the empty glenoid fossa can be felt; the outer margin of the acromion is prominent and can be easily traced.

If the elbow be further abducted and the surgeon pass his fingers well up into the axilla he can there feel the head of the humerus.

If the distance be measured from the outer margin of the acromion to the external epicondyle of the humerus or the olecranon, it will usually be found somewhat greater, perhaps half an inch, on the injured than on the uninjured side, but if successive measurements are taken as the arms are abducted the difference will disappear, and in complete abduction the distance will be greater on the opposite side. The reason of this is seen by a glance at Fig. 51. This method of examination is uncertain in its results and not very trustworthy at the best. The natural fulness of the uninjured shoulder may so deflect the tape as to make the measured distance on that side equal to that on the other, or the acromion on the injured side may be so depressed that even when the arms are symmetrically placed as regards the body the affected limb is more abducted than the other as regards the scapula, and the measured distance on that side is consequently less. The risk of error is less when both limbs are abducted to the height of the shoulder, and in this position the dislocated one should be shorter than the other. If the measurement is made with the arms dependent, care must be taken to have the two acromions at the same height and to have the inferior angles and vertebral borders of the two scapulæ at the same distance from the spinous processes of the vertebræ.

FIG. 51.

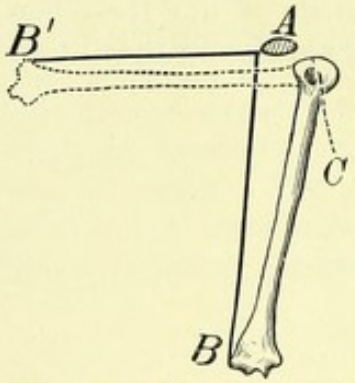


Diagram to show the effect of position upon the apparent length of the arm in dislocation of the shoulder. *A*, acromion; *B*, lower end of humerus

As in most other dislocations, the capital point in the diagnosis is the recognition of the head of the bone and the determination of its relations to the socket from which it has escaped. Ordinarily, both of these can

be accomplished at the shoulder with ease and certainty, and the examination is difficult only when the patient is very fat or the parts much swollen.

As the attitude and fixation of the limb depend mainly upon the tension of the untorn portion of the capsule, the limb will be found much more freely movable and capable of taking and keeping other attitudes when the capsule is freely torn; this fact has an important bearing upon the method of reduction, for the "manipulative" methods depend for their efficiency upon the prevention of certain movements of the limb and the compulsion of others by the untorn portion of the capsule. It is in such cases, too, that the diagnostic sign so freely trusted, the inability to bring the elbow against the side and to place the hand on the opposite shoulder, is lacking or only slightly marked.

When the displacement of the humerus is less than usual, when its head rests upon the edge of the fossa, the "incomplete" dislocation, the symptoms are modified to this extent, that the flattening of the shoulder and the abduction of the elbow are less,—the elbow may even lie close to the body; but the limb is equally fixed and incapable of being voluntarily moved. It has not infrequently happened that the dislocation has been reduced by the manipulations used to make the diagnosis.

The *treatment* will be described in connection with that of the following variety.

2. Intracoracoid Dislocations (Subclavicular Dislocations).

To avoid misapprehension I repeat that the term "intracoracoid" was applied by Malgaigne to the class of cases which he deemed of most frequent occurrence, comprising two-thirds of the forty-nine cases of shoulder dislocation observed by him at the Hôpital St. Louis, those in which the head of the humerus is so placed that from one-third to two-thirds or three-fourths of its transverse diameter lies to the inner side of the coracoid process. Most of such cases are now habitually spoken of as "subcoracoid," and the terms intracoracoid and subclavicular are restricted to those cases in which the bone is displaced still further inward. As between "intracoracoid" and "subclavicular" thus employed, I prefer the former name because it contains that of the anatomical landmark the relations to which form the basis of the classification.

The injury may be produced by direct violence received upon the outer aspect of the shoulder or by hyperabduction of the arm. The essential causative feature of the variety, as compared with the subcoracoid, is that the action of the original violence is prolonged, or that the secondary cause exaggerates the secondary displacement upward and inward. After a primary displacement forward and downward by abduction of the limb, anything that forcibly presses or draws the arm inward such as pressure inward against the elbow, or the contraction of the deltoid and pectoralis major, may effect this displacement if the head of the bone has passed under the subscapularis, or if this muscle has been sufficiently torn. The head of the humerus lies against the wall of the chest, or rather against the serratus magnus, on one side, and against the

costal surface of the neck of the scapula on the other. The subscapularis usually is widely torn; in MacNamara's case, quoted by Malgaigne, loc. cit., p. 525, it was untorn, and the head of the humerus had stripped it away from the scapula and had risen above its upper border, lying against the root of the coracoid process. No muscle or tendon was torn. Pinel dissected an old case in which the head of the humerus was covered by the subscapularis although it was situated on the inner side of the coracoid process and was distant only one and a half inches from the sternal end of the clavicle; its anatomical neck rested against the under surface of the middle of the clavicle.

The capsule is extensively torn, and the greater tuberosity usually broken off in whole or in part and lying in the glenoid fossa.

The head of the humerus passes behind the muscles arising from the coracoid process (in one recorded case, Roser's,[1] in front of the coraco-brachialis and biceps and behind the pectoralis minor) and occasionally is partly interposed between the contiguous borders of the deltoid and pectoralis major, being then subcutaneous. It may lie immediately under or a little behind the clavicle, in one case (Meyer) it even projected above and behind it, and it has usually been found rotated inward, although it seems probable that the free laceration of the capsule, the rupture of the subscapularis, and the avulsion of the greater tuberosity which usually occur would leave it very movable, and that this observed position has been rather the consequence of such mobility which has made it possible for the patient to place and keep the limb in the attitude of greatest ease, supported across the chest.

The long tendon of the biceps is broken, or displaced across and beyond the fractured surface left by the avulsion of the greater tuberosity.

The main vessels and nerves lie on the inner and under side of the head, and rather behind than directly at the point of contact with the wall of the chest.

Symptoms.—The attitude of the patient and the general appearance of the shoulder are the same as in the subcoracoid variety; the details differ mainly in degree, some being less, others more, marked. The flattening of the shoulder is greater, as is also, in some cases, the fulness of the subclavicular fossa, but this fulness is nearer the median line. The elbow lies near the side, may be even in contact with it; the axis of the arm prolonged upward in front passes well to the inner side of the coracoid process, and the head can be felt to move when the limb is gently rotated.

The fingers cannot be passed between the head of the humerus and the chest-wall, consequently only the shaft and lower portion of the head can be felt through the axilla; but, on the other hand, the lower anterior edge of the glenoid fossa and the neck of the scapula can sometimes be felt behind the shaft.

Abduction of the limb is not easy, and is effected by elevation of the scapula rather than by movement of the humerus upon it. Differences in length, when the arm is dependent, are less constant and marked than

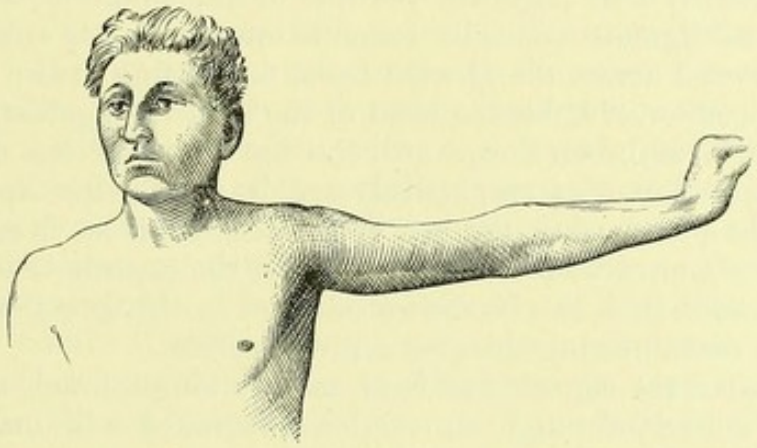
[1] Roser: Arch. für phys. Heilkunde, 1844, p. 582. The dislocation had lasted for seven years, and many attempts had been made to reduce it.

in the preceding variety, but if the arm can be abducted upon the scapula the shortening is then greater.

The dislocation can be transformed into a subcoracoid by traction downward and outward.

Bardenheuer[1] describes in detail two cases coming under his own observation in which the dislocated arm was fixed in the position of complete horizontal abduction (Fig. 52). In the first case the patient caught at an

FIG. 52.



Intracoracoid dislocation, with arm fixed in horizontal abduction (BARDENHEUER.)

object above his head to save himself from a fall forward, and thus caused the dislocation by hyperelevation and retroversion of the arm; in the second case the patient fell down a flight of steps, striking upon his side with the arm raised. In each case the arm was abducted at a right angle with the body and rotated in the direction of supination of the hand; it could be moved forward or downward about 30° and backward 10°, but the scapula shared largely in the movements. Rotation of the limb was not possible. Measuring from the acromion, the arm was shortened an inch or more, and the anterior wall of the axilla was narrowed. The head of the humerus passed behind the coraco-brachialis and short head of the biceps and lay far to the inner side of the coracoid process under the clavicle in the first case, and so far inward in the second case that its anatomical neck was directly under the process, and its articular surface well to its inner side. Reduction was easily effected in each case with the aid of anæsthesia by slight outward rotation and traction.

Bardenheuer attributes the fixation in this position to the supposed anterior situation and narrowness of the rent in the capsule. The integrity of the outer portion of the capsule would, I think, be sufficient to account for the attitude. (See, also, *Luxatio erecta*. Chapter XVII.)

TREATMENT OF ANTERIOR DISLOCATIONS. (See, also, Chapter VII.)

Obstacles to the return of the head of the humerus to its socket may be created by the tension of portions of the capsule which oppose its movement toward the socket, except in certain attitudes of the limb, by

[1] Bardenheuer: Deutsche Chirurgie, Lief. 63, a, p. 317.

the approximation of the sides of the rent in the capsule through which it has passed, by the interposition of portions of the capsule or of the tendon of the biceps, by its engagement behind the edge of the glenoid cavity or the coracoid process, and by the contraction or rigidity of the muscles and the swelling of the soft parts. Those which are most frequently concerned are the opposition of the anterior portion of the capsule and the contraction of the muscles.

The portion of the capsule which extends from the base of the coracoid process and the outer, or posterior, edge of the glenoid fossa to the greater tuberosity and posterior portion of the humerus, including the coraco-humeral ligament, usually remains untorn, and is stretched downward and forward across the glenoid fossa, and, being drawn tight by the weight of the elbow, it holds the head of the humerus against the scapula. If now the arm is drawn downward, the insertions of the capsule upon the scapula and humerus respectively are drawn further apart, the capsule made more tense, and the two bones pressed more firmly together; but if, on the contrary, the elbow is raised, the capsule is then relaxed, and the abducted limb can be drawn outward in the direction of its long axis without encountering the previous opposition.

If the rent in the capsule has been mainly longitudinal, and the head has passed entirely through it, traction downward will make its sides tense, and thus draw them nearer together, narrow the opening, and impede the return of the head; but if the limb is abducted and rotated outward, the anterior edge of the rent will be carried away from the other, and the opening made larger.

If the capsule is so freely torn away from the humerus on the outer side that it falls down between it and the glenoid fossa, it cannot be lifted out of the way by manipulation of the arm, because its separation is so complete that it is no longer affected by the position given to the latter. It may, perhaps, be pushed out of the way by the returning bone, but that is a matter of chance rather than of skill. Probably, full elevation of the arm followed by traction upward would be most likely to accomplish the object under such circumstances. Fortunately, such a condition of things is rare.

Dislocation and interposition of the tendon of the long head of the biceps occurs only with avulsion of the greater tuberosity, and not always then, for it may, instead, be ruptured. Even when interposed, the tendon may be fairly expected to have preserved its relations with the lower part of the bicipital groove and sheath, and consequently to be still somewhat under control by the humerus. By elevating the arm and flexing the elbow it will be relaxed and raised toward the upper part of the joint, leaving space below for the head of the bone to pass back under it.

Abduction of the arm and external rotation are, then, the means by which the most common obstacles created by the capsule are to be avoided.

As the muscles are elastic and normally somewhat stretched, approximation of their ends is immediately followed by a corresponding retraction, to overcome which some force is necessary. In addition, there is commonly the contraction excited by pain or the fear of pain, which,

unless relieved by anæsthesia, must also be forcibly overcome. Surgeons and writers differ widely in their estimate of the importance of this obstacle to reduction. Some, arguing from the well-established influence of the capsule in determining the position and fixation of the limb, assert that the muscles may be disregarded; others, in my opinion more justly, see in them an obstacle of which serious account must be taken, and which can prevent the success of the most correct manipulative method. It is a matter of common experience that a dislocated bone which remains almost absolutely fixed and immovable under forcible traction and manipulation will slip into place almost at a touch after anæsthesia has relaxed the muscles. It is going as much too far on the other side to claim that the muscles alone are the obstacle; their contraction simply holds the limb fixed in the position determined by the capsule and opposes movement in any direction, and when mobility has been restored to the limb by anæsthesia or fatigue, then advantage must be taken of it to move the bone in the direction determined by its relations to the capsule and the neck of the scapula. The habitual facility of reduction and the infrequency of failure at the present time as compared with the past are due much more to anæsthesia than to differences in method, for most of those methods that are in successful use now have been known and practised for centuries.

A certain anxiety connected with resort to the aid of anæsthesia has arisen from the fact that a disproportionate number of the deaths caused by chloroform have occurred in the reduction of dislocations (see p. 64), but I am not aware that death has ever followed the use of ether under such circumstances. There are many reasons why reduction should be made, when conveniently practicable, without its aid, but, unless in the presence of some important contraindication, I should never hesitate to avail myself of the aid of ether in preference to the employment of long-continued, forcible, or painful traction, even in recent cases. In those of long standing in which adhesions must be broken, the capsule retorn, and the shortened muscles elongated, it is indispensable.

Reduction in recent cases is usually easy, and it has been safely accomplished after the lapse of many weeks and even months. It is impossible to fix a period after which reduction by traction should no longer be attempted; each case must be judged by itself. Serious, even fatal, accidents have followed the attempt so often that the surgeon is fully justified in advising abstention on the ground that the risk is too great to be taken. Personally, I should prefer in a doubtful case to expose the joint by incision and liberate the head of the humerus with the knife, rather than seek blindly to break up the adhesions by rotation and traction.

In all the methods in which forcible traction is made upon the arm success depends largely upon efficient fixation of the scapula. When the traction is made by specially constructed apparatus the counter-extension is effected by a ring or crutch arranged to bear against the scapula (Fig. 58), but when it is made by the hands of assistants the scapula should be fixed by bands as in Fig. 53 or 57. In some cases in which only moderate traction is made a simple band about the chest

is sufficient, or the pressure of the surgeon's foot or hand against the side of the chest or the top of the acromion.

Direct reposition.—This method, the use of which can be traced back to the time of Avicenna, has been of late especially recommended by Richet and Von Pitha. It is often successful in recent cases in which the displacement and muscular contraction are not great, and especially when aided by anæsthesia. The arm, somewhat abducted, is supported by the side, and the surgeon placing his fingers in the axilla on the under and inner side of the head of the humerus, and his thumbs upon the acromion, seeks to press the bone directly into place. Or the position of the hands may be reversed, the thumbs being placed in the axilla and the fingers upon the acromion. Or, the patient being seated, the surgeon supports the flexed elbow upon his own forearm, gets his fingers around the head of the humerus in the axilla, and presses it toward the glenoid cavity while he steadies the scapula with the other hand.

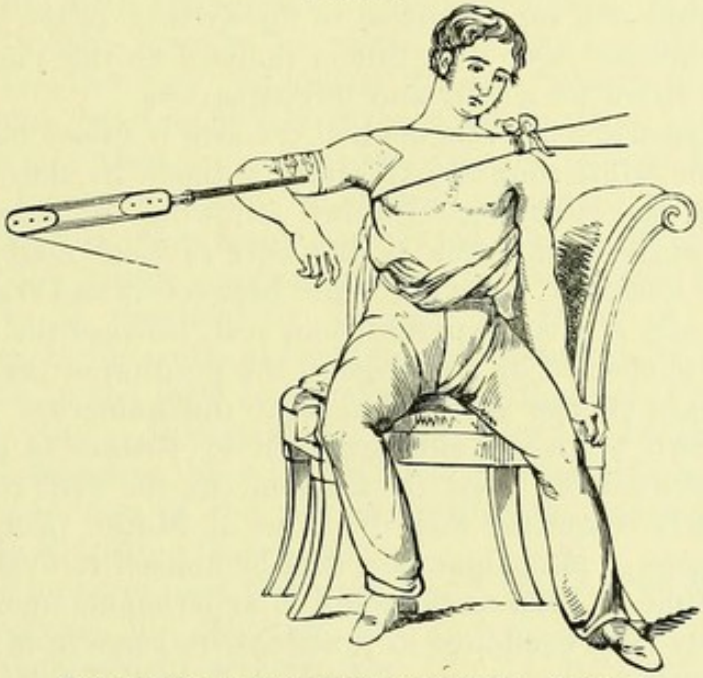
Traction downward and outward with coaptation.—This method in its many forms differs from the preceding one rather in the amount of force employed than in the direction in which it is exerted. Instead of exerting only the pressure of the fingers and thumbs to force the head of the humerus outward and upward, traction is made upon the arm by the surgeon himself or an assistant to draw it outward, and the pressure upward is made either by the hands, as in the preceding method, or by traction with a band in the axilla. Experience has shown that the method is of wider application and more generally successful than the more brilliant rotation and fulcrum methods, and the reason is to be found in the fact that it more satisfactorily meets all the indications arising from the opposition of the capsule and the muscles. It has, however, a risk from which the rotation method is free and which must be borne in mind especially in elderly patients and in the lower displacements, that of injury to the bloodvessels by overstretching them.

In its simplest form, one that is successful in a large proportion of cases, the method is practised as follows: The patient is placed upon a bed and counter-extension is provided by a band passed around his chest and made fast to a support on the sound side. If anæsthesia is used the weight of the body is usually sufficient for counter-extension, and this band can be dispensed with. Traction is made by an assistant, who grasps the arm above the elbow and pulls steadily downward and outward at first, and then slowly changes the direction by increasing the abduction until the arm is nearly or quite at right angles with the body, while, at the same time, he rotates the arm outward. The surgeon, standing beside the patient, watches the movement of the head of the humerus, and when it has approached the joint he presses it upward into place with his fingers or thumb, making counter-pressure on the acromion.

If anæsthesia is not used, or if more force is used, the scapula must be fixed by bands passing over and under the shoulder, as in Fig. 53. Or the patient can be laid on his back on the floor, and the surgeon seated beside him places his foot against the side of his chest and draws the arm directly outward. Reduction may be effected in this manner without the aid of coaptative pressure.

It is desirable that the elbow should be kept flexed at a right angle to relax the biceps, and also, if the surgeon himself is making traction, to enable him to rotate the limb inward when the head has been brought close to its socket, since this manœuvre is sometimes an efficient substitute for direct pressure upon the head.

FIG. 53.



Reduction by traction; fixation of scapula. (COOPER.)

An ingenious method of developing and applying the necessary force was suggested by Dr. J. E. Kelly,[1] who had then employed it in twenty cases with only one failure. The patient is placed upon a bed about three feet high, close to its edge, and his arm abducted at right angles. The surgeon, standing by the side of the bed and facing toward its head with his hip against the patient's chest near the axilla, draws the patient's arm and forearm across the front of his own pelvis and around to the opposite hip, where he holds the wrist firmly Then placing the thumb of the other hand in the axilla and the fingers on the acromion he rotates his body outward, keeping the hip well pressed up into the axilla and making pressure on the head of the humerus with his thumb. The method is capable of developing more force than traction by the hands alone, and although it is open to the objection of applying it rather blindly and uncertainly, and in that respect is inferior to the others, it seems capable of rendering a useful service in some cases.

An excellent modification in cases in which it is desired to avoid the use of an anæsthetic is the substitution of continuous traction by India-rubber or a weight and pulley, as used by Legros and Anger, and described in Chapter VII., p. 69.

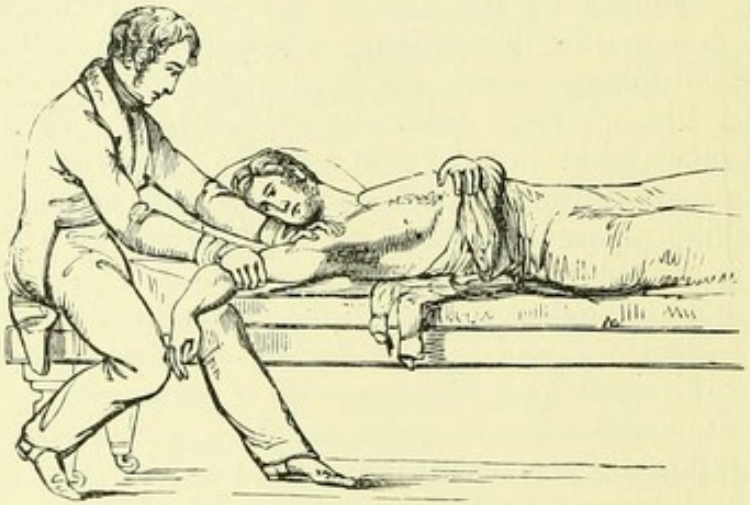
Another is the so-called "*pendel-methode*," which occupies a position intermediate between this and the following method, hyper-elevation of the arm, and in which the weight of the patient's body is used to make

[1] Kelly: Dublin Journ. Med. Sci., Sept. 1882, p. 45.

the traction. The patient is laid upon the floor on the sound side, and an assistant, standing upon a stool at his head, grasps the dislocated arm and lifts the shoulders from the floor while the surgeon presses the head of the bone toward its socket. If a greater weight is needed another assistant raises the feet so that the body is wholly off the floor, or presses downward against the side of the chest. If a sufficiently robust assistant is not at hand, or if the effort is to be prolonged, the suspension should be made by means of a rope attached to the wrist or to the arm above the elbow. Bardenheuer says that Simon reduced by this means a dislocation that had existed for a year and three-quarters.

Traction upward.—In this method the arm is raised beside the head and drawn upon while counter-extension is made by the hand or foot upon the top of the shoulder. Duplay, following Malgaigne, speaks of it in rather exaggerated terms as the only rational method, because it relaxes all the muscles. The difference between it and traction at right angles to the body is more apparent than real, because the further elevation of the arm is effected by a change in the position of the scapula upon the chest, without change in its relations to the humerus. The method, which was known to Celsus and practised by Brunus in the thirteenth century, was extensively used in England in the last century, but is more particularly connected with the name of Mothe in France, and of Kluge in Germany. Malgaigne says that he himself reinvented it for the fourth or fifth time in 1828 as the result of experiments upon the cadaver. It has commonly been combined in practice with some form of the method next to be described, the *bascule* of the French and German authors, that in which the head of the bone is pressed outward by placing a fulcrum high up in the axilla and then swinging the elbow in toward the body, and has also been frequently supplemented with external, followed by internal, rotation.

FIG. 54.



Reduction by vertical traction. (COOPER.)

In its simplest form, as described by Bransby Cooper, and shown in Fig. 54, the patient is placed upon his back on the bed or table, and the surgeon sitting beside his head draws the dislocated arm upward with one hand and fixes the scapula with the other; the counter-extension

may be aided by a long bandage or towel passing over the shoulder and fixed by both ends to the foot of the bed. After reduction has taken place, and while the arm is being lowered, the head of the humerus should be held in place by direct pressure upon it.

Malgaigne's plan, when more force was needed, was to rest the patient on the floor, and lift the arm directly upward with both hands, counter-extension being made by the weight of the body and aided, if necessary, by pressure made upon the acromion by an assistant. If this failed and he wished to try more force before resorting to the *bascule*, he made the patient stand beside a door and raised the arm to a vertical position by means of a strong band made fast at the wrist or elbow and carried over the top of the door; then the patient was directed to bend his knees until the weight of his body should be entirely supported by the dislocated arm, and, in addition, the surgeon contributed his own weight by clasping his hands over the patient's acromion and kneeling beside him.

The addition, as proposed by Lacour[1] in 1847, of external and internal rotation to the vertical traction, has added to its efficiency, and this combination in the form recommended by the late Professor H. H. Smith of Philadelphia is very highly praised by Dr. D. Hayes Agnew.[2]

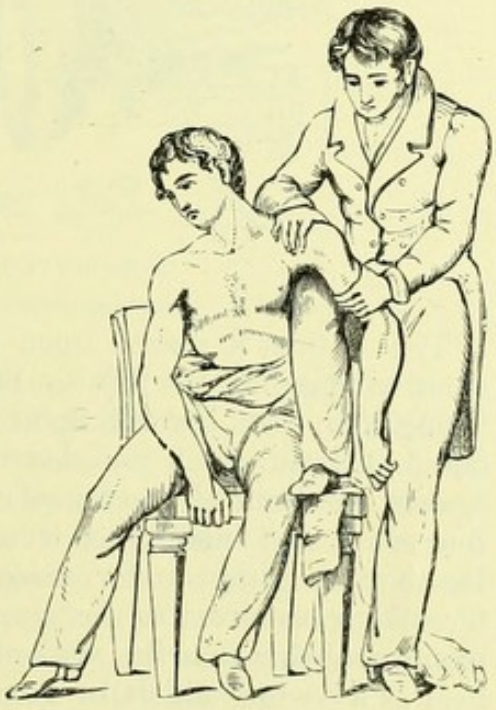
The chief objection to this method is that mentioned in connection with the preceding one, that of the risk of injuring the main vessels in the axilla by unduly stretching them around the head of the humerus, and it is even greater here because the elevation, or abduction, is made without preliminary traction to bring the head nearer the socket.

Another objection is that it is likely to increase the laceration of the capsule and of the subscapularis and thereby promote recurrence of the dislocation.

Traction with leverage.—This method differs from that of traction downward and outward in the addition, or the substitution for direct coaptative pressure by the hands, of a leverage movement in which the head of the bone is forced outward by the adduction of the limb over a fulcrum placed in the axilla. The fulcrum is usually the closed fist, the heel, or the knee.

When the hand is used traction is made outward and downward by an assistant, and when the head of the bone has been moved sufficiently far the surgeon places his closed fist well up in the axilla, and the assistant, still maintaining the traction,

FIG. 55.



Reduction by the knee in the axilla (COOPER)

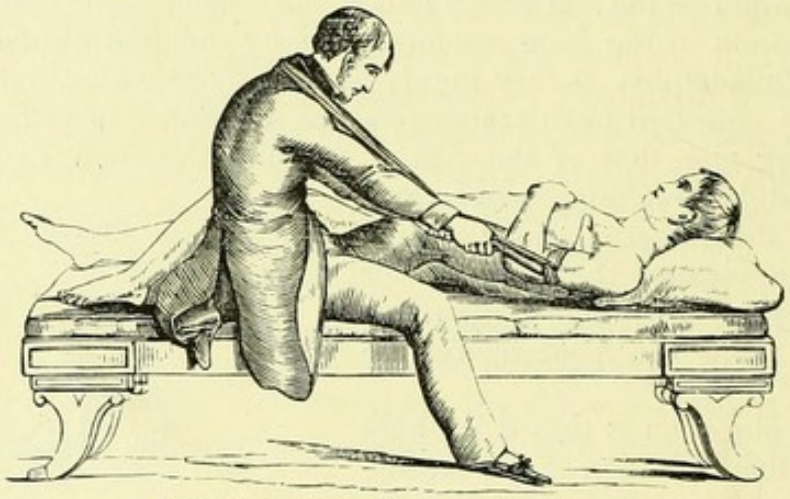
[1] Lacour: Mém. de Chirurgie, 1847, vol. 1, p. 387.
[2] Agnew: Surgery, vol. 2, p. 59.

swings the arm toward the side (adduction), sometimes combining with it moderate inward rotation.

If the knee is used the surgeon stands behind the seated patient (Fig. 55) and resting his foot upon the edge of the chair places his knee in the axilla; then grasping the arm above the elbow with one hand and pressing upon the acromion with the other he makes traction downward, and then pressing the elbow inward he raises his foot upon the toes. The plan is clumsier and less efficient than the fist in the axilla, but can be executed without the aid of an assistant.

The heel in the axilla.—(Fig. 56.) This method, generally known as Sir Astley Cooper's, but really dating back to the time of Hippocrates, was in very general use in England and America until quite recently. It is unfortunately responsible for not a few more or less serious injuries to the bloodvessels and nerves of the axilla.

FIG. 56.



Reduction by the heel in the axilla. (COOPER.)

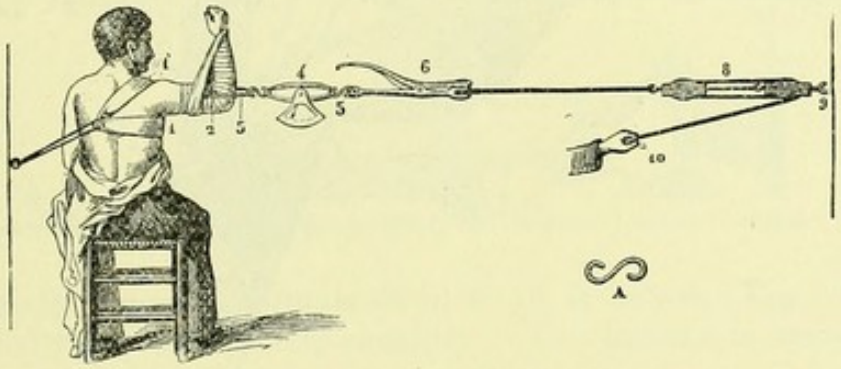
The patient is placed upon his back on a bed or sofa and a towel or stout bandage made fast to the arm above the elbow. The surgeon, facing him, seats himself upon the side of the bed and places the heel of one foot, from which the shoe has been removed, well up in the axilla against the head of the humerus and then makes traction downward upon the towel and maintains it until the bone is felt to slip into place. Remembering that under these conditions traction upon the humerus is directly transmitted to the scapula through the already tense capsule, it seems probable that the method owes its efficiency to the action of the heel as a wedge, which by being forced in between the thorax and the humerus presses the latter directly outward. If the traction is made at first in a direction inclined away from the body, and then brought more nearly parallel to it, the mechanical effect is the same as when the fist is used as above described.

It may be proper to employ this method if no more force is used than can be exerted by the surgeon himself, although accidents have happened even under such circumstances, but it is certainly dangerous and improper to employ it with the pulleys or assistants, and still more so to substitute an iron plug for the heel as recommended and practised by Skey. The

large vessels and nerves lie upon the inner side of the head of the humerus and are exposed to be compressed between it and the heel and thus directly bruised or so held fast that they may be overstretched and torn as their distal portions are drawn downward in the sliding of the soft parts of the arm toward the elbow.

Forcible extension.—If more forcible traction is needed than can be made in the methods already described, resort should be had to the pulleys or specially constructed apparatus. The pulleys are made fast to the arm above the elbow by a broad leather band buckled tightly around it or by a strap or band made fast by several turns of a wet bandage; it is necessary to secure it tightly to the arm, for this does not increase the bruising caused by the traction, and if it should slip the soft parts might be seriously torn, as in the case quoted from Malgaigne on page 75. As a further precaution against slipping the forearm should be bandaged and the elbow fixed at a right angle. It is also advisable to interpose a dynamometer between the pulleys and the limb to indicate the amount of force that is being employed, and a pair of "liberation forceps" to allow the traction to be suddenly relaxed and the position of the arm changed. (Fig. 57.)

FIG. 57.



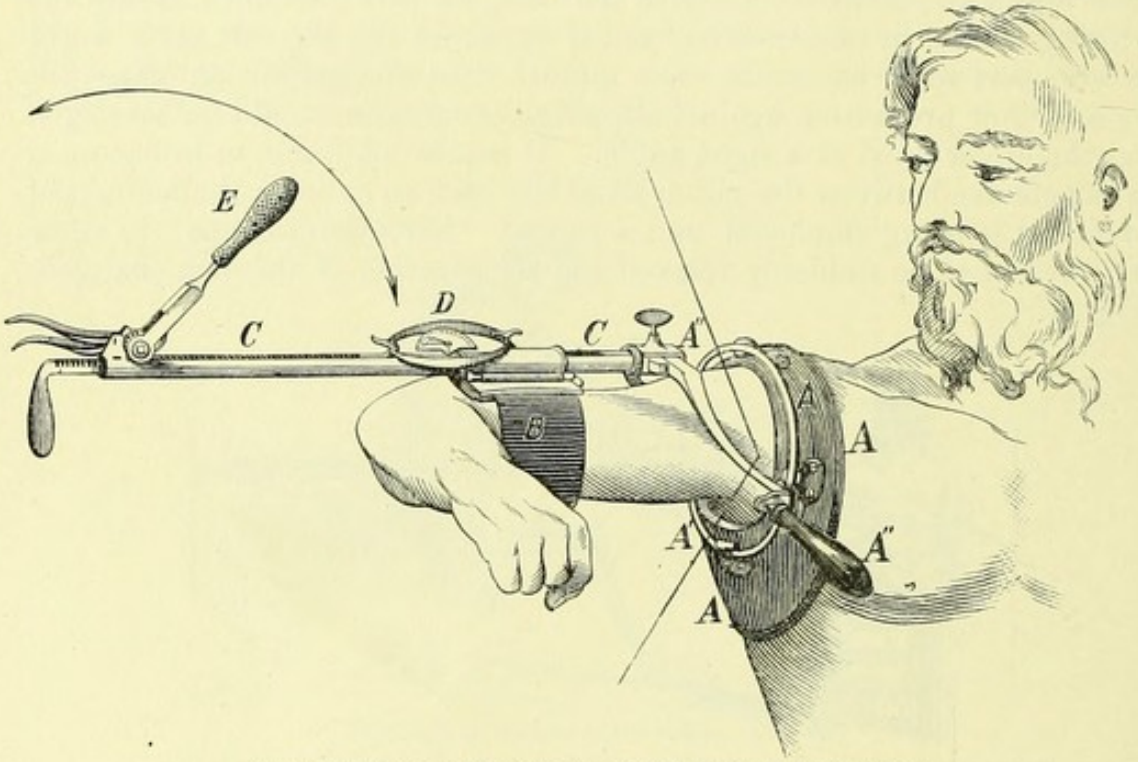
Reduction with the pulleys; 4, dynamometer; 6, "liberation forceps." (DUPLAY.)

The special instruments, of which the most elaborate and ingenious are made in France, are, in the main, modifications of the "adjuster" invented by Dr. Jarvis, of Portland, Connecticut. They consist (Fig. 58) of two bars movable upon each other by a rack and pinion, one of which is made fast by a leather bracelet to the lower part of the arm, and the other to a ring or crutch that fits against the scapula. A dynamometer indicates the force exerted, and a catch sets it instantly free at will. As the instruments are expensive and the occasions for their use are rare, it is seldom practicable to obtain one when wanted.

Reduction by manipulation.—(Rotation.) It has been already mentioned that rotation of the arm has long been used in connection with the various methods of extension to effect reduction, and it also appears that from time to time men have sought to reduce, and sometimes with success, by moving the limb in various directions without the aid of much traction, but it is only within the present century that methods of manipulation founded upon a correct appreciation of the obstacles and of the means by which they may be overcome have been devised and practised with intelligence and success. Rotation inward was long employed as the

final manœuvre to turn the head of the bone into its socket after it had been brought opposite it by traction, and it still constitutes the final step in the pure manipulative method. External rotation during traction was first employed under the influence of various ideas concerning the part taken by the muscles in opposing the return of the bone, or to dislodge the head from its position behind the lip of the glenoid fossa; then, in the light of more accurate knowledge of the influence of the untorn portion of the capsule, it became the first step in the methods of reduction without traction.

FIG. 58.



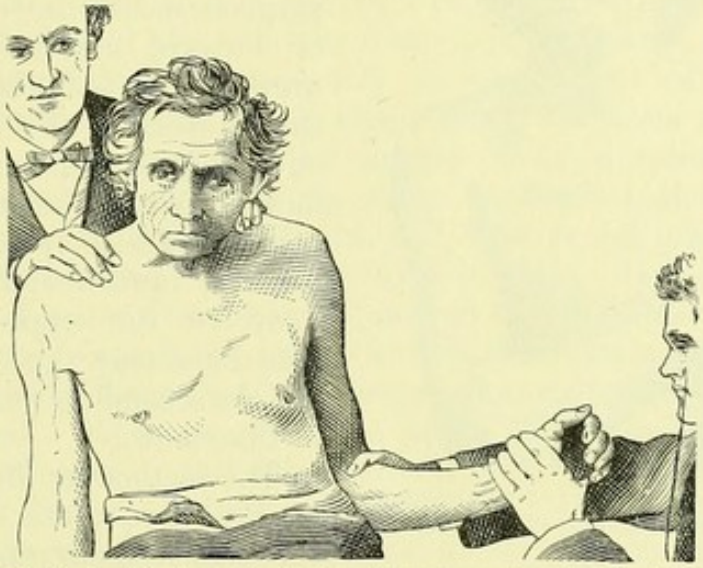
Collin's instrument for reduction of dislocation of the shoulder.

Of these methods the one that is most highly esteemed and generally practised is that recommended by Prof. Kocher,[1] of Bern. The following description is taken from one given at the Surgical Congress in London, and published by his pupil Ceppi in the *Revue de Chirurgie*, 1882, p. 831. "In the subcoracoid dislocation the posterior portion of the capsule and the tendons of the posterior scapular muscles which cover and strengthen it are untorn and are stretched over the glenoid fossa. The inferior portion of the capsule which forms the lower border of the rent is also very tense. But the tension is greatest at the upper part of the capsule, and especially between the long tendon of the biceps and the upper border of the subscapularis, there where it is reinforced by the fibres of the coraco-humeral ligament. This portion of the capsule is twisted in the dislocation, and stretched in the form of a solid cord. If now the humerus is rotated externally until the flexed forearm is turned directly outward, this cord will be at the same time rotated outward, the

[1] Kocher: Berlin. klin. Wochenschrift, 1870, No. 9, and Volkmann's Sammlung klin. Vorträge, No. 83, p. 611.

posterior part of the capsule will be widely removed from the fossa, and the rent in the capsule will gape; but the head of the humerus will still remain solidly fixed against the anterior edge of the glenoid fossa because the upper and lower portions of the capsule have not been relaxed by this movement. It is only when the elbow is carried forward and raised in the sagittal plane, while the arm is still held in external rotation, that the upper part of the capsule is seen to relax, and the head of the humerus, thanks to the tension of the lower portion which keeps it from moving forward, to enter its socket. Rotation inward then completes the reduction."

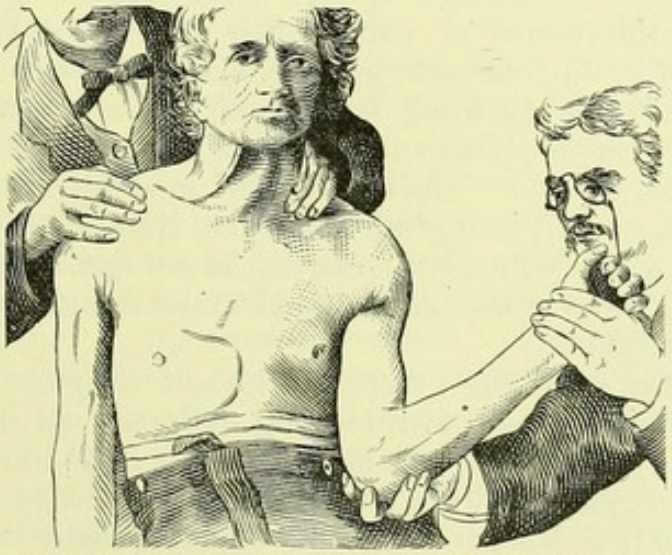
FIG. 59.



Kocher's method of reduction by manipulation; 1st movement, outward rotation. (CEPPI.)

The method may be formulated in detail as follows (Figs. 59, 60, and 61). Dislocation of the left shoulder. The patient is seated, and the

FIG. 60.

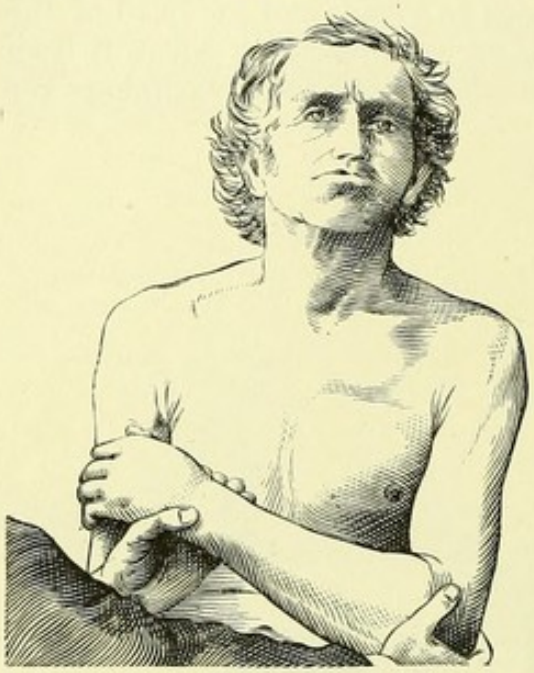


Kocher's method of reduction; 2d movement, elevation of elbow. (CEPPI.)

surgeon, kneeling beside him, flexes his elbow at a right angle and presses it with his right hand against his side; then, holding the elbow firmly in

place, he slowly and steadily moves the wrist outward with his left hand (external rotation of the humerus), and stops when the resistance becomes considerable. The evidence that the movement has accomplished what was expected of it is the appearance of greater fulness of the outer deltoid region. If the resistance begins promptly, before the fulness has appeared, the pressure should be steadily maintained for a few moments. Then, still maintaining the external rotation of the arm and the flexion of the elbow, the surgeon moves the elbow forward, or forward and slightly inward, until the arm is horizontal; during this movement the fulness of the outer deltoid region becomes more marked, and at its termination the manœuvre is completed by rotating the arm inward and bringing the hand to the opposite shoulder. The bone may slip into place during the second movement, elevation of the elbow.

FIG. 61.



Kocher's method of reduction; 3d movement, inward rotation and lowering of elbow. (CEPPI.)

The method as thus described is applicable to those cases in which the displacement is neither very far inward nor low down, in short, to the medium forms of the subcoracoid variety; and as it depends for its success upon the resistance of the untorn portion of the capsule it will also fail whenever the capsule is very extensively torn. It has sometimes been applied with success to the more marked inward dislocations by exaggerating the outward rotation and maintaining it for about a minute before beginning to elevate the elbow; during this period of waiting it is said a peculiar crackling is heard, produced by the outward movement of the head of the humerus. I have heard the same crackling during both outward rotation and elevation in cases of less displacement and have attributed it to progressive laceration of the capsule. Kocher himself modifies the manœuvre in these inward cases by placing the elbow not simply against the side of the body in the axillary line, but as far backward and inward as possible, or he steadies the head of the humerus and draws it outward by a bandage passed under the axilla.

König[1] modifies it for the lower anterior and subglenoid dislocations by making traction in abduction, rotating outward, and then adducting. This is practically the same as the method described as traction downward and outward and generally known as Lacour's method by manipulation.

Farabeuf[2] studied Kocher's method experimentally with a view to determine the mechanism by which its result was accomplished, and

[1] König: Speciel. Chirurgie, 3d ed., vol. iii. p. 40.
[2] Farabeuf: Bull. de la Soc. de la Chir., 1885, p. 395.

reached the conclusion that the efficient agent was the untorn posterior portion of the capsule, and that the upper portion, the coraco-humeral ligament, had little or nothing to do with it. He showed, experimentally, that when this latter had been divided and the posterior portion left intact the manœuvre would still effect reduction, but that when the posterior portion was divided and the upper portion left whole it failed, and that then the head of the humerus instead of being moved outward by the external rotation simply revolved about the longitudinal axis of the shaft. His explanation is clear and intelligible. According to it the approximation of the elbow to the side tightens the posterior portion of the capsule where it extends between the posterior lip of the glenoid fossa and the under and back part of the neck of the humerus; this prevents the posterior surface of the humerus from moving inward when the arm is rotated outward, and consequently its attachment to the humerus serves as the fixed point or centre about which the bone rolls outward, winding itself, as it were, upon the capsule. The elevation and adduction of the elbow, turning upon the same fixed point, then throws the head backward and further outward, and finally the internal rotation unwinds the capsule and leaves everything in place.

When Prof. Kocher first made his method known he thought it would be useful only in recent cases, but he has since ascertained that it can be successfully used in those that have remained unreduced for three or four months. Ceppi's paper contains the notes of twenty cases in which reduction was effected by this means after a lapse of from three weeks to four months. Twelve of them were Kocher's; in one the dislocation was three weeks old, in two five weeks, in three seven weeks, in four three months, and in two four months. He failed in only one case, a dislocation of eight weeks' standing in a woman seventy years of age; the humerus broke below its middle during the attempt. With such a record in its favor the method should certainly receive a trial before resort is had to the more dangerous methods of abduction and forcible traction.

Schinzinger's method, the introduction of which appears to have antedated Kocher's, was in like manner based upon the persistence of the posterior portion of the capsule, but differed from Kocher's in the second and third steps of the manœuvre. He rotated the arm outward until the hand was as far back as the elbow, and then either pressed the bone upward and outward into place by direct pressure, or turned it in by slow internal rotation while an assistant made pressure on the inner side of its head to prevent it from slipping back into the position from which it had been removed by the outward rotation. The method is favorably spoken of by several of the later German writers, and is thought to be especially useful in rupturing the adhesions of old dislocations without the risk of injury to the vessels or nerves.

Circumduction, sometimes known as Heine's method, in which, after fixation of the scapula as for traction, the arm is slowly abducted, raised to the side of the head, inclined slightly backward, and then brought forward and downward across the face and chest, has been recommended and used in old dislocations; it is undoubtedly efficient in breaking up

the adhesions, but it is a rough, uncertain, and dangerous plan, and should be condemned.

To recapitulate, the treatment of a recent anterior dislocation of average displacement may be thus summed up: Kocher's method may first be tried; if that fails, traction downward and outward should be tried, the elbow not being raised higher than the shoulder, combined with direct pressure upon the head, or followed by adduction over the fist in the axilla. If these also fail, the patient should be etherized, and the attempts repeated.

In older dislocations the same plan should be followed, and resort should be had to forcible traction only after other measures have failed.

The signs of a successful reduction are the sound that is usually heard when the bone slips into place, the restoration of form and function, and the diminution or cessation of pain. The sound is not always heard, and, on the other hand, a similar sound may be caused by the rupture of adhesions or by the slipping of the bones upon each other. Complete restoration of form is the best evidence; this is to be determined by an examination similar to that employed in making the diagnosis of a dislocation and by attention to the same signs. The reduction may be incomplete because of the interposition of a portion of the capsule, or because of the presence of tissues of new formation in the glenoid cavity. The incompleteness is shown by the abnormal projection forward of the head of the humerus under the acromion.

After-treatment.—After reduction has been obtained it is highly desirable that the arm should be immobilized for two or three weeks in a position that will favor the speedy repair of the lacerations of the capsule, tendons, and muscles; otherwise the joint may remain in a condition that favors recurrence, and the patient may suffer much inconvenience or even disability in consequence. As the rent in the capsule is on the inner side, and as its edges are separated by external rotation of the limb, the head of the humerus should be directed toward the outer side (adduction of the elbow) and the arm should be kept rotated inward. These two indications are met by binding the limb to the body with the hand resting just below the opposite clavicle. Fixation may be made by a silicate-of-soda or plaster-of-Paris dressing or even by simple bandages, but the most convenient and effective dressing is a strip of adhesive plaster arranged as follows: beginning in front at the clavicle it is carried over the shoulder and down the back of the arm, then under the elbow to the back of the forearm, and along the latter and the back of the hand to and over the top of the opposite shoulder. A small pad of absorbent cotton or lint should be placed in the axilla and between surfaces of skin that are in contact. If the patient is unruly a second band may be placed circularly about the body and lower part of the arm. This dressing should be retained for two or three weeks, and the arm carried in a sling for a fortnight longer. If passive motion is made, abduction and external rotation should be avoided.

If the greater tuberosity has been broken off in whole or in part and widely separated by the retraction of the attached muscles, the indication is to favor its reunion by keeping the limb in the position of outward

rotation, an indication that is difficult of accomplishment unless the patient stays in bed. Fortunately, such separation of the fragments as would make this position desirable is rare; they are usually kept in sufficiently close approximation by the untorn periosteum and ligamentous surroundings.

For complications, accidents, prognosis, and the treatment of old dislocations, see Chapter XVIII.

CHAPTER XVII.

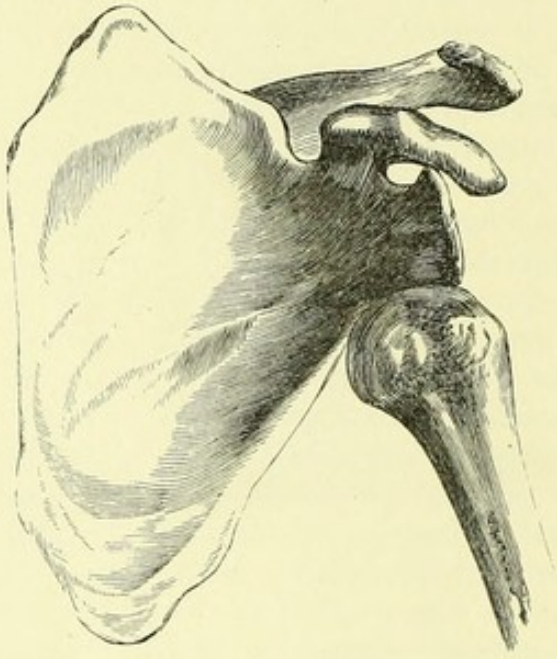
DISLOCATIONS OF THE SHOULDER.—(*Continued.*)

DOWNWARD DISLOCATIONS: SUBGLENOID, LUXATIO ERECTA, SUBTRICIPITAL DISLOCATION. POSTERIOR DISLOCATIONS: SUBACROMIAL, SUBSPINOUS. UPWARD DISLOCATIONS.

Downward Dislocations. (Subglenoid.)

Under this title are here included those rare cases in which the head of the humerus is displaced directly downward upon the tendon of the long head of the triceps, and those more frequent ones in which it is engaged under the lower and inner edge of the glenoid cavity, and rests against the flattened upper portion of the axillary border of the scapula on the inner side of the tendon of the triceps. (Fig. 62.) As explained in connection with the classification given in the preceding chapter, the name is here restricted to a portion of those cases which are termed subglenoid by most English and American authors, to those, namely, in which the head of the bone is low in the axilla. By some the term is still further restricted in use, and is applied only to the first of the two forms above-mentioned, those in which the head is displaced directly downward upon the tendon of the triceps. Although it is denied by some on theoretical grounds that this form can exist, yet it must be admitted not only as possible, but as having been actually observed, on the evidence of several observers who fully understood the point in dispute. Von Pitha (quoted by Bardenheuer) says that he had seen it only in cases in which he had the opportunity to examine the patient immediately after the accident, and before any movements had been communicated to the limb or attempts made to reduce. He believes that the head can be easily displaced from its new position, and moved upward and forward, the dislocation being thus transformed into a subcoracoid, by involuntary or communicated

Fig. 62.



Subglenoid dislocation.

movements of the arm, or even by muscular action. Tillaux[1] observed this transformation in a case while he was preparing to make a cast of the limb.

Two subvarieties, representing extreme displacements, and characterized by exceptional symptoms, the *luxatio erecta* and the *subtricipital*, will be separately described.

This form of dislocation was studied experimentally by Malle,[2] Goyrand,[3] and Panas.[4] They found that if the scapula was fixed, and the arm was forcibly elevated, the head of the humerus presented through a large rent in the capsule between the subscapularis and the long head of the triceps, and that if the arm was then lowered the head would often return to its socket, but that if it was twisted outward while being lowered the dislocation would persist. The lower border of the subscapularis was always found torn, and its untorn portion rested upon the upper surface of the head; and Malle claimed that in order to produce the dislocation upon the cadaver it was necessary to divide the portion of the capsule between the acromion and the lesser tuberosity.

The cause, with the single exception of Desault's case,[5] in which the injury was said to have been produced by a fall upon the shoulder, has always been the forcible elevation of the arm, as in a fall through a narrow opening or upon the extended elbow, by a horse throwing up his head while being led by the bridle, or as in Goyrand's case of a woman who, having fallen to the ground, had her arm dislocated by a passer-by who sought to raise her. In one of Tillaux's cases a young girl dislocated her shoulder by suddenly raising her arm while playing at raquettes.

The rent in the capsule in the specimens produced experimentally has always been comparatively small, and situated in the lower and inner portion between the triceps and the subscapularis, and differs from that of the subcoracoid form in not extending so far upward along the anterior edge of the glenoid cavity. In a specimen presented by Leroy[6] to the Société Anatomique the lesions were identical with those produced experimentally. The upper part of the capsule, including the insertion of the supra- and infra-spinatus muscles, was torn away from the humerus, from the anterior border of the bicipital groove to the tendon of the teres minor, a distance of four centimetres; in the lower portion was the usual rent, two and three-quarters inches long, extending from the tendon of the teres minor inward and then upward along the anterior border of the glenoid cavity. The head of the humerus lay upon the axillary border of the scapula one inch below the anterior border of the coracoid process, the limb being so far rotated outward that the internal epicondyle was directed forward, and the greater tuberosity rested against the anterior lip of the axillary border and the adjoining portion of the neck of the scapula. The subscapularis was pushed upward and overlapped the head.

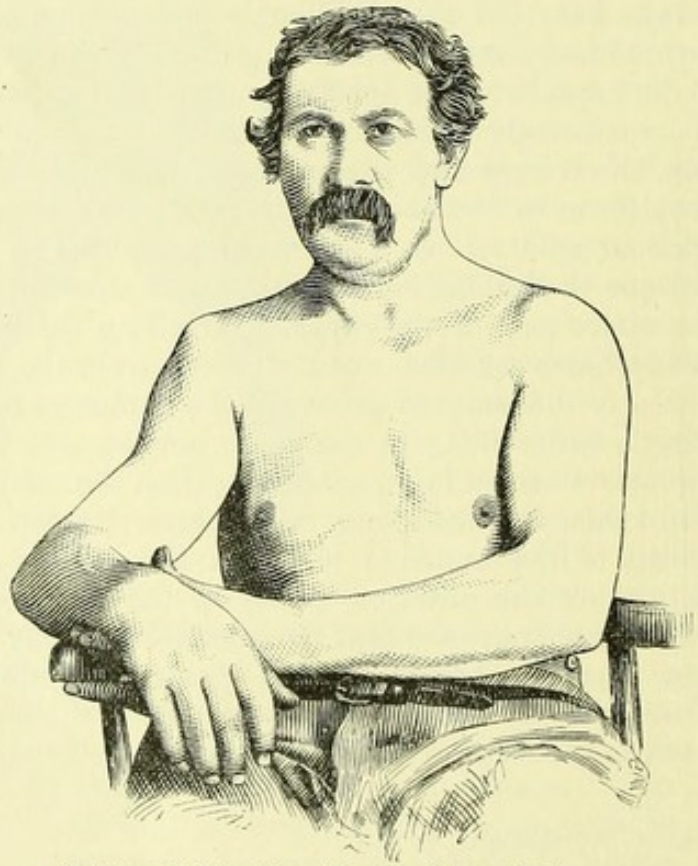
[1] Tillaux: Anat. topographique, p. 536.
[2] Malle: Bull. de l'Acad. de Méd., Paris, 1838, vol. 2, p. 941.
[3] Goyrand: Mém. de la Soc. de Chir., 1847, vol. 1, p. 21.
[4] Panas: Dict. de méd. et de chir. pratiques, art. Epaule, p. 462.
[5] The diagnosis in this case has been questioned. The limb is described as having been very movable, and Goyrand thinks the injury was a fracture.
[6] Leroy: Bull. de la Soc. Anatomique, 1844, p. 102.

In a case reported by Jössel[1] of subglenoid dislocation caused by a fall from the second story of a house, in which death followed on the second day in consequence of an associated fracture of the skull, the following conditions were found: The subscapular artery was entirely torn across. The head of the humerus lay between the partly torn subscapularis muscle and the triceps "upon the triangular surface of the lower border of the scapula directly below the glenoid fossa." The capsule was entirely torn from the humerus, the subscapularis was pushed upward, the edge of the glenoid fossa was a little broken at its widest part, and the upper and middle facets of the greater tuberosity were broken off, the line of fracture running into and opening the bicipital groove.

In Sédillot's case, quoted by Malgaigne as of this kind, the conditions were quite exceptional; abduction was so marked that the arm was held almost horizontal, the head of the humerus was situated half an inch below the glenoid fossa, resting against the scapula, but also engaged between the latissimus dorsi and teres major in front and the triceps behind.

Apparently the failure of the head to rise as usual to the level which would make the dislocation subcoracoid is due to the resistance of the untorn portion of the capsule on the inner side; and the greater abduction of the limb is due to this retention of the head at a lower level, for the untorn outer portion prevents the shaft from sinking unless the head correspondingly rises.

FIG. 63.



Subglenoid dislocation. (From a photograph.)

Avulsion of the whole or part of the greater tuberosity seems to be the rule; this is equivalent to the division of the upper part of the cap-

[1] Jössel: Deutsche Zeitschrift für Chirurgie, 1874, vol. 4, p. 124,

sule which was said by Malle to be a necessary preliminary to the production upon the cadaver of a dislocation directly downward.

Symptoms.—The flattening of the outer portion of the shoulder, the prominence of the acromion, and the abduction of the elbow are all more marked than in the subcoracoid dislocation; and the axis of the arm prolonged by the eye in front passes below and to the inner side of the glenoid cavity. Measured in partial abduction from the acromion to the elbow, the arm appears longer than its fellow, and this elongation may not give place in complete horizontal abduction to as much shortening as is found in the subcoracoid form. The head of the humerus can be plainly felt in the axilla, and is separated from the coracoid process by an interval of from half an inch to an inch.

The arm is widely abducted, and is usually directed forward and rotated outward, and the elbow cannot be brought to the side; the angle made by the flat outline of the deltoid with the axis of the shaft is very marked.

The differential diagnosis from subcoracoid dislocation is made by recognition of the position of the head below the glenoid fossa; the corroborative symptoms are the more marked flattening of the deltoid, and the wider abduction of the elbow.

Treatment.—Theoretically, the position of the head below the glenoid fossa suggests that traction should be made upward and outward, the elbow being raised above the shoulder, and this plan is generally recommended and usually successful. The objection to it is the added risk of doing injury to the bloodvessels in the axilla by overstretching them around the head of the humerus, as explained in the preceding chapter. It is prudent, therefore, that a trial should first be made of the method of *direct reposition* (p. 222), and, that failing, of traction in the direction of the arm as found, or with a little more abduction, combined with external rotation and followed by adduction while pressure outward and upward is made upon the head of the bone, or with the fist in the axilla. The reader is referred to the preceding chapter for the details.

Luxatio erecta.—This striking dislocation first described by Middeldorpf, and his pupil Scharm,[1] who reported the former's two cases, is characterized by the marked elevation of the arm beside the head, a position from which it cannot be lowered without causing great pain. Besides Middeldorpf's two cases I have met with the description or mention of four others by Busch,[2] Panas,[3] Lange,[4] and Alberti,[5] and a reference by Bardenheuer (loc. cit., p. 303), without details, to a case reported by Bertin and two cases reported by Meyer. They are in brief as follows:

Busch. A man carrying a heavy sack on his left shoulder down a flight of steps fell when near the bottom. He came at once to the hospital, with his left arm upright, the forearm resting across the top of

[1] Middeldorpf: Clinique Européenne, 1859, vol. 2, and Scharm, De nova humeri luxationis specie. Dissert. Inaug. Breslau, 1859; quoted by Alberti, *vide infra*.

[2] Busch: Archiv für. klin. Chir., 1863, vol. 4, p. 30.

[3] Panas: Dict. de Méd. et Chir. pratiques, art. Epaule, p. 405.

[4] Lange: New York Med. Record, 1879, vol. 16, p. 400.

[5] Alberti: Deutsche Zeitschrift für Chir., 1884, vol. 20, p. 475.

the head, and the wrist held firmly in the other hand opposite the right ear. He complained of pain extending from the shoulder to the finger-tips. The arm was easily lowered nearly to the side, and then presented the usual signs of a dislocation, the head of the humerus lying in the axilla on the lower border of the glenoid fossa, but after it had been lowered the patient asked to be allowed to raise it again to relieve the intolerable pain which the position caused. The permission having been granted, he threw the arm sharply upward and replaced it in its original position. This was repeated several times. When the arm was upright the head of the humerus projected markedly in the axilla. Reduction was easily made by slight traction upward.

Panas says only that the patient presented himself with the hand resting on top of his head, and sustaining the arm with his other hand. The slightest attempt to lower the limb caused sharp pain, and even when in bed he rested it upon the pillow beside his head.

Lange. A man forty-five years old fell forward, grasping with his elevated right hand the edge of a barrel as he fell. When seen eight hours later, the arm was elevated at an angle of 120°; its axis, prolonged, would have crossed the junction of the sternum and the third rib. Every attempt to lower it caused pain at its middle third, which Dr. Lange thought might have been due to tension of the coraco-brachialis. The deltoid was relaxed; the elbow was extended, and the hand supinated. By bending the body as far as possible toward the injured side while the patient was seated the hand could be brought down to the knee. The head of the humerus was below and to the inner side of the coracoid process and apparently rested against the latter. Reduction was effected by increasing the elevation and making traction until the head was brought under the coracoid, and then lowering the elbow and rotating inward.

Alberti. A man thirty-two years old was leading a horse which reared and, while descending, struck his elevated arm with his knee. The man felt sharp pain in the shoulder, and was unable to lower the arm. When seen, the arm was held vertically and inclined slightly forward and outward, the forearm resting on top of the head; the hand was pronated. Any change of position was guarded against by grasping the wrist with the other hand. The acromion was prominent, the glenoid fossa easily felt, the deltoid relaxed and thrown into two folds. The head of the humerus lay a little behind the axillary line at the level of the middle of the outer border of the scapula. The distance from the elbow to the acromion was seven centimetres less than on the opposite side when the other arm was placed in a similar position. The patient could not straighten the elbow, and could only move the fingers a little. He complained that the hand was numb. He insisted upon taking chloroform; reduction was then easily effected by traction upward and outward.

The only opportunity for direct examination of the parts was furnished in one of Middeldorpf's cases; the patient's right arm was caught in some machinery and he was whirled around, receiving in addition to the dislocation a wound of the deltoid; he died of pyæmia. The greater tuberosity had been torn off, remaining attached to its three muscles, and the acromion was broken. Scharm produced the dislocation five times upon

the cadaver; in every case the supra- and infra-spinatus muscles were torn away, and in two there was partial rupture of the subscapularis and pectoralis major. The main bloodvessels and nerves were uninjured. My only knowledge of Middeldorpf's cases and Scharm's experiments comes from the brief mention made of them by Alberti.

Dr. Lange's case, in which the dislocation was intracoracoid rather than subglenoid, differs also from the others in the less complete elevation of the arm. Bardenheuer (loc. cit., p. 303) says that in his experience, covering about four hundred cases of dislocation of the shoulder, he had never encountered a pure luxatio erecta, but he had met with two cases in which the arm was abducted beyond a right angle with the body. Probably they are the two cases quoted in the preceding chapter as unique cases of horizontal abduction. Dr. Lange's case might properly be regarded as an exceptional form of intracoracoid dislocation intermediate between the usual form and the luxatio erecta.

The mechanism appears to have been forcible and extreme elevation of the arm, combined in one case (Alberti's) with a blow upon the arm from above downward, and the elevated position after dislocation was plainly due to the tension of the anterior soft parts created by the shifting of the centre of motion to a point so far below the glenoid cavity. In one of Meyer's cases mentioned by Bardenheuer, a woman sixty-two years old, it is said that the dislocation occurred during an epileptic fit. It is stated also that in one of the cases "paralysis of the brachial plexus" persisted after reduction.

The method of reduction adopted in all the cases was clearly the proper one, not only because it succeeded but also because it corresponded to the anatomical indications. Traction in the direction assumed by the arm drew the head directly back toward its socket by the route along which it had escaped.

Subtricipital dislocation.—Our knowledge of this very rare form is limited to a single case observed clinically by Farabeuf,[1] and to subsequent experiments made by him upon the cadaver. As the luxatio erecta is produced from a subglenoid by exaggerating the descent of the head of the humerus, so the subtricipital is produced from the erecta by a consecutive displacement of the head upward and backward, at first underneath and then behind and above the long tendon of the triceps, a displacement effected by the descent of the elbow in front.

The case was that of a sailor who injured his shoulder while at sea; five weeks later he landed at Bordeaux, and, attempts made there to reduce having failed, he went to Paris. The arm was abducted and carried forward, and the head of the humerus rested on the back of the scapula two finger-breadths below the angle of the acromion. Reduction was not obtained.

In his experiments upon the cadaver Farabeuf found that after raising the arm forcibly and thus tearing the capsule at its lower part he could, by a vigorous push or a blow upon the elbow with a mallet, make the head of the humerus descend several centimetres below the glenoid cavity; if then the arm was lowered in front the head of the bone moved

[1] Farabeuf: Bull. de la Soc. de Chirurgie, 1879, p. 778, and 1885, p. 396.

backward and became engaged under the tendon, which then held the arm abducted and directed forward and more or less rotated inward.

The circumflex vessels and nerves were bruised and sometimes torn. He thought the head of the bone tended always to pass first in front of them and then below and behind them as the arm was lowered. The capsule and the insertions of the rotator muscles were more or less extensively torn.

Farabeuf's case is apparently the one mentioned by Poinsot[1] as Sebilleau's and as having been examined by himself in 1881, The limb was then in slight abduction and inward rotation, the elbow and fingers flexed; movements at the shoulder were almost completely lost. The case is described by Poinsot as one of dislocation backward (sub-acromial or subspinous), and no reference is made by him to Farabeuf's opinion concerning it although he is named among the surgeons who had examined it.

Farabeuf maintains that two very similar cases observed by Richet and Bottey and named by the former *retro-axillary* (see posterior dislocations) were really examples of this variety described by him.

The reason for taking this very exceptional form of dislocation out of the group of irregular forms and making of it a class apart is the necessity for emphasizing the route by which the head of the bone has passed to its new position. If in a similar case it should be thought, as was thought in Richet's and Bottey's cases, that the tendon of the triceps lay below the head and that the dislocation was only an exceptional form of the subacromial variety, the attempt to reduce would probably fail, because it would be made according to the method suitable to that variety, whereas it should be made by first transforming the dislocation into a luxatio erecta by raising the elbow to the side of the head, and then reducing by direct traction upward.

Posterior Dislocations. (Subacromial and Subspinous.)

Dislocations backward are divided into two classes, the subacromial and the subspinous, according as the head lies under the projecting outer border of the acromion or further back below the spine of the scapula, respectively. A variety of the subacromial, to which the name *retro-axillary* has been given, has been recently observed and described by Richet and Bottey.

Although I think this division into two groups is quite generally accepted by the profession, yet English and American systematic writers upon the subject have, as a rule, refused to adopt it, giving as a reason therefor, the fact that the two differ only in an unimportant feature, the degree of the displacement, and they apply the term *subspinous* to all. Flower[2] justifies the choice of this name in preference to *subacromial* on the ground that the latter does not express any change from the normal situation of the head of the humerus under the acromion. On the other hand, it may be fairly urged that as in the great majority of cases the

[1] Poinsot: Translation of Hamilton's Fract. and Dis., p. 867.
[2] Flower: Holmes's System of Surg., Am. ed., vol. i. p. 875.

head is not displaced so far as to the spine of the scapula, the term subspinous is misleading and improper. I have preferred, in accordance with what I believe to be the general practice of the profession, to retain both terms with the distinction between them established by Malgaigne. Of the two groups the subacromial is much the more frequent, the subspinous being very rare. The actual difference in their frequency is greater than a collation of the reported cases by the titles given them would indicate, for not a few of the former have been described as "subspinous," because the reporters have not discriminated between the two varieties but have applied that term to all.

According to Malgaigne, the earliest recorded mention of this dislocation was in 1834, and when he wrote, in 1855, he could collect only 34 cases, of which he had himself observed 3. A very considerable number of cases have been recorded since that time (I found 7 in the *Index Medicus* for the years 1878 to 1882), and Panas's opinion that many escape recognition, by being mistaken for a sprain or an articular fracture, seems fairly justified, for not only are the diagnostic symptoms sometimes very obscure, but Nélaton said that he had within a short period of time seen three cases that had passed unrecognized by surgeons of merit. In Malgaigne's statistics 26 were men, and 5 women; and in rather more than a quarter of them the cause was muscular action. Bardenheuer quotes Knox, but without giving the reference, as having seen two cases in which the injury was caused by obstetrical manipulations; when seen by him one patient was twenty-one months, the other three years old. Possibly these were examples of dislocation due to paralysis of the muscles of the shoulder, the paralysis itself being the result of obstetrical manipulations. The investigations of Duchenne de Boulogne indicate that this is not an infrequent accident, and that the resulting dislocation is always subacromial. (See Chapter XVIII.) Bardenheuer himself had met with four cases of backward dislocation, in one of which both shoulders had been dislocated by a fall forward upon the elbows.

Experiment upon the cadaver shows that the dislocation can be readily produced by forcible internal rotation of the arm, by which the posterior portion of the capsule is torn and the passage backward and outward of the head is made easy. In some of the cases clinically observed also it is plain that this has been the mechanism, and in others it has undoubtedly aided. Thus, Piel, who wrote a thesis on the subject in 1851, saw a woman in whom it had been caused by her husband twisting her arm in a quarrel. In seven of Malgaigne's cases and in several that have since been reported the dislocation occurred during an epileptic fit, presumably by internal rotation of the limb. In other cases the cause has been a blow upon the front of the shoulder (twice a blow with the fist), pressure upon the back of the shoulder while the elbow rested against the ground, an attempt to control the patient in convulsions, once the throwing of a stone by a boy ten years old, and frequently a fall. The anatomical features of the joint, the results of cadaveric experiment, and such histories of cases as are sufficiently complete, indicate that the common mode of production is pressure backward and outward upon the head of the humerus, either directly or through the elbow, combined with adduction of the limb across the front of the chest and internal rotation. Such a

combination is most frequently found in falls forward in which the weight is received upon the elbow, not upon the hand, for in the latter case the arm is usually slightly abducted and the force is received squarely against the surface of the glenoid fossa instead of obliquely outward. It will be remembered that this surface is directed forward and outward, and that as the dislocating force must be exerted obliquely to it it must come from a point that is in front and more or less to the inner side. One of Malgaigne's cases is especially interesting from this point of view, as showing the conditions of the production almost as clearly as an experiment. A woman was trying to take down a box placed high above her head, it slipped suddenly into her extended hand, and the dislocation occurred. In other words, the force was exerted in a suitable direction upon an arm that was elevated, adducted, and rotated inward.

In a case observed by Tillaux[1] the patient, a man twenty-four years old, had his right arm caught in some machinery and was drawn several times about a revolving shaft, receiving a subspinous dislocation, and in addition having the arm almost completely torn away at its middle by being twisted several times upon itself.

Autopsies have been made in six recent cases in which death was caused by associated injuries. In Maisonneuve's case (the specimen is pictured in Malgaigne's Atlas, Plate XXII., Figs. 5 and 6) the patient fell from a height of thirty feet. The capsule was torn above, below, and on its outer side; the greater tuberosity was torn off, broken into two pieces, and drawn back below the acromio-clavicular arch by the supra- and infra-spinatus muscles to which it remained attached. The teres minor and subscapularis were still attached to the humerus; the long tendon of the biceps had been torn out of its groove. The circumflex nerve was uninjured. The head of the humerus lay just below the posterior angle of the acromion and was not in contact with either the spine or the neck of the scapula, but rested against the posterior edge of the glenoid cavity.

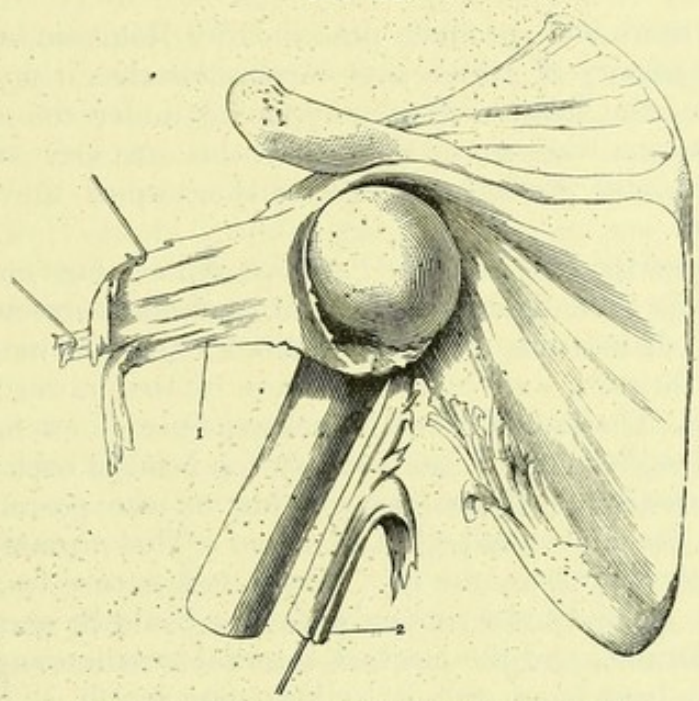
In Laugier's[2] case the subscapularis and supraspinatus were torn from their insertions, and the head of the humerus had passed, as in Maisonneuve's case also, between the infraspinatus and teres minor and was covered only by the deltoid.

Two cases were reported by Jössel,[3] one a subacromial, the other a subspinous dislocation. In the first the injury, together with a fracture of skull, was caused by a fall into a cellar. The head of the humerus had torn through the teres minor and lay under the acromion; the limb was so far rotated inward that the articular surface looked directly outward. The supraspinatus and infraspinatus were uninjured. The capsule showed a triangular rent on the outer side just large enough to let the head through. The tendon of the subscapularis was still attached to the humerus, but under it and close by the tendon of the biceps an irregular, movable piece of bone could be felt, the lesser tuberosity, the fracture by which it was separated extending into the bicipital groove; the tubercle was split into two pieces, both adherent to the tendon.

[1] Tillaux: Anatomie topographique, p. 536.
[2] Laugier: Gaz. des Hôpitaux, 1846, p. 60.
[3] Jössel: Deutsche Zeitschrift für Chir., 1874, vol. 4, p. 125.

In the second case the patient fell from the height of two stories, dislocated the left shoulder, and sustained a compound fracture of the thigh; he died on the fifth day. The head of the humerus (Fig. 64) had torn

FIG. 64.



Subspinous dislocation of the shoulder. (JÖSSEL.)

through the teres minor and lay under the spine of the scapula, separated from it by the interposed infraspinatus; it was directed backward. The long head of the triceps was almost entirely torn through, and a piece was broken from the axillary border of the scapula just below the glenoid fossa. The subscapularis and the adjoining part of the capsule were torn away from the humerus, bringing with them the lesser tuberosity, the fracture of which was broader than in the preceding case.

In the remaining two cases the dislocations were subspinous; in one of them, quoted by Malgaigne[1] (loc. cit., p. 541), the patient, a man sixty-two years old, fell backward, and the wheel of his wagon, which carried a load of three and a half tons, passed obliquely across the right side of his chest, causing injuries which resulted in his death thirty hours later. Several ribs were fractured, as were also the body of the scapula and the inner portion of its spine. The deltoid, pectoralis major, teres major, and teres minor were torn or crushed, and the capsule was almost entirely detached. When the arm was lowered the head of the humerus lay below the spine of the scapula in the outermost part of the subspinous fossa, the lesser tuberosity corresponding to the edge of the glenoid fossa.

In the other, reported by Collins,[2] a man sixty years old was knocked down and run over, sustaining, in addition to the dislocation of his right shoulder, fracture of several ribs; he died in a few days of pneumonia.

[1] According to Soyez (Thèse de Paris, 1880, No. 179) the case was treated by Denonvilliers, who deposited the specimen in the Musée Dupuytren. It is reported by Malgaigne as if he had himself observed it; hence has arisen the error of supposing that they were different cases.

[2] Collins: Dublin Journ. Med. Sci., 1879, ii. p. 166.

The capsule was torn on all sides; the supraspinatus and subscapularis were torn away at their insertions, and the long tendon of the biceps was detached from the bicipital groove. The head of the humerus lay between the teres minor and the infraspinatus "immediately beneath the scapular spine."

In addition, there is a specimen described by Bouisson, and quoted by Malgaigne, the history of which is so incomplete that it must be treated as an exception; the head of the humerus lay under the acromion, and the inward rotation was so marked that the articular surface looked directly outward, and the greater tuberosity occupied the outer half of the glenoid fossa.

In a case described by Küster[1] as congenital, but concerning the etiology of which some doubt may be felt, a child fourteen months old had a backward dislocation of both shoulders; the elbows were directed downward and forward, and both arms were rotated inward, the left one very markedly. The patient died in consequence of an operation done upon the left shoulder, and at the autopsy the head of each humerus was found to be normally developed and resting on the posterior border of the abnormally flat and small glenoid fossa. The normal development of the head of the humerus, the fact that the departure from the normal condition of the glenoid fossa was only such as could be accounted for by the changed relations, and the marked internal rotation suggest that the dislocations may have been caused by muscular action, or have been the consequence of local paralysis due to the pressure of the forceps in delivery (see Chapter XVIII.), especially since the report indicates that Küster himself felt there might be a doubt of the supposed congenital character.

The important complication of fracture of the anatomical neck has been reported in two cases, one by Delpech, the other by Malgaigne;[2] in each the cause was a fall upon the shoulder. In Delpech's case the fall was due to an apoplexy which soon proved fatal; the head had passed entirely through a large rent in the postero-external part of the capsule, its fractured surface lay against the subspinous fossa, and its articular surface was directed backward and covered by the infraspinatus muscle. The muscular attachments to the humerus were all preserved, and the long tendon of the biceps was intact.

Malgaigne's case was not seen by him until eleven months after the receipt of the injury; the head of the humerus could be felt as an immovable, hemispherical body, two inches in diameter, and half an inch below the posterior angle of the acromion. The arm was shortened half an inch, the elbow slightly abducted and not rotated. The upper end of the shaft corresponded to the glenoid cavity. The arm was slightly movable; the head did not share in its movements.

The results obtained by experiment upon the cadaver are in harmony with these post-mortem records. In the subacromial variety the head of the humerus is found under the acromion looking backward and inward, with its anatomical neck engaged against the posterior edge of the glenoid fossa, and the lesser tuberosity lying on the latter. The tendon of the

[1] Küster: Ein chirurg. Triennium, 1882, p. 256.
[2] Soyez: Thèse de Paris, 1880, No. 179, p. 28.

subscapularis covers the anterior and inner part of the fossa, and is usually more or less detached from its insertion upon the humerus, probably by direct pressure against the anterior edge of the fossa. The dislocation can be transformed into a subspinous one by diminishing the internal rotation sufficiently to free the lesser tuberosity, and then forcing the humerus backward toward the dorsum of the scapula, tearing the capsule more extensively, lacerating the infraspinatus, increasing the separation of the subscapularis, and tearing off also the supraspinatus from its insertion. The dividing line between the two varieties is necessarily an arbitrary one, and in some cases it must be difficult to determine to which variety the case belongs. Malgaigne's definitions are as follows: The subacromial is one in which the head of the humerus lies under the posterior angle of the acromion; the subspinous, one in which it has been displaced behind the angle of the acromion, and lies under the spine of the scapula.

The *symptoms* in recent cases are not very marked, and the characteristic ones may be ma-ked by the swelling. In the subacromial variety the shoulder is somewhat broadened, and seems full behind and flattened in front. The arm hangs by the side, the elbow usually directed somewhat forward, and is rotated inward. The coracoid process can be plainly felt, and perhaps seen; the acromion is prominent in front, and the soft parts below it can sometimes be sufficiently depressed to allow the glenoid fossa to be felt. The absence of the head of the humerus from its socket is recognized by pressure made in front, and its presence behind and to the outer side is determined by palpation combined with gentle movements of the limb. In the older cases the subsidence of the inflammatory swelling and the atrophy of the deltoid consequent upon disuse make the deformity more marked. Voluntary movements are abolished, and communicated movements restricted and painful. Comparative measurements have not shown constant or notable differences in length.

The anteversion and adduction are probably due to the persistence of the anterior portion of the capsule, which is noted in most of the autopsies and all the experiments upon the cadaver.

In the subspinous variety the attitude of the arm in the few reported cases has not been always the same; sometimes the elbow has been held close to the trunk and projected forward; in Malgaigne's it was rotated inward, but otherwise freely movable, and remained in such position as was given to it. In Desclaux's it was held horizontally in front of the upper and anterior part of the chest, and as any attempt to lower it caused great pain, the patient sought to keep it immovable by placing the hand on the top of his head. The local symptoms at the shoulder are much the same as those in the subacromial variety; there is the same prominence of the coracoid process and acromion, the flattening of the front, and the fulness of the back of the shoulder, the absence of the head of the humerus from its socket, and its presence behind, in this case, of course, further back behind the angle of the acromion, and below the spine of the scapula. In two cases (Desprès,[1] René[2]) there

[1] Desprès: Bull. de la Soc. de Chir., 1879, p. 776.
[2] René: Gaz. des Hôpitaux, 1882, p. 581.

was an ecchymosis as large as a silver dollar under the skin at the point where it covered the head of the humerus; in each case it disappeared promptly after reduction and was attributed to the pressure of the bone.

Richet, in 1882, treated a case which differed widely in one respect from both the subacromial and subspinous forms, namely, in that the head of the humerus, instead of being in contact with the acromion, lay at a distance of two finger-breadths below it, close behind the glenoid fossa. He considered it a new variety, representing the first stage in the production of the subacromial, and gave it the name of *retro-axillary*. The case was published by Bottey, his interne, in the *Progrès Médical*, August 5, 1882, and subsequently republished with another also observed by Bottey in his graduating thesis.[1] The two cases resembled each other very closely; the patients were women, aged seventy-eight and seventy-two years, respectively, and the injury was caused in each case by a fall upon the shoulder; in one, while walking in the street; in the other, from her bed, against a chair. The elbow was directed forward and held near the body, and in the second case the patient supported the limb with the other hand because of the pain its weight caused. The antero-external aspect of the shoulder was flattened, and the anterior border of the axilla lowered. The coracoid process and acromion were prominent, and the glenoid fossa was empty. The head of the humerus could be very distinctly felt, for both patients were thin, and there was no swelling, behind the posterior edge of the glenoid fossa and slightly separated from it, and distant from the acromion by two good finger-breadths. In each case it is stated that the distance measured from the acromion to the epicondyle was about half an inch less on the injured, than on the uninjured limb, a statement which is inexplicable, except on the supposition that the limbs were not symmetrically placed when measured, or that their positions were such that the elbows were considerably raised in front. External rotation of the limb was marked. Reduction was easily effected by direct impulsion, and both patients recovered promptly.

Farabeuf claims that both these cases were examples of the variety of downward dislocation to which he gave the name of *subtricipital*, but although the symptoms were similar, I think the mode of production, and especially the facility of reduction by direct impulsion forward of the head make it impossible to accept his opinion. The position of the head may be explained by assuming that the rent in the capsule was exceptionally low, and did not extend upward along the posterior border of the glenoid fossa.

The prognosis is favorable as regards the probability of effecting reduction (in two or three cases the head has been unexpectedly returned to its place by the manipulations employed to make the diagnosis), but it is very unfavorable if the dislocation is left unreduced, for then the range of motion is usually very slight. In a case reported by Sir Astley Cooper, in which the dislocation immediately recurred after every reduction, and was finally abandoned; the patient survived seven years, but

[1] Bottey: Deux cas de luxation de l'épaule en arrière et en bas (luxation rétro-axillaire). Thèse de Paris, 1884, No. 13.

remained unable to use or even move the arm to any extent. The tendency to recurrence was attributed to the separation of the tendon of the subscapularis from the humerus, and to the consequent lack of support on that side. The same tendency has been noted in other cases. Bardenheuer says it existed in three of his four, and that in two of them movements of the joint gave rise to crepitation. In some of the cases the full use of the limb has been regained in a very short time after reduction, a week or ten days.

The diagnosis, as has been already said, may be difficult, especially if there is much swelling. The injury appears to have been not infrequently mistaken for a sprain or a contusion. The attitude and the direction of the axis of the arm, except in the rare subspinous cases, are not sufficiently characteristic even to suggest the existence of the injury, and unless the examination is systematically made with a view to determine the position of the head of the humerus, as should be done in all cases of injury in this region, the dislocation may be overlooked. If the head of the bone can be felt, and its relations to the acromion determined, all doubts would be removed.

Treatment.—Reduction has been easily effected in both recent and old cases by a variety of methods. The one that has furnished the largest number of successes is direct pressure from behind forward upon the head of the humerus with counter-pressure upon the front of the acromion, usually associated with traction upon the arm, forward or backward, or with gentle movements of the limb in various directions. Sédillot successfully reduced a dislocation that had existed for a year and fifteen days.

The position and relations of the untorn portion of the capsule indicate that the best manipulations would be elevation of the elbow in front and toward the median line, combined with inward rotation to relax the anterior portion of the capsule, and followed by direct propulsion of the head from behind toward its socket, or by traction in the direction of the long axis of the arm. Simple external rotation might succeed when the articular surface of the head rests against the edge of the glenoid cavity, as it sometimes does, for by making the front of the capsule tense, it would rotate the posterior surface of the bone inward and forward, but the success of this manipulation might easily be prevented by the increased friction between the two bones; if the articular surface has slipped entirely beyond the edge of the fossa, external rotation would only engage it more profoundly behind the neck of the scapula.

Jobert de Lamballe (quoted by Soyez, loc. cit., p. 32) accidentally transformed one of these into an axillary dislocation while trying to reduce it. After making traction to bring the head near the socket he carried the limb in a movement of circumduction upward, backward, and downward, by which the head was moved to the inner side of the glenoid fossa, probably passing below it. Reduction was then made by traction outward and forward, followed by a leverage movement over the hand in the axilla.

In a case of subspinous dislocation reported by Dr. J. E. Michæl[1]

[1] Michæl: The Medical News, 1884, p. 621.

reduction made on the fifty-ninth day remained incomplete. The patient was a boy, sixteen years old, who had received the injury by a fall from a horse; the head of the humerus lay at the junction of the middle and outer thirds of the spine of the scapula, the arm was slightly rotated inward, and the hand could be raised only to the nipple. After trying elevation and rotation without success, the head was brought by traction so nearly into place that the hand could be placed upon the opposite shoulder, but the form of the shoulder remained imperfect because of the undue prominence of the head of the humerus behind and on the outer side. Six months later the deformity persisted and there was considerable emaciation of the region; there was slight mobility, rotation was entirely lost, and the hand could be brought to the head only with an effort.

Upward Dislocations. (Supracoracoid, Supraglenoid.)

The possibility of the occurrence of this rare form of dislocation, which has often been denied, has at last been established by the clinical observation of several cases and the post-mortem examination of two.

The first alleged case was reported by Laugier[1] in 1834 as an incomplete dislocation upward; the second was by Malgaigne.[2] In 1858 Bourget submitted to the Société de Chirurgie a paper upon the subject containing the accounts of three cases observed by himself, two of which he diagnosticated as complete dislocations and one as incomplete, and reproducing the cases of Laugier, Malgaigne, and Avrard. Upon this paper Morel-Lavallée[3] made an elaborate report, denying the correctness of the diagnosis in all the reported cases and attributing the observed deformity to a prolonged arthritis, and he supported this opinion by quoting the case of Soden,[4] in which the symptoms were the same as in Laugier's case, but the autopsy, five months later, showed only an arthritis. His arguments appear to me to be sufficiently strong to justify the rejection of all the so-called incomplete cases, but the others may, I think, be retained in consideration of the results of experiment upon the cadaver and of the autopsy in Albert's case, which has been accepted as a dislocation although it must be admitted, I think, that in it, too, the theory of an old arthritis could be plausibly maintained. The cases on record, then, are Malgaigne's, two of Bourget's, and those of Chassaignac,[5] Holmes,[6] Prescott Hewett (quoted by Holmes), Denonvillier's,[7] Albert,[8] Busch,[9] Verneuil,[10] and Le Dentu, eleven in all, in one of which (Albert) both shoulders were dislocated in the same manner and at the same time.

The cases that furnished autopsies are Holmes's and Albert's. Holmes's patient was a man fifty years old, who had fallen from a height of about

[1] Laugier: Arch. gén. de Méd., 1834, vol. 10, p. 65; also in Dictionnaire en 30 vols., vol. 13, p. 81.
[2] Malgaigne: Rev. médico-chirurg., 1849, vol. 5, p. 30, and Luxations, p. 530.
[3] Morel-Lavallée: Bull. de la Soc. de Chir., 1858, vol. 8, p. 490.
[4] Soden: Med. Chirurg. Trans., vol. 24, p. 212.
[5] Chassaignac: Bull. de la Soc. de Chir., 1858, vol. 8, p. 472.
[6] Holmes: Med. Chirurg. Trans., 1858, vol. 41, p. 447.
[7] Panas: Dict. de méd. et chir. pratiques, art. Epaule, p, 469.
[8] Albert: Chirurgie, 2d ed., 1881, vol. 2, p. 287; also in Wiener med. Blätter, 1879, p. 453.
[9] Busch: Arch. für klin. Chir., 1876, vol. 19, p. 400.
[10] Pellier: Thèse de Paris, 1878.

thirty feet, striking upon his head, the left side of his chest, and left elbow, and receiving in addition to the dislocation in question a compound dislocation of the radius and a comminuted fracture of the upper portion of the ulna. The head of the humerus formed a large prominence in front of the outer part of the clavicle; movements of the arm gave rise to crepitus. No attempt to reduce was made, and the patient died on the fifteenth day.

At the autopsy the head of the humerus was found immediately under the skin, having passed through the deltoid near its inner anterior margin; its articular surface was entirely above the glenoid fossa and rested upon the stump left by fracture of the coracoid process near its base. It was slightly rotated inward. The coracoid process lay on its inner, the acromion on its outer side and somewhat posteriorly; the coraco-acromial ligament appears to have been in part torn. The subscapularis was intact, but the muscles attached to the greater tuberosity were torn through, except a part of the teres minor. The long tendon of the biceps lay below the head on its outer side; it was still attached to the upper margin of the glenoid fossa, but some of its inner fibres had been broken away from the muscle. The capsule was torn at its upper and inner part.

Albert's case was first seen by him several years after the injury was received. The patient had dislocated both shoulders by holding on to the reins of a pair of runaway horses and being drawn along the ground. The deformity was more marked on the left than on the right side, and there consisted of a marked rounded prominence on the front and upper part of the shoulder (Fig. 65). Both arms hung close by the side, the axis being directed obliquely from below upward and forward in front of the glenoid fossa. The prominence formed by the head of the humerus was situated in front of the acromion, rising about two centimetres above its upper surface, and this elevation could be increased by pressing the elbow upward; the arms were so far rotated outward that the transverse diameter of the lower end of the humerus coincided with the transverse axis of the trunk. The outer deltoid region was not noticeably flattened, but posteriorly the fibres of that muscle were greatly relaxed and the posterior edge of the glenoid fossa could be distinctly felt through them. The point of the finger could be pressed in between the head and the coracoid process. Slight voluntary rotation and movement of the elbow forward and back were possible; very slight passive abduction. The left elbow could be flexed only to a right angle, further flexion being arrested by the triceps. On the right side the deformity was the same in character, but less in degree, and there was the same limitation of motion. If pressure was made upon the elbow directly upward the movement could be distinctly felt to be arrested by bony contact, and this demonstrably occurred between the head of the humerus and the clavicle, but if the elbow was first carried backward the head could then be pushed up higher.

FIG. 65.



Supracoracoid dislocation. (ALBERT.)

At the autopsy the capsule was found attached throughout to the anatomical neck of the humerus and adherent also to the upper part of

its articular surface; thence it extended without interruption to the margin of the glenoid fossa, but its cavity was considerably enlarged. The coraco-acromial and coraco-clavicular ligaments were uninjured. The upper third of the head of the humerus lay above the level of the coraco-acromial ligament, and this overlapping could easily be increased to half the head. The glenoid fossa was filled by a thick layer of fibrous tissue.

In the fuller account given in the *Wiener medicinische Blätter*, 1879, p. 453, quoted by Poinsot, it is said that the long tendon of the biceps on the left side was ruptured and its end adherent to the bone in the bicipital groove, and that an osteophyte an inch long had grown from the base of the coracoid process.

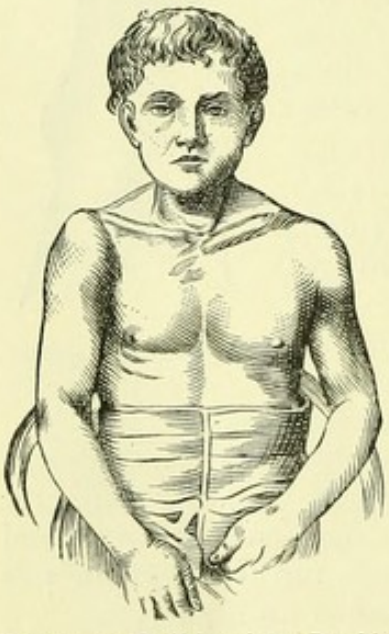
The other cases are as follows :

Malgaigne. A man sixty years old was thrown from a wagon, striking upon his shoulder while his arm was held close to his side. There was much pain and he was unable to move the limb. A " bone-setter " handled him roughly and sent him away with his arm in a sling. Two and a half months later he consulted Malgaigne. The head of the humerus was dislocated upward and forward above the coracoid process, and above it reached the under surface of the clavicle, stretching the overlying deltoid so that on perforation with a pin the latter proved to be only eight millimetres in thickness; shortening one-fifth of an inch. Traction to the extent of more than 400 pounds, combined with pressure upon the head downward, outward, and backward and counter-pressure on the acromion, failed to effect reduction although it made the head so movable that it could be drawn down a finger-breadth below the clavicle. Malgaigne meditated division of the coraco-acromial ligament, which seemed to be the obstacle, but refrained.

Bourget's cases resembled Malgaigne's closely.

Busch. (Fig. 66.) A horse reared and struck the patient, who was holding him by the bridle, upon the inner and anterior part of the shoulder with his hoof. The head of the humerus was displaced upward and forward, the deformity closely resembling that in Malgaigne's case; the infraclavicular fossa was deepened, the arm hung close by the side, the posterior deltoid region was hollowed, the coracoid process could not be felt in its place. Reduction failed.

FIG. 66.



Supracoracoid dislocation; Busch's case. (BARDENHEUER.)

Denonvilliers. A man fell upon his arm, but was unable to give the details of the fall. The limb hung by the side and was strongly rotated outward. Ecchymosis, pain, loss of function. The head of the humerus projected forward and upward between the coracoid and the acromion and in front of the clavicle. Oblique traction, combined with a slight movement of leverage, effected reduction.

Chassaignac. A man fell from the third story of a building. The head of the humerus projected directly outward and extended above

the coraco-acromial ligament. Movements of the elbow forward were impossible, backward they were more free than normal. The dislocation was easily reduced by exaggerated elevation of the arm, but recurred when the arm was lowered.

Hewett. The patient was a middle-aged woman; the head of the humerus lay on the upper and inner side of the glenoid cavity; there was distinct crepitus which ceased after reduction had been made by traction with the heel in the axilla. Apparently the patient made a complete recovery.

These accounts are so imperfect that the mode of production cannot be determined with any approach to precision except in the cases of Holmes and Busch; in the former the associated injuries at the elbow indicate that the blow which produced the dislocation was received there, and that the humerus was thereby driven upward and inward, breaking off the coracoid process. In Busch's case the blow, by the horse's hoof, was received upon the inner and anterior part of the shoulder while the arm was elevated; it seems probable that it struck upon the acromion and clavicle and forced them downward past the head of the humerus, and that the coracoid process was broken by the pressure of the head of the humerus against it, not by the direct impact of the blow.

The cause in Bourget's first case was quite exceptional: the patient was a girl nineteen years old, and the injury was produced during an epileptic convulsion by the extension of the arm while the hand was pressed against a table.

Panas's experiments upon the cadaver show that if the arm is strongly rotated outward while held close to the body, and then pressed bodily upward and forward, the capsule will tear at its upper part and the dislocation will be produced without fracture of the coracoid process; at the same time the upper portion of the subscapularis is torn. The head of the humerus is found to be raised not more than one centimetre above its normal position; the greater tuberosity, which has become posterior by the rotation, lies against the under surface of the coraco-acromial ligament and the tip of the acromion, while the articular surface, looking forward and inward, lies partly above and partly below the level of this ligament. While the condition thus produced upon the cadaver unquestionably constitutes a dislocation, yet there is nothing in the histories of the cases above given to indicate that the same condition existed in them, and even supposing it to have been produced in the living it seems highly improbable that it would persist long enough to come under the observation of the surgeon, for there is nothing to prevent the weight of the limb and the tension of the untorn portion of the subscapularis from drawing the bone back into place.

Fracture of the coracoid process certainly existed in Holmes's case and possibly also in Hewett's and Busch's. Busch was led by his experiments to think that this fracture was necessary to the production of the dislocation, an opinion that cannot stand in the face of the other reported cases although in them the integrity of the process is not always specifically stated. He knew only of Malgaigne's case and his own, and his experimental reproductions of the dislocation were effected by first making

a subcoracoid dislocation and then a secondary displacement upward, a method in which fracture of the coracoid is essential to success.

The symptoms consist in the absence of the head of the humerus from the glenoid cavity and its presence in the interval between the coracoid process and the acromion, close in front of the clavicle and usually rising above its level. The coracoid process can be felt with difficulty, if at all. The limb hangs by the side, perhaps slightly abducted, and rotated outward; its axis is directed from below upward and forward, passing in front of the normal position of the head. Usually voluntary movements are almost or quite impossible, and passive movements greatly restricted, and this restriction exists in old as well as in recent cases.

In three cases seen while the injury was recent, Denonvilliers, Chassaignac, and Hewett, reduction was easily effected by traction in two and by elevation of the elbow in one, but the dislocation recurred in the latter; Verneuil reduced on the thirty-sixth day by traction aided by anæsthesia. In Holmes's case the associated injuries were so severe that reduction, for which the aid of chloroform was thought to be necessary, was not attempted. Malgaigne, Bourget, and Busch failed, the duration of the dislocation at the time of the attempt being two and a half, six, and five months respectively. The details of Bourget's second case are not given, and the result in Le Dentu's I do not know. In Albert's the dislocation had existed for many years, and no mention is made of any attempt to reduce.

CHAPTER XVIII.

DISLOCATIONS OF THE SHOULDER.—(*Continued.*)

ASSOCIATED INJURIES AND COMPLICATIONS. ACCIDENTS. PROGNOSIS AND AFTER-TREATMENT. HABITUAL DISLOCATIONS. CONGENITAL AND PATHOLOGICAL DISLOCATIONS.

THE complications which may coexist with a dislocation have been described in Chapter III., and will therefore be treated but briefly here, and mainly with the view of adding some details to the account already given. In like manner the accidents which may be caused by attempts to reduce a dislocation have been described in Chapter VIII., some of them, especially those relating to the bloodvessels, in detail.

The injuries which are more or less frequently associated with dislocations of the shoulder, but which are without such special bearing upon the prognosis or treatment as would make them actual complications, have been mentioned in connection with the different forms of dislocation in the preceding chapters. The most important are the lacerations of the different muscles and tendons or their equivalent avulsion from the humerus with more or less of the tuberosities to which they are attached.

Laceration of the subscapularis is the rule in most dislocations, and avulsion of the lesser tuberosity to which it is attached is very rarely substituted for it, apparently only in some of the backward dislocations. The extent of the laceration of the muscle can only be inferred from the extent and direction of the displacement, and it is believed to be without important influence upon the completeness of the repair and the subsequent security of the joint. The position of adduction and inward rotation in which the limb is habitually kept during the period of convalescence favors the repair of the muscle, and since the rupture is usually incomplete the torn portions do not widely retract.

With the *muscles attached to the greater tuberosity* it is somewhat different. The muscles themselves are rarely torn, although in the infrequent backward dislocations the lower portion of the infraspinatus is usually lacerated, but the upper and middle facets of the greater tuberosity to which the supra- and infra-spinatus muscles are attached are frequently broken off and more or less retracted under the acromion, or the tendons are torn away from them and retracted. The importance of this associated injury, through its effect upon the subsequent usefulness and security of the joint, is often great; not only may the power of voluntary external rotation be diminished thereby, but the consequent loss of support on the outer side of the joint favors recurrence of anterior dislocation, and the great lengthening of the upper portion of the capsule and the enlargement of its cavity which are effected by the retraction of the supraspinatus and the establishment of free communication between

the joint and the subacromial bursa make the joint much less secure, and this condition is thought to be the cause of the marked tendency to recurrence observed after many anterior dislocations (see Chapter III.). Similarly the avulsion or rupture of the subscapularis in backward dislocations is responsible for the tendency to recurrence that has been so frequently noted in them.

The tendon of the *long head of the biceps* appears habitually to escape rupture; its sheath may be opened by the avulsion of either tuberosity, and then it may slip over the corresponding portion of the head, and, becoming engaged between the latter and the glenoid cavity, thus constitute a serious obstacle to reduction. When ruptured, its end is retracted into its sheath in the bicipital groove and there becomes united with the bone.

Fracture of the greater tuberosity appears to be not often capable of demonstration; at least it has often been found post-mortem when it had not been recognized during life, although the proper explanation of the failure to recognize it may be that it was not sought for. If the fragment is retained in contact with the humerus by the untorn periosteum crepitation may perhaps be obtained by manipulation; and when the fragment is widely withdrawn it may perhaps be felt under the acromion, or its absence may be recognized by the change in the shape of the corresponding part of the humerus, or the fracture may be indicated by exceptional symptoms accompanying the dislocation, such as greater mobility of the limb or the absence of fixed abduction of the elbow. Bardenheuer attaches much diagnostic importance to the presence of an extensive ecchymosis on the arm as indicative of fracture of the greater tuberosity.

Fracture of the lesser tuberosity is much less frequent. To the three cases mentioned in the chapter on fractures of the tuberosities of the humerus (Fractures, p. 363), may be added the two reported by Jössel and quoted in the preceding chapter in the section on posterior dislocations (p. 242).

The treatment of associated fracture of the greater tuberosity does not hold out much promise. All that can be done in case of separation is to place the limb in a position that diminishes or annuls the separation between the fragment and the surface from which it has been torn, but unfortunately this position (abduction and external rotation) is not only one that cannot well be maintained except in bed, but it also is one that opposes the prompt and complete repair of the rent in the inner and lower part of the capsule which is usually associated with the fracture. Possibly the two opposing indications could be harmonized by first keeping the limb abducted and rotated outward for a week or more until the fragment shall have probably formed a sufficiently firm union with the humerus to allow the limb to be adducted and rotated inward without renewing the separation. Probably the occasions are very rare when the separation is so complete that satisfactory union will not take place even if the arm is kept in the usual attitude of adduction and internal rotation.

The serious complication of *fracture of the anatomical or surgical neck* of the humerus has been described with illustrative cases in Fractures, p. 372. The complication has recently been made the subject of

a thesis by Oger,[1] who has collected in it a large number of recorded cases.

The fracture may occupy the anatomical or the surgical neck, or may extend through the tuberosities, or may be extensively comminuted. Of 68 cases collected by Thamhayn[2] the fracture in 14 was of the anatomical neck; in 2 of these reduction was effected. The displacement in the great majority of cases is forward and inward, the head lying under or on the inner side of the coracoid process; in a few cases it has been backward under the acromion. The upper fragment may, in addition, undergo rotation that will widely separate its broken surface from that of the shaft. Illustrative cases of the rare form in which the head, after fracture of the anatomical neck, has undergone complete reversal while remaining within the cavity of the joint have been quoted in Chapter III., and in Fractures, p. 360. The upper end of the lower fragment is usually drawn upward toward the glenoid fossa, overlapping the upper fragment on the outer side, and it may unite in this position by fibrous or bony union with the other fragment, or with the scapula.

Even when the upper fragment is completely detached from its periosteal and tendinous connections it may preserve its vitality and establish new vascular connections; in rare instances it has become necrotic and has been eliminated after prolonged suppuration; usually it atrophies and undergoes those interstitial changes which are so frequently seen in disused bones.

The diagnosis appears, in some cases, to have presented serious difficulties, because the fracture removed some of the most characteristic symptoms of the dislocation, such as the fixation and attitude of the limb, and the indication of the position of the head of the bone that is furnished by the direction of its long axis. In general terms, it may be said that when the dislocation of the head has been recognized the coexistence of a fracture may be determined by the mobility of the limb, by its shortening, and by the greater extent of the ecchymosis, in case the independent mobility of the head and shaft cannot be recognized and crepitation is not perceived. When the signs of fracture are apparent the coexistence of a dislocation can only be recognized by determining the absence of the head from its socket, and this may be made very difficult by the swelling of the soft parts. The importance of the mobility of the limb as an indication of a coexistent fracture when the presence of a dislocation has been recognized, of the possibility of bringing the elbow into contact with the side of the body, has been strongly insisted upon by one of the most skilful and experienced of the younger French surgeons, M. Berger,[3] but, I think, without giving full weight to the fact that the same mobility may be the consequence of extensive laceration of the capsule without fracture. The two positive signs, which the surgeon should spare no pains to recognize, are the absence of the head of the humerus from its socket, which proves the dislocation, and its failure to share its movements communicated to the shaft, which proves the fracture. The recog-

[1] Oger: Luxations scapulo-humérales compliquées de fracture. Thèse de Paris, 1884, No. 361.

[2] Thamhayn: Schmidt's Jahrbuch, 1868, vol. 140, p. 194

[3] France Médicale, 1884, Nos. 132–134.

nition of fracture of the anatomical neck can hardly fail to be very difficult.

The treatment also presents grave difficulties because the existence of the fracture deprives the surgeon of that control over the movements of the head of the bone which, in a simple dislocation, can be exerted through its shaft. Reduction in a recent case can be effected, if at all, only by direct impulsion of the head back into place. This should always be attempted, and with the aid of anæsthesia. It may be aided by gentle traction in a suitable direction upon the shaft, for the periosteal connection may be sufficient to make it practicable thereby to bring the upper fragment into a more favorable position. If the attempt succeeds, the joint must be carefully watched in order to detect a recurrence of the dislocation, for if the upper fragment is small it may be pushed out of place by the lower fragment as the latter is drawn upward by the contraction of the deltoid. This late displacement after fracture of the anatomical neck has been observed and pointed out by Mr. Hutchinson (see Fractures, p. 359), and, of course, it is still more likely to occur when there is a rent in the capsule through which the head can escape. It is best guarded against by continuous traction downward to oppose the action of the deltoid.

In case of failure to effect reduction while the injury is recent, the surgeon has the choice between seeking to obtain consolidation, either with a view to effect reduction afterward, or to have the limb in the best obtainable position, or establishing a false joint at the point of fracture. Illustrative examples of the different plans have been given in Fractures, p. 382. In addition to the two cases there quoted, von Langenbeck's and Warren's, I know of only one other in which the attempt to reduce after consolidation of the fracture was successful, while the failures have been comparatively numerous, and the consequences of the attempt sometimes serious or fatal. The conditions appear to be far less favorable for reduction even than in simple dislocations that have remained unreduced for any length of time, and the reason therefor is undoubtedly to be found in the altered condition of the soft parts adjoining the fracture which have become matted together in their new relations. Fortunately the records show that in many of the cases left unreduced the limb became fairly useful.

The establishment of a nearthrosis between the upper end of the lower fragment and the glenoid cavity has been followed by excellent functional results in some cases. The smaller the upper fragment the more likely is this plan to be successful, for not only does the subsequent usefulness of the arm depend largely on the preservation of the attachments of the scapular muscles, but also, if the fracture is through the surgical neck, the fragments are likely to remain in such relations to each other, and to be so connected by bands of periosteum that close, perhaps bony, union will take place between them and defeat the attempt to create a new joint. If the attempt is made the upper end of the lower fragment should be kept pressed outward and upward; Volkmann recommends for this purpose a pad in the axilla, with adduction of the elbow to the side, and its support by bandages passed under it and over the shoulder. The arm should be kept perfectly quiet for a fortnight, and the inflammatory

reaction further opposed, if necessary, by the application of cold, and then, when the danger of provoking suppuration by passive motion has passed, the limb may be gently moved daily, and the range of motion increased as experience shows it prudent and safe to do so.

Operations with the knife for the removal of obstacles to reduction in fresh cases are, in my opinion, to be condemned. Surgeons relying upon the security afforded by antiseptic treatment have sometimes recommended this plan of making reduction, but I am convinced that no antiseptics can make it safe to lay open a large joint that is in communication with a recent fracture and so extensively lacerated soft parts as are found about a dislocation. For the same reason I would reject primary excision of the upper fragment; it is, in my opinion, far more safe to wait until the inflammatory and reparative processes have ceased; the surgeon may then make his incision and remove the upper fragment, if it seems desirable, with a reasonable expectation that his wound will not suppurate, or that if it does the suppuration will be slight and the patient's life will not be put in danger.

Fracture of the shaft associated with dislocation of the shoulder has also been observed several times. It is a much less serious complication than fracture of either the anatomical or the surgical neck, because the greater length of the upper fragment makes it easier to effect reduction.

Fracture of the coracoid process has been observed in connection with dislocation of the humerus, not only in the two cases of supracoracoid dislocation mentioned above (Holmes and Busch), but also in dislocation forward. One case reported by Manzini, and also seen and quoted by Malgaigne,[1] is interesting also because of the extent of the associated fractures and the preservation of the vitality of the completely separated head. The patient survived the injury two months. The autopsy showed a comminuted fracture that separated the head at the anatomical neck and included the surgical neck, the coracoid process broken in several pieces, and the head greatly hypertrophied, covered with irregular bony growths, and firmly attached to the surrounding parts by cellular tissue of new formation.

Fracture of the acromion has also been occasionally observed. Krönlein's unique case in which a blow received upon the top of the shoulder first broke the acromion and then dislocated the humerus into the axilla has already been mentioned. Bardenheuer (loc. cit., p. 343) briefly mentions a case in which a man was run over by a wagon and received a fracture of the acromion, a fracture of the surgical neck of the humerus, and a dislocation of the humerus into the axilla.

Fracture of the glenoid fossa.—Probably the chipping of the edge of the glenoid fossa is not infrequent in dislocation, and passes unrecognized because of the lack of symptoms. Fracture of a large portion has been occasionally observed, both clinically and after death, and is of great importance in favoring recurrence of the dislocation. Malgaigne represents in his *Atlas* (plate 22, Fig. 4) a case in which the anterior third of the fossa was broken off and had been displaced backward and become united with the neck of the scapula; the symptoms in the case were that

[1] Malgaigne: Luxations, p. 547.

the shoulder was less full and rounded than normal, and that the head of the humerus, while still in relation with the anterior part of the acromion, projected a few lines in front of the inner border of the coracoid process. Bardenheuer made the diagnosis of fracture of the posterior border of the fossa in three cases of backward dislocation, on the ground that he could easily move the head of the humerus backward and forward by pressure, each movement being accompanied by crepitation in the posterior part of the joint.

The special indication for treatment is to prevent recurrence of the dislocation by fixation of the limb and pressure upon the head from the side on which the fracture has taken place.

Nerves.—Injury to the nerves, except of a slight and transitory character, is rare, and in most of the cases reported as such the injury has been inflicted during reduction. I know of only two cases in which the injury has been demonstrated by post-mortem examination, Hilton's[1] and Parise's;[2] and even in these there was only a partial laceration of the circumflex nerve in the former, and in the latter rupture at different levels of the fibres composing it, only recognizable on minute dissection; the nerve trunk was extensively infiltrated with blood; the dislocation was subglenoid, and the nerve was tightly stretched around the head of the humerus. In all the others the evidence is clinical; and in estimating this evidence it must be borne in mind that partial paralysis of the arm may be caused by a fall in which neither the shoulder-joint nor the main nerve trunks have been directly involved.

It is far from uncommon to find in unreduced dislocations that the sensibility of the skin over most of the deltoid region, which is supplied by the circumflex nerve, is diminished or lost, and that in others after reduction the deltoid is paralyzed. This paralysis of the deltoid is thought frequently to be the result of direct bruising of the muscle by the violence that caused the dislocation, but that explanation does not satisfactorily account also for the loss of sensibility in the skin, and we must, in such cases, assume that the trunk of the circumflex has been stretched in the dislocation.

In many of the reported cases it cannot be determined whether the injury to the nerve was caused by the dislocation or by the manœuvres made to effect reduction; in others it is clearly due to the dislocation. Illustrative examples have been quoted in Chapter III.

The cause of the paralysis, when it involves more than the circumflex nerve, is very obscure. It has been attributed to compression of the main trunks in the axilla, but this explanation is not satisfactorily supported by post-mortem examination or experiment, and the fact already mentioned that similar symptoms may follow blows that neither produce a dislocation nor directly involve the nerves adds to the difficulty. Nélaton sought to explain it by supposing a compression of the nerves between the clavicle and the first rib, and some cases have been reported which indicate that this explanation may, sometimes at least, be the correct one. On the other hand, the prompt disappearance of the symp-

[1] Hilton: Guy's Hosp. Rep., 1847, vol. v. p. 93.
[2] Parise: Gaz. Médicale de Paris, 1863, p. 210.

toms in some cases after reduction clearly points to pressure by the head of the humerus upon the nerves as the cause.

The paralysis may appear immediately or may develop gradually during the first two or three days, and it may be complete or partial. In some cases (see Chapter III.) it has been followed by serious changes in the appearance and nutrition of the limb, presumably the effect of an ascending neuritis. In one case Bardenheuer (loc. cit., p. 335) demonstrated the existence of neuritis and perineuritis by exposing the nerves, and worked a gradual cure by stretching their trunks.

Whatever doubt may exist as to the direct cause of the paralysis, the first step in the treatment is to reduce the dislocation; after that has been accomplished, or even if it should fail, electricity should be persistently employed. Some cases respond promptly to treatment, the contractility of the muscle sometimes reappearing after even the single application of a blister, while others, after weeks or months of treatment, will show no improvement. So long as the muscle reacts to electrical stimulation the prognosis is good.

Bloodvessels.—The complication of serious injury to the bloodvessels in the neighborhood of the joint is not frequent, and in the recorded cases there is often a doubt whether the injury was caused by the dislocation or by the attempt to reduce it. The subject has been discussed in detail in Chapters III. and VIII.

An interesting variety of the lesion is one noted by Parise in the case quoted in the preceding section (p. 258): the inner and middle coats of the posterior circumflex artery were torn through along the upper half of their junction with the axillary artery, the outer coat at the corresponding point and all three coats of the lower half of the junction remaining untorn. No extravasation of blood took place during the three and a half hours the patient survived after the accident. What results would have followed if the patient had permanently survived is an interesting subject of speculation. Certainly the conditions were favorable for the formation of an aneurism.

Chest.—A unique case reported by Prochaska, in which the head of the humerus was forced into the chest between the second and third ribs is quoted in Chapter III., p. 38.

Compound dislocations are rare; the wound in the skin is commonly in the axilla, sometimes further inward through the pectoralis major, sometimes behind the joint. It is a very serious complication, although there is reason to hope that a larger proportion of successes will be obtained in the future under the improved methods of treating wounds than was possible in the past. The essentials of such treatment are immobilization of the joint, drainage, and surgical cleanliness; excision of the head of the humerus may also be required under certain circumstances, such as difficulty of reduction or retention, coincident fracture, uncleanliness of the wound, and imperfect drainage of the joint. Several striking cases of rapid, uneventful recovery have been reported, but I must again repeat that the laceration and bruising of the soft parts, the extravasation of blood, in short, the traumatism, create a condition which is radically different from that created by an incision made by the surgeon through healthy, uninjured soft parts into a joint that is not already

acutely inflamed, and that a repetition of the successes so commonly obtained under these latter circumstances is not to be expected under the former. I believe the more prudent course is to assume that the wound will probably suppurate, and to modify the dressing accordingly, by providing abundantly for drainage, by not closing the skin wound except, perhaps, in part, and by packing with iodoform gauze for at least twenty-four hours. The last-named precaution, which has proved so valuable in other irregular and oozing wounds, seems to be equally indicated here; its chief advantage is that it provides a prompt and ready means of escape for the blood and exudations, and at the same time does not prevent the wound from being closed a day or two later with sutures and then healing as rapidly and kindly as if it were entirely fresh. I must add, however, that I have never had to treat a compound dislocation of the shoulder.

Simultaneous dislocation of both shoulders is deemed a rare occurrence; possibly it is more frequent than is generally supposed, for I found five cases mentioned in the *Index Medicus* for the years 1880 to 1885. It is of interest only as a curiosity, for the combination does not seriously affect the prognosis or treatment. The causes in the five cases referred to were as follows. In one[1] the patient was seized in the street by two thieves who drew his arms upward, outward, and backward, producing subcoracoid dislocations; both joints had previously been repeatedly dislocated. In the second[2] the patient, while standing on a platform, was caught under one arm by a chain and thrown to the ground. In the third[3] a woman, eighty-six years old, fell out of bed, receiving an intracoracoid and a subcoracoid dislocation. In the fourth[4] a girl, twenty-one years old, was knocked down by a falling wall; and in the fifth[5] the injuries occurred during an epileptic convulsion. All of them were anterior dislocations. Mention has been made in the preceding chapter of Bardenheuer's case in which both shoulders were dislocated backward by a fall forward upon the elbows, and of Küster's case of double backward dislocation which he reported as congenital.

Associated dislocation of the elbow has been twice reported. Morel-Lavallée's[6] patient was injured in a railway accident; the head of the humerus was driven out through the skin of the outer part of the shoulder and projected so far that the elbow was in contact with the axilla; the elbow also was dislocated.

Moxhay's[7] patient was a man, fifty-six years old, who was struck on the back of the arm by the handle of a wrench and sustained a backward dislocation of both bones of the forearm and a subcoracoid dislocation of the shoulder; the latter injury was not discovered by the surgeon until the seventh week after the accident; it was then successfully reduced.

Injuries caused by attempts made to reduce dislocations have been described in Chapter VIII.

[1] G. E. Moore: N. Y. Medical Record, 1880, vol. 18, p. 96.
[2] Caskie: British Med. Journ., 1881, ii. p. 854.
[3] Güterbock: Berlin. klin. Wochenschrift, 1885, vol. 12, p. 346..
[4] Zinker: Idem, p. 418.
[5] Fränkel: Verhandl. Berlin. med. Gesellschaft, 1885, xiii. p. 150.
[6] Morel-Lavallée: Bull. de la Soc. de Chir., 1858, vol. 8, p. 490.
[7] Moxhay: Lancet, 1882, ii. p. 938.

Prognosis and After-treatment.

Since our knowledge of the pathology of dislocations and of the common obstacles to reduction has become so much more accurate and complete, and especially since the introduction of the use of ether and chloroform, failure to reduce a recent dislocation of the shoulder has become very exceptional. Bardenheuer says that of 400 such cases treated by him within ten years he has not failed in any, and only once has he had any difficulty. The prognosis, therefore, so far as the reduction of recent dislocations is concerned, is eminently favorable. It is also more favorable for the older dislocations, up to four or five months, than it formerly was, and for the same reasons; and at the same time such cases have become more uncommon, for, as a rule, they are now only those in which the dislocation has been overlooked or not treated.

The prognosis is also favorable as regards the complete restoration of the functions and security of the joint, but this restoration may be delayed or prevented by inflammation or partial ankylosis of the joint or by paralysis of some of the muscles, and the security may be seriously diminished by partial failure of repair or by permanent changes in the joint surfaces.

The after-treatment is directed to the retention of the head of the bone in its place until such time as the repair of the injuries to the capsule and periarticular tissues is sufficiently advanced, and to the prevention or cure of inflammation and ankylosis.

It occasionally, though very rarely, happens that the dislocation is reproduced within a few minutes of the reduction, without such movement of the arm (abduction or elevation of the elbow) as would explain it, and it is then presumably due to muscular contraction, perhaps aided by the interposition of a clot or of a portion of the capsule. It suggests the desirability of immediately and securely fixing the arm to the side of the body before the patient is allowed to move after reduction has been made, and of inspecting the limb shortly afterward.

The traumatism is always followed by some inflammatory reaction and the evidences of a more or less prolonged arthritis, but it seldom happens that this is sufficiently violent to cause apprehension or require other treatment than immobilization of the limb. The severer cases are those in which the limb has been too early or too freely used. The fear that prolonged immobilization of a joint would lead to its permanent stiffness is, or has been, too prevalent and has led to much untimely passive or active motion of joints that have been injured, and this in turn, by keeping up the irritation, has increased the stiffness which it was designed to diminish. As has been well pointed out by several writers, notably by Verneuil,[1] the best antiphlogistic for an inflamed joint is absolute rest, and the stiffness which is found afterward is the result of the inflammation, not of the immobility, and may confidently be expected to diminish or disappear if permanent changes have not taken place in the constituent parts of the joint. By this it is not meant that the position of the joint may not be changed from time to time, or even that passive motion

[1] Verneuil: Bull. de la Soc. de Chirurgie, 1879.

within the limits set by pain is not allowable in cases in which the arthritis is slight. On the contrary, such measures may not only be permissible but may even be advantageous in suitable cases in shortening the term of convalescence, and may possibly prevent the formation of adhesions that would permanently limit the range of motion. But the formation of such adhesions is exceptional, and, moreover, there is every reason to believe they can subsequently be broken or lengthened if they should form. The retraction of the capsule, the loss of its pliability, to which some writers attach so much importance, is, except in the case of prolonged inflammation and in some highly arthritic individuals, only temporary and will ordinarily yield to the natural daily use of the limb.

If the inflammation is more severe or if it has been prolonged by imprudent use of the limb the immobilization should be supplemented by traction downward. Bardenheuer (loc. cit., p. 412) highly recommends in addition that the upper end of the humerus should be kept pressed outward and backward by a pad in the axilla attached to a weight above and behind the shoulder. This necessitates the recumbent posture.

If marked rigidity persists after the subsidence of the inflammation and does not yield to ordinary use of the limb the adhesions should be broken up by the surgeon by freely moving the limb in all directions with the aid of anæsthesia. See also Chapter VII., p. 72.

Paralysis of the deltoid causes the loss of voluntary abduction of the arm, and if prolonged leads to permanent shortening of the under and inner portion of the capsule with consequent limitation of passive abduction. It may also be followed by the sinking of the humerus downward through lack of the support normally given by the deltoid, and by consequent loss of security in the joint. Usually these paralyses get well spontaneously or under treatment by blisters or electricity, but sometimes they are permanent.

Habitual dislocation, by which is meant a more or less marked tendency to the reproduction of the dislocation by slight causes, such as the abduction of the arm, is not infrequent and may constitute a serious disability; it is most frequently observed after anterior dislocations, but appears to be relatively more common after the posterior ones.

This tendency has generally been attributed, though without anatomical proof, to laxity of the capsule, itself the consequence of imperfect repair of the rent made in it at the time of the dislocation, but the recent researches of Jössel[1] show, for the forward dislocation, that the enlargement of the capsule observed in such cases takes place at its upper portion in consequence of the rupture or avulsion of the tendons of the supra- and infraspinatus muscles, which involves the rupture of the capsule at the same level and the creation of a free communication between its cavity and that of the subcoracoid bursa (see Chapter III., p. 41). He found this condition at the autopsies of five joints which had been subject to habitual dislocation during life and in four other specimens found in the course of an examination made with this object of all bodies received in the dissecting-room during two successive winters.

Not only is the cavity of the joint enlarged and the upper portion

[1] Jössel: Deutsche Zeitschrift für Chir., 1880, vol. 13, p. 167.

of the capsule greatly relaxed by this lesion, but the connection of the two muscles above named with the humerus is permanently lost, and this latter is probably the efficient factor in diminishing the security of the joint and favoring recurrence of the dislocation. Abnormal laxity of the upper portion of the capsule would not favor dislocation forward when the arm is in the attitude (abduction) which experience has shown to be most favorable to its occurrence, for even the normal capsule is then relaxed, and dislocation takes place by rupture on the opposite side. But the loss of the control normally exerted by the external rotators allows the bone to move bodily to the inner (anterior) side, at the same time that it diminishes the steadiness and vigor with which the head of the humerus is pressed against the glenoid fossa.

The relative frequency of recurrence of the subacromial dislocation, and the fact that rupture or avulsion of the tendon of the subscapularis is common in this form confirm this view. The head of the humerus is held against the shallow glenoid fossa by the muscles that pass on either side from the dorsal and costal surfaces of the scapula to the greater and lesser tuberosities, respectively, and the destruction of these connections on either side leaves the head loose and free to move to the opposite side.

Löbker[1] presented at the Fifteenth Congress of German Surgeons a specimen obtained, post-mortem, from a case of habitual dislocation, which showed changes in the head and glenoid fossa which were thought to be the effect of the frequent recurrence, and another specimen obtained by Vogt by excision in a similar case, and showing the same changes in the head of the humerus. The head in each case was normal only on its inner anterior half; the other half had lost its roundness, and showed a depression one centimetre deep and two centimetres wide, extending from top to bottom, and separated from the normal inner half by a sharp prominent border. The surface was covered throughout by cartilage, and the depression was evidently not the result of a fracture with loss of substance. The tuberosities and bicipital groove were intact; the long tendon of the biceps was torn from its insertion, and had become adherent in its groove. There were evidences of the avulsion of the muscles from the greater tuberosity. The outer portion of the glenoid fossa was normal, and separated by a sharp vertical border from the large inner portion which was angularly deflected backward. Both portions were covered with cartilage, and showed no sign of fracture. The head and fossa fitted together in such a way that the inner-half of the head articulated with the inner-half of the fossa, and the sharp edge of the latter occupied the depression in the former.

He refers to the fact that specimens obtained by excision by Cramer, Küster, and von Volkmann, showed similar losses of substance in the head of the humerus, and accepts Jössel's explanation as correct for a large number of cases of habitual dislocation. The changes shown by his own, and the other similar specimens, he attributes to the frequent recurrence or to a persistent subluxation by which the head is made to

[1] Löbker: Beilage zum Centralblatt für Chir., 1886, p. 90.

rest against the inner border of the fossa, instead of squarely against its face.

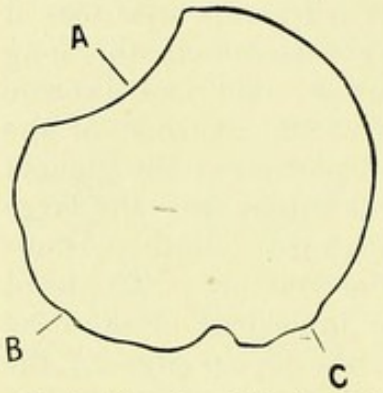
The symptoms presented by Löbker's case during life are not given, but it does not seem possible that they could have been, at least, at the last, such as are found in habitual dislocation, for that is characterized by complete restoration of form in the intervals between the recurrences, while in this case the subluxation must have been persistent.

Three cases of habitual dislocation in which the head of the humerus was excised are referred to by Löbker as showing similar losses of substance in the humerus, but a reference to the original reports shows that in all three the loss was thought to be the result of a fracture, although in the discussion on one of them (Küster's), Riedinger expressed the opinion that it was due to absorption. As the cases illustrate also the method of treatment by excision, I quote them briefly.

Cramer's[1] patient was a woman thirty years old, who dislocated her shoulder forward and inward during an epileptic fit, and again in another two months later; the arm was then immobilized for several months, and a special dressing was worn most of the time afterward, especially at the menstrual periods, when the attacks of epilepsy were most likely to occur, but nevertheless the dislocation recurred nineteen times within five years, each time during a fit; reduction was sometimes easy, sometimes quite difficult, and the patient was eager to be relieved of the annoyance and the dread. The head was excised through an anterior incision, and the patient made a good recovery. The functional result was fairly satisfactory and was still improving two years after the operation.

The articular surface of the head of the humerus showed a shallow loss of substance on its outer side four centimetres long, two broad, and about three-fourths of a centimetre in depth at the centre (Fig. 67), and there was found a small body of irregular shape, one centimetre in its greatest diameter, with a smooth surface, and attached by a long, thin pedicle to the posterior margin of the glenoid fossa. It was composed of bone covered by fibrous tissue with bits of cartilage between them in places, and was thought to be a fragment broken from the head.

FIG. 67.



Horizontal section of the head of the humerus in Cramer's case of habitual dislocation. A, loss of substance. B, greater tuberosity. C, lesser tuberosity.

Volkmann's[2] patient was a man thirty years old, who dislocated his shoulder during an epileptic fit; three years afterward it was again dislocated by slight external violence, and in the following three years it was again dislocated eight times at shorter and shorter intervals, and by the slightest causes. When taken into the hospital the dislocation could be easily produced and reduced, and the patient earnestly desired an operation, because no bandage was sufficient to keep the bone in place. Singularly enough, after the patient had been

[1] Cramer: Berlin. klin. Wochenschrift, 1882, p. 21.

[2] Volkmann, reported by Popke: Zur Kasuistik und Therapie der inveterirten und habituellen Schulterluxationen, Halle, 1882. Abstract in Ctlblatt für Chir., 1883, p. 28.

anæsthetized for the operation, the dislocation could not be reproduced; at the most, the head could only be so far subluxated as to rest on the anterior edge of the glenoid fossa. The excision was done through an anterior incision.

The posterior third of the head showed a smooth surface not covered by cartilage, which had been "undoubtedly" produced by the breaking off of a wedge-shaped piece. No such fragment could be found in the cavity, and it was thought to have been absorbed. The glenoid articular fossa was altered in shape, having become narrower below than above. The capsule was torn away from the inner and lower margin of the glenoid fossa, thus creating an opening which communicated with the subscapular bursa. On the thickened edge of this opening was attached, by a sort of pedicle, a piece of cartilage-covered bone, "which was evidently the remains of a fragment broken from the edge of the glenoid fossa." (This, if so, would be a sufficient explanation of the recurrence.) The patient recovered from the operation, and subsequently reported by letter that the condition of his arm was much more satisfactory than before the operation.

Küster's[1] patient was a young man whose dislocation was caused by the fall of a box upon his shoulder; it recurred on the fourteenth day and again five times during the following three or four months. Küster made an exploratory incision in the axilla, thinking he might find an unhealed rent in the capsule; no rent was found, but, on the contrary, the capsule was exceptionally thick and firm. The incision was extended into the joint, and the head of the humerus was excised. It showed a large loss of substance, but no fragment was found in the cavity. At the time of the report, seven weeks after the operation, the patient could already make all voluntary movements of the limb except elevation.

These changes in the bones are essentially the same as those described in cases of chronic, non-suppurative inflammation, in some of which it is evident that the process originated in a dislocation. (See Gurlt; *Path.-Anat. der Gelenkkrankheiten*, pp. 250–267, and especially Curling's case, 280, also described in the *Med.-Chirurg. Transactions*, 1837, vol. 20, p. 336, as a partial dislocation forward.) It seems not improbable that the series of observed changes may be started by an ordinary dislocation, that is, by one that is not distinguished by any exceptional lesion such as partial fracture of the head or of the edge of the glenoid cavity; this is followed by a non-suppurative arthritis which so modifies the capsule and the shape of the surfaces that a recurrence of the dislocation is made easy. The pedunculated bodies composed of bone and cartilage, sometimes found in the joint and thought to have been broken from the head of the humerus or the edge of the glenoid fossa, may be of new formation.

The frequency of recurrence varies greatly in the different cases; in some the intervals are long, in others the dislocation is produced every time the elbow is raised, and in some the bone can be voluntarily thrown out of place by the contraction of the muscles.

[1] Küster: Eleventh Congress of German Surgeons. Beilage zum Centralblatt für Chir., 1882, p. 73.

Ordinarily reduction is very easy, and the patient learns to effect it himself; in others it is at times difficult.

The treatment by injections of iodine and by excision of a portion of the capsule on the inner side has been mentioned in Chapter VII., p. 73. In view of the above explanation of the cause of the tendency it is not entirely clear how the removal of a piece of the inner portion of the capsule in anterior dislocations should do any good, unless, in consequence of the frequent recurrence, that side also should have become relaxed and elongated. Excision of the head of the humerus has been resorted to in at least four cases, and the reported results in three of them were good. I should think the disability would have to be great to justify so radical a measure, one which may in itself be so disabling.

Another class of cases in which the tendency to recurrence is the result not of a primary traumatic dislocation but of pathological changes in the joint or of paralysis of the muscles will be considered in a subsequent section.

If the *dislocation remains permanently unreduced* the periarticular muscles become wasted and the deformity of the region is thereby increased. The head forms a new socket for itself, but its availability for motion is slight, and the use of the limb is confined as a rule to the "underhand" movements. In some cases the compensatory mobility of the scapula is such that the hand can be raised to the head, and in some a degree of usefulness has been exceptionally obtained that is far in excess of what is usual. Thus, Prochaska's patient, the head of whose humerus was lodged in the chest after having passed between the second and third ribs, earned his living for many years as a woodchopper.

Treatment of old dislocations that cannot be reduced by manipulation and forcible traction.—The urgent desire of patients to be relieved of their disability or of the pain caused by the persistence of the displacement has occasionally led surgeons to resort to cutting operations in the hope of restoring the bone to its place or improving its position, or to excise the head. The attempts made by Desault and Dupuytren at the thumb found few imitators there or at other joints until quite recently, since improved methods of treating wounds have diminished the attendant risks; but in the meantime subcutaneous division of the muscles or tendons was occasionally employed with apparent success, and of late subcutaneous division of the capsule or of tissues of new formation about the displaced bone has been recommended or employed. Others have sought to improve the position of the limb or to create a false joint by subcutaneous fracture or division with the saw, and others again have excised the head of the humerus. It is not always easy to determine from the histories of the cases the measure of success or improvement, for in some the report ends with the operation, and in others although the result is called a success the description leaves the reader in doubt as to the completeness of the reduction or as to the improvement in function. With our more accurate knowledge of the changes in the condition of the glenoid fossa and in its relations with the capsule that follow the prolonged absence of the head of the humerus from it, we may well doubt the completeness of any reputed reduction obtained by subcutaneous measures or feel justified in believing that the benefit attributed to the

use of the tenotome was a delusion, and that the really efficient agents were the manipulation and the traction. In this criticism I do not include those tenotomies or divisions of muscles which in the earlier days took the place now filled so much more easily and safely by anæsthetics. It is addressed mainly to a method employed by Polaillon[1] in 1882, and subsequently used by some and highly recommended by others on his authority.

Subcutaneous section.—Polaillon's patient had an intracoracoid dislocation, produced during an epileptic fit, that had existed for four months. An attempt to reduce with the pulleys, aided by chloroform, failed, but brought the head of the humerus nearer its socket and directly under the coracoid process. Eleven days later the patient was again chloroformed, a blunt-pointed tenotome introduced through a small cut made through the skin and muscle a finger-breadth below the tip of the acromion, and carried horizontally inward between the deltoid and the point of the humerus, its edge turned backward, and then withdrawn so as to divide the tissues lying upon the bone; the point of the knife was then carried through the same incision to the back of the humerus, and a similar cut made along the outer aspect of the head. Two days later the traction was renewed under chloroform, and the dislocation reduced. A week later, the bone having meanwhile shown a constant tendency to become displaced forward and inward, a tourniquet was applied about the shoulder to keep it in place. A month later the patient was able to raise his hand to his mouth and to pull it behind his head, and "the movements were daily gaining in extent."

It is not so uncommon for a second or third attempt to reduce by traction to succeed after the first has failed, that the success in this case can be unhesitatingly attributed to the subcutaneous division, and, furthermore, it seems doubtful whether an incision made from the outer side in this manner could divide anything that offered any serious obstacle to the return of the bone.

The additional cases, in which this method was successfully employed by Polaillon, are briefly mentioned in a thesis by Bardon-Lacroze.[2] One patient was sixty-two years old, and had an intracoracoid dislocation of four weeks' standing. After an unsuccessful attempt to reduce by traction, the subcutaneous section was made, and two days later the attempt was renewed, and reduction was obtained when the traction reached 160 kilogrammes. The other patient was seventy-six years old, very feeble, and partly paralyzed, with a subclavicular dislocation of seven weeks' standing. The section was made without any previous attempt to reduce; the following day reduction was easily obtained with a traction of 70 to 80 kilogrammes. It cannot be said that these cases are any more demonstrative of the value of the section than the first one was.

On the other hand, the same writer quotes from a private communication made to him by Molière, of Lyons, as follows: "I believe the method of subcutaneous section of the fibrous bands is an excellent one. In the

[1] Polaillon: Bull. de la Soc. de Chir. 1882, p. 129.

[2] Bardon-Lacroze: Des sections sous-cutanées comme moyen de réduction des luxations anciennes du coude et de l'épaule. Thèse de Paris, 1882, No. 209.

case in which I used it it gave me a perfect and unexpected result; I had previously made traction with an enormous force without result."

An *open arthrotomy*, by which the surgeon is enabled to see and remove the obstacles to reduction, is not only more likely to be successful than subcutaneous division, but, if carefully done when the tissues have not been lacerated and inflamed by recent forcible attempts to reduce by traction and manipulation, is also, in my opinion, not more dangerous. How serious the consequences may be, if the operation (arthrotomy) is undertaken in recent cases or after forcible attempts to reduce, is shown by the result in Polaillon's[1] case of dislocation of the femur thus treated; it ended promptly in death by acute septicæmia, although conducted under antiseptic precautions. It has of late been quite frequently employed in the dislocation of other joints, especially the elbow, thumb, and astragalus, but only rarely at the shoulder, only three times, the cases of Albert, Thiersch, and Burkhardt, although in one or two others it was undertaken and then completed as a resection.[2]

Albert's[3] case was a subcoracoid dislocation, the duration of which is not stated. An incision, eight centimetres long, was made in front between the humerus and glenoid fossa, the sides of the wound held widely apart, and all tense bands divided; then rotatory movements were made by which the head was moved in a "really gorgeous" manner toward its socket, but, just as it was about to spring in, the bone broke at the surgical neck. Two sharp hooks were then engaged in the head, and it was drawn into place, and the fragments were united by a suture. "The result was a pseudarthrosis at the seat of fracture, but the patient was bettered by the operation; the movements were much more free, and he was content."

Of Thiersch's case I have only the brief mention by Albert that the operation was an arthrotomy, and failed to effect reduction.

Burkhardt's[4] patient was a woman forty-eight years old; the dislocation was downward and forward, and had lasted seven months. Several unsuccessful attempts had been made to reduce it. A longitudinal incision, 13 centimetres long, and beginning midway between the acromion and coracoid, was made and carried down to the glenoid fossa, which was found to be covered with thick fibrous tissue; this was dissected away, and a very strong band which held the head in its abnormal position was divided, and the "tendons on the inner side were subperiosteally detached. The reduction, however, could not be effected without tearing off the greater tuberosity." A drainage tube was placed in an opening made at the back of the shoulder, and the limb was immobilized as for fracture of the clavicle. The operation lasted an hour and a half, recovery followed, without accident or suppuration, in four weeks. Three

[1] Polaillon: Bull. de la Soc. de Chir., 1883, p. 101.

[2] Dr. Garmany, of New York, has recently (Oct. 1887) employed it with success in a fresh case.

[3] Albert: Chirurgie, 1881, 2d ed., vol. 2, 319. Nicoladoni quotes Rosenmayer, Wiener med. Blätter, 1883, p. 17, as saying that Albert did this operation twice in 1874 for old dislocations of the shoulder; but this seems to have been an error, the second operation being on the elbow.

[4] Burkhardt: Wurtemberg med. correspondenzblatt, 1878, No. 4, p. 35, quoted by Poinsot in Rev. de Chirurgie, 1883, p. 629.

months afterward the limb could be abducted 45°, and the hand placed on the opposite shoulder, on the top of the head, and behind the hips, but external rotation remained very limited.

Burkhardt's is, then, the only successful case, for, although Albert effected reduction, he broke the humerus and got a false joint at the seat of fracture; but still I think Albert's opinion that the security afforded by antiseptic methods of operating will lead surgeons to repeat the attempt will prove correct. Personally, I should resort to it in preference to forcible traction or subcutaneous division or resection. My only hesitation would arise from some doubt concerning the effect of the operation upon the vitality of the cartilage of incrustation. In a similar operation upon the elbow I had reason to think that the dissection of the capsule led to the destruction of much of the cartilage and to rarefaction of the epiphysis of the humerus. Perhaps this consequence would be avoided by leaving the periosteum untouched, and by dividing the adhesions and ligaments instead of dissecting them away from the bone.

Excision of the head has been done in a few cases, among others by Edward Warren, Annandale, von Volkmann, and Ollier.

Warren's operation was done in Baltimore in 1869. The following account is given by Gross:[1] "His patient was a female, fifty years of age, who, twelve months previously, in a fall, had luxated the humerus, throwing it down into the axilla beneath the coracoid process, in contact with the brachial plexus of nerves, occasioning violent and persistent pain, with great disability and gradual emaciation. The joint was exposed by a V-shaped incision, and the head of the bone, firmly wedged in its new position, divided through the surgical neck. The patient rapidly recovered with a good use of the arm."

Annandale's[2] patient was a woman, sixty-two years old, with a subclavicular dislocation that had lasted six weeks and caused much pain. He made an incision along the anterior border of the deltoid, hoping to be able to free the head and replace it in its socket; but finding this impossible, he divided the bone at the surgical neck and removed the head piecemeal; it was very firmly adherent to the ribs. During the operation he wounded the posterior circumflex artery and tied it, but the ligature cut through, and as the stump of the vessel was only one-eighth of an inch long, he tied the axillary artery above and below it. Gangrene of the limb ensued, and the patient died on the third day.

Volkmann's[3] patient was a man, fifty-five years old, with a subcoracoid dislocation of five weeks' standing, and very marked hard œdema of the lower part of the limb. Three attempts to reduce were made, but they resulted only in bringing the head into the axilla; crepitation was perceived on certain movements, especially rotation. An incision was made in the axilla upon the head of the bone which, the arm being elevated, projected prominently under the skin; a considerable amount of dark-brown, sero-sanguinolent liquid escaped through the incision, and the head was found lying in a cavity as large as the fist and filled with partly

[1] Surgery, 5th ed., vol. ii. p. 38.
[2] Annandale: Med. Times and Gaz., 1875, vol. i. p. 576.
[3] Volkmann: Centralblatt für Chir., 1883, p. 28.

clotted blood; venous bleeding came from the bottom of the wound. The head was then separated by means of a chain-saw and removed, and the bleeding was found to come from an opening in the axillary vein, which was displaced toward the anterior wall of the axilla and lay so deep that a ligature could not be placed upon it until after the skin and pectoralis major had been divided at right angles to the first incision. The wound in the vein must have been caused either by the dislocation itself or by the attempts to reduce, and probably, it was thought, by the intervention of a sharp fragment of bone as large as the end of the finger, which had been broken from the humerus at a point near the lesser tuberosity and, still adherent to the periosteum, lay in the cavity of the wound. Even after the excision the resistance of the soft parts was such that the limb could at first be brought only incompletely into position. The incision was closed with sutures; three drainage tubes; Lister dressing. Primary union took place, the temperature rising only once to $100\frac{3}{4}^{\circ}$; the œdema diminished, and the patient was discharged at the end of five weeks with good position and good passive mobility of the limb. The ultimate result is unknown.

Ollier[1] attempted to reduce by arthrotomy an intracoracoid dislocation of nine months' standing, and, failing, did resection. He made an anterior incision. After resection a portion of the capsule was found bunched in the glenoid cavity; even after the removal of the head it was difficult to bring the end of the shaft into contact with the glenoid cavity because of the retraction of the muscles. The ultimate result was good.

Fracture of the surgical neck of the humerus, which has not infrequently been caused by the attempts made to reduce, has sometimes been taken advantage of to place the limb in a better position, and Després[2] recommends that it should be intentionally produced. Others have done it with the view of subsequently preventing its reunion and establishing a false joint between the upper end of the shaft and the glenoid fossa. Després's first operation (loc. cit., p. 22) was done with the view of obtaining a pseudarthrosis at the seat of fracture, but bony union took place. The usefulness of the limb was, however, so much increased by the change in its position that he repeated the operation upon another patient with the view of simply effecting this change, and was in this case also well satisfied with the result. The proposal to generalize the practice does not appear to have been received with much favor by his colleagues in the Society. A great objection to it as practised by him, in my opinion, was that he fractured the bone by forcibly abducting the elbow, using the edge of the acromion as a fulcrum; he claims that the fragility of the bone is so much increased by the persistence of the dislocation that the fracture can be readily effected, and that after the fracture the head atrophies and its mobility in its abnormal position is thereby increased. However that may be, the manipulation is one that exposes to the danger of rupturing the vessels of the axilla, and that danger is too great to be offset by the comparatively slight improvement in the functions of the limb.

[1] Ollier: Rev. de Chirurgie, 1886, p. 904.
[2] Després: Bull. de la Soc. de Chir., 1879, p. 742.

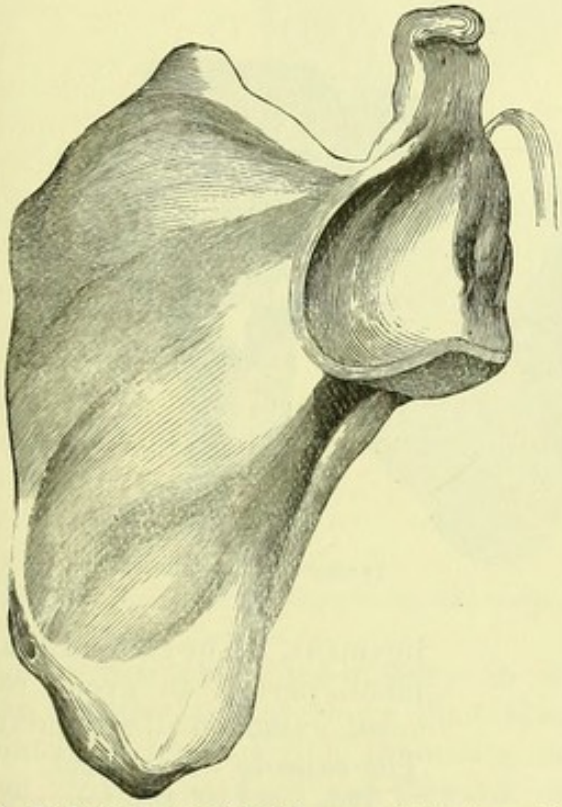
Other features of this subject have been considered in the first part of this chapter.

Dr. J. Ewing Mears[1] divided the surgical neck subcutaneously with an Adams's saw and obtained an excellent result by pseudarthrosis. His patient was a man, thirty-nine years of age, and the dislocation was of two years' standing. The saw was entered on the outer side, and the division was easily effected in about five minutes. The case deserves to be remembered, and the method is to be preferred to fracturing as less dangerous and more precise.

Congenital Dislocations.

Congenital dislocations are very rare, and even in many of the reported cases there is much uncertainty as to the correctness of the diagnosis if we exclude from this class those cases in which a dislocation is produced during delivery. There is good reason to think that cases are reported as congenital with no better reason for the opinion than the facts that the dislocation has been discovered at an early age and that there is no history

Fig. 68.



R. W. Smith's case of double congenital subcoracoid dislocation of the shoulder. Scapula of left side.

Fig 69.



The same ; left humerus.

of a traumatic cause. Consequently there may be, and doubtless are, included traumatic cases occurring at the time of birth and paralytic cases of infancy, especially the so-called "obstetrical paralyses" (*vide infra*), and some doubt is thus cast upon all reported cases.

Krönlein says that of 98 congenital dislocations treated in von Langenbeck's poliklinik, 90 were of the hip, 5 of the shoulder, 2 of the head of the radius, and 1 of the knee.

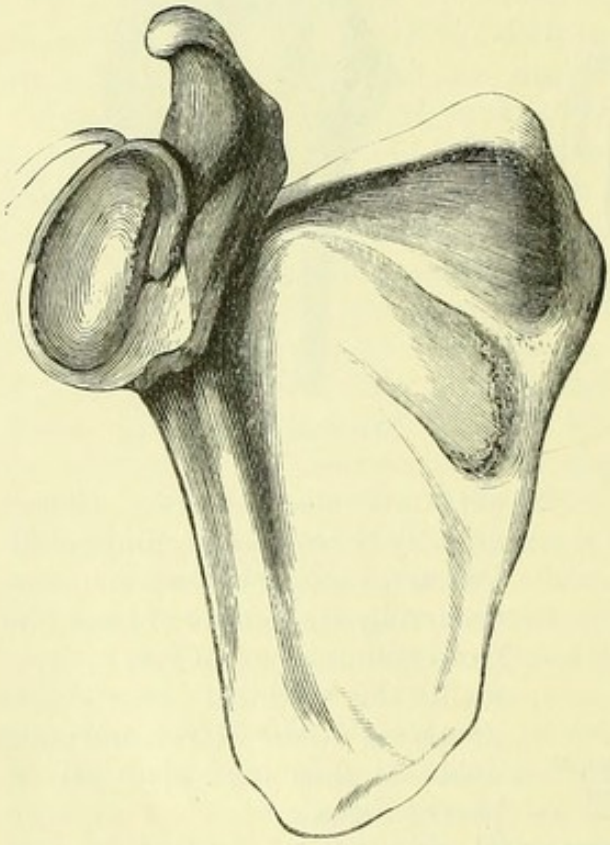
It is probable that the cause is an arrest of development, as has been so well proved for congenital dislocations of the hip, and the opinion is

[1] Mears: Philadelphia Med. and Surg. Reporter, 1877, vol. xxxvii. p. 287.

supported by the facts that the lesion is often double and often associated with other congenital defects; thus, R. W. Smith[1] saw one case in which there were double subcoracoid, and another in which there were double subacromial dislocations, and a third in which there was a subcoracoid dislocation with clubfoot on the same side. Krönlein[2] saw a subacromial dislocation associated with congenital dislocation forward of the head of the radius on the same side, and another with rudimentary development of the radius.

The varieties that have been observed are the subcoracoid and the subacromial, and perhaps the subspinous (Gaillard). For an account of the pathological changes we are indebted almost exclusively to R. W. Smith. In his case of double subcoracoid dislocation, a lunatic woman twenty-nine years old, "there existed on the left side scarcely any trace of an articulating surface in the situation which the glenoid cavity occupies in the normal state; but there had been formed upon the costal surface of the scapula a socket of a glenoid shape, measuring about an inch and a half in its vertical direction and an inch and a quarter transversely (Fig. 68). It reached upward to the under surface of the coracoid process, from which the head of the humerus was merely separated by the capsular ligament." The glenoid ligament, perfect in every respect, extended all around it. The capsule was perfect.

Fig. 70.



The same; right scapula.

Fig. 71.



The same; right humerus.

The head of the humerus (Fig. 69) "was of an oval shape, its long axis corresponding with the shaft of the bone. The oval shape was principally due to the deficiency of its posterior part, and there existed between the greater tubercle and the margin of the head of the bone,

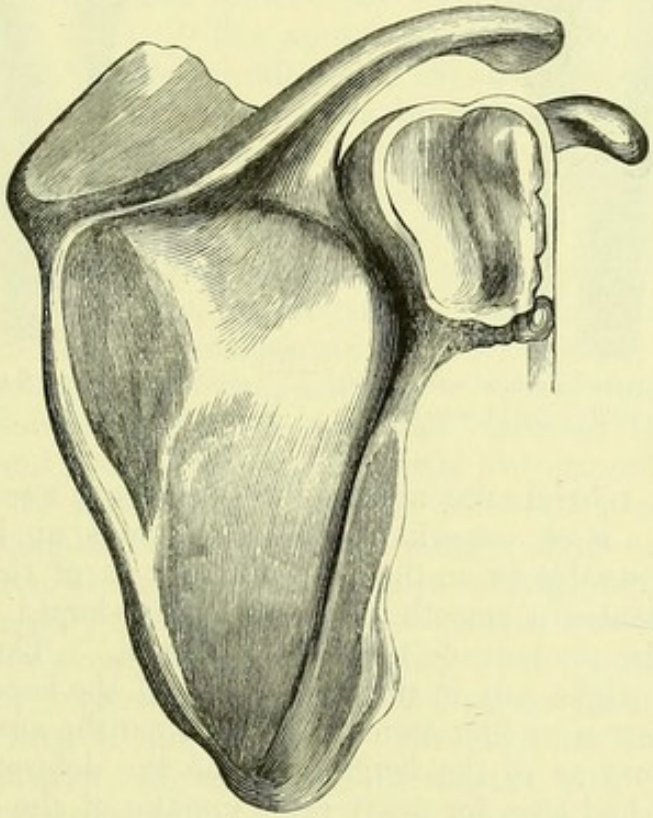
[1] R. W. Smith: Fractures and Dislocations, 1847, p. 256.
[2] Krönlein: Deutsche Chirurgie, Lief. 26, p. 97.

where the investing cartilage terminated, a broad, shallow depression, corresponding to the edge which separated the normal from the abnormal portion of the glenoid cavity. The shaft of the humerus was small and seemingly atrophied."

Upon the right side, although the condition of the bone was somewhat different the characteristic features of the deformity were similar. (Figs. 70 and 71.)

In his double subacromial case, a lunatic woman forty-two years old, "there was no trace of a glenoid cavity in the natural situation; but upon the external surface of the neck of the scapula there was a well-formed socket which received the head of the humerus (Fig. 72). It

FIG. 72.



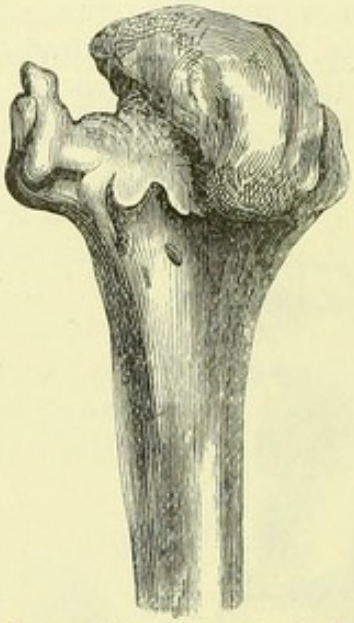
Double congenital, subacromial dislocation. (R. W. SMITH.)

was an inch and three-quarters in length, and an inch in breadth; it was a little broader above than below, and its summit was less than a quarter of an inch from the under surface of the acromion process. It was directed outward and forward, was covered with cartilage, and surrounded by a perfect glenoid ligament. The tendon of the biceps muscle arose from the most internal part of its superior extremity, whence it passed downward and outward very obliquely, in order to reach the bicipital groove of the humerus. The axillary margin of the scapula, if prolonged upward, would have passed nearly altogether internal to the abnormal socket. . . . The capsular ligament was perfect. The scapula was smaller than natural, and its muscles badly developed."

"The head of the humerus (Figs. 73 and 74), upon the right side, was of an oval or oblong form, somewhat broader above than below; its

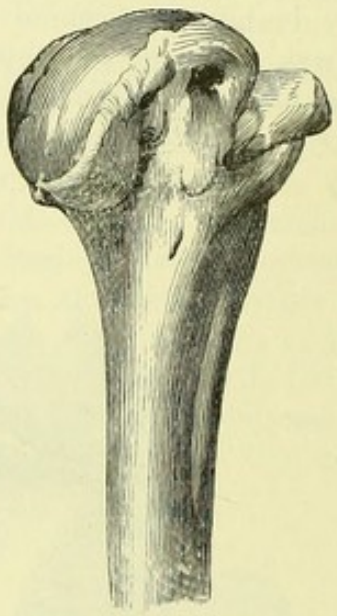
anterior half alone was in contact with the glenoid cavity. This portion was covered with cartilage, the remaining half being rough and scabrous, and totally destitute of articular cartilage. The inner edge of the humerus, if prolonged upward, would have passed between these two portions of the head of the bone."

FIG. 73.



R. W. Smith's case of double congenital subacromial dislocation of the shoulder; right humerus.

FIG. 74.



The same; left humerus

"The greater tubercle was natural, but the lesser was elongated and curved, forming a most remarkable process: it was an inch in length, and bore some resemblance to the coracoid process of the scapula. At its root it presented a smooth, convex, pulley-shaped surface, round which passed the tendon of the biceps muscle." The left humerus differed from the right only in the smaller size of the lesser tuberosity.

Both these cases were first seen by Smith upon the autopsy-table, and he gives no history as to the length of time the deformity had lasted. Both individuals had been for many years inmates of the lunatic asylum, and the second one was subject to epileptic convulsions, in one of which she died. It must be admitted that the appearances are not incompatible with the theory of a post-natal origin, perhaps by muscular action in an epileptic convulsion, as in Fränkel's case of double simultaneous dislocation quoted above, p. 260. Küster's case of supposed congenital double dislocation backward in a child fourteen months old, with the autopsy, has been quoted in Chapter XVII.; in it each glenoid fossa was normally placed and shaped, but small, and the humerus rested on its posterior border, the limb being strongly rotated inward; a condition which, in my opinion, is much more suggestive of a traumatic or paralytic (*vide infra*) origin than of pre-natal arrest of development.

The three cases of single subcoracoid dislocation observed during life by Smith presented the same appearances. The muscles of the shoulder and arm were notably wasted, with the exception of the trapezius, and the wasting extended to the muscles which pass from the side of the

chest to the humerus and scapula, so that the thorax on the dislocated side measured one inch and a half less in circumference than on the other. The motions of the limb were extremely limited; as it hung by the side it could only be swung backward and forward, and even in that motion the scapula largely participated; active abduction or elevation was entirely lost, and passive abduction was slight. The scapula was more freely movable upon the chest than usual. The muscles of the forearm were wasted, but not so much so as those of the arm.

The head of the humerus presented nearly its natural form, so far as could be ascertained; it could be easily pressed inward or outward. The acromion was prominent, and the thumb could be easily inserted between it and the head of the humerus. The shoulder did not present its natural rounded form, but was not so much flattened as in traumatic dislocations.

The history of his third case, a boy nine years old, is in part as follows (loc. cit., p. 261): "The aunt of the child stated that his right arm was paralyzed, but the peculiar and characteristic manner in which the limb hung by his side induced me to suspect the existence of an original malformation of the shoulder-joint. It was stated that he had nearly attained the age of one year before the condition of the limb attracted attention, which was then excited, not by the deformity of the shoulder, but by the atrophied condition of the muscles of the arm, when contrasted with those of the opposite side. The child had not met with any accident, nor did he ever complain of pain or of any other symptom indicative of disease of the articulation. . . . I inquired particularly whether the deformity of the shoulder had increased since it had first been observed, and learned that several years had elapsed before the full development of the appearances which the joint now presented."

In his subacromial case the coracoid process and the anterior margin of the coraco-acromial ligament stood out in strong relief; the acromion process was unusually prominent, but not so much so as in accidental dislocations. The shoulder appeared higher than natural, and was flattened anteriorly; posteriorly a round solid tumor plainly indicated the situation of the head of the humerus. The arm was directed obliquely downward and inward; the elbow was in contact with the side, and the hand and forearm pronated.

Gaillard's case of subspinous dislocation, quoted by Malgaigne, loc. cit., p. 569, is as follows. The patient was a girl sixteen years old. A few days after birth it was noticed that the left arm was deformed and the elbow abducted; later the arm was immovable. The dislocation was not recognized until she was four years old. When she came under Gaillard's care, at the age of sixteen, the head of the humerus lay in the subspinous fossa at about an equal distance from the two ends of the spine of the scapula. The scapula and clavicle had suffered an arrest of development; the arm was thin and four centimetres shorter than the other; the forearm was well developed, but could not be completely extended or supinated. Four times in the course of a week Gaillard made horizontal traction on the arm by means of a weight of sixteen pounds, continued for fifteen or twenty minutes, and reinforced occasionally by traction with his hands. On the last occasion the head moved an inch and a half along the scapula to the edge of the glenoid fossa and

was then thrown into it by a movement of leverage. It almost immediately came out again. The next day it was again reduced and kept in place for a hour. Ten days later it was again reduced, and the arm fixed by a bandage; this time the reduction persisted. Two years later the limb was found to have gained half an inch in length; the patient could move it inward, outward, forward, and backward, could lace her clothes behind her back, carry a chair, feed herself, and play on a guitar. Possibly this also was a case of dislocation by obstetrical paralysis (*vide infra*).

The only case within my knowledge in which an operation was undertaken was Küster's (quoted above, Chap. XVII., p. 244); he excised the head of the humerus in a subacromial dislocation in a child fourteen months old; the case terminated fatally.

The prognosis is unfavorable as regards reduction or benefit by operation; if the glenoid fossa does not exist there can be no question of returning the head of the humerus to it, and an operation can only place the limb in a position where its range of motion will be more free; it will always be doubtful whether the long disused or paralyzed muscles will regain an active control over it.

Pathological Dislocations and Subluxations.

Subluxation or complete dislocation may be made easy by changes effected in the articular surfaces or the capsule by disease, or by paralysis of the deltoid or rotator muscles which normally aid in maintaining the close contact between the bones. The reported instances are not very numerous, and even in some of these the evidence, clinical or post-mortem, has left not only the character and extent of the displacement in doubt, but also its essential cause. Such cases do duty with the different writers as supposed examples of widely different lesions, such as partial traumatic dislocations, new forms of dislocation, and chronic arthritis. Gurlt[1] gives to Adams (Todd's *Cyclopædia*, article Shoulder-joint) and Canton (*London Med. Gazette*, 1848, vol. 6, p. 410, and vol. 8, p. 111) the credit of having first shown that cases described as partial dislocation by Sir Astley Cooper, Hargrave, and others were actually examples of chronic non-suppurative arthritis. In his own description of the changes effected by this disease in the quoted cases he does not always discriminate between those which were the effect of the prolonged inflammation and those which should probably be attributed to an antecedent traumatic dislocation which originated the process, such as rupture of the tendons of the supra- and infra-spinatus and subscapularis muscles, and the establishment of a large opening between the cavity of the joint and the subacromial bursa. A dislocation recurring after such injuries should be classed with the "habitual dislocations."

Of the three classes made by Volkmann—dislocations by distention, by destruction, and by deformity (see Chapter X.)—the second is by far the most rare, and the third apparently the most common, although the distinction between the latter and the first cannot always be determined

[1] Gurlt: Patholog. Anat. der Gelenkkrankheiten, 1853, p. 250.

clinically. Indeed, I know of only one recorded case in which the history clearly shows an acute non-traumatic effusion in the joint promptly followed by an abrupt appearance of the deformity with instant relief of the pain, such as has been observed at the hip and knee in the course of acute rheumatism or the eruptive fevers. At the shoulder the effusion has taken place more slowly, usually as the result of a traumatism, and the dislocation has been partial; in traumatic cases there is always the possibility that the ligaments may have been torn or the bones chipped in such a way as to facilitate dislocation. The case referred to was reported by Hannon and is quoted by Malgaigne (loc. cit., p. 562). A man forty-five years old, who had previously suffered with acute rheumatism in the knee and hip, became feverish, and on the following day had an acute inflammation of the shoulder-joint. The pain increased, and on the night between the fifth and sixth days became suddenly very severe; the next morning a subcoracoid dislocation was found, and was reduced with some relief of the pain. The next day the dislocation was found to have partially recurred; it was again reduced, and the limb fixed with a bandage. Recovery followed.

Malgaigne thinks the over-distended capsule is ruptured on the inner side, and thus the dislocation made possible; the view seems insufficient to explain the easy partial recurrence. When the effusion is more slowly produced and is large the head of the humerus is separated from direct contact with the glenoid cavity by a layer of liquid, the depth of which may amount to one centimetre (Albert, loc. cit., p. 320), under which circumstances it is evident that a slight force would be sufficient to displace the humerus to either side and without rupture of the capsule, just as one easily produces a dislocation in a freshly dissected shoulder after making a small opening in the capsule to admit the air. This requires relaxation of the scapular muscles which normally hold the bones close together, and such relaxation would not be found when the arthritis is acute and painful. In Lesauvage's[1] case the dislocation did not take place until ten years after the beginning of the arthritis and three years after a marked exacerbation had begun which lasted until the dislocation (subcoracoid) occurred.

A class of cases, of which quite a number have been reported, are sometimes described as traumatic dislocations upward, but Malgaigne's opinion that they are the result of arthritis is now generally accepted for most of them. They are characterized by the projection of the head upward and forward and rigidity of the limb. Malgaigne quotes a case to show that the displacement may be caused by carrying the arm in a sling that is too short and tight.

Most of the specimens of *dislocation by deformity* are open to the doubt whether they may not actually be nearthroses following traumatic dislocation, and this is especially true of those in which the dislocation is forward. Gurlt (loc. cit., p. 274) describes seventeen specimens concerning which this doubt exists, and I think he might well have added to them several of those which he describes as examples of chronic inflammation. The following are examples of the different forms.

[1] Lesauvage: Arch. gén. de Méd., 1835, vol. 9, p. 261.

Dislocation downward, forward, and inward. (Gurlt, loc. cit., p. 276, No. 3. From Museum of Royal College of Surgeons, No. 3275.) The head of the humerus is flattened and enlarged, and its articular surface rests upon a deep concave surface composed of new bone deposited upon the anterior and under portion of the scapula immediately below and upon the inner side of the glenoid fossa. A large irregular prominence of new bone extends from the greater tuberosity upward and backward, and it is probable that the elongated supra- and infra-spinatus muscles were attached to it. The glenoid fossa has lost its original form; its border and surface are irregular, and its cartilage is entirely lacking. The humerus appears to have been freely movable. (Gurlt speaks of it as a somewhat doubtful case.)

Partial subglenoid dislocation. (Gurlt, loc. cit., p. 266, No. 22. Quoted from Adams, in Todd's *Cyclopædia*, art. Shoulder-joint, p. 599.) The head of the humerus lies so far below its usual position that a new socket has formed upon the axillary border of the scapula. The original socket is still in part occupied by the enlarged head of the humerus. The glenoid fossa is enlarged downward one and a half inches below its usual space. The new cavity is smooth, and enlarged on its posterior border by several irregular masses of bone. The capsular ligament is in part ossified.

Dislocation backward, on both sides. (Gurlt, loc. cit., p. 266, No. 20. From St. Bartholomew's Hospital, series II., subseries B, No. 32.) The heads of the humeri are flattened and enlarged by bony outgrowths about their edges; the glenoid fossæ are also correspondingly enlarged and deepened, and extend backward and inward to the spina scapulæ; they are hard, perforated by numerous holes, and smooth in places. The changes are symmetrical in the two joints, except that the surfaces on the right side are smoother.

Dislocations due to Paralysis.

This variety, rare in the adult, has been shown by the investigations of Duchenne de Boulogne[1] to be much more common in newborn children, the paralysis being due to the pressure of the forceps or to traction in delivery. In consequence of the lack of support which ensues upon the paralysis of the muscles of the shoulder, the weight of the limb causes it to sink downward, the only remaining support, that of atmospheric pressure, being presumably overcome gradually by the accumulation of liquid within the capsule. The condition of the joint then resembles that of hydrarthrosis, plus the relaxation of the muscles, and, as has been above described, any slight force is then sufficient to displace the head of the humerus to one side. Malgaigne says that when all the muscles of the shoulder are paralyzed the displacement is always downward and forward, and usually incomplete; and that when the paralysis is partial the displacement is always effected by the action of the unparalyzed muscles and is reduced by the weight of the limb; in the only cases of the latter

[1] Duchenne de Boulogne: De l'Electrisation localisée, 1871, 2d ed., and Panas Dict. de méd. et chir. pratiques, art. Epaule, p. 514.

kind of which he had knowledge, two in number, the displacement was backward. He saw in a man, thirty-four years old, a double paralytic dislocation.

In newborn children the dislocation is said to be always backward, subacromial. Duchenne saw in ten years eight cases of this kind. In all the cases of obstetrical paralysis which he had seen the same group of muscles was affected, namely, the deltoid, infraspinatus, biceps, and brachialis anticus; in some there was also paralysis of the muscles in the forearm and hand supplied by the musculo-spiral or ulnar nerve. I have seen paralysis of the same muscles (the deltoid, biceps, and brachialis anticus) appear spontaneously at the age of one year, with consequent laxity of the joint that permitted dislocation forward and backward. I have seen only one case of subacromial dislocation dating from about the time of birth. The delivery had been effected with forceps. When the paralysis is caused by the application of the forceps the mechanism appears to be the pressure of the edge of the instrument upon the brachial plexus on the side of the neck; in other cases it is the pressure of the finger used as a hook in the axilla or to bring down the arm when raised beside the head.

In one of Duchenne's cases, treated by Chassaignac, a permanent cure was obtained by a fixation dressing, worn for five or six weeks.

Occasionally the disability of the muscles is due to a traumatism (myopathic dislocation). In a case reported by Wolff,[1] in which the head of the humerus had sunk almost three centimetres below the acromion, and the disability was very great, the functions of the limb were much improved by an operation; the joint was opened posteriorly along the margin of the glenoid fossa, the articular cartilage removed, and the bones fastened together with strong silver wire. The control over the limb thus obtained through the scapula was such that it could be raised and lowered and even a little adducted and abducted.

[1] Wolff: Berl. klin. Wochenschrift, 1886, No. 52. Abstract in Centblatt. für Chir., 1887, p. 637.

CHAPTER XIX.

DISLOCATIONS OF THE ELBOW.

DISLOCATIONS OF BOTH BONES BACKWARD, FORWARD, LATERAL, DIVERGENT.

Anatomy.—On either side of the lower end of the humerus is a prominence, the epicondyle, which can be easily felt, and is of great importance in the recognition of any change in the relations of the bones that constitute the elbow-joint. The inner one, commonly called the epitrochlea, is more prominent and well-defined than the outer one, and its upper margin joins the shaft of the humerus by a sharp curve, while on the outer side of the shaft the supinator ridge connects the side of the shaft with the epicondyle by a gradual slope. Below the epitrochlea is the flattened circular side of the trochlea, projecting downward and forward about half an inch, with a sharp, well-defined margin, which is masked by the olecranon and ulna when the bones are in place. From this edge the articular surface of the trochlea passes outward like a cone, its diameter becoming rapidly smaller for about half an inch, and then enlarges again, but less abruptly, for nearly an equal distance. Above it, posteriorly, is a deep depression, the olecranon fossa, into which the tip of the olecranon is received in full extension of the joint, and above it, anteriorly, is a corresponding, smaller one, to receive the tip of the coronoid process in full flexion. On the outer side of the anterior and lower part of the trochlea, and separated from it by a shallow vertical groove, is the capitellum, or radial head, of the humerus with which the head of the radius articulates, a rounded prominence looking directly forward.

The ulna articulates with the trochlea by its greater sigmoid cavity, which is concave from above downward and has a central longitudinal ridge which fits like a wedge into the central depression of the trochlea, or like a rope into the groove of the wheel of a pulley, and thus opposes displacement to either side. The posterior end of the concavity is formed by the tip of the olecranon, the anterior end by the coronoid process.

The radius articulates with the capitellum by the slightly concave, circular upper surface of its cylindrical head, and with the lesser sigmoid cavity on the outer side of the ulna and coracoid process by the side of its head. This articular surface on the side of the head is about three-eighths of an inch long (from above downward) on the inner and posterior side of the bone, the part that is in contact with the ulna in supination, but is shorter on the outer side at the part which comes in contact with the ulna in pronation.

The long axes of the trochlear cones and the ovoid capitellum coincide with one another and represent the axis of the joint for flexion and

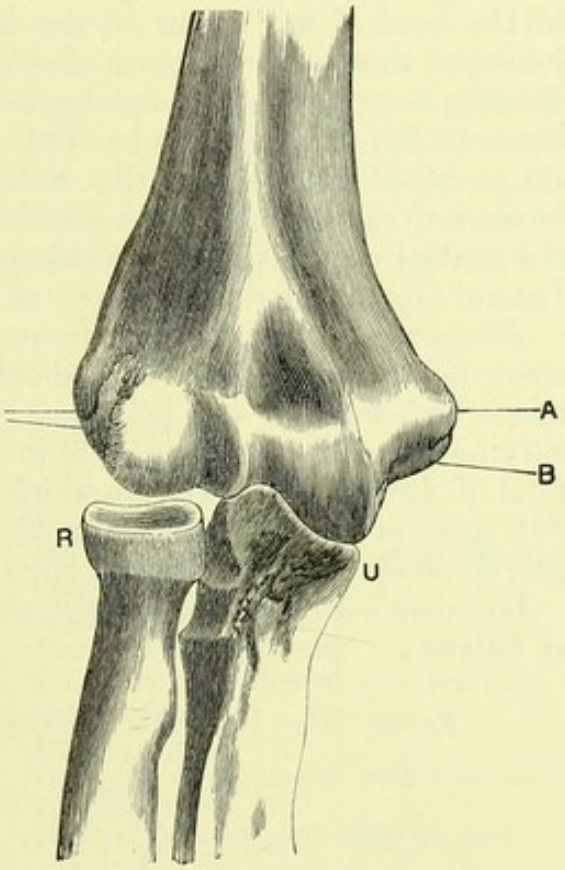
extension ; this line crosses the lower end of the humerus from a point just below and in front of the external epicondyle to one that is just covered by the lower part of the epitrochlea, and is inclined downward and inward from the transverse axis of the lower end of the humerus, so that the long axis of the forearm does not coincide with that of the arm but deviates to the outer side as it passes downward.

When the bones are in place and the forearm fully extended the uppermost part of the olecranon, the "point of the elbow," lies on or close below a transverse line drawn behind the limb from the epitrochlea to the epicondyle ; and when the elbow is flexed at a right angle the same point lies a little more than an inch directly below and nearly midway between these two prominences in the prolongation of the long axis of the shaft of the humerus. Ordinarily the relations of these three points to one another can be readily determined, even when the region is swollen, and they are the most convenient and trustworthy aid in the recognition of the existence of a dislocation of the ulna.

The outer border of the head of the radius can be felt about three-quarters of an inch below the epicondyle in a line drawn from the latter to the wrist, and it can be felt to move when the hand is gently rotated. This is the only point where the interarticular line is distinctly accessible to palpation ; at all other points it is too thickly covered by soft parts or masked by the parallelism and close contact of adjoining surfaces.

The internal lateral ligament arises above from the anterior, lower, and posterior portion of the epitrochlea and is broadly inserted below along the inner margin of the greater sigmoid cavity.

Fig. 75.



The bones of the elbow. B, the axis of motion. (Tillaux.)

The external lateral ligament, shorter and narrower than the internal, arises above just below the epicondyle and becomes blended below with the orbicular ligament that surrounds the head of the radius, some of its posterior fibres being continued to the ulna.

The anterior and posterior ligaments are thin and loose, and close in the joint between the lateral ligaments in front and behind, respectively.

The orbicular, or annular, ligament, placed like a ring about the head of the radius and the adjoining portion of its neck, occupies three-fourths of a circle of which the remaining fourth is formed by the lesser sigmoid cavity of the ulna ; it is thus attached by its two ends to the ulna and encircles the head of the radius. It is reinforced externally and

posteriorly by the fibres of the external lateral ligament. The synovial sac extends beyond its lower border for a short distance along the neck of the radius, and is then reflected upward and attached to this bone.

The capsule forms a single, completely closed sac, enveloping all parts of the joint and extending above the olecranon and coracoid fossæ. Some of the deepest fibres of the triceps and brachialis anticus are attached to it and draw it out of the way when it is relaxed in flexion or extension.

The ulnar nerve passes close behind the joint on the inner side between the olecranon and epitrochlea in close relations with the capsule and lateral ligament.

The movements of the joint are flexion and extension, which, strictly speaking, are provided for by the humero-ulnar articulation, and rotation of the forearm, which belongs to the radio-ulnar joints. The relations of the head of the radius to the humerus give greater breadth to the joint and thus secure it more effectually against angular lateral motion. Flexion is arrested by the interposition of the soft parts between the bones in front or, if pushed to the extreme, by the contact of the tip of the coracoid process with the humerus. Extension is arrested by the tension of the ligaments and muscles on the front of the joint and by the contact of the tip of the olecranon with the back of the humerus. Lateral angular motion is prevented by the lateral ligaments.

Frequency.—In order of frequency the dislocations of the elbow come next after those of the shoulder. The Tables in Chapter I. in which both hospital and polyclinic cases are included show percentages varying from 27 (Krönlein, 109 in a total of 400) to 16 (Prahl, 69 in a total of 420). Table III., in which several statistics are combined, gives 315 cases in a total of 1432, or 22 per cent., for combined hospital and polyclinic service, while 964 hospital cases give only 97, or 10 per cent.

Krönlein's 109 cases arranged according to age, sex, and variety are as follows:

TABLE XI.—109 DISLOCATIONS OF THE ELBOW. (KRÖNLEIN.)

Variety.	Sex.		Age.							
	M.	F.	1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
Forearm, backward . . .	77	17	22	44	14	5	4	3	1	1
Radius, alone	9	6	9	5	1	...	...	...	...	...

This shows the same preponderance in males over females, 4 to 1, that is shown by dislocations in general, and that the great majority, 80 out of 109, occur during the first twenty-four years of life. Attention was called in Chapter XVI. to the difference in respect of age between dislocations of the elbow and those of the shoulder, the latter being rare at the age when the former are common, and most frequent in middle life; and Krönlein's opinion was there quoted that fractures of the clavicle are in childhood the equivalent injury—that is, are produced by the same cause—of dislocations of the shoulder by direct violence in middle life,

and that dislocations of the elbow are the equivalent injury of dislocations of the shoulder by indirect violence.

Classification.—The different forms of dislocation of the elbow are numerous, for the two bones of the forearm may be displaced together in any one of the four principal directions, or each may take a different direction, or either may be dislocated while the other remains in place. The number of named forms has been still further increased by making in some a distinction between "complete" and "incomplete" which not only is not justified by any corresponding important pathological or clinical difference, but which also does not even correspond with the definition of "incomplete" given by those who make most use of the term.

The following table prepared by Denucé[1] in 1869, and reprinted by Pingaud[2] in 1878, gives in a convenient form most of the varieties thus far observed; it is reproduced here because of the prominence given to it by its publication in these two important works, and because of the frequent references to it in current literature, but it must be regarded rather as a working schedule or table of contents prepared for convenience of reference than as a complete classification or even as an accurate one within its own limits. While some of its subdivisions are created on the authority of single, and more or less doubtful cases, others are made to include cases that differ quite as much from one another as do those that are separately classified.

CLASSIFICATION OF DISLOCATIONS AT THE ELBOW. (DENUCÉ.)

1. Dislocations of the forearm upon the arm,	A. Backward,	Complete.	
		Incomplete.	
		Backward and outward.	
		Backward and inward.	
		Backward, complicated with fracture.	
	B. Forward,	Complete.	
		Incomplete.	
		Forward and outward.	
		Forward, complicated with fracture.	
	C. Outward,	Complete.	
		Incomplete.	
		Outward, complicated with fracture.	
	D. Inward,	Incomplete.	
		Inward, complicated with fracture.	
2. Dislocations of the ulna alone,	Ulna backward,	Complete.	
		Incomplete.	
		Backward and inward.	
		Backward and outward.	
3. Dislocations of the radius alone,	A. Radius backward,	Complete.	
		Incomplete.	
		Backward and outward.	
	B. Radius forward,	Complete.	
		Incomplete.	
		Forward and outward.	
	C. Of the radius by elongation, or the incomplete dislocation of children.		

[1] Denucé: Dict. de Méd. et Chir. pratiques, art. Coude.
[2] Pingaud: Dict. encyclopédique des Sci. Méd., art. Co de.

4. Simultaneous dislocations of the two bones,
   - A. Dislocation of the ulna backward and of the radius forward.
   - B. Dislocation of the ulna backward and of the radius outward.

Many of these varieties are closely allied to one another, and produced by causes that differ very slightly. Thus, if the joint is hyper-extended, the ligaments torn, and a backward dislocation of both bones begun, the final position taken will vary with the direction in which the force continues to act, and with the addition to it of lateral flexion of the joint or rotation of the forearm, so that forms as widely different in appearance as direct backward dislocation, lateral dislocation, and divergent dislocation may be produced. It will be proper, therefore, as well as convenient, to describe under the more common type, backward dislocation of both bones, much that concerns many of the other forms, and to limit the descriptions of the latter mainly to the points of difference.

The classification which will be here followed is the same in its principal features as the above and as those adopted by most recent writers. The differences are in the grouping and recognition of the varieties.

Dislocations of the forearm on the arm,
1. Dislocations backward.
   - backward and outward.
   - backward and inward.
2. Lateral dislocations,
   - incomplete { inward. / outward.
   - complete outward.
3. Forward dislocations,
   - incomplete, or 1st degree.
   - complete, or 2d degree.
   - with fracture of the olecranon.
4. Divergent dislocations,
   - antero-posterior.
   - transverse.

Dislocations of the ulna alone,
1, 2. Backward and upward, { 1. Incomplete, or 1st degree. / 2. Complete, or 2d degree.
3. Backward and outward, behind radius.

Dislocations of the radius alone,
1. Backward.
2. Outward.
3. Forward.
4. By elongation, or the subluxation of children.
5. Associated with fracture of the ulna.

Congenital and pathological dislocations.

[1] This variety rests upon a single reported case (Cooper: Disloc. and Fracts., Am. ed., 1844, p. 384), a compound dislocation quoted by Cooper as a dislocation backward. It does not appear from the account that the radius and ulna were separated from each other, and consequently this classification is misleading. It should not be confounded with Malgaigne's "dislocation of the ulna backward and to the outside of the radius," which is bracketed by him with the above variety A, class 4, to form a class entitled "Double dislocation of the ulna upon the humerus and radius," but which is more properly placed by Denucé in class 2, dislocations of the ulna alone, 4th variety, backward and outward, the mechanism of which is torsion (pronation) of the forearm about the radius, by which the ulna is carried backward and outward.

Dislocations of the Forearm Backward.

This is the most common of all the dislocations of the elbow. It is habitually produced by a fall, but although the examples are so numerous the mechanism or mode of production has been the subject of much controversy, largely due to the resort to hypotheses which was stimulated by the lack of definite knowledge. Few who fall are able to describe the circumstances of the fall, to say whether the arm was fully extended or partly flexed, whether the violence was received upon the hand or upon the elbow, and a preconceived theory in the mind of the surgeon is a great help to the discovery of facts that favor it.

The theory of production by *forced flexion* is supported, so far as I know, by only one case, and that a case that has only recently been reported. Stetter[1] had a patient who, while working in a mine, was caught under a falling stone in such a way that his left elbow was forcibly flexed between the stone and the wall and was dislocated backward. When seen, about an hour afterward, the joint was in the position of extension. Reduction was easily effected by traction, and recovery took place without incident. Fracture of the coronoid process could not be recognized.

The theory of *direct displacement* backward ("glissement") formulated by Boyer, and at one time widely held, has not withstood the criticism of later writers and is no longer accepted in explanation of dislocations caused by falls. A case reported by Weber nearly fifty years ago, and much quoted since, is an example of production in this manner, but not in a fall: a young man, wishing to show his strength, held his arm extended while another tried to bend it; the latter not succeeding, struck the front of the upper part of the forearm violently with his fist, at the same time pressing the wrist forward, and caused a dislocation which could not be reduced. In like manner, the dislocation can be produced by a blow upon the back of the arm just above the elbow, as in a case quoted by Malgaigne from Flaubert, in which the patient's arm was caught under an overturned wagon, and in another seen by Hamilton. A similar mechanism has also been observed in outward dislocation.

The theory of *torsion* presented by Malgaigne, according to which the patient in his fall strikes upon the inner side of the slightly flexed forearm and the elbow, the limb being somewhat abducted, is perhaps true of some cases. Malgaigne's explanation is very brief; he simply says the dislocation is effected by "a movement of torsion which brings the coronoid process successively inward, downward, and backward." Pingaud (loc. cit., p. 601) describes it in detail. He says that "at the moment the inner and posterior part of the elbow strikes the ground the humerus, under the influence of the weight of the body, tilts outward, and the ulna, pressed against the ground, turns in the opposite direction (pronation). From this result: 1st, rupture of the internal lateral ligament; 2d, separation of the articular surfaces on the inner side; 3d, a torsion inward of the forearm about its axis." The details of this torsion into which he enters are far from clear, but the outcome is that, the bones being sepa-

[1] Stetter: Compendium der Lehre von den Luxationen, 1886, p. 43.

rated on the inner side, the coronoid process slips back behind the trochlea, or the latter turns forward over the former, and then as the limb untwists itself the radius also passes behind the humerus. He adds that the latter part of the process is open to modifications which result in a great variety of displacements. However obscure the explanation may be, and it suggests an origin in speculation rather than in observation, the fact remains that in a few well-authenticated cases the violence has certainly been received upon the upper and inner part of the forearm and not upon the palm of the hand. Pingaud (loc. cit., p. 496) quotes three such: a rider falling with his horse and dislocating his elbow while the hand still held the bridle; a man falling in the gymnasium with his forearm bent behind his back; another falling backward and rolling upon his side while his hand held his cloak together in front of his chest.

Hyperextension.—It is now generally believed that the injury is habitually caused by a fall upon the palm of the outstretched hand, the elbow being in complete extension, and that the primary rupture of the ligaments which makes the dislocation possible is effected by hyperextension of the joint. That this was a possible cause was known to Petit, who had seen a compound dislocation thus produced; and Desault and Bichat, anticipating in this, as in so many other things, the slower judgment of the profession, declared it to be the common mechanism, but the investigations which first satisfactorily demonstrated it were made by a young German surgeon in 1844, Roser.[1] His results were quoted and his experiments repeated and extended to other than backward dislocations by Streubel,[2] and to these two papers and the articles by Denucé and Pingaud, above mentioned, the reader is referred for details to which the needed space cannot here be given.

Experiment upon the cadaver shows that when this action, of a fall upon the outstretched hand, is imitated, the hand being supinated, the anterior portion of the internal lateral ligament becomes tense and then yields, usually at its upper insertion; then, as the movement is continued, the rupture extends along the anterior ligament, perhaps involving part of the brachialis anticus, the elbow bends inward, and if pressure is made downward upon the head of the humerus this bone passes down in front of the coronoid process and radius, and a backward dislocation is produced. A dislocation can in this way be easily produced upon the cadaver, and the temptation to infer that it correctly represents what occurs in a fall upon the hand is great. It is defective in not fully reproducing the action of the weight of the body upon the limb, and the reference of the effect solely to hyperextension is, I think, too exclusive. In the few cases in which I have been able to determine with any degree of certainty the position of the limb at the moment of the fall, it has seemed probable that the arm was abducted or thrown backward, not stretched out in front, that is, that its position was such that the hand would be more or less supinated in the effort to prevent the body from striking the ground. In this position, the normal outward deviation of the radius from the axis of the humerus is greatest, and the resistance transmitted

[1] Roser: Arch. für physiolog. Heilkünde, 1844, Heft 2, p. 185.
[2] Streubel: Prager Vierteljahrschrift, 1850, vol. i. p. 1.

through it tends to increase the angle of deviation, and subject the internal lateral ligament to a rupturing strain. If it yields, the angle is rapidly increased, and then hyperextension and rotation complete the rupture and the dislocation. The various positions which the limb may assume during the continuation of the force, and the consequent changes in its relative direction, are manifested in the various forms of dislocation which may ensue, and which are, therefore, really secondary or consecutive displacements.

If the action is arrested immediately after the first rupture of the ligament, the bones may remain in or return to their place as the limb is subsequently flexed, and the injury is then a sprain; if it is arrested when the tip of the coronoid process has barely passed under the lowest part of the trochlea, the bones may remain in that position, "incomplete dislocation;" or they may be pressed further backward and upward by the contraction of the triceps and the dislocation made complete, the tip of the coronoid process then lying in the olecranon fossa when the limb is extended.

In a case that came under my observation the dislocation was effected by hyperextension and torsion without the aid of the weight of the body to press the humerus downward. The patient, in jumping down from his wagon, steadied himself by grasping the rail of the seat, and, the height being considerable, the wrench was sufficient to dislocate the elbow.

Pathology.—The opportunities to examine recent cases of dislocation backward have been few, but the study of older ones and experiment upon the cadaver have made our knowledge of the lesions sufficiently full. The reports of the autopsies are not very detailed. Sir Astley Cooper[1] reports two of them. In one, a compound dislocation, the specimen of which is preserved in the museum of St. Thomas's Hospital, "the coronoid process of the ulna was thrown into the posterior fossa of the os humeri, and the olecranon projected on the back part of the elbow an inch and a half above its usual position; the radius was placed behind the external condyle. . . . The capsular ligament was torn through, anteriorly, to a great extent. The coronary ligament remained entire. The biceps muscle was slightly put upon the stretch, and the brachialis anticus was excessively stretched. In another case, neither the muscles about the joint nor the coronary ligament were torn, but the anterior portion of the capsular ligament was extensively lacerated."

In a specimen presented by Robert[2] to the Société de Chirurgie, the ulna was displaced upward behind the humerus, the radius did not accompany it entirely, but was only partly dislocated backward; the external lateral ligament was partly torn; the orbicular ligament was ruptured, and a piece of it was interposed in the joint. The brachial artery was ruptured. Robert deemed it a dislocation of the ulna alone, but Malgaigne and others thought it should be classed as an incomplete dislocation of both bones backward. In accordance with Robert's view

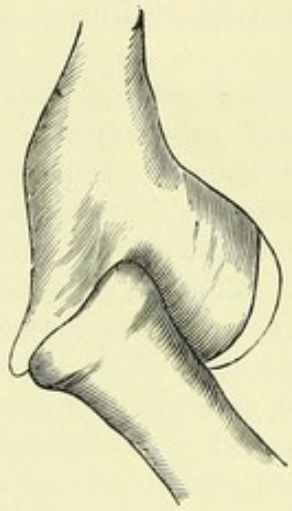
[1] Cooper: Disloc. and Fractures, Am. ed., 1844, p. 382.
[2] Robert: Gaz. des Hôpitaux, 1847, p. 272.

of it, the case will be quoted again in Chapter XX. among dislocations of the ulna alone.

In a case reported by Broca,[1] the coronoid process lay in the olecranon fossa, the anterior ligament was torn across midway between its attachments, the internal lateral ligament was ruptured, and the external lateral ligament was detached from the humerus, the annular ligament consequently remaining intact. The biceps was displaced to the outer side of the joint, the brachialis anticus wrapped around the trochlea, and torn at several points. The median nerve accompanied the muscle in its displacement, but the artery passed directly in front of the humerus without changing its direction; the ulnar nerve was much bruised.

The detachment of the external lateral ligament from the humerus, as in this case, is of much importance if the patient is young, and if the dislocation remains long unreduced. In a case of four months' standing in a girl eleven years old, which I treated by arthrotomy (*vide infra*, Chapter XXI.), the ligament had apparently been detached in this manner, and the periosteum of the posterior surface of the external condyle stripped up with it by the displaced head of the radius; a new mass of bone continuous with the back of the condyle had formed above and behind the head of the radius, making a new socket to which it was closely attached (Fig. 76). The internal epicondyle had also been torn off and displaced upward, and had reunited with the side of the humerus about half an inch above its normal position.

FIG. 76.



New formation of bone in an unreduced dislocation of the elbow backward.

This avulsion of the epitrochlea has been noticed in some other cases (see Fractures, p. 393); its occurrence is more easily explained on the theory of production of the dislocation by lateral flexion of the elbow than on that of hyperextension in which only the anterior part of the lateral ligament is at first put upon the stretch.

In an autopsy reported by Debruyn and quoted by Denucé (loc. cit., pp. 742 and 744) of dislocation backward and outward, the epitrochlea was torn off and the brachial artery ruptured.

The displacement of the bone varies greatly, both in extent and in direction. As has been said, the top of the coronoid process may rest against the lower and posterior surface of the trochlea, and the radius still remain in contact with the under surface of the capitellum by the anterior portion of its disk, or it may be entirely dislocated and rest against the posterior face of the external condyle, as in a specimen of old dislocation described by Gély,[2] and now deposited in the Musée Dupuytren. The elbow was flexed almost at a right angle and did not appear noticeably deformed. The coronoid process lay in a deep groove on the

[1] Broca: Bull. de la Soc. Anatomique, 1852, p. 26.
[2] Gély: quoted by Pingaud, loc. cit., p. 485.

posterior surface of the trochlea a little nearer its outer than its inner border. The head of the radius corresponded by its anterior border with the posterior surface of the humerus between the olecranon fossa and the epicondyle, and lay in a hollow formed by the excavation of the back of the external condyle. The situation of the head of the radius at a higher level than the coronoid process shows that the forearm had been rotated about its long axis in the direction of pronation; in addition the wrist was deviated to the outer side.

When the ulna is more and the radius less displaced the deviation of the wrist is to the inner side; and when both bones are completely displaced backward deviation of the wrist to either side will incline their upper ends to the opposite side, and thus bring them nearer to the internal or the external epicondyle respectively.

If, in the production of the dislocation, the lateral outward flexion is more marked than the hyperextension, the capitellum slips along the head of the radius to its inner side, and the latter lodges on the outer surface of the former just below the epicondyle, while the coronoid process rests against the posterior surface of the external condyle, having been carried outward by pronation of the forearm. The posterior surface of the ulna is directed outward, and the anterior edge of the head of the radius rests against the condyle of the humerus. In addition, the long axis of the forearm is deviated to the inner or the outer side; the internal lateral ligament is freely torn. This is the dislocation *backward and outward*, classed by some with the outward, by others with the backward dislocations, and sometimes misleadingly reported as a pure outward dislocation.

In dislocations backward and inward it is inferred from experiments upon the cadaver that the coronoid process rests against the posterior surface of the epitrochlea, and the head of the radius by its edge against the inner slope of the posterior part of the trochlea. The external lateral ligament is torn away from the humerus. The dislocation, according to Pingaud, can be produced by hyperextension and supination, but only with difficulty and by associating with the movement internal lateral flexion, at least so I understand his phrase that "the effort must be directed toward the inner and posterior side of the elbow, and continued until the external ligament is entirely torn." Streubel produced it by first creating a backward dislocation, and then twisting the forearm inward.

A specimen of entirely exceptional displacement was reported by Henriet;[1] it was obtained from a cadaver in the dissecting-room, without history. The general appearance of the limb was that of a backward dislocation; the elbow was stiff and slightly flexed, the wrist slightly pronated. The head of the radius had not only passed up with the ulna behind the humerus, but had also passed upward in front of the former, and was lodged in the great sigmoid cavity between it and the back of the humerus, and articulated with the outer half of the anterior surface of the olecranon. The ulna was not displaced laterally, but only upward and backward. There was strong peripheral fibrous ankylosis; no sign

[1] Henriet: Bull. de la Soc. Anatomique, 1879, vol. 54, p. 26.

of old fracture. The only change in the shape of the bones was a slight secondary accommodative one in the head of the radius.

Complications.—Fractures of the olecranon, the coronoid process, the head, shaft, and lower extremity of the radius, and the epitrochlea have been observed in connection with dislocation backward. *Fracture of the olecranon* is effected, presumably, by the pressure of its tip against the back of the humerus when the posterior part of the lateral ligaments proves stronger than the bone, and a fracture is produced with angular deformity and crushing of the posterior portion of the bone at the seat of fracture. Malgaigne represents such a case in his *Atlas*, Plate XX., figure 2, in which union has taken place with preservation of the angular displacement. He classifies this case as an incomplete dislocation forward of both bones, but in estimating his opinion it must be remembered that he thought almost all dislocations backward were produced by falls upon the elbow, and that he did not accept the theory of production by hyperextension. In a case reported by W. H. Daly[1] of fracture of the olecranon, and probably of the coronoid process also, the coexistence of a Colles's fracture at the wrist showed plainly that the injury was produced by a fall upon the extended hand. In this case, also, there was union with angular displacement, but the direction of the angle is not stated.

Fracture of the coronoid process, not unfrequently diagnosticated clinically, has been demonstrated by a number of specimens. It is probably produced in a dislocation when the momentum of the fall is sufficient to force the humerus downward before the hyperextension has quite carried the tip of the coronoid process past the trochlea; and Lotzbeck's experiments indicate that it can also be caused, when the elbow is slightly flexed, by the direct impulsion of the lower end of the humerus in a direction parallel to that of the long axis of the forearm. Whether or not it has ever been so produced upon the living individual is not known. As the brachialis anticus is attached, not to the tip of the process, but to its anterior face and the adjoining surface of the ulna, the displacement is usually slight. The symptoms, diagnosis, and other details have been described in Fractures, p. 427.

Partial fracture of the head of the radius has been observed in a number of cases, often associated with fracture of the coronoid process. It has been described, with illustrative cases, in Fractures, p. 431. The portion broken off is the anterior or inner third, and the fracture is effected by the direct pressure of the condyle brought to bear upon the periphery of the disk by the displacement backward of the latter.

One case of fracture of the *shaft of the radius* and three of fracture of its *lower end*, Colles's fracture, complicating backward dislocation of the elbow, are reported in a thesis by Dupuy (Thèse de Paris, 1882, No. 151).

The dislocation may be made *compound* by the projection of the trochlea through the skin in the fold of the elbow, and the brachial artery, and perhaps even the median nerve, may be ruptured. In a case reported by Ledderhose,[2] in which the dislocation was made compound by a trans-

[1] Daly: Philadelphia Med. and Surg. Reporter, 1880, vol. 43, p. 71.

[2] Ledderhose: Deutsche Zeitschrift für Chirurgie, vol. 25, p. 238, abst. in Ctlblatt für Chir., 1887, p. 732.

verse wound in the fold of the elbow, the musculo-spiral nerve was torn. Five months later the nerve was successfully reunited by suture.

In another, reported by Ferret, the median nerve, exposed for more than three inches in the wound and tightly stretched, sloughed away. (See page 37.)

Symptoms.—The elbow is usually flexed at an angle about midway between complete extension and flexion at a right angle, but it may be completely extended, or even hyperextended, as in a case reported by Morel-Lavallée,[1] or semiflexed. The limb is shortened, by an inch or more, and if viewed from behind the shortening appears to be in the arm, because of the elevation of the olecranon, but if viewed from in front in the forearm. If a few hours have passed since the injury was received, the region of the elbow is occupied by a swelling which may be so great as completely to mask the bony points and the characteristic changes in outline; but if this swelling is slight or absent the antero-posterior diameter of the joint appears increased, and the transverse diameter unchanged. The lower part of the triceps curves backward in the median line to the end of the olecranon, creating a hollow on either side, in the outer one of which may be seen a slight elevation, marking the position of the head of the radius.

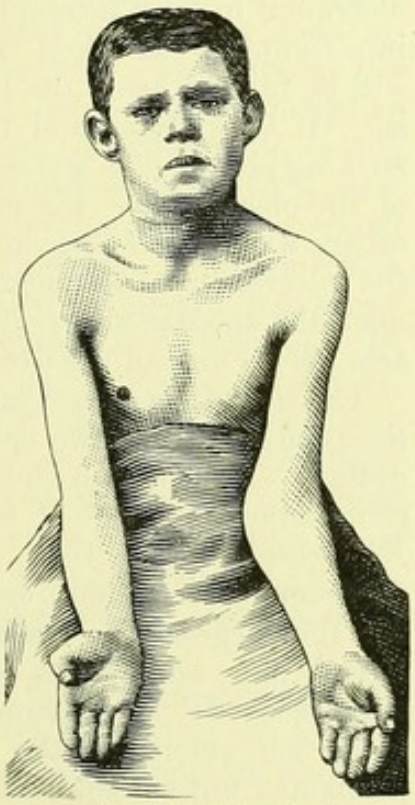
The front of the joint appears full, and the forearm just below it is broadened by the shortening of the muscles that arise from either condyle. Sometimes the outline of the trochlea can be distinctly felt or even seen, but ordinarily it is masked by the overlying muscles.

The forearm may take any attitude between pronation and supination, for, as voluntary rotation is possible, the patient places it in the most convenient attitude. The axis of the forearm may be deviated to the inner or, more frequently, I think, to the outer side (Fig. 77).

Flexion and extension are possible within variable, but always narrow, limits and painful; and when flexion is made the prominence of the olecranon behind the joint is increased. Abnormal lateral mobility of the joint exists.

If now the positions of the two epicondyles and the tuberosity of the olecranon can be recognized, it will be seen that the latter is displaced backward and upward, rising, if the limb is extended, above the horizontal line joining the epicondyles, or projecting far behind a vertical plane passing through these two points if the limb is partly flexed. This backward projection of the olecranon will be increased by flexion of the elbow, and at the same

FIG. 77.



Dislocation of the elbow backward. (From a photograph.)

[1] Morel-Lavallée, Bull. de la Soc. de Chir., 1856, vol 7, p. 9.

time it will descend; while by extension it will be moved to a higher level and brought nearer the back of the humerus.

The head of the radius can be felt, perhaps even seen, under the skin below and to the outer side of the olecranon close behind the external condyle, and can be recognized by the concavity of its upper surface and felt to move under the finger when the wrist is gently rotated.

On the inner side, if the swelling is not too great, the finger passing forward and downward from the tip of the olecranon successively recognizes the curved inner margin of the great sigmoid cavity, possibly also the coronoid process, and the back of the trochlea, and then moving around the inner side below the epitrochlea to the front may trace the sharp circular margin of the trochlea and recognize its rounded surface and groove in front.

In the so-called "incomplete" cases, those in which the tip of the coronoid process has passed only a short distance beyond the centre of the under surface of the trochlea, the weight of evidence indicates that the elbow is held more nearly at a right angle and that its extension is resisted. The description is made difficult by the fact that some authors, notably Malgaigne, make the class a large one and include in it, consequently, many cases which seem properly to belong in the main, or "complete," class. The distinction between the two would not be worth preserving were it not that reduction may be reasonably hoped for in the lesser form after a longer lapse of time than in the other. In the position of flexion of the elbow at or near a right angle, then, the end of the olecranon in an "incomplete" dislocation will not project so far as it does in a complete one when the limb is placed in the same position, and it will be further below the line of the epicondyles than its normal position is. Of the only case of the kind that von Pitha saw he says[1] it was "a striking picture of a dislocation backward, marked by unusual prominence of the olecranon;" the explanation of this feature must be that in the others with which he mentally compared it the limb was less flexed and the olecranon consequently less prominent. His diagnosis was made upon the spontaneous reduction of the dislocation by a movement of the arm before he had time to examine it.

The *diagnosis* should be made upon actual recognition by palpation of the position of the two epicondyles, the olecranon, and the head of the radius. The surgeon should never be satisfied with less than that, and if it cannot be obtained he should refuse to make a positive diagnosis. No attitude of the limb, no measurements, no apparent changes in its diameter, no considerations of abnormal mobility or fixation are sufficient, and the surgeon who trusts to them will be only too likely to add to the already too long series of limbs crippled in consequence of errors in diagnosis. If the swelling is too great to permit the bony prominences to be felt, even with the aid of anæsthesia, the examination must be postponed until it shall have subsided.

Of the different fractures that have been mentioned as complications, those of the olecranon and epitrochlea are easily recognized by manipulation; that of the coronoid process is indicated by easy recurrence of the

[1] Pitha and Billroth's Chirurgie, vol. 4, Part 2, p. 70.

dislocation after its reduction, but if the patient is etherized at the time this symptom is by no means characteristic, and furthermore, it is also present in those fractures of the internal condyle which are complicated by displacement of the fragment and dislocation of the radius backward (Fractures, p. 399). Sometimes the tip of the process can be felt as a small, hard, movable body in the fold of the elbow and in the line of the brachialis anticus. Fracture of the head of the radius can hardly be recognized unless the fragment should be so displaced that it can be felt on the outer side of the condyle.

The records of discussions over cases presented to the various learned societies show very clearly the great difficulty of making a diagnosis in cases that have remained unreduced for any length of time, especially in children in whom the injured or stripped up periosteum rapidly forms new bone which obscures the original outlines. Much of the uncertainty concerning the character and results of reported cases is due to this fact.

The *prognosis* is favorable; reduction in recent cases may be confidently expected, with complete or almost complete restoration of function. In old cases, of more than six weeks' standing, the probability of reduction is greatly diminished, although successes have been reported after three, five, and even seven months. The greater the displacement upward, the arm being only slightly flexed, the less is the probability of reduction after the lapse of some time, for the lacerated lateral ligaments have then formed new attachments at points so high on the humerus that they must be again ruptured before the ulna and radius can be brought below the end of the humerus, and in attempting to rupture them by flexing the elbow the olecranon is liable to be broken. In addition, the sigmoid cavity fills up with fibrous tissue that obliterates its articular surface and binds it to the back of the humerus. Furthermore, as the injury is most frequent in the young, whose periosteum is active to produce bone when irritated or stripped up, obstacles may thus be created which cannot safely be overcome except by arthrotomy. In some cases of unreduced dislocation the patients have in time obtained a free range of motion and a useful limb, but usually the mobility is very slight. In a discussion upon the subject in the Société de Chirurgie (*Bulletins*, 1861, p. 103), it was stated as the experience of several of the members that, in the older cases at least, it was not uncommon to fail to make complete reduction of the radius, but that nevertheless the patients recovered full use of the joint. Recurrence of the dislocation of the radius alone had also been observed. Mason[1] reported such a case in which the recurrence was thought to have taken place during the agitation accompanying the recovery from the effects of the ether.

Even after an early reduction the mobility may be diminished by the results of the arthritis, especially in the old and rheumatic, or by new formations of bone about the joint which mechanically limit its range of motion.

Compound dislocations usually do well if kept surgically clean and well drained; primary resection, in the absence of special indications, should not be done.

[1] Mason: N. Y. Medical Record, 1880, vol. 19, p. 398.

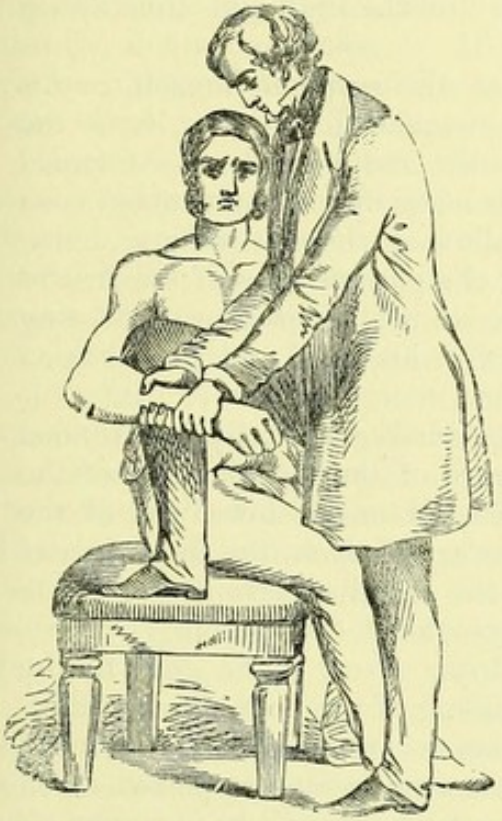
Treatment.—Much less attention has been paid in the treatment of dislocations backward of the elbow to the obstacles created by the untorn ligaments than in those of the shoulder or hip, and methods are in general and successful use that are directly opposed in character to those based upon a consideration of such obstacles and upon the principle that a dislocated bone should be returned along the route by which it has been displaced. The explanation of this success of faulty methods is to be found either in an extensive primary laceration of both lateral ligaments or in the possible overcoming of the obstacles by increasing the laceration. The easy reduction of most dislocations under ether by direct pressure in suitable directions upon the projecting ends of the bones is an indication that ligamentous obstacles of importance do not exist and that the chief opposition is furnished by the muscles spasmodically contracted on all sides of the joint, and the inference is too often drawn that, provided this opposition is overcome by force or by anæsthesia, the surgeon need not particularly concern himself with the attitude of the limb during his efforts to reduce. But the success of a faulty method should not make us unmindful of its defects; our work should be done skilfully, as well as successfully, and even if our errors will pass undetected and their consequences be promptly repaired, we should not lightly commit them.

Such a generally successful but faulty method is that in which the forearm is flexed as nearly as possible to a right angle, drawn directly away from the humerus in the direction of the long axis of the latter until the tip of the coronoid process is brought below the trochlea and then, the traction being relaxed, is moved forward and upward into place. Many different methods of effecting this manœuvre have been employed, the one commonly known as Sir Astley Cooper's, although practised in exactly the same manner long before his time, in which the surgeon's knee is placed in the bend of the elbow, being the most common. Cooper's description of it is as follows (loc. cit., p. 382): "The patient is made to sit down upon a chair, and the surgeon, placing his knee on the inner side of the elbow-joint, in the bend of the arm, takes hold of the patient's wrist, and bends the arm. At the same time he presses on the radius and ulna with his knee, so as to separate them from the os humeri, and thus the coronoid process is thrown from the posterior fossa of the humerus; and whilst this pressure is supported by the knee, the arm is to be forcibly but slowly bent, and the reduction is soon effected. It may also be accomplished by placing the arm around the post of a bed, and by forcibly bending it while it is thus confined."

The knee is thus used as the fulcrum of a lever of which the wrist is at the end of the long arm, and the olecranon at that of the short one. The resistance to be overcome is that of the muscles and of the soft parts which bind the ulna and radius to the humerus, and it must be overcome to an extent that will allow the ulna to be directly separated from the lower border of the humerus to a distance equal to the height of the coronoid process, more than half an inch (Fig. 79); the lateral ligaments, the upper fibres of the anconæus, and the stout fascia on the outer side of the elbow must all yield to this extent. That they commonly do so is a proof of the amount of the laceration and of the force employed. The method is faulty because it requires for its accomplishment a maximum of lacera-

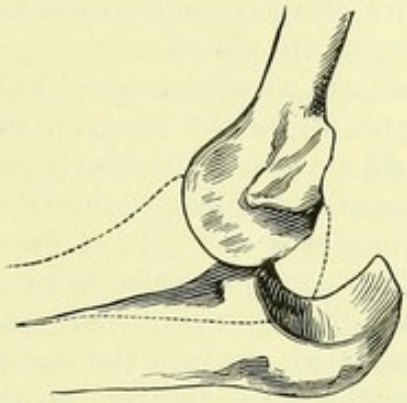
tion on both sides of the joint which may have, and probably has, been escaped in the original injury, and because it requires the simultaneous elongation of the muscles of the front and back of the arm.

FIG. 78.



Reduction of dislocation of the elbow backward. (HAMILTON.)

FIG. 79.



To show the extent of separation of the bones necessary in reduction with the elbow at a right angle. The dotted line indicates the normal position of the ulna.

It has been employed from very early times. A cut copied by Albert from Oribasius shows that it was in use as early as the fourth century in a form in which the application of the force was as direct and efficient, although more complicated, and it appears even to have been known to Hippocrates.

Forced flexion, to break up adhesions, may, however, be useful as a preliminary to reduction by more suitable methods.

The specific objection made to this method applies equally to all in which reduction is made while the elbow is flexed at a right angle, and in a less degree to those in which the joint is partly flexed. In the latter the modes of application of the force are numerous and varied: traction by pulleys, by the hand, or by a loop placed above the olecranon, and pressure by the thumbs upon the olecranon and head of the radius while the fingers are interlocked in front of the lower end of the humerus. The more extended the limb the more easily will methods of this kind succeed, but they then need to be supplemented by flexion or direct coaptation after the coronoid process has been brought sufficiently low.

A possible obstacle in the way of traction in the extended or slightly flexed position is the engagement of the tip of the coronoid process in the olecranon fossa of the humerus in such a way that its under surface rests directly against the upper posterior portion of the trochlea and prevents the ulna from moving bodily in the direction of its long axis. It can be disengaged either by hyperextending the elbow or by pressing the upper part of the forearm backward and the lower part of the arm forward. Except for this possible obstacle traction in complete extension meets the indications sufficiently and without needless increase of the

laceration, and the obstacle can be readily overcome, as has just been said, by slight hyperextension as suggested by Roser in 1844. He went further and proposed that the hyperextension should be increased so as not only to free the coronoid process from the fossa but also to bring the tip of the olecranon into it, and then, while maintaining it there by the pressure of the thumb or hand above it, to flex the limb and thus swing the bones into place.

Traction may be made by the hands of the surgeon himself, or by assistants while the surgeon watches the descent of the ulna, frees the coronoid process if necessary, and presses the radius and ulna forward into place at the proper time; or it may be made by an India-rubber cord or by fastening a weight to the wrist and allowing the arm to hang down. A unique case of reduction by traction by the patient himself was briefly reported by Verneuil:[1] the patient, alarmed at the prospect of being chloroformed, grasped the bar of the bed with his hand and pulled upon it until the bones returned to their place.

This method, traction upon the fully extended or even hyperextended forearm, followed by direct pressure forward of the upper ends of the ulna and radius and counter-pressure backward on the lower end of the humerus, or simply by flexion, corresponds as nearly to the fundamental principle of reduction as is practicable in the usual uncertainty as to the exact attitude taken by the limb at the moment of dislocation.

The pure hyperextension method of Roser seems to be open to the charge of neglect of the fact that the overriding of the bones is caused by the direct downward pressure of the humerus and should therefore be corrected by traction. It may be true that in many cases hyperextension will bring the olecranon back to its fossa, where it will be a centre of motion for the movement of flexion which brings the coronoid process under the trochlea and the head of the radius under the external condyle, but if the hyperextension necessary to effect this is in excess of that actually made at the moment of dislocation, it will be obtained in the reduction only at the price of additional laceration, and is therefore open to the same objection that was urged against the method by "distraction." The objection would lie especially, I think, in cases in which the displacement is outward as well as backward, and in which there is reason to think that the external lateral ligament is not extensively torn, cases, in a word, in which outward lateral flexion has predominated over hyperextension in producing the displacement. In such cases traction associated with gradual return of the forearm to the axial line and with rotation of the forearm or ulna to lift the tip of the coronoid past the outer edge of the trochlea would meet the indications.

In all cases of doubt or difficulty anæsthesia should be used; and, as a general rule, whenever a lateral displacement is associated with the backward one the bones should be pressed sideways into line before they are drawn downward.

When the lateral element of the displacement is very marked and it is probable that the primary dislocation was directly outward and has been followed by a consecutive displacement backward, anæsthesia should

[1] Verneuil: Bull. de la Soc. de Chir., 1861, p. 495.

not be omitted, and after full relaxation has been obtained the first attempt should be to move the olecranon and head of the radius to the radial side of the humerus, to transform the dislocation into a pure outward one. By so doing the principle of replacing the bones by the route along which they have been displaced is followed, and the risk of engaging the tendon of the biceps behind the external condyle is avoided. (See also the following section.) If the attempt, cautiously made, does not succeed, the surgeon should next seek to change the displacement into a pure backward one and reduce as before described.

If some time has elapsed since the accident, more than ten or fifteen days, it may be desirable to break up such adhesions as have formed by flexion, extension, and lateral flexion, but it must be borne in mind that forced flexion always carries the risk of fracturing the olecranon. This is sometimes intentionally done to facilitate reduction in old cases; it is of course followed by more or less loss of the power of active extension.

Fracture of the coronoid process requires no special treatment; apparently the fragment is seldom, if ever, much displaced, for it retains its connection with the capsule and, after reduction, is steadied between the lower end of the humerus and the tendon of the brachialis anticus. The special indication arising from it is to guard against a recurrence of the dislocation, which is best done by keeping the elbow flexed at or even within a right angle. A posterior moulded splint is an additional safeguard.

Fracture of the olecranon requires the special treatment proper to that injury, but as the extended position of the joint, which is most favorable for the prompt and close repair of the fracture, exposes to a partial or even complete recurrence of the dislocation it must be avoided until after the rupture of the lateral ligaments has been in great part repaired. If, in the flexed position, the olecranon is separated from the ulna it should be drawn down and held in contact by adhesive plaster, rubber cords, or metal hooks. I prefer the latter in most cases, but they are not generally acceptable to patients. The contraindications to their use are much bruising and swelling of the region, and such local or general conditions as predispose to suppuration.

Fracture of the head of the radius requires prolonged rest of the joint, with a view to reunion if the fragment remains in place. If displaced and readily accessible, as in the case reported in Fractures, page 433, it may be removed, but such removal should not, in my opinion, be undertaken until after the lapse of at least a fortnight after the accident, at a time, in other words, when the primary laceration of the soft parts has been recovered from. Possibly it might be safely left until its presence in its abnormal position has proved disadvantageous. Possibly, also, it might prove desirable in case of non-union or faulty union to remove a fragment that has remained within the joint; the only cases in which this has thus far been done have been cases of unreduced dislocation of the radius alone. If the fragment should remain on the inner side of the joint, between the radius and ulna, it would be most easily reached through an anterior incision, in making which, however, special care would have to be taken to avoid injury to the musculo-spiral nerve and its two branches, the radial and posterior interosseous.

Fracture of the epitrochlea requires that the elbow should be kept well flexed, to relax the muscles of the forearm that arise from this prominence.

If the dislocation is compound, but without laceration of the soft parts so extensive as to make amputation unavoidable, the parts must be thoroughly cleansed and replaced, efficient drainage provided through the wound and through counter-openings at the back of the joint, and the limb immobilized in a plaster splint. Some, perhaps extensive, suppuration is probable in the soft parts, but the joint is likely to escape so far as to preserve a fair amount of motion. As I write, there is in my service at Bellevue Hospital a flabby, alcoholic, elderly woman who is convalescing satisfactorily from such an injury with fair mobility of the joint. Even if the brachial artery is torn the limb may still be saved; and although the additional complication of rupture of the median nerve has been thought to make amputation necessary, I think a different view would now be taken and the attempt would be made to reunite its ends. Fortunately both complications, especially the latter, are very rare.

If the swelling and bruising are such that reduction cannot be made, or, if made, would create such tension as to endanger the vitality of the limb the end of the humerus should be excised. The results of excision of the elbow for all causes are, as a rule, very good, the worst being those in which the connection of the bone remains very loose. Ankylosis is to be preferred to a "flail-joint," particularly if the patient is a laboring man. An arm, the elbow of which is stiff, is capable of rendering much useful service.

After-treatment.—In uncomplicated cases it is necessary only to retain the limb in a sling for two or three weeks, or until such time as the dependent position does not cause pain. Passive motion, to prevent ankylosis, is not necessary and is actually harmful during the first fortnight if it causes pain. The limb may safely be immobilized until the injury to the capsule and ligaments has been repaired. It will be more or less stiff when first taken out of the dressings, but complete restoration of its functions may be confidently expected under daily use. Exceptions to this complete recovery are sometimes found in the old and rheumatic, in complicated cases, and in the young if the periosteum has been extensively stripped up. In the first class, the old and rheumatic, gentle passive motion strictly confined within the limits beyond which persistent pain and tenderness are caused, may be of service to diminish the subsequent stiffness and hasten its disappearance, and in all it may be useful to change every day or two the angle at which the limb is immobilized.

Lateral Dislocations of the Forearm.

Both bones of the forearm may be together dislocated to the inner or to the outer side, and the dislocation may be complete or incomplete. In the incomplete form, in the sense in which the term has been generally, and will here be, used, one of the two bones still remains below or in front of the lower end of the humerus, although it may have entirely left its own corresponding articular surface; thus, in the incomplete outward dislocation the sigmoid cavity of the ulna lies below and embraces the external condyle, and its inner slope may still correspond to the outer

part of the trochlea or may have passed entirely to its outer side. In the complete outward dislocation, on the other hand, the sigmoid cavity of the ulna is turned toward (pronation) and embraces the outer side of the external condyle or the supinator ridge, and the head of the radius lies nearer the median line in front of the humerus. Much confusion has arisen from the use of the terms outward and inward dislocation to include also the outward and backward and the inward and backward respectively, both in text-books and in the reports of cases in the journals. The terms will be here restricted to those cases in which the primary dislocation is directly outward or inward, the coronoid process remaining in front of, and the olecranon behind, the transverse longitudinal plane of the humerus. In some cases of outward and backward dislocation the question may arise whether the position in which the bones are found is not the result of a consecutive displacement following a primary outward displacement. I believe such consecutive displacements to be very rare, and that the great majority of backward and outward dislocations belong, by their essential features, among the backward ones with which I have above described them.

In a dislocation backward and inward this question does not arise, for a complete inward dislocation has never yet been reported; but the confusion is, nevertheless, equally great, for the epithet "backward and inward" has been indiscriminately applied to all displacements toward the inner side, including, as Trélat pointed out, three distinct varieties: 1st, dislocations of both bones inward; 2d, dislocations of both bones backward and inward, and 3d, dislocations backward of the ulna alone.

Incomplete Lateral Dislocations.

Doubtless it must be attributed to this confusion in the use of terms that the frequency of incomplete dislocations to the outer or the inner side passed unnoticed until 1863, when a German surgeon, Hahn, who had practised for more than forty years at Stuttgard, published a paper[1] upon the subject in which he stated he had treated 21 cases of this injury in thirty years, nearly as many as those of dislocation backward observed during the same period; of these, 18 were in children, 3 in adults; 12 of the former and 2 of the latter were in males, and in all but one the dislocation was inward. The statement, which was supported in many points by the observations of the reviewer of the paper, Streubel, at once attracted attention and has been confirmed and accepted by subsequent writers; the principal contributions to the subject have been made by Hueter,[2] Nicoladoni,[3] and Sprengel.[4] Hueter described 6 specimens of outward dislocation obtained by resection and 3 cases observed clinically; Nicoladoni found 4 incomplete outward dislocations in 16 dislocations of the elbow observed in four and a half years; and Sprengel reported that the records of the Halle clinic for the years 1873–1879 contained 32 cases, of which 20 were inward and 12 outward. An important feature

[1] Hahn: Schmidt's Jahrbuch, vol. 119, p. 74, and vol. 120, p. 88.
[2] Hueter: Arch. für klin. Chirurgie, 1867, vol. 8, p. 153, and vol. 9, p. 935.
[3] Nicoladoni: Wiener med. Wochenschrift, 1876, pp. 570, 599, 640, and 670.
[4] Sprengel: Centralblatt für Chir., 1880, p. 129.

of the last communication is that 15 of the 32 (11 inward, 4 outward) were old cases and in only 1 of them could reduction be obtained. Although it is not so stated, it is probable that in many of them an error in diagnosis had been committed; Hahn says the injury is frequently mistaken for fracture of the lower end of the humerus. In a case seven months old reported by Sprengel the injury had been pronounced by a well-known London surgeon, who gave the patient a written opinion, an intercondyloid fracture of the humerus, and he added that there was no trace of the dislocation said to have existed; Sprengel excised the joint and demonstrated the dislocation. In view of these facts, of the possible errors in diagnosis, of the frequency of the injury in children, it has seemed best to treat of the two varieties under a single head, as incomplete lateral dislocations.

The cause is usually a fall upon the outstretched hand; exceptional causes are falls upon the inner side of the elbow and blows received upon the forearm. The interlocking of the central ridge of the sigmoid cavity in the groove of the trochlea is such that direct lateral displacement without preliminary separation of the articular surfaces, or without their fracture, is impossible, and it is highly probable that the dislocation is produced by lateral flexion outward of the completely extended forearm, or possibly by its equivalent pronation when partly flexed—that is, the ulna is moved downward (in the prolongation of the transverse longitudinal plane of the humerus) and outward, turning upon the humero-radial articulation as a centre, and thus the internal lateral ligament is ruptured. The joint is thus opened upon its inner side, the sigmoid cavity and trochlea separated from each other, and only the radius and capitellum remain in contact at their outer borders. If now the capitellum slips inward along the upper surface of the radius an incomplete outward dislocation is produced; if, on the contrary, the radius slips inward along the capitellum an incomplete inward dislocation is the result. This mechanism can be reproduced upon the cadaver, but it must be admitted that the explanation is theoretical; accurate clinical observation, for reasons often above referred to, are not obtainable, and it is impossible to reproduce all the factors upon the cadaver.

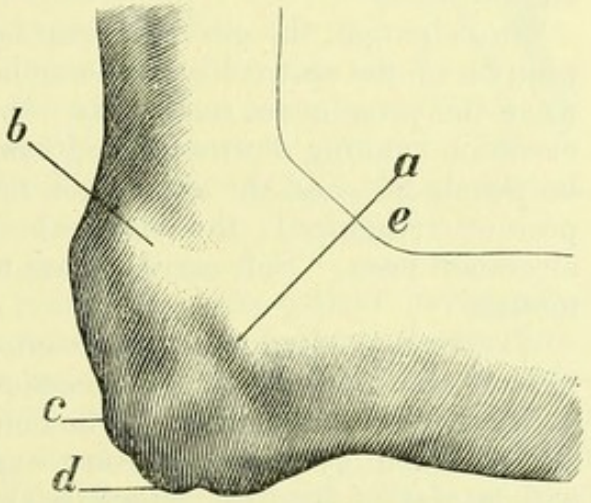
It is thought by some that the mechanism is the same in its first part as that of backward dislocation, and that, the force being less, the bones of the forearm are not displaced so far that the coronoid process clears the trochlea, but that on the cessation of the violence and the straightening of the limb the point of this process finds itself not only in front of the trochlea, but also on the outer or inner side of its outer or inner margin, against which it is so locked that on the straightening of the limb the bones are moved sideways to come into line with its new position. The theory finds some support in the results of cadaveric experimentation, in which the sigmoid cavity is sometimes found to embrace the lower end of the humerus obliquely, and also in the fact made known by Streubel, and verified by others, that the outward dislocation can be produced by hyperextension if it is accompanied by forcible supination and followed by flexion.

A. *Incomplete inward dislocations.*

Pathology.—The autopsies and direct examinations that have been reported and are available to show the new relations of the bones are few in number. There are two autopsies reported by Broca[1] and Jolivet,[2] and the case above referred to in which Sprengel excised the joint seven months after the injury was received. In the latter the head of the radius rested against the lateral part of the trochlea, and the ulna was displaced so far inward that nearly half of the sigmoid cavity projected free beyond the trochlea; upon this free part, and united with it, lay the fractured tip of the epitrochlea. There was close fibrous union between the opposing articular surfaces.

Broca's case was a much older one; the specimen and a plaster cast of the limb are preserved in the Musée Dupuytren, the latter is represented in Fig. 80. It differs from the usual clinical form in the very marked displacement downward and backward of the head of the radius. The new joint permitted full flexion and almost complete extension, and the axis of the forearm was inclined downward and outward 30° from the prolongation of that of the humerus. The distance between the prominences formed by the tip of the olecranon and the head of the radius was six centimetres. There remained no trace of the lateral and annular ligaments; a fibrous capsule of new formation connected the bones with one another. Broca says there was no sign of former fracture, but Denucé (loc. cit., p. 765), who appears to have examined the specimen, says the external condyle appears to have been broken off and displaced forward. The sigmoid cavity embraces the epitrochlea, and forms a new articulation with it; the radius lies below the inner part of the trochlea and projects notably behind it.

FIG. 80.



Old incomplete dislocation inward; Broca's case. *a*, epitrochlea; *c b*, olecranon; *d*, head of radius. (DENUCÉ.)

Jolivet's specimen was obtained by amputation eighteen months after the injury. The patient was a man thirty-six years old, and the dislocation was caused by a mine explosion. The elbow was flexed, the forearm semipronated, and there was very slight mobility. The olecranon, displaced inward, embraced the epitrochlea by its sigmoid cavity and even projected a little beyond its inner side. The olecranon fossa was empty; the anterior and inner part of the head of the radius rested upon the outer articular half of the trochlea, the sharp inner border of the latter lying like a wedge between the radius and ulna. The coronoid process

[1] Broca: Bull. de la Soc. Anatomique, 1849, p. 272.
[2] Jolivet: Bull. de la Soc. Anatomique, 1865, p. 184.

lay in a new groove formed at the expense of the epitrochlea and the adjoining side of the trochlea. The posterior edge of the head of the radius could be felt as a prominence at the back of the joint.

Both lateral ligaments are necessarily torn, and probably the anterior one likewise; the annular ligament may perhaps resist, though it must at least be put upon the stretch by the interposition of the inner anterior edge of the trochlea between the head of the radius and the coronoid process. The clinical features indicate that the head of the radius lies rather below than directly in front of the trochlea, even in flexion of the elbow at a right angle.

Symptoms.—The elbow is slightly flexed, less so, Hahn says, than is common in backward dislocations, and is pronated. The axis of the forearm is parallel with that of the arm and a little to its inner side. The prominence of the epitrochlea is lost, that of the outer epicondyle increased; the diameters of the elbow do not seem to be increased, nor the limb to be shortened. Flexion and extension are quite free, and painless within certain limits.

On palpation, the olecranon can be recognized immediately behind the position of the epitrochlea and extending so far to the inner side as to mask this prominence completely; the triceps shows as a rather prominent elevation running downward and inward. The external epicondyle can be plainly felt, and the absence of the head of the radius from its normal position recognized; the latter can sometimes be felt below the empty olecranon fossa. Soft cartilaginous crepitation is felt on making passive motion.

Treatment.—Reduction in recent cases appears to be easy by traction in the extended position and direct pressure upon the side of the ulna. Theoretically, outward lateral flexion combined with moderate traction and followed by direct pressure ought to effect reduction readily and without risk of fracture, especially if anæsthesia is employed.

Sprengel's statistics, quoted above, indicate that reduction is very difficult in old cases; out of 11 only 1 was reduced, but the length of time that had elapsed is not given except in the one case that was reduced, eight weeks. Pingaud recommends that the dislocation should be transformed into one that is backward and inward, and then reduced.

Broca's specimen and two of Sprengel's cases show that the joint, even if reduction is not made, may have a free range of motion and the limb may be useful; in his other cases Sprengel's attempts to increase the range of motion failed more or less completely.

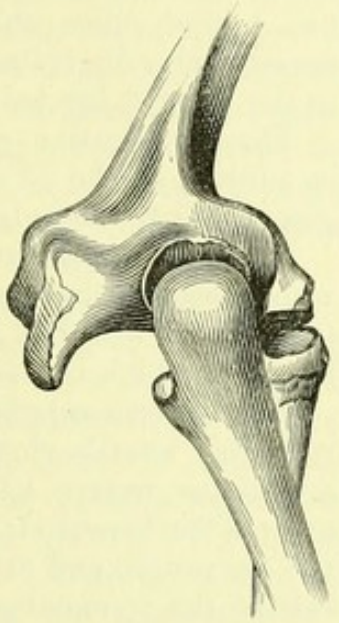
B. *Incomplete outward dislocation.*

This form, although apparently somewhat less frequent than the preceding, has been more fully studied. Its causes and mechanism have been described above.

Pathology.—Fig. 81 represents a specimen from an old case presented to the Société Anatomique by Poumet; it is described by Malgaigne, Denucé, and Pingaud as one of the only two cases known, the other, Pinel's, being very similar. The list has since been increased by the five specimens obtained by Hueter by resection, by Hutchinson's

autopsy, and by Sprengel's case in which the dislocation became compound. The last two are the only examples of the condition in the recent state of which I have knowledge, and the information furnished by the last one relates only to the position of the bones.

Fig. 81.



Incomplete outward dislocation. (Poumet.)

Sprengel's patient (loc. cit.) was a girl seven years old; the injury was caused by a fall, was supposed to be a fracture, and was treated by immobilization in a gypsum dressing. Five weeks later she came under Sprengel's observation. On removal of the dressing a slough an inch in diameter was found to have formed, and through the opening created by it the internal condyle presented. The head of the radius could be distinctly felt below the external condyle, the ulna was displaced outward so that the outer half of the sigmoid cavity embraced the capitellum; the forearm was pronated and fixed in a position midway between flexion and extension. Forcible abduction was made as a preliminary to reduction, and the opening of the slough was thereby so enlarged that the position of the bones as described was verified by direct inspection. The child made a good recovery.

Hutchinson's[1] specimen was of a recent case, the patient having died of associated injuries. The dislocation had been reduced during life; on the table it could be easily reproduced, and the bones could be dislocated to either the outer or the inner side. The sigmoid notch rested against the external condyle and the head of the radius projected beyond the latter. The lateral ligaments were completely torn, and there were several rents in the anterior one; the orbicular ligament was entire, but much stretched. Small portions of cartilage had been broken from the articular surfaces of all three bones.

Poumet's specimen (Fig. 81) is thus described by Pingaud (loc. cit., page 526). "The ulna, carried directly outward, has completely left the trochlea, which projects on the inner side and contains in its groove a large sesamoid bone [evidently the broken-off epitrochlea, *vide infra*]. The external articular slope of the sigmoid cavity is in relation with the capitellum, which is notably hypertrophied, as is also the epicondyle, while the trochlea and epitrochlea are atrophied. The radius, displaced outward and especially forward, is in indirect relations with the epicondyle and the remainder of the condyle, outside of which is a small sesamoid bone which completes the surface of articulation on this side. It results from these anatomical relations that the forearm is in slight flexion with rotation inward; the ligaments, especially the lateral ones, are in great part ruptured.

Hueter's six specimens all showed the same displacement, and the epitrochlea torn off and lodged in the groove of the trochlea. The same

[1] Hutchinson: Med. Times and Gazette, 1866, i. p. 410.

avulsion of the epitrochlea has been observed clinically in five other cases, Albert and von Dumreicher[1] each one, and Hueter[2] three, in two of which it prevented reduction, and in the others made reduction very difficult. In two other cases also observed clinically by Nicoladoni, in which reduction was not attempted because of the length of time that had passed since the injury was received, fourteen and five months respectively, the epitrochlea was broken off; in one it could not be found, in the other it lay below and near the sharp inner edge of the trochlea.

The complication appears to be much more common in children than in adults; of the 13 cases here quoted 7 were young, in 4 the age is not given, and 2 were adults when the joints were excised.

Nicoladoni, after experimenting upon the cadaver, reached the opinion, which seems to be correct, that this avulsion of the epitrochlea is effected through the attached flexor muscles and not through the internal lateral ligament which is inserted only upon its base.

His experiments show that the internal lateral ligament is always ruptured, usually close to its insertion at the base of the epitrochlea, but sometimes nearer to or at its attachment to the ulna. The rupture extends backward along the margin of the sigmoid cavity to the tip of the olecranon, and in front through the anterior ligament to the outer side of the coronoid process. The external lateral and the annular ligaments are untorn. The clinical cases indicate, however, that the annular ligament also is sometimes ruptured.

Symptoms.—The elbow is somewhat flexed, the angle varying in the different cases, the forearm pronated. The axis of the forearm is sometimes parallel with and external to that of the arm, sometimes adducted. The prominence of the internal condyle is increased, even if the epitrochlea is broken off, and the skin is tightly stretched over it. The transverse diameter of the elbow is increased by the projection of the muscles and the head of the radius on the outer side. Flexion and extension are painful and restricted. In the reported cases no mention is made of lateral mobility, and it seems probable that if present it is only slight.

On palpation the epitrochlea, unless broken off, is very readily felt; if it is broken off, the inner side and edge of the trochlea can be plainly traced, and the epitrochlea may perhaps be recognized as a movable body below it, or it may have been drawn past the edge of the trochlea into its groove where it cannot be felt.

On the outer side the head of the radius projects in a line with the anterior or under surface of the condyle, according as the elbow is more or less flexed. The olecranon is more prominent than normal, because it is lifted out of its fossa and lies against the back of the more prominent external condyle; it is distant from the epitrochlea about two inches. The triceps appears as a prominent cord directed downward and outward to the olecranon. The external epicondyle may be felt by pressing the finger firmly in above the head of the radius and behind the prominence formed by the extensor muscles of the hand.

[1] Nicoladoni: Loc. cit., p. 571.
[2] Hueter: Arch. für klin. Chir., vol. 9, p. 935.

According to Pingaud, the forearm is so pronated that the posterior surface of the ulna looks outward, and the head of the radius lies in front of the capitellum instead of being displaced outwardly. Such cases belong, I think, to the class of dislocations of the ulna alone.

Treatment.—The first indication of treatment is to lift the central ridge of the sigmoid cavity and the coronoid process out of the groove between the capitellum and the trochlea, or, in other words, to separate this portion of the ulna sufficiently from the under surface of the humerus to allow it to be pushed inward past the projecting outer border of the trochlea. This may be effected by hyperextension, or by outward lateral flexion if the head of the radius still rests against the under surface of the humerus so as to form a fulcrum or centre for the movement.

If hyperextension is made, the movement takes place about the tip of the olecranon as a centre, where it rests against the back of the humerus, and the coronoid process is carried downward away from the humerus as well as backward, and when the separation is sufficient direct pressure with the thumbs upon the head of the radius will force the bones into place, or rotation of the ulna inward will carry the tip of the coronoid process past the margin of the trochlea into the groove. Nicoladoni suggests that in the latter manœuvre an assistant should press with his thumb upon the back of the olecranon to prevent the production of a backward dislocation.

Outward lateral flexion should be aided by traction upon the extended or slightly flexed forearm, by which the articular surfaces will be separated as far as the untorn ligaments will permit, then pressure by the thumb upon the head of the radius, associated, of course, with counter-pressure on the inner side of the humerus, will force the inner ends of the bones back into line, and the straightening of the limb completes the reduction.

If the annular ligament is torn, its outer portion and the adjoining part of the external lateral ligament may be interposed between the radius and the humerus and oppose the return of the former; under such circumstances the ulna can still be reduced, but the lateral pressure to effect this must be made upon the olecranon instead of the radius, and then by pronating and adducting the forearm the radius is drawn past the obstacle into place. The suggestion of the existence of this obstacle and of the means by which it may be avoided rests entirely upon experiments on the cadaver. I do not know that it has ever been encountered and thus overcome in practice.

The complication of avulsion of the epitrochlea and its lodgement in the groove of the trochlea seriously increases the difficulty of reduction. As above stated, in two of the five recent cases in which it was recognized reduction failed. The reason of the failure is that the displacement of the fragment from the groove by the returning ulna is prevented by the sharply inclined inner slope of the trochlea and by the pressure of the overlying muscles and fascia. The fragment needs to be drawn downward as well as pushed inward. Albert succeeded by flexing the forearm at a right angle, and then drawing it forcibly away from the humerus in the direction of the long axis of the latter by means of a cord passed across its anterior surface close to the elbow. The same method, when

employed by von Dumreicher, failed, as did also forcible outward lateral flexion and traction, although carried so far as to threaten rupture of the skin on the inner side of the joint.

Possibly the transformation of the dislocation into the direct backward form, or backward and inward, would remove the fragment from the groove, and make reduction possible. It would involve additional laceration of the soft parts, it might even be advisable to divide the external lateral ligament subcutaneously, but those disadvantages would be less than the crippling due to an unreduced dislocation. Possibly too, it would be practicable to draw the fragment downward out of the way by a sharp hook passed through the skin.

Complete Dislocations Outward.

These dislocations, of which the first observation was reported by Dupuytren in 1807, although the form had been described by Petit nearly one hundred years before, were apparently so rare that Malgaigne could collect only ten reported cases. Of late, reports have so multiplied that, excluding irregular cases, and those of which the description is not sufficiently detailed, and those which seem more properly to belong among the dislocations backward and outward, the number of those available for study and generalization is about twenty-five.[1]

In most of the cases the mechanism of production cannot be determined, but the histories of a few are sufficiently complete to show that the cause may be a fall upon the outstretched palm or upon the elbow, or a blow received upon the inner side of the forearm. Hatry's case is a clear example of the first, the patient stumbled and fell forward upon his hand; von Pitha's patient, who fell while her hands were in her muff, is an example of the second; and Mears's patient, who was struck upon the inner and upper part of the forearm by a revolving piece of wood while the elbow was partly flexed in an effort to draw down some object from above his head, is an example of the third. The mechanism in a fall upon the hand is doubtless the same as that in incomplete dislocation

[1] The bibliography, excluding doubtful cases is as follows: Dupuytren, Leçons orales, vol. 1, p. 131; Bouley, Bull. de la Soc. Anatomique, 1837, p. 101; Nélaton, Pathol. chirurgicale, vol. 2, p. 391; Neilson, Lancet, 1844, ii. p. 559; Robert, Gaz. des Hôpitaux, 1849, p. 180; Soulé, Gaz. Médicale, 1849, p. 717; Verneuil and Triquet, Gaz. Médicale, 1851 [?]; Piogey and Dubrueil, Gaz. des Hôpitaux, 1851, p. 30; Denucé, Thèse de Paris, 1853; Flaubert, idem; Puech, Gaz. des Hôpitaux, 1859, p. 434; Sistach, Bull. de la Soc. de Chirurgie, 1866, p 520; Varick, N. Y. Med. Record, 1867, vol. 2, p. 387; Andrews, idem, 1875, p. 720; Von Pitha, Pitha and Billroth's Chirurgie, vol. 4, abt. 2, B, p. 71, 4 cases; Hatry, Lyon Médical, 1876, vol. 18, p. 13; Wylie, in Hamilton's Fracts. and Dis., p. 698; Bertin, Union Méd., 1876, p. 609; Osborne, N. Y. Hosp. Gaz., 1879, p. 613; Mason, N. Y. Med. Record, 1880, vol. 17, p. 397, 2 cases; Towne, idem, p. 525; Ekwurzel, Phil. Med. and Surg. Reporter, 1881, vol. 45, p. 38; Mears, Phil. Med. Times, 1880–1, vol. 11, p. 89; Johnson, Trans. Mo. State Med. Assoc., 1880, p. 33; Battiscombe, Lancet, 1886, ii. p. 397. I have not been able to verify the reference for Dupuytren's and Verneuil's cases. The Gazette Médicale for 1851 does not contain the latter; in the Gazette des Hôpitaux, 1851, pp. 93 and 201, is an article by Verneuil and Triquet which contains a case of *incomplete* outward dislocation.

outward produced in the same manner—that is, outward lateral flexion is produced; the internal lateral ligament is ruptured, and then the bones are displaced laterally past one another by the continued action of the weight of the body. In one of von Pitha's cases this lateral flexion was observed by the mother of the patient, a boy, six years old, who saw the elbow bend as he fell from a tree upon his outstretched hand.

Pathology.—The only recorded autopsy is the one reported by Bouley, a compound dislocation with fracture of the external condyle produced by a fall upon the elbow from a height of twenty-eight feet; amputation was refused, and the patient died on the twenty-fifth day. The lateral ligaments of the elbow were entirely ruptured; both bones of the forearm were placed externally to the lower extremity of the humerus, and the ulnar nerve was lacerated at the level of the trochlea. Our knowledge of the pathology of the dislocation is mainly derived, therefore, from experiment and from clinical observation. Disregarding one or two exceptional forms, the cases may be grouped in three classes according to the character of the displacement, but in some the account is not sufficiently complete to determine to which class the case should belong.

In one, apparently the least frequent, the displacement is directly outward and a little upward, so that the inner edge of the sigmoid cavity rests against the outer surface of the external condyle, the elbow being partly flexed, with the olecranon behind and the coronoid process in front of the epicondyle. The radius preserves its relations with the ulna and is situated still further to the outer side, or is carried to a somewhat higher level by pronation of the forearm. This involves complete rupture of the lateral and anterior ligaments. In Neilson's case it was thought the external condyle was broken; the olecranon was three inches above its usual position.

In the second class the forearm is pronated as well as flexed, and this pronation is effected by rotation about the long axis of the ulna, so that the head of the radius lies above, or is even carried to the inner side of the ulna. The great sigmoid cavity embraces the outer surface of the external condyle, the tip of the olecranon lying behind the condyle and that of the coronoid process in front of it. The anterior surface of the ulna looks inward. The head of the radius lies above its normal position, in front of the humerus, and possibly still in contact with the upper part of the articular surface of the capitellum. Study of the skeleton indicates that this form can be easily produced from an incomplete outward dislocation by pronation of the limb; it is, I think, the most common of the three classes, and it seems possible that the external lateral ligament may be preserved untorn. Denucé has given it the name of *sub-epicondylar*, in distinction from the following, third, class, which he terms *supra-epicondylar*. He thinks the distinction is an important one and that the difference depends upon the rupture or the integrity of the attachment of the muscles upon the epicondyle.

In the third class the ulna and radius, pronated and flexed, are carried higher up along the outer border of the humerus, two inches in Osborne's case. The sigmoid cavity may embrace the supinator ridge, and the radius still lie in front of the humerus, or both bones may be displaced

also backward so that the coronoid process and the articular surface of the radius are posterior to the ridge.

It is noteworthy that in none of the cases is fracture of the epitrochlea mentioned; in one or two it is said that the epitrochlear muscles were torn away at their insertion.

Two cases, in which an additional consecutive displacement had followed by which both bones were brought around in front of the humerus and pronated so far that their posterior surfaces were directed forward, were reported by Cloquet (quoted by Malgaigne, loc. cit., p. 616) and Maisonneuve.[1] The latter's patient was a woman who had fallen out of bed upon her elbow, and who was so thin that the position of the bones could be accurately determined; the lower end of the humerus projected prominently behind and was there covered only by the skin, while the triceps ran forward and outward over the epicondyle. The ulna was completely turned around so that its posterior surface looked forward and the sigmoid cavity lay against the front of the trochlea. The head of the radius could not be felt. The limb was slightly flexed and greatly pronated. Reduction was effected by moving the olecranon outward and backward around the external condyle to the back of the humerus, and then reducing in the usual manner the backward dislocation thus produced.

A case of Velpeau's, briefly reported in the *Bulletin de Thérapeutique*, 1848, vol. 35, p. 128, as a forward dislocation and quoted by several authors, is an incomplete dislocation inward. The above-mentioned report is apparently unofficial and is full of errors and contradictions. The case is reported in detail by Verneuil and Triquet, *Gazette des Hôpitaux*, 1851, p. 94; it is that of a woman, twenty-two years old, who had been run over by a wagon.

Symptoms.—Of the first variety, dislocation directly outward without rotation of the forearm, Puech's case may be taken as a type. The patient was a man forty-one years old, and the injury was caused by a fall from a height of about two feet, the elbow striking against some stones. The forearm was extended and supinated; it could be passively flexed nearly to a right angle but could not be pronated; its axis lay entirely to the outside of the humerus, and the transverse diameter of the elbow was nearly doubled. Tracing the bones with the finger behind, from the epitrochlea outward, the surgeon recognized all the points of the lower end of the humerus, then the olecranon well above and to the outer side of the condyle, and then the head of the radius lower than the olecranon but still above the lower line of the humerus. In other similar cases extreme mobility of the joint is mentioned; as if the two segments of the limb were very loosely attached to each other.

In the second variety, "*sub-epicondylar*," the axis of the forearm appears generally to be inclined downward and inward (adduction); flexion at, or even within (Pitha), a right angle is common; semi-, or full, pronation. The transverse diameter of the elbow is increased, but not so much as in the preceding variety. The supinator and radial extensor muscles form a well defined prominence above and in front of the

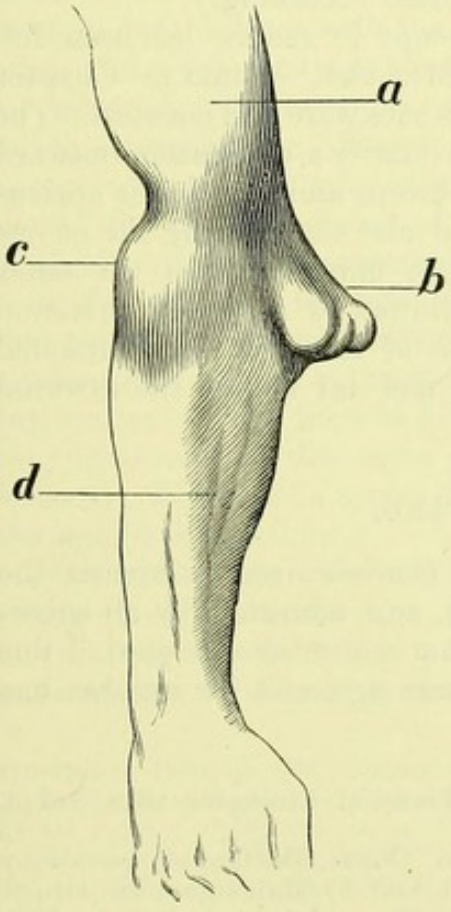
[1] Maisonneuve: Gaz. des Hôpitaux, 1867, p. 145.

joint; the tendon of the triceps shows as a prominence directed downward and outward, and the tendon of the biceps can sometimes be felt running in the same direction in front.

The outlines of the lower end of the humerus can be distinctly traced from the epitrochlea outward to the capitellum; the external epicondyle is masked by the ulna, but sometimes can be felt by pressing the finger deeply in above the latter. The cup-shaped surface of the head of the radius can be felt unless it has been carried so far inward by the pronation of the limb that it rests against the front of the humerus.

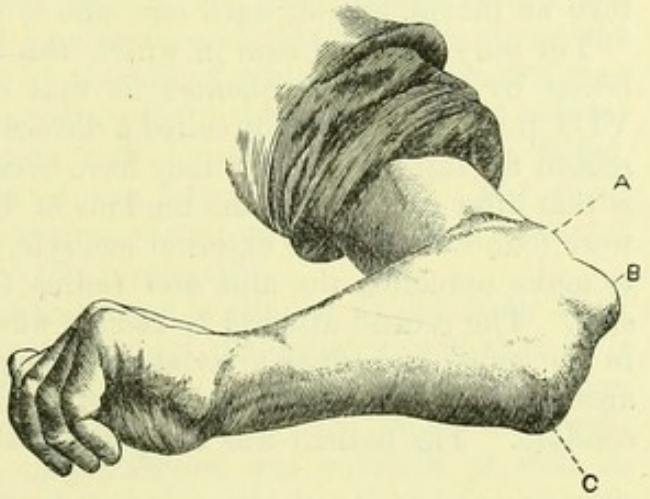
In the third variety, "*supra-epicondylar*," the forearm is flexed at, or nearly at, a right angle and pronated. The limb is shortened from one and a half to two inches, and the transverse diameter of the lower part of the arm is increased. The greater the displacement upward, the greater is the passive mobility of the limb in the plane of flexion and extension. It is noted in some cases also that the lateral mobility was marked. The lower end of the humerus is accessible to the touch even more completely than in the two preceding varieties, for it projects completely below, and even its external condyle can be traced. The deformity on the outer side varies with the extent and character of the final displacement, for the

FIG. 82.



Complete outward dislocation. (DENUCÉ.)

FIG. 83.



Complete outward dislocation of the elbow. (HAMILTON.)

bones of the forearm are sometimes carried backward, crossing the humerus, or, as in Maisonneuve's and Cloquet's cases, carried forward to the front of the humerus.

It is noteworthy that in three of the four cases in which reduction was not made the patients had good control of the limb and a free range of motion was established. Wylie's patient (Fig. 83) thought his arm was as serviceable as ever. Robert's patient was seventy years old and his injury dated from infancy; he had an extensive range of flexion and extension. In

Denucé's case (Fig. 82) the olecranon projected nearly an inch behind the humerus, the arm could be fully extended and flexed nearly to a right angle. In Nélaton's case there was flexion nearly at a right angle.

It is also noteworthy that in no case were there symptoms of interference with the circulation, and in only one case (Mears) were there symptoms of injury to the nerves. In his there was pain in the fingers and numbness in the distribution of the median nerve.

Treatment.—Reduction has been effected without difficulty in all the recent cases by extension and direct manipulation of the upper ends of the radius and ulna. The laceration of the ligaments and muscles is so great that the bones are freely movable, and special manœuvres intended to relax opposing bands are seldom necessary. Exceptions to this may be found sometimes in the first and second varieties; in the first the head of the radius may pass through and be caught, as apparently happened in Puech's case, between two muscular bundles which may then need to be relaxed by flexing and abducting the forearm; in the second, which appears sometimes, as has been said, to differ from the incomplete outward dislocations only in the addition of pronation of the forearm, the external lateral ligament remaining untorn, the first movement must be to supinate the limb and thus turn the sigmoid cavity under the capitellum and bring the head of the radius to the outer side; the dislocation is then an incomplete outward one, and is reduced accordingly.

The only reported case in which the attempt to reduce has been followed by grave consequences is that of Michaux,[1] quoted in Chapter VIII. p. 80, and generally called a dislocation backward and outward. The reason for thinking that it may have been primarily a dislocation outward is that after amputation the tendons of the biceps and brachialis anticus were found behind the external condyle, and also that during the efforts to make reduction the ulna and radius always moved toward the outer side. The second attempt to reduce was followed by arrest of pulsation in the radial and ulnar arteries and gangrene of the limb. The brachial artery and median nerve had been ruptured and lay behind the external condyle. The patient was ten years old.

Dislocations of the Forearm Forward.

Although mentioned by Hippocrates and characterized by him as the most painful of all and fatal in a few days, and admitted by all subsequent writers, the first recorded case (and that a questionable one) of this dislocation was published only a hundred years ago, and the number has now barely reached 20.[2]

[1] Reported by Debruyn, Annales de la Chir. Franç. et Etrangère, 1843, vol. 9, p. 66.

[2] The bibliography is as follows: Evers, Monin, Guyot, Wittlinger, quoted by Streubel in Prager Vierteljahrschrift, 1850, 2, p. 37, and by Malgaigne, loc. cit., p. 626; Guerre, quoted by Pingaud in Dict. Encyclopédique, 1st. ser. vol. 21, p. 708; Chapel, quoted by Malgaigne, loc. cit., p. 617, as a dislocation outward; Colson, Leva, quoted by Debruyn in Annales de la Chirurgie Française et Etrangère, 1843, vol. 9, p. 44 and 45, and by Streubel; Richet, Archives générales, 1839, vol. 6, p. 472; Prior, Lancet, 1844, ii. p. 366; Ancelon, L'Union Médicale, 1859, vol. 3, p. 394; Canton, Dublin Medical Journal, 1860, ii. p. 24; Secrestan, Gazette des

Of the 11 cases in which the age is mentioned, 1 was 6 years old, 2 were 8, 1 was 14, 2 were 15, and 1 each 18, 20, 34, 38, and 40 years old; another was an "adult." The cause in the greater number of cases appears to have been a fall upon the flexed elbow; in one (Prior) it was a blow by the handle of a crane upon the back of the elbow; in one certainly (Date), and probably in others, it was a fall upon the palm of the hand; in one (Caussin) the patient's hand was caught between two cogwheels and both bones of the forearm were broken at the middle as well as dislocated; and in one (Morel-Lavallée) the patient fell from a wagon and was run over, the wheel passing across the elbow and breaking the olecranon and coronoid process.

In 6 of the cases the olecranon was broken, and in these the mechanism of the dislocation is easily understood, for, the resistance of the olecranon being removed, the two bones can be easily displaced forward and upward along the front of the humerus by a force acting upon the back of the forearm. In the case of a fall or of a blow upon the flexed elbow the direction of the force is probably inclined somewhat away from the axis of the forearm and is more nearly parallel with the posterior portion of the articular surface of the olecranon, and it must be great enough to rupture the lateral ligaments without the aid of leverage, unless the flexion of the elbow is at the same time carried so far that the tip of the coronoid process and the anterior edge of the head of the radius are brought into contact with the anterior surface of the humerus above the joint, and a fulcrum thus created by the aid of which the ligaments may be ruptured. All attempts to reproduce the dislocation upon the cadaver by this mechanism, forced flexion and direct impulsion, have failed, except after preliminary division of the lateral ligaments. The small size of the projecting part of the olecranon and its cartilaginous character in children favor displacement by this mechanism.

In the case of a fall upon the hand there is clinical evidence to show that this form is closely allied to the lateral dislocations, and that it is produced by lateral outward flexion supplemented by sufficient torsion (supination) of the limb to bring the olecranon forward under the trochlea; in several of the cases the displacement was outward as well as forward; in Chapel's so far outward that the case has been classed with the lateral dislocations.

It has also been claimed that the dislocation may be produced by exaggerated hyperextension, bringing the upper surface of the olecranon down along the back and under surface of the trochlea, but Guérin's experiments failed to confirm this, even when the dorsal flexion was

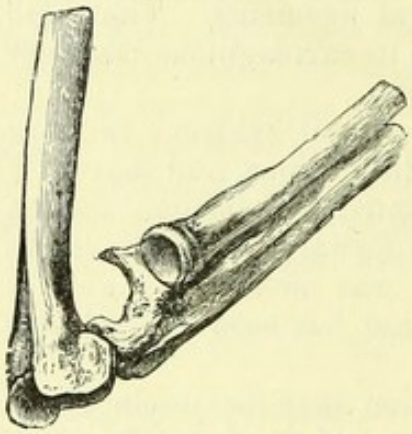
Hôpitaux, 1860, p. 598; Caussin, L'Union Médicale, 1861, vol. 11, p. 475, and Bulletins de la Société de Chirurgie, 1861, vol. 2, p. 451; Richet, Bull. de la. Soc. de Chirurgie, 1859, vol. 9, p. 110; Morel-Lavallée, Idem, p. 107; Greenaway, quoted by Hutchinson, Med. Times and Gazette, 1866, i. p. 409; Langmore, Lancet, Abstract in New York Medical Record, 1867, vol. 2, p. 10; Rigaud, Bulletins de la Société Anatomique, 1870, p. 15; Date, Lancet, 1872, ii. p. 597; Mons, Deutsche Mil. Zeitschrift, 1877, p. 401; quoted by Poinsot, loc. cit., p. 951; Krönlein, Deutsche Chirurgie, Lief. 26, p. 30 References have also been made to a case by Ferguson, Surgery, 3d. ed. p. 241, one by Roser, Chirur. Anat., 1844, p. 477, and one by Flaubert.

carried so far that the whole length of the forearm rested against the back of the arm ; he found the posterior portion of the lateral ligament remained untorn and effectually opposed the displacement forward.

Pathology.—One autopsy (Richet), three amputations (Canton, Morel-Lavallée, Rigaud), two compound fractures of the olecranon without amputation (Richet, Guerre), one compound dislocation without fracture (Prior), and experiments upon the cadaver show how great the laceration sometimes is. In Prior's case, in which the patient was struck upon the "under side of the left arm at the elbow-joint" by the rapidly revolving handle of a crane, there was a large wound at the point where the blow was received, "occasioning a general disconnexion of its parts, muscular and otherwise, excepting immediately in front." The radius and ulna were driven upward and forward on the humerus ; the condyles of the latter and its shaft for two and a half or three inches projected through the wound nearly at right angles with the forearm, as completely stripped as if cleaned with a knife. There was no fracture. Reduction was made ; the patient recovered after much suppuration in and around the joint, and the final result was good, "the limb gaining in freedom and power."

In Canton's case, the patient, a man forty years old, was thrown from a wagon ; apparently he struck upon the extended hand, but the forearm was immediately flexed and twisted under his chest. The forearm was flexed, the hand supinated, the swelling very great, and the skin tense and threatening to slough over the internal condyle. The antero-posterior and lateral diameters of the joint were increased, and the head of the radius could be indistinctly felt externally and anteriorly. The diagnosis was not made, and "attempts to correct the maladjustment" failed ; after a delay of forty-eight hours, during which the swelling increased and sloughing was established, amputation well above the condyles was resorted to.

FIG. 84.



Forward dislocation of the elbow ; Canton's case.

Examination of the limb showed (Fig. 84) that the upper surface of the olecranon rested against the front of the capitellum ; the annular and interosseous ligaments were whole, the anterior ligament was ruptured except in its centre, the posterior and both lateral ligaments ruptured. The triceps was completely detached from the olecranon. The two radial extensor muscles and all the muscles arising from the epicondyle except the supinator brevis and the anconeus were detached, as was also the epitrochlear head of the flexor carpi ulnaris. The ulnar nerve was torn behind the condyle. The other large nerves and the main vessels were uninjured.

Morel-Lavallée's patient was a man thirty-eight years old who had fallen from and been run over by a wagon, the wheel passing across the front of the elbow from the outer to the inner side. There was a compound fracture of the olecranon, and the skin was broken on each side

of the joint. There was great swelling; passive movements were very free. The olecranon remained in place; the radius and ulna were displaced forward and outward. Amputation was done on the fourteenth day. The coronoid process was found to have been broken off parallel to the anterior surface of the ulna and turned outward; it remained attached to the ulna by the soft parts. The truncated end of the ulna rested against the capitellum.

Richet's first patient was eighteen years old and had fallen from a height of forty-five feet. The forearm was slightly flexed and in supination, and was immovable; it was shortened an inch, measuring from the epicondyles to the lower ends of the radius and ulna. The olecranon was in place and movable; two inches below it was a large wound through which the lower end of this fragment projected. The head of the radius and the broken end of the ulna were recognizable in the fold of the elbow a fingerbreadth above the condyles. Reduction was easy by traction, but recurrence at once followed. The patient died three hours later. The autopsy showed the annular ligament to be intact.

In addition to these two varieties, dislocation with and without fracture of the olecranon, the difference between which is so important, there is another, based upon clinical and experimental evidence to which the name *incomplete* is given; in it the upper end of the olecranon rests against the under and anterior surface of the humerus instead of passing upward in front of it. So far as can be inferred from the reported cases it is the most common form. The use of the terms first and second degree, to distinguish between the two forms, is, I think, to be preferred to that of incomplete and complete.

In Chapel's case the additional outward dislocation, which is noted in several of the others, was so great that Malgaigne classes it with the outward dislocations. The patient was a boy fourteen years old. The radius formed a marked prominence under the skin on the outer side; on its inner side could be felt the olecranon and its sigmoid cavity, with the coronoid process in front. The two bones overrode the humerus in front about two centimetres; the epicondyle lay behind the ulna. Mons's case seems to me to be of the same kind. It is quoted by Poinsot as a unique example of divergent dislocation, ulna forward and radius outward. The description is limited to this statement and does not definitely exclude the possibility that the ulna may have been displaced outward as well as forward. This supposition seems justified by the fact that the injury was caused by direct violence upon the completely flexed elbow.

Fracture of the epitrochlea has been observed in one case, Date's, a boy fourteen years old, and this is the one in which the evidence that the dislocation was produced by external lateral flexion in a fall upon the hand is most complete. The head of the radius was prominent outside of and below the outer condyle; above it was a deep depression in which the condyle could be obscurely felt; the olecranon was below its usual position, resting with its extreme end against the trochlea (first degree, or incomplete.) The limb was semi-flexed. Reduction was easy under chloroform; the radius first, and then the ulna, going back into place

with a distinct snap. If this account of the positions of the two bones is accurate the annular ligament was probably torn.

Symptoms.—In five of the cases uncomplicated by fracture it is stated that the forearm was lengthened, more than an inch in one of them, and with this coincided a position of the limb which is mentioned in several others, namely slight or partial flexion, which could generally be changed somewhat in either direction. In one in which the range of motion is specified, Longmore, the limb was held at an angle of 130°, could be flexed to a right angle, and extended to 160°; in another, Colson, hyperextension could be made without causing pain, and during the movement the olecranon passed forward between the biceps and pronator teres.

In correspondence with this lengthening there is flattening of each side and of the back of the elbow, unless the swelling is sufficient to mask it, with prominence of the inner and sometimes of the outer condyle, and the formation of a transverse sulcus appreciable by the touch behind between the humerus and the olecranon. In one case the forearm was also abducted. In Canton's case the forearm was flexed beyond a right angle; the olecranon rested against the capitellum, and the triceps was torn completely from it. It seems probable that detachment or rupture of the triceps is a necessary condition of the passage of the olecranon to any distance along the front of the humerus, and that the existence or absence of the detachment may constitute the essential difference between the complete and incomplete forms, or the first and second degrees. The clinical features which differentiate the two forms are that in the lesser form the olecranon is prominent below the humerus when the elbow is flexed, and the forearm is lengthened when it is extended or but slightly flexed. In the second, "complete" form, the forearm is more or less shortened when extended, but is lengthened when flexed at or near a right angle, and its antero-posterior diameter is increased because of the projection of the coronoid process in the fold of the elbow. The biceps tendon can be recognized on the outer side of the latter, and beyond it the head of the radius. Posteriorly, in both forms, the olecranon fossa is empty; the direction of the ulna also plainly indicates the change in the position of its upper end unless the swelling is great.

Course and Prognosis.—In only one case, Canton, did the dislocation remain unreduced, and, as in this the diagnosis was not made because of the swelling, there is no reason to suppose that a suitable attempt to reduce would have been less successful than it proved in the others. It was also the only case, of those uncomplicated by a compound fracture of the olecranon, that did badly and in which amputation was thought to be necessary. The history of the case, moreover, suggests that the decision was reached rather hastily and on grounds that might be deemed insufficient. With this exception, there is nothing to show that an uncomplicated dislocation of this kind is more likely to be followed by grave consequences than one of another form in which the displacement is marked and the laceration notable.

Of the 7 compound dislocations, of which 6 were complicated by fracture of the olecranon, 3 recovered, 2 underwent amputation after the joint had suppurated, 1 died three hours after the accident, which was a

fall from a height of forty-eight feet, and in 1, Krönlein, the result is unknown. Of the 3 recoveries, the joint suppurated in 2, Prior, Richet's 2d, the process ending in ankylosis in one of them; in the remaining 1 the patient recovered apparently without suppuration, the fracture of the olecranon united by a fibrous band one centimetre long, and two and a half months after the accident the hand could be brought to the mouth and the elbow extended to an angle of 150°. Whether antiseptic methods will improve this poor record remains to be seen.

Treatment.—In all the cases in which the olecranon rests against the lower part of the end of the humerus, the so-called imcomplete dislocacations, reduction has been easily effected by pressing or pulling the upper end of the forearm downward and backward, or by flexing the limb against the knee or the arm of an assistant placed in the fold of the elbow. In Greenaway's case the bones slipped into place almost spontaneously when the elbow was flexed.

In the cases in which the bones are displaced further upward it is desirable to flex the limb within a right angle and then to pull the upper ends of the bones back into place by a strap passed around the front of the forearm close to the elbow.

Dislocations complicated by compound fracture of the olecranon must be treated in accordance with the general principles of treatment of compound articular fractures, of which they are a severe form, severe because of the greater extent of the laceration of the soft parts.

Divergent Dislocations of the Radius and Ulna.

The characteristic feature of this form is that the radius and ulna do not accompany each other, but are displaced in divergent directions. Two varieties have been observed: the *antero-posterior*, in which the ulna passes up behind the humerus, and the radius passes up in front, and of which there are 11 recorded cases;[1] and the *transverse*, of which there is only a single case, in which the divergence was mainly lateral, the olecranon passing to the inner side behind the epitrochlea, and the radius to the outer side.[2] Several authors make an additional variety, ulna backward, radius outward, on the basis of the case of Samuel White quoted by Cooper (*Disloc. and Fracts.* Am. Ed. page 384) which seems to me to be a dislocation of both bones backward and outward; and Poinsot makes a fourth variety of the case of Mons which I have placed among dislocations of both bones forward.

[1] Bulley, Provincial Med. and Surg. Journal, 1841, quoted in the Gazette Médicale, 1841, p. 666; Michaux, quoted by Debruyn in Annales de Chir. Française et Etrangère, 1843, vol. 9, p. 52; Mayer, Gazette des Hôpitaux, 1848, p. 232; Von Pitha, Pitha and Billroth's Chirurgie, 4th vol. 2d Abt. B. p. 78; Chevalier, Arch. Méd. Belges, Oct. 1870, quoted by Bardeleben, Chirurgie, vol. 2, p. 759; Gripat, Bull. de la Société Anatomique, 1872, p. 176; Arnozan, Bordeaux Méd. 1873, p. 402, quoted by Poinsot, loc. cit., p. 945; Tillaux, Gazette des Hôpitaux, 1877; p. 786; Minich, Lo Sperimentale, 1880, quoted by Poinsot; Mason, N. Y. Medical Record, 1880, vol. 17, p. 397; Scott, Bristol Med. Chir. Journal, March, 1886, p. 36.

[2] Guersant, reported by Warmont in Revue Médico-Chirurgicale. vol. 16, p. 303, quoted by Pingaud in Dict. Encyclopédique, art. Coude, p. 600, and by Poinsot.

A. *Antero-posterior.*—Excluding Chevalier's case, of which I have no details, the ten patients were, with one exception, Tillaux, males, and with two exceptions, adults; one was nine years old, Arnozan; another thirteen, Gripat. The cause was usually a fall from a considerable height, or with violence, as from a moving railway car, a horse, or a wagon; in one it was a fall while carrying a heavy timber, in another while wrestling; and in Tillaux's the patient, while lighting a match, struck her elbow against a piece of furniture behind her; the pain was so great that she fainted and fell to the floor, where she was found with her elbow abducted and flexed. Scott's patient was thrown from a horse, striking upon his head and hands; he found his elbow dislocated and the forearm partly flexed; a bystander pulled it straight, and he felt something give way in the joint, and a bone appeared to slip forward; possibly a dislocation of the ulna alone backward was thereby transformed into the divergent one which was afterward recognized. Von Pitha's patient fell head foremost from the second story of a building upon a pile of planks between which the extended forearm was caught and held while the body was violently precipitated backward.

Pingaud (loc. cit., p. 598), experimenting upon the cadaver, found it easy to produce the dislocation by forced pronation of the forearm after division of the internal lateral ligament; this fact, taken in connection with the fall upon the hand noted in several of the cases, indicates that the mechanism, in these cases at least, is a lateral outward flexion, by which the internal lateral ligament is ruptured, followed or accompanied by forcible pronation, and then by the direct movement downward of the humerus between the two bones. Fracture of the epitrochlea observed in one case, Arnozan, supports the theory of outward lateral flexion. In two cases, von Pitha, Gripat, the coronoid process was broken; in both the fall was from a considerable height.

The explanation of the mechanism in the two cases in which the injury was attributed to a fall upon the abducted and flexed elbow, Michaux and Tillaux, shares in the difficulty which attaches to the explanation of dislocation of both bones backward by the same cause. If the alleged rotation of the ulna backward and outward around the radius, by which the internal lateral ligament is torn, is accepted, it will not be difficult to conceive that the radius may remain in front; but even this leaves unexplained the forcible descent of the humerus between the two bones which requires the rupture of the annular and interosseous ligaments.

Pathology.—Two of the patients, von Pitha, Gripat, died of the associated injuries, but the displacement at the elbow was much greater than that observed in the other cases.

In von Pitha's the limb was shortened about three inches, and very much enlarged at the elbow. The olecranon and radius were easily recognized behind and in front of the humerus respectively, and were reduced by slight traction, but the reduction had no permanence. The skin was unbroken. The autopsy showed a wide separation of the radius and ulna from each other, complete rupture of the capsule, and of the annular, interosseous, and both lateral ligaments, fracture of the coronoid process, and avulsion of the biceps and brachialis anticus.

In Gripat's case, a boy thirteen years old, the coronoid process had been broken off and the olecranon had passed almost directly upward, remaining close to the posterior surface of the humerus; the radius was displaced forward and outward. The internal lateral ligament had been torn away at both its insertions; the external one remained attached at its upper insertion, and to the broken coronoid process, and part of the anterior ligament. The annular ligament was torn away at its posterior attachment to the ulna.

Symptoms.—The attitude of the limb is noted in seven cases; in five it was slightly flexed, in two nearly straight; in one case supinated, in the others midway between pronation and supination, or slightly pronated. The general appearance of the region probably resembles that of dislocation of both bones backward, for in three of the cases the anterior position of the radius was not noticed until after the ulna had been reduced. Excluding the two fatal cases, the displacement of the ulna upward is still very marked; four centimetres in Tillaux's case, two or three finger-breadths in Michaux's, and one and a half inches above the condyles in Scott's; in Tillaux's it was also displaced somewhat to the inner side. In three cases the position of the radius is exactly noted; in two, Bulley, Tillaux, it was in the coronoid fosssa; in one, Mason, it rested on the outer portion of the humerus.

Active movements, both flexion and rotation, are impossible, and passive movements restricted and painful.

In two cases, Mayer, Tillaux, reduction failed, the attempt being made on the fourteenth and eighth days respectively. In both the joint remained quite stiff. In Mason's the attempt was made on the nineteenth day; prolonged efforts under ether brought the ulna into place, but the radius slipped toward the outer side and could not be entirely reduced. The final result is not known. In the others reduction was effected without much difficulty, usually the ulna first, then the radius, but in Bulley's the radius remained a little forward, and was finally reduced by continuous pressure upon it.

Treatment.—Traction should be made in the direction of the axis of the forearm to bring the ulna into place, and in case of need it might be well to combine it with some outward lateral flexion to avoid the opposition of the external lateral ligament; after the ulna is reduced the radius should be pressed back into place with the thumbs aided by pronation and adduction of the forearm. It is quite likely that the return of the radius to its place may be impeded by the interposition of the annular ligament.

B. *Transverse*—Of this variety there is, as above stated, only one recorded case, Guersant's. It is as follows: The patient was a boy fifteen years old, who fell from a tree, three or four metres, on his left side, striking on the palm of his hand. The elbow was enormously swollen; its transverse diameter was greatly increased, and the antero-posterior one seemed lessened. The head of the radius formed a considerable prominence entirely to the outer side of the epiphysis of the humerus and a little upward along its outer border. It was so far displaced outward that there seemed to be an interval betweeen it and the epicondyle; the skin was very tightly stretched over it.

The olecranon was displaced inward behind the epitrochlea, which it embraced in its sigmoid cavity. In the great space between the olecranon and radius lay almost the entire articular surface of the humerus.

The forearm was semi-flexed, and in a position midway between pronation and supination; voluntary movements were impossible, passive movements very restricted. There was also a fracture of the forearm three centimetres from the wrist.

CHAPTER XX.

DISLOCATIONS AT THE ELBOW.—(*Continued.*)

ISOLATED DISLOCATIONS OF THE ULNA AND RADIUS.

Dislocations of the Ulna alone.

Sédillot, in a paper presented to the Académie des Sciences in 1837, was the first of modern writers to call attention to this class of dislocations, although Sir Astley Cooper had previously described as of this kind a specimen preserved at St. Thomas's Hospital. Malgaigne and other surgeons and writers have strenuously opposed the interpretation of cases cited in support of the claim that the occurrence of this form is possible, and have denied the possibility on anatomical grounds, claiming that the ulna cannot be displaced backward and upward unaccompanied by the radius, except after rupture of the interosseous ligament and those uniting the lower ends of the bones, of which there is no clinical evidence. The specimen figured and described by Cooper is claimed by them to be one of dislocation backward of both bones, and one presented by Robert to the Société de Chirurgie, in 1847, was declared by Malgaigne to be of the same character. Malgaigne admits, however, on the authority of a case observed by himself, the possible dislocation of the ulna alone backward and to the outer side behind the radius. The dispute is in part one of terms; it must be admitted, I think, that the head of the radius in some of the reported cases has changed its relations with the capitellum, but the change is a very slight one, a simple slipping backward or forward for a distance of a few millimetres, without a change in its level corresponding to that of the ulna. The erroneous belief in the impossibility of the occurrence without the extensive lacerations mentioned arose apparently from a failure to consider the effect of a change in the relation of the axes of the arm and forearm, for while the occurrence of an isolated dislocation of the ulna backward and upward might be impossible while those relations remained unchanged, yet if, the joint being extended, the forearm is adducted, turning upon the head of the radius as a centre, the olecranon must necessarily move upward behind the humerus; or, the joint being flexed at a right angle, the same movement of adduction or the equivalent outward rotation of the humerus will displace the olecranon backward.

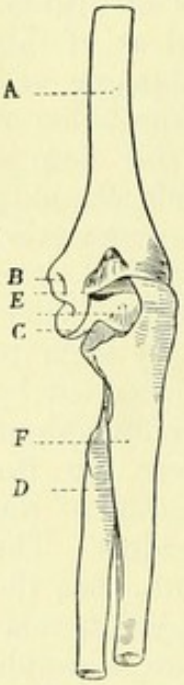
The following recorded cases serve as the basis of the description to be given. Some in which the correctness of the diagnosis is in doubt, or of which I have not been able to consult the detailed reports, have been omitted.

Cooper, *Dislocations and Fractures*, Amer. Ed., 1844, p. 390; Boudant, *Revue Médicale*, 1830, vol. 1, p. 75, quoted in full by Sédillot;

Sédillot, *Gazette Médicale*, 1839, vol. 7, p. 369; Diday, *Idem*, p. 393; Brun (three cases), *Idem*, 1844, p. 580; Robert, *Gazette des Hôpitaux*, 1847, p. 272; von Pitha, Pitha and Billroth's *Chirurgie*, vol. 4, Part 2, B, p. 87; Malgaigne, *Luxations*, p. 631; Duguet, *Bulletins de la Société Anatomique*, 1863, p. 278; Mathieu, *Gazette des Hôpitaux*, 1866, p. 330; Waterman, *Boston Medical and Surgical Journal*, 1869, vol. 81, p. 187; Wilson, *Canada Journal of the Med. Sciences*, 1880, vol. 5, p. 346; Waters, *Maryland Medical Journal*, 1883, vol. 10, p. 402.

The dislocation presents itself under three forms. In the first, that in which the displacement is slightest, the ulna is carried backward, either directly or by inward rotation of the forearm about the radius as a centre, until the coronoid process has cleared the trochlea, and then is moved slightly upward behind it by adduction of the forearm (Fig. 85); in the second form, the movement upward is prolonged until the coronoid process lodges in the olecranon fossa; in the third, the primary movement of rotation is prolonged until the olecranon lies behind the radius. The first form is the most common, and is sometimes termed "incomplete," in accordance with a similar use of the term in the backward dislocation of both bones; of the second form there are only two recorded examples (Malgaigne, Wilson). Some writers make an additional variety, dislocation backward and inward, a distinction which it does not seem necessary to preserve.

Fig. 85.



Dislocation of ulna alone backward, first form. (Sédillot.)

The *cause* in the larger number of cases has clearly been a fall upon the outstretched hand; in one, Brun, a blow received upon the elbow from behind while the weight of the body rested upon the extended arm. In other cases the cause was thought to have been a fall upon the elbow, but it does not appear in the accounts that the opinion had any better basis than the supposition that, as the elbow was the part injured, the violence must have been directly received upon it.

In von Pitha's case the injury was received in such a way that the mode of production is clearer than in most accidents, and, as the the case is typical in other respects, I reproduce the account.

A girl six years old and her little brother were engaged in a trial of strength, in which each sought to move an open door against the other's opposition, the girl standing with her back against the wall and her outstretched hands against the door, the hinges being at her left side. Two other brothers came to the help of the first, and under their combined efforts the girl's left arm suddenly doubled up with an audible snap, and when von Pitha examined it half an hour later, he found "the most distinct picture of a dislocation of the ulna backward." The thin arm was in almost complete extension, the forearm being slightly inclined toward the ulnar side; the fold of the elbow was somewhat raised by the projecting trochlea; the olecranon was very prominent behind, but barely raised above its normal level; the elbow was notably thicker, but not

broader; the head of the radius was in its place; pronation and supination were but slightly restricted, but the least movement of flexion was very painful. Reduction was easily accomplished by grasping with the left hand the humerus above the condyles, and with the right the forearm in such a way that the thumb and fingers especially compressed the ulna, and then supinating, abducting, and extending until there was slight dorsal flexion; at this moment he distinctly felt the lifting of the coronoid process, and on increasing the traction it suddenly slipped back over the trochlea with a snap. Pain at once ceased, and the patient could flex the joint.

Experiments upon the cadaver by Sédillot and Streubel[1] indicate that the mode of production is similar to that of backward dislocations of both bones together—that is, the forearm is abducted (Streubel) or hyperextended (Sédillot) until the internal lateral ligament yields, and then rotated inward and adducted to carry the coronoid process past the trochlea and engage its point against the posterior surface of the latter. If the adduction is increased, and especially if at the same time the orbicular ligament is torn, the olecranon rises to a higher point and may pass to the inner side. If, on the other hand, adduction is absent and the rotation is prolonged, the olecranon is carried around behind the radius, and the third form is produced.

Pathology.—Three specimens (Cooper, Robert, Duguet) and one compound dislocation (Boudant) furnish but scanty information of the pathological details, for which we must mainly depend upon experiment. Of the three specimens, Robert's alone was of a recent case. Cooper's specimen, preserved in St. Thomas's Hospital, is thus described by him: "It had existed a great length of time without reduction; the coronoid process of the ulna was thrown into the posterior fossa of the humerus; the olecranon is seen projecting behind the os humeri; the radius rests upon the external condyle, and has formed a small socket for its head, in which it was able to roll. The coronary and oblique ligaments had been torn through, and also a small part of the interosseous ligament. The lower extremity of the internal condyle of the humerus seems to have had an oblique fracture in it; but I doubt whether it had been broken, or only altered in form, on account of the unnatural position of the ulna; if it had been broken it was reunited. The triceps was thrown backward, and the brachialis internus muscle was stretched under the extremity of the humerus."

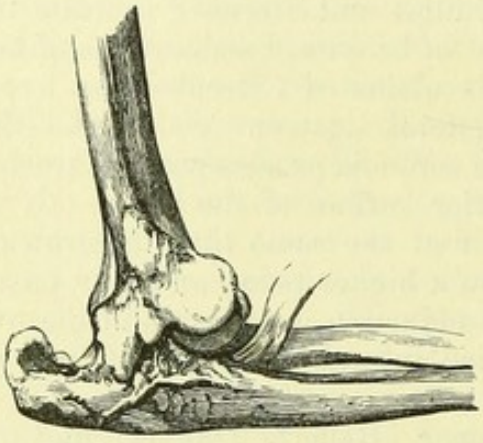
The accompanying figures (Figs. 86 and 87) indicate that the appearance of fracture of the internal condyle was due to new formation of bone on its posterior aspect, and that the front portion of the capitellum had disappeared by absorption.

Duguet's specimen was taken from a man, fifty years old, who had received the injury twenty years previously. There was ankylosis in the extended position, but pronation and supination were preserved. The ulna was displaced backward and upward so that its upper end was two centimetres above the line uniting the two epicondyles, and a nearthrosis had formed between the tip of the olecranon and the back of the humerus

[1] Streubel: Prager Vierteljahrschrift, 1850, ii. p. 54.

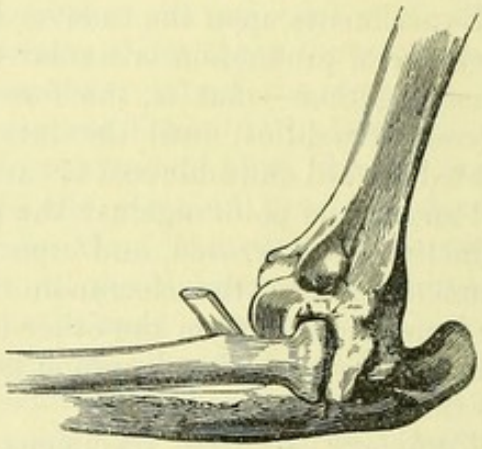
above and a little to the inner side of the olecranon fossa. It is probable, therefore, that the coronoid process was lodged in the olecranon fossa. Concerning the radius two statements are made: the first is that it had preserved its relations with the external condyle; the second, that it was appreciably (sensiblement) displaced forward, and preserved its movements of rotation. I understand these to mean that the head was directly below the condyle and a very little in front of the position it would normally occupy in that attitude (extension) of the limb.

FIG. 86.



Dislocation of the ulna alone backward; inner side. (COOPER.)

FIG. 87.



The same outer side (COOPER.)

In Robert's case the injury was caused by a fall on the palm of the hand; the limb was partly flexed, the olecranon prominent posteriorly and elevated; the head of the radius could not be felt because of the swelling, but it could be moved backward and forward with cartilaginous crepitation. At the autopsy the coronoid process was found in the olecranon fossa, and the radius in place; the humerus appeared to have been twisted so that its anterior aspect looked outward (in other words, the forearm was adducted); the annular ligament and some of the fibres of the external lateral ligament were torn. The condition of the internal lateral ligament is not mentioned. The brachialis anticus and brachial artery were ruptured.

Boudant's patient was a man, forty-nine years old, who had fallen from the first story of a building and received a compound dislocation; the wound was eighteen or twenty lines in length on the inner and anterior part of the elbow, and was thought to have been caused by contact with a large, rough stone. It seems, however, not unlikely that it was caused from within outward by the pressure of the trochlea in hyperextension of the joint. The olecranon, which was prominent posteriorly, could be seen through the wound, and the finger introduced into the latter recognized the radius in place. Reduction was easy, and the patient made a good recovery.

The experiments made upon the cadaver show that the internal lateral ligament is always ruptured, and that the orbicular ligament escapes injury if the displacement is not great.

Symptoms.—In the first and second forms, dislocation backward and upward, the limb is usually in almost complete extension (in Cooper's,

Duguet's, and Waterman's cases it was flexed at a right angle), and cannot be flexed without causing much pain, but pronation and supination are free and painless. The normal deflection of the forearm toward the outer side is lost, and in its place may be a deflection toward the ulnar side. This deflection is easily recognized by the eye when the limb is extended, but when the joint is flexed at or near a right angle it may be overlooked unless comparative measurements are made; in Diday's case the length of the ulnar border, from the epitrochlea to the lower end of the ulna, was an inch shorter than that of the other arm, while the radial borders were of equal length. The antero-posterior diameter of the joint is increased, and the fold of the elbow is filled out by the trochlea.

The olecranon is prominent behind the humerus, and may rise well above the line of the epicondyles; it may be nearer the epitrochlea than usual. The head of the radius, unless the swelling is too great, can be felt in its place, and it is by the determination of this fact, together with the displacement of the olecranon, that the diagnosis of the variety of the dislocation is made.

In the two recorded cases of the third form, dislocation of the ulna backward and outward behind the radius (Malgaigne, Wilson), the elbow was flexed nearly at a right angle. In Malgaigne's the forearm was pronated and deviated outward; the greater sigmoid cavity was directed outward, the coronoid process outward and forward. This attitude of the ulna suggests that the dislocation was not effected by rotation of the forearm.

Treatment.—In two cases (Cooper, Duguet) reduction was not made; in the others it was easily obtained. Waterman tried Cooper's method of the knee in the elbow, and Skey's of traction upon the upper part of the flexed forearm in the line of the humerus without success, and then easily reduced by hyperextension. The readiest method in the first and second forms appears to be that employed by von Pitha, and described above, supination, abduction, and hyperextension of the forearm. Malgaigne and Wilson reduced (third form) by direct pressure upon the olecranon, first backward to free it from the radius, and then inward.

(A case described by Richet[1] as a new kind of dislocation by rotation, seems from its title, and from some of its features, to belong to this class, but the account is so incomplete that is not available.)

Dislocations of the Radius Alone.

Although statistics show that these dislocations are not very rare, three and three-quarters per cent. according to Krönlein (see Chapter I., Table I.), and, although the earliest writers mentioned them, yet they were almost completely lost sight of until about one hundred and fifty years ago, and even now are far from being clearly understood. Petit, while admitting their possibility, claimed that they were exceedingly rare, and although Duverney, in 1751, gave a detailed account of two forms, they were still looked upon as so rare that when, in the latter

[1] Richet: Nouveau genre de luxation incomplète du coude par pivotement. Gaz. des Hôpitaux, 1879, p. 737.

part of the century, Butet reported a case to the Académie de Chirurgie, Sabatier and Louis were sent to Etampes, a journey of sixty miles, to verify it. Since that time observations have accumulated, and four varieties are now well established, the dislocations forward, backward, and outward, and one seen exclusively in children, and caused by traction upon the wrist, the nature of which is not entirely undisputed, but is generally thought to be a diastasis or direct separation; it is usually termed dislocation by elongation.

The mode of production of all the forms is still obscure, and the numerous experiments that have been made upon the cadaver by various investigators, Roser, Malgaigne, Streubel, Denucé, Pingaud, Barros, while they have shown how the dislocations may be produced upon the cadaver, have not made it clear how they actually are produced in the patients who come under observation; in some cases the clinical facts directly contradict the conclusions drawn from experiment.

1. *Dislocation backward.*—This was one of the forms described by Duverney, and one of the earliest to be accepted as proved by later surgeons. Its apparent frequency is in part due to the inclusion in the list of reported cases of those in which the dislocation is associated with fracture of the internal condyle (Fractures, p. 399), and probably also of others which belong in the somewhat vague group of dislocations by elongation. Two forms are described, the complete and the incomplete, the latter resting upon a few questionable, and one well observed case, that of Denucé:[1] a lad nineteen years old, fell from a swing, his pronated arm being caught under his body in such a way that the blow, as shown by an ecchymosis, was received upon the middle of the anterior aspect of the forearm. Pain; limitation of motion; the elbow semiflexed, the forearm fixed in complete pronation. A bone-setter tried in vain to reduce it, and a fortnight later the patient consulted Denucé, who found "behind the elbow, on a level with the condyle, and to the inner side of the epicondyle, a small prominent tumor, which rolled under the finger in pronation, and was evidently the head of the radius, a little overlapping its ordinary position posteriorly."

Of the complete cases the instances are much more numerous, but in some of them the question arises whether the upper surface of the radius had entirely left the articular surface of the capitellum, or was not still in contact with it by its anterior portion; if such contact did exist, the term "complete" can be properly applied only to the separation of the radius from the lesser sigmoid cavity of the ulna.

The cause, in the majority of cases, appears to have been a fall upon the outstretched hand; that the cause was a fall in most cases is certain, but whether it was upon the hand or the elbow is often far from clear, or whether it acted by direct impulsion or by exaggerated rotation.

In some cases of backward dislocation of both bones it has been possible to restore only the ulna to its place, and the radius has remained permanently dislocated; and in a case reported by Mason,[2] after reduction of a backward dislocation of both bones in a man thirty-seven years old,

[1] Denucé: Dict. de méd. and chir. pratiques, art. Coude, p. 777.
[2] Mason: New York Medical Record, 1880, vol. 17, p. 398.

recurrence of the dislocation of the radius was detected on the following day, and was attributed to his struggles while recovering from the effects of the ether. Some cases observed in adults, and thought to have occurred in childhood during convulsions have been attributed to muscular action, but the history usually leaves in doubt not only the mode of production, but even the character of the change, whether traumatic or congenital.

In a case reported by Cameron[1] the character and mode of action of the violence are more clearly shown than usual, but they are entirely exceptional, and the case does not aid to clear up the obscurity in which the question is enveloped. The patient was a man fifty-two years old, who was caught between a wall and a cart backing against it in such a way that his forearm was compressed lengthwise between them, the palm of the hand being pressed against the cart, and the back of the elbow against the wall; probably the hand was completely pronated. When seen, immediately after the accident, the head of the radius lay just under the skin behind the external condyle, where it formed a distinct projection, revealing to the eye its characteristic shape with the cavity on its extremity. The hand and forearm were prone; all movements were painful, and gave the impression of considerable fixity of the joint. Pain at the wrist led to an examination, which showed that "the styloid extremity was also dislocated downward, exactly as in cases in which the radius is shortened by the common fracture of its lower extremity."

While the character of the force and the direction of its action in this case are clear, pressure exerted against the lower end of the radius in the line of its long axis, yet it is far from being clear how such a force, so applied, could produce such a displacement. The skeleton shows that in this position the head of the radius is squarely placed against the anterior face of the capitellum, not upon an inclined surface along which it could be displaced. And yet, that there is something in the anatomical structure of the joint which favors the occurrence and forbids the rejection of the case on the supposition of abnormal conditions, is indicated by the fact that two similar cases have been reported by Wagner,[2] in which the mode of production was the same as in Cameron's, but the head of the radius was displaced to the outer side of the condyle instead of behind it, and a flat, wedge-shaped piece representing one-sixth of its diameter was broken off its inner side in one case.

Streubel,[3] in his experiments upon the cadaver, found that he could produce the dislocation in only one way, by hyperextending the supinated forearm until the head of the radius had been carried completely behind the line of the condyle, then forcing it upward, and at the same time bending it to the radial side, and finally flexing it again while holding the radius pressed firmly back with the thumb of the hand that grasped the forearm. It is by no means probable that this rather complicated manœuvre, which, moreover, has entirely failed in my hands, is a reproduction of what has taken place in the falls that have produced the dislocation. The radius is dislocated not only from the humerus, but also

[1] Cameron: Lancet, 1884, i. p. 885.
[2] Wagner: Beilage zum Centralblatt für Chirurgie, 1886, No. 24, p. 93.
[3] Streubel: Prager Vierteljahrschrift, 1850, 2, p. 68.

from the ulna, and this requires the rupture of the orbicular ligament. To effect that, something more is required than hyperextension of the elbow, even with the addition of direct propulsion upward of the radius. Supination of the forearm, in which many have sought the explanation, will not effect it, for the movement is almost a pure rotation of the head about its centre, and is not arrested at its normal limits by the orbicular ligament. Direct propulsion backward of the bone would undoubtedly produce the dislocation, but the clinical facts do not indicate this as the cause. Possibly in hyperextension and outward lateral flexion, as in Streubel's experiments, the head of the radius may become engaged behind the slight projection of the articular surface of the capitellum at the bottom of the condyle, and be thereby prevented from accompanying the ulna in its return forward when the elbow is again flexed; this would supply the strain necessary to separate the radius from the ulna, but I must add that all the attempts I have made thus to produce the dislocation were fruitless; the result was always a dislocation of both bones.

Barros[1] produced the dislocation experimentally in the bodies of young children and women in two ways: occasionally by direct violence upon the front of the head, although this usually caused a fracture; and, secondly, by traction upon the pronated hand, followed by forcible flexion. He found that rupture of the posterior segment of the external lateral ligament was an essential preliminary; if this was cut, simple extension (traction?) at the pronated hand was sufficient. He usually found the orbicular ligament only partly torn.

The anatomical obstacles in the way of such a dislocation of the radius that its head should lie, in the extended position of the elbow, against the back of the external condyle—that is, should be displaced upward as well as backward—are such that some writers, notably Dr. Markoe,[2] have maintained that it was possible only when associated with fracture of the internal condyle of the humerus or of the shaft of the ulna, or with rupture of the ligaments of the lower radio-ulnar joint, or with extreme lateral flexion of the elbow. Of these conditions, all except the last one have been observed clinically. But the records show that the dislocation may be simply backward, and not at all upward, a condition to which the above objection does not apply. There are no post-mortem records of recent cases, and the dissection of those of long standing is not an entirely trustworthy indication of the condition and the relations of the parts when the injury is fresh. A case observed by Mr. Rivington[3] is of particular importance, because the position of the head is more exactly noted than is usual in the descriptions. The patient was a lad, fourteen years old, and the injury had been received five months previously in a scuffle, during which he was violently shaken by the forearm, and thrown down, striking his elbow against the leg of a table. There was a marked prominence "at the back of the joint below the external condyle, and by the side of the olecranon process." "The

[1] Barros: Contribution à l'étude des luxations de l' extremité supérieure du Radius, Genève, 1886. Abstract in Centralblatt für Chirurgie, 1886, p. 718.

[2] Markoe: N. Y. Journ. of Med. 1855, p. 382, and N. Y. Med. Record, 1880, vol. 18, p. 118. See also Fractures, p. 398.

[3] Rivington: Lancet, 1879, ii., p. 942.

head of the radius was displaced more directly backward than is usual, according to the descriptions of the books, not lying in any wise behind the external condyle, but a little overlapping the articular end of the humerus." Flexion and extension were almost unimpaired, pronation was good, and supination to more than half the usual extent. Reduction failed.

Mr. Rivington refers briefly to two specimens known to him, in both of which "the head of the radius has contracted new connections. In the one in the St. George's Hospital Museum, the new attachments formed by the ends of the orbicular ligament with the humerus prevented pronation and supination."

It does not seem possible that the head of the radius in his case could have remained "behind the articular end of the humerus" in full flexion, and the persistence of the displacement must, therefore, be attributed to the formation of new attachments by the torn orbicular ligament.

In a specimen of an old dislocation, that had been received in childhood and had existed for many years, presented by Petit[1] to the Société Anatomique the head of the radius was directly below the summit of the epicondyle when the elbow was flexed at a right angle. There was much overgrowth of bone on the trochlea, olecranon, and epicondyle; the capitellum had been absorbed. Flexion and extension were rather limited; rotation was preserved. In another specimen found in the dissecting-room and described and figured by Sir Astley Cooper, "the head of the radius could be seen, as well as felt, behind the external condyle of the os humeri. The coronary ligament was torn through at its fore part, and the oblique had given way. The capsular ligament was partially torn, and the head of the radius would have receded still more, had it not been supported by the fascia which extends over the muscles of the forearm." The accompanying figure (Fig. 88) indicates that the head of the radius had risen very slightly above the lowest part of the articular portion of the condyle, and that its position was probably the same as in Mr. Rivington's case. In two cases quoted by Cooper from Langenbeck "the head of the radius was found thrown a little backward and outward from the external condyle of the humerus and could not be immediately detected."

FIG. 88.



Dislocation of the head of radius backward. (COOPER.)

In another specimen of old dislocation presented to the Société de Chirurgie by Bernadet,[2] the head of the radius had been displaced a little backward, downward, and outward; the external lateral ligament entirely covered the cup-shaped surface of the head; the annular ligament no longer existed except upon the inner side, and there it was notably thickened and obliquely deviated.

In the specimens which Streubel obtained by experiment he always found the anterior portion of the capsule torn and the capitellum projecting through the rent; the external lateral ligament

[1] Petit: Bull. de la Société Anatomique, 1874, p. 904.
[2] Bernadet: Bull. de la Soc. de Chir., 1861, p. 462.

was more or less torn at its anterior border, the internal lateral ligament uninjured; the annular ligament was always torn in front, either at its insertion by the lower sigmoid cavity, or further outward; the oblique ligament was torn, doubtless in consequence of the exaggerated supination.

These facts, though not numerous or entirely free from objection, indicate that the position of the dislocated head of the radius, even in full extension, is lower than that commonly assigned to it in the systematic descriptions and shown in the plates accompanying them, that it does not rise above the shallow groove which marks the posterior and lower margin of the articular surface of the capitellum. At this point the upper margin of its head would be but very little below the axis of the joint, and consequently would have to move over only a short distance in full flexion and extension of the limb.

In recent cases the elbow is slightly flexed, the forearm pronated; voluntary and communicated movements are painful and limited in range, but in old cases the freedom of motion is almost completely restored, supination remaining the most imperfect. The diagnosis is made by recognition of the head of the radius behind its normal place in extension, behind and below it in flexion at a right angle. It may lie close beside the olecranon or further to the outer side. Its projection, unless the swelling is considerable, is such that the entire extent of its concave upper surface can be felt. Measurement of the radial border of the forearm, from the epicondyle to the styloid process of the radius, may show some shortening, half an inch according to Streubel.

Treatment.—The dislocation in recent cases has usually been reduced promptly by pressure on the head of the radius, aided or not by traction upon the wrist, and this method has succeeded even when several weeks had passed since the receipt of the injury. But in some cases reduction has been impossible or the displacement has shown a marked tendency to recur, both circumstances being probably due in the recent cases to the interposition of a portion of the capsule, but in the older ones also to permanent change in the relations of the shafts of the radius and ulna and to adhesions between them. This interposition of the capsule has been demonstrated in one or two cases in which arthrotomy has been done (see Chapter XXI.). Probably the best position to give the limb during the attempt is that of supination and full extension, and if direct pressure does not then restore the bone to its place traction should be made at the wrist, and the forearm gradually bent to the inner side, and then the direct pressure renewed.

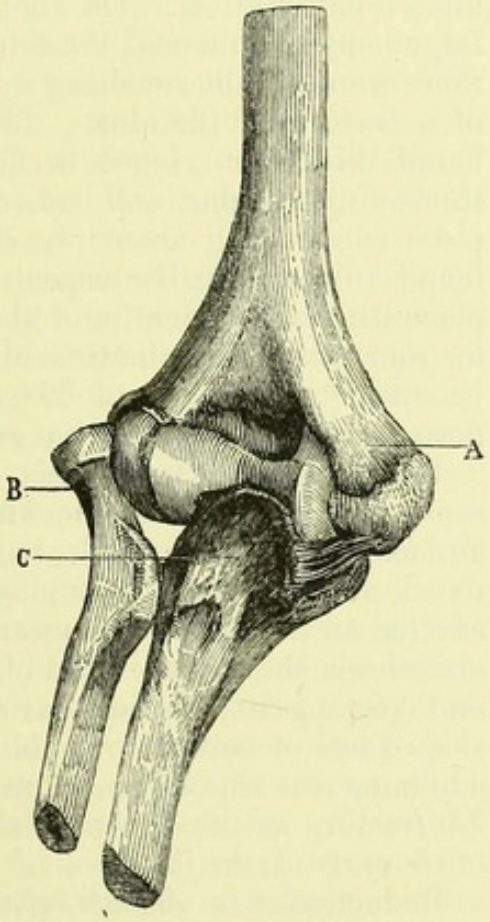
2. *Dislocation of the radius outward.*—Excluding the cases in which the dislocation is accompanied by fracture of the ulna in its upper portion and those in which the displacement outward is comparatively slight and is associated with a more important displacement backward or forward, the recorded instances of this injury are very few, and in some of these, even, the description justifies a doubt whether they should not rather be placed in one of the two other classes.

Thomassin reported two cases to the Académie de Chirurgie in 1776, and Chédieu a third in 1805, which are quoted by Malgaigne, loc. cit., p. 668. In the former "the head of the radius projected at the top of the convex border of the forearm, pressing outward the mass of the supi-

nator and radial (extensores radiales) muscles which cover it; it was separated from the ulna, and a gap between the two could be easily recognized." In Chédieu's "the head of the radius projected at the outer and upper part of the forearm, rising higher than the external condyle, and pushing away the portion of the radials which there covers it." The position of the head which these descriptions indicate is such, I think, as would justify placing them in the class of dislocations forward, in which the radius passes upward in front of the humerus.

In Nélaton's[1] case the dislocation occurred in childhood, as was also the case with the preceding three, and had existed for twenty years; the position of the radius is shown in Fig. 89. Flexion and extension were preserved; supination was impossible.

FIG. 89.



Dislocation of the head of the radius outward; the trochlea is much broadened. (NÉLATON.)

Gerdy[2] briefly reported a case which he had seen some time previously and of which he had preserved no notes; the patient was a man, and the dislocation was old. "The head of the radius projected considerably outside of the epicondyle." There was little or no limitation of the movements of the joint.

Dr. Willard Parker[3] saw a child which, six weeks before, had fallen down stairs "with the right arm twisted behind the back in such a position that the whole weight of her body came upon her arm." The head of the radius projected externally and could be easily reduced by pressure, but the displacement immediately recurred when the pressure was renewed and the forearm was flexed or extended. The movements of the joint were free.

Von Pitha[4] saw a case in a girl, nine years old; the injury was caused by a maid servant who stepped with her heel upon the elbow while the child was sleeping on the floor with her arm extended and supinated. The head of the radius lay upon the outer surface of the condyle.

Broca's[5] patient was a girl, eleven years old, and the dislocation had existed fifteen months. The head of the radius lay immediately under

[1] Nélaton: Pathol. Chirurgicale, vol. 2, p. 400.
[2] Gerdy: Archives gén. de Méd., 1835, vol. 7, p. 161.
[3] Parker: N. Y. Journ. of Med., 1852, p. 189.
[4] Pitha and Billroth: Chirurgie, vol. 4, Part 2, B, p. 92.
[5] Reported in a thesis by Boularan, Paris, 1875, and quoted by Pingaud and Poinsot.

the skin and could be grasped by the fingers and freely moved forward, backward, or outward.

Wagner[1] reported to the German Surgical Congress, in 1886, three cases of dislocation outward complicated by fracture of the inner portion of the head of the radius. In the first two cases the injury was caused by pressure against the back of the flexed elbow while the palm of the hand was resting against a firm object in front. Thus, a lad, eighteen years old, pushing a coal-wagon on a tramway with his forearm pronated and flexed, was struck on the elbow by another wagon coming up from behind. A year had elapsed since the accident when the first case was seen, during which the joint had been steadily growing stiffer. The elbow was flexed at a right angle; flexion, extension, and rotation were almost entirely lost. On the outer side of the external condyle was a large bony prominence, the thickened and immovable head of the radius; there were no abnormalities in the other parts of the joint, and no sign of a fracture of the ulna. The head of the radius was excised; it was found thickly enveloped in fibrous tissue, to which the appearance of thickening was due, and had lost from its inner side a flat, wedge-shaped piece constituting about one-sixth of its diameter. The fragment was found adherent to the capsule and was also removed. Recovery took place without accident, and the mobility of the joint steadily increased for some time. At the time of the report, nine years later, flexion could be made to an angle of 80°, extension to 150°, pronation was almost normal, supination somewhat restricted.

In the second case, a man twenty-six years old, was injured in the same manner, and was seen while the injury was fresh. Passive flexion and extension were possible, but painful; the forearm was completely pronated, and could not be supinated. The region of the joint was much swollen on the outer side, normal on the inner side. Examination under anæsthesia showed the head of the radius outside the external condyle, and keeping its position during flexion and extension; a flat, wedge-shaped loss of substance could be recognized by the touch on the side adjoining the capitellum, more distinctly when the limb was supinated. No fracture or other abnormality could be found in the ulna or in the other parts of the joint.

Reduction was effected, after several unsuccessful attempts, by, first, adduction of the flexed limb, then by the utmost possible abduction, with supination, of the completely extended limb, combined with pressure upon the head of the radius. When the dressings were removed, a month later, passive movements were very painful and limited, and, as no improvement followed, excision was done five months after the accident. The head of the radius was found thickened and absolutely fixed, and the fragment reunited to it by a loose fibrous union; the failure of union was attributed to the interposition of a small piece of the articular cartilage. Recovery followed without accident, but the mobility of the joint was not increased.

In the third case the patient had received his injury twenty-two years before, when six years old, by a fall from a horse. "The head of the

[1] Wagner: Beilage zum Centralblatt für Chir., 1886, No. 24, p. 93.

radius stood outside upon the external condyle," and was flattened on its inner side; there was no sign of any injury to the ulna. The movements of the joint were completely normal.

Löbker,[1] in a paper read before the same congress, reported two cases of the same combination of dislocation outward with fracture of the inner portion of the head of the radius treated by excision. In each case the fragment had become united to the adjoining parts by a pedicle.

Bartels[2] reported a unique case in which the heads of both radii had gradually become displaced outward. The patient was a man forty-three years old, who, while lying in hospital with a broken leg, called the surgeon's attention to his elbows. He said that the deformity dated from his eleventh year; his father had at that time put him at hard work, usually pushing a loaded cart; pain was soon felt in the elbows, and increased steadily, but he was kept at work. The head of the radius rested on the outer side of the external condyle when the limb was fully extended and supinated; when extended and pronated, the head was less prominent, and rested partly on the outer part of the articular surface of the capitellum, and when flexed and pronated the head returned to its place.

Barros could produce the dislocation experimentally in only one way, by pressure against the ball of the hand, and simultaneous forcible adduction of the forearm, by which the external lateral ligament was torn.

The general symptoms in the recent cases showed no special or characteristic features; the limb appears to have been partly flexed and pronated, and the movements of the joint restricted. In the older cases, the normal movements were more or less completely reëstablished.

In both of Thomassin's and in Broca's cases the dislocation was reduced without difficulty, but recurred repeatedly, and was finally abandoned. Chédieu failed to effect reduction a fortnight after the accident. In Sprengel's case of backward and outward dislocation, treated by arthrotomy (see Chapter XXI.), a portion of the capsule was found interposed.

3. *Dislocations forward.*—These are the most common of the three varieties, even excluding from them the not unusual subluxation which occurs in children and will be described in the next section. The dislocation is characterized by the position of the head of the radius in front of its normal position when the forearm is extended, and above it when the forearm is flexed at a right angle. Several authors describe two forms, the complete and the incomplete, including in the latter those cases in which in flexion at a right angle the head of the radius has not entirely left the articular surface of the capitellum, but remains in contact with its upper portion. Malgaigne also includes in the incomplete variety the subluxations or "dislocations by elongation" in children. The distinction between complete and incomplete is an arbitrary one and does not seem to deserve to be retained, for even in the former the head of the radius sometimes descends upon the articular surface of the capitellum when the limb is extended.

The causes mentioned in the reported cases include falls upon the hand

[1] Löbker, Idem, p. 92.
[2] Bartels: Archiv für klin. Chir., 1874, vol. 16, p. 643.

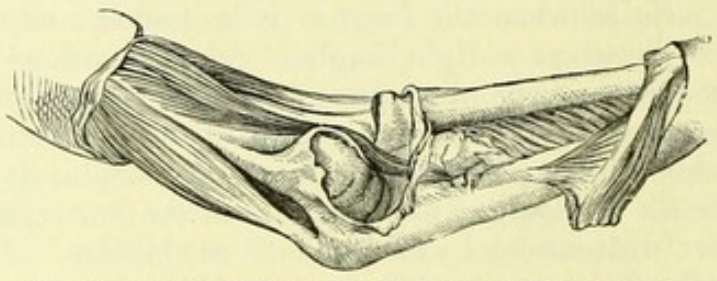
or upon the elbow, and traction upon the forearm. In experiments upon the cadaver the dislocation has been produced by forced pronation, in which, according to Filugelli, quoted by Streubel, a fulcrum is established by contact between the radius and ulna in their upper third at the point at which they cross, the effect of which is to cause the head of the radius to move forward and inward, with rupture of the anterior portion of the annular ligament when the pronation is exaggerated.

As in the two preceding varieties, the mode of production is far from clear. That the head should be displaced by direct violence is not difficult to comprehend, but the cases in which this mode of production can be invoked are few. Traction upon the forearm, combined probably with exaggerated pronation, must also, I think, be admitted as an occasional cause, especially in children, both because of its efficiency to produce the dislocation upon the cadaver, and because the histories of one or two cases in adults are not open to any other explanation, as in Boyer's case of the footman who slipped while getting up behind a carriage, and remained suspended by his hands. It seems probable that some of the cases in which the injury was received in childhood, and remained unreduced, may have been dislocations by elongation, and that the head remained fixed in its new position, or perhaps was still further displaced by use. In a fall upon the hand, it seems probable that the dislocation could be produced only by hyperextension and pressure upon the lower end of the radius, aided by supination or pronation, and this opinion is confirmed by experiment. A case of Malgaigne's (loc. cit., p. 651) seems to support this theory, for at the patient's death, seven weeks after the accident, the posterior fourth of the head of the radius was proved to have been broken off. In two of Löbker's cases (loc. cit., p. 92) a piece was broken from the outer portion of the head, which suggests, what is probable also on other grounds, that abduction of the forearm may also be a factor.

In a case reported by Ross (Streubel, loc. cit., p. 75) the dislocation occurred during an epileptic convulsion and was attributed to muscular action, the unopposed contraction of the biceps and pronator radii teres.

Pathology.—No autopsies have been reported in recent cases. In

FIG. 90.



Hilton's case of dislocation of the head of the radius forward.

experiments upon the cadaver (Streubel, Pingaud) the capsule has been found torn transversely in front close to its attachment to the humerus (Fig. 90), and the annular ligament untorn and encircling only the neck of the radius while the head projected forward through the rent in the capsule and rested, by its posterior edge only, against the articular surface of the capitellum.

In a number of cases, ten or twelve, the opportunity has arisen to examine old dislocations. Malgaigne has described his own, quoted above, in which the posterior fourth of the head of the radius was broken off and the capsule was intact, and two specimens in the Musée Dupuytren (cases of Desault and Prestat). Cooper (loc. cit., p. 392) describes and figures a specimen preserved at St. Thomas's Hospital: Danyau,[1] Debruyn,[2] two cases, Hilton,[3] Trélat[4], Krönlein,[5] a specimen in the Museum at Zurich, and Löbker the two cases above referred to.

In Malgaigne's, Danyau's one of Debruyn's, Trélat's and the two specimens of the Musée Dupuytren the annular ligament was stretched but not torn; in Hilton's its upper portion was torn but the more external and superficial fibres remained intact and were closely wrapped about the neck of the radius; in Cooper's the annular, oblique, forepart of the capsular, and a portion of the interosseous ligament were torn through. With reference to some of these cases the question has been raised whether the annular ligament found at the autopsy was not one of new formation.

The head of the radius rests, in partial flexion, upon the anterior surface of the external condyle above and usually somewhat to the inner side of its normal position, and either in contact with the coronoid process or (Hilton) separated from it by the interposed tendon of the brachialis anticus. In three cases (Malgaigne, Löbker) a piece had been broken from its posterior or outer border. In several of the cases a hollow had formed for its reception on the anterior surface of the humerus; the new articulation was either entirely above the old one, or included the upper part of the capitellum, or (Trélat) extended over the outer portion of the front of the trochlea. The head of the radius was deformed and had suffered the loss of more or less of its cartilage of incrustation; in some cases it was enlarged, in others diminished in size. In Krönlein's specimen an extensive outgrowth of bone had formed upon the inner side, giving the upper end of the bone an appearance similar to that of the upper end of the femur, and articulating with a new cavity upon the humerus; it is stated that the movements of rotation had been completely restored.

An interesting feature in Hilton's case was that the radius had been displaced bodily upward along the ulna, and this displacement had produced changes at the wrist; there was an aperture in the articular fibrocartilage uniting the radius and ulna, the semilunar and pyramidal bones had lost some of their articular cartilage, and the former had undergone a marked change in shape.

Malgaigne observed and called especial attention to abduction of the forearm, which does not appear to have been observed by others. It furnishes a satisfactory explanation of the displacement of the radius upward as well as forward, which could not otherwise be accounted for except by such a change in the level of the bones at the wrist as was

[1] Danyau: Annales de la Chir. Française et Etrangère, 1841, vol. 2, p. 72.
[2] Debruyn: Annales de la Chir. Française et Etrangère, 1843, vol. 9, p. 88.
[3] Hilton: Guy's Hosp. Reports, 1847, vol. 5, p. 93.
[4] Trélat: Bull. de la Société Anatomique, 1858, p. 487.
[5] Krönlein: Deutsche Chirurgie, Lief. 26, p. 44.

noted in Hilton's case. Abduction of the forearm might easily be overlooked while the joint is partly flexed unless comparative measurements are made.

Symptoms.—The elbow is slightly flexed and the forearm almost always more or less pronated; in a few cases supination has been present. Voluntary and communicated movements are painful, and of the latter flexion nearly to a right angle and almost complete extension are possible, pronation is usually complete, but supination much restricted. Abduction of the forearm has been noted, possibly it is quite common, and when present it can be demonstrated by comparative measurements of the radial borders of the two forearms, the injured one being shortened. The region of the elbow is swollen in front and on the outer side; the absence of the head of the radius from its normal position is shown by the depressibility of the soft parts on the outer side of the joint below the condyle, and its presence in the fold of the elbow can generally be recognized by the finger; sometimes it is so prominent there that it appears to be subcutaneous, and the saucer-like depression of its upper surface can be traced when the joint is extended. Flexion of the forearm is abruptly arrested at or near a right angle by the impact of the head of the radius upon the front of the humerus, and this is sometimes accompanied by a shock or blow distinctly perceptible by the surgeon.

In the older cases the restoration of function may be almost complete, the range of motion being limited only in extreme flexion and supination.

In Hilton's case the associated changes at the wrist caused a corresponding deformity there, abduction of the hand; and it seems not unlikely that even in some recent cases the wrist may be painful or distorted. This coincidence has been noted in cases of dislocation by elongation in which subluxation forward of the head of the radius was demonstrated.

Treatment.—Reduction has been easy in some recent cases, and difficult or impossible in others. The measures which have been most successful are traction upon the radius at the wrist, the forearm being supinated and extended, combined with pressure upon the head of the radius. Malgaigne suggests, very properly, that adduction of the forearm would be more likely than traction to overcome the overriding of the radius. Hilton reduced the displacement in his specimen, which had existed for many years, by placing a small wedge between the upper surface of the radius and the humerus, and then flexing the forearm by pressing upon the lower end of the ulna; when flexion was nearly complete direct pressure upon the head of the radius forced it backward into place. The effect of this device was to displace the radius downward along the ulna to a distance equal to the thickness of the wedge, and to rupture the ligaments which bound the two bones together. Possibly it would be prudent to employ it upon the living patient in more recent cases in which a displacement of the radius upward along the ulna could be demonstrated. A marked tendency to recurrence has been frequently noticed, and has generally been attributed to interposition of a portion of the capsule. I am inclined to think it due, in some cases at least, to the persistence of this bodily displacement of the radius upward. If so, the condition would be shown, after reduction, by loss of the outward inclination of the fore-

arm in full extension, and the effort should be made to overcome it by restoring this angle by forcible abduction.

The position of the rent in the anterior portion of the capsule suggests that after reduction the joint should be kept flexed, and although recurrence of the dislocation has taken place with the limb in this position, it does not seem so likely to favor such recurrence as the extended position.

4. *Dislocation by elongation*, or *the subluxation of young children.*— Under these names is described an injury which is very frequently observed, but the nature of which, after nearly two centuries of discussion, is still in dispute. Its features are well marked; a young child, generally less than three years old, is lifted or pulled by the hand; it cries out with pain, and refuses to use the limb, which hangs motionless by the side, somewhat flexed at the elbow, and more or less pronated. A careful examination fails to discover marked change in the anatomical relations of the bones at the elbow or wrist; passive motion at both joints is free, but painful, except supination, which is resisted; often during the manipulations made in the examination, or on forced supination, a slight click is heard, and the child at once is able to use the limb freely without pain.

The history of the views that have been held concerning the nature of the affection was written by Malgaigne in 1843, and repeated in his work on dislocations, and his account has been quoted by several systematic writers on the subject, notably Streubel and Pingaud, and was continued to date, in 1861, by Goyrand,[1] who then presented a new theory, and although the injury was fully described by Gardner[2] in 1837, and by Hodges[3] in 1862, yet it is still so little known in England and the United States that cases are reported from time to time in the journals as rarities, it is usually passed by without mention in the text-books, and as recently as 1885, Mr. J. Hutchinson, Jr.,[4] of London, published an account of it, in which he quoted Mr. Christopher Heath as authority for the statement that it was made known in England by McNab in 1862, and he offered as a discovery an explanation which was given by Duverney in 1751, had been discussed and rejected by Goyrand[5] in 1837, elaborately studied and accepted by Pingaud[6] in 1878, quoted and accepted by Poinsot in 1884, and discussed by Hamilton,[7] with a translation of Poinsot's article in 1885. It will be sufficient to trace merely the outlines of this history, and only so far as to bring out the theories that need to be considered.

As early as 1671 Fournier described the injury as an incomplete dislocation characterized by relaxation of the ligaments and elongation of the radius, meaning by the latter direct separation downward or diastasis. Nearly a hundred years later, Duverney[8] gave a clear and exact descrip-

[1] Goyrand: Bull. de la Société de Chirurgie, 1861, p. 605.
[2] Gardner: London Medical Gazette, 1837, vol. 20, p. 878.
[3] Hodges: Boston Medical and Surgical Journal, 1862, vol. 67, p. 129.
[4] Hutchinson, Jr.: Annals of Surgery, August, 1885, and British Medical Journal, 1886, i. p. 9.
[5] Goyrand: Gazette médicale de Paris, 1837, p. 115.
[6] Pingaud: Dict. encyclopédique. art. Coude, p. 580.
[7] Hamilton: New York Medical Journal, Jan. 3, 1885, p. 8.
[8] Duverney: Maladies des Os, 1751.

tion of it as an injury occurring frequently in children; he attributed it to forcible traction at the wrist, and gave as its chief symptom the opposition to supination of the forearm, and as the treatment forcible supination with pressure from before backward upon the head of the radius followed by flexion of the elbow. He thought the injury was not merely an elongation of the radius, but also the escape of its head below the edge of the orbicular ligament. Nearly a century and a half has passed since the publication of his views, and but little has been added to his description of the etiology, symptoms, or treatment, and while the years have brought many other theories concerning the pathology his is the one that is now most widely held.

In 1787 Bottentuit presided at the presentation, and, according to Malgaigne, was probably the real author, of a thesis by Bouley before the Ecoles de Chirurgie,[1] in which the theory of the agency of forced pronation in the production of the injury was advanced; it was argued that in this movement the radius and ulna came into contact at the point where they crossed each other near the elbow, and that, the movement being continued, the head of the radius was displaced forward or outward.

At the beginning of the present century Martin, in France, 1809, and Monteggia, in Italy, 1814, described the injury and reported cases, but the former, unfortunately, appears to have encountered also some dislocations backward, and he not only included them in the same group, but he also thought that the radius was dislocated backward in all, and this opinion has survived in a measure until the present time, and has led systematic writers to describe a dislocation backward as one of the forms, although it does not appear that there is any other authority for the statement than Martin.

As the injury is one that seems but rarely to fall under the observation of the general surgeon, probably because of the facility with which it is reduced, the authors of the surgical text-books either made no mention of it or followed in their brief descriptions the account given by Martin, or by those who had copied from him. But between 1836 and 1850 several cases were published in England and in France, and new theories concerning its nature were advanced. Gardner in 1837 (ut supra), and Rendu[2] in 1841, attributed the fixation to the locking of the bicipital tuberosity behind the ulna, but the latter, who in two cases had made the important observation that the wrist also was swollen and tender, added to this supposed locking of the tuberosity which he regarded as probably exceptional, a rupture of the ligaments of the wrist. Perrin,[3] in 1849, thought the head of the radius was caught below the lower edge of the lesser sigmoid cavity, and Goyrand, who saw a large number of cases, thought the lesion was an incomplete dislocation, in which the displacement was so slight as to cause no recognizable deformity at the elbow. Malgaigne, 1854, included it among the incomplete dislocations forward, and others did likewise.

In 1850, Streubel[4] made the theory of incomplete luxation more

[1] Bouley: De radii superioris extremitatis dimotione, in infantibus frequentiori.
[2] Rendu: Gazette médicale, 1841, p. 301.
[3] Perrin: Journ. de chirurgie de Malgaigne, vol. 5, p. 145.
[4] Streubel: Prager Vierteljahrschrift, 1850, ii. p. 90.

definite, by showing that if the forearm of the cadaver of a young child was forcibly pronated, the head of the radius moved forward, and the posterior portion of the capsule was forced in by atmospheric pressure between the radius and the capitellum, and that if then the pronation was diminished, the slight displacement of the radius and the interposition of the capsule would persist even while gentle movements of the joint were made; but that under sudden extension and supination the normal relations would be established. In like manner, forced supination would displace the radius backward, and lead to interposition of the anterior portion of the capsule. In the bodies of adults, neither manipulation would produce this result.

In 1856, Chassaignac[1] described, under the title "*paralysie douloureuse des jeunes enfants*," a number of cases of the injury under discussion, together with others of a different nature, and attributed the symptoms in all to injury of the nerves of the limb. Finally, in 1861, Goyrand[2] returned to the subject in a lengthy paper, in which he abandoned his previous view and advanced the last new theory, that the lesion was situated not at the elbow, but exclusively at the wrist, and consisted in a dislocation of the triangular fibro-cartilage in front of the lower end of the ulna. His experiments showed that in complete pronation the fibro-cartilage was carried so far forward as almost entirely to uncover the end of the ulna, and that in forced pronation the uncovering became complete. In reply to a question asked by Velpeau, he admitted that the displacement did not persist upon the cadaver unless the hand was held upward and supinated, but he thought that the tonic contraction of the muscles in the living would maintain it. He did not explain why such a lesion should be more easily produced in a child than in an adult.

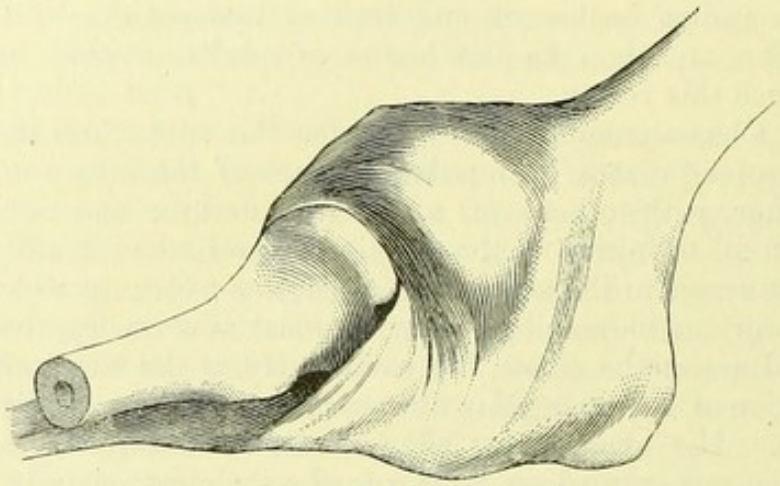
It may be worth while to add that the editor of the *Medico-Chirurgical Review*, in 1839, thought the injury was a separation of the upper epiphysis of the radius, and Fougeu, 1861, a separation of the lower one.

Pingaud (loc. cit., 1878), in his experiments upon the cadaver, found, as Goyrand had similarly done in 1837, that the head of the radius could be drawn out through the orbicular ligament by forcible adduction of the forearm, so far that its anterior edge would engage below the lower border of the ligament (Fig. 91), and the bones would remain separated by a distance of about a quarter of an inch, but without displacement of the radius forward, backward, or outward, unless forced pronation was added to the adduction, in which case the head moved forward; and as this condition of the parts coincided with a limitation of the freedom of rotation of the forearm similar to that observed clinically in the cases in question, and as the normal relations of the parts were restored by the same manœuvres which relieved the little patients, he reached the conclusion that the nature of the lesion observed clinically was the same as that which he had produced experimentally, and that the clinical injury was, therefore, a dislocation of the radius downward below the annular ligament, or, in other words, that Duverney's theory was the correct one. He showed further, that the younger the child the more easily could this

[1] Chassaignac: Archives générales de Méd., 1856, i. p. 653.
[2] Goyrand: Bull. de la Société de Chir., 1861, p. 596.

displacement be effected, and the more complete, circularly, would it be. He would not assert that this was the only cause of the clinical condition, but contented himself with proving that it was at least one; his reserve being apparently due to the inapplicability of the explanation to the reported cases in which the radius was said to have been displaced backward, cases which we have seen to rest only upon Martin's assertion.

Fig. 91.



Subluxation of the head of the radius. (Pingaud)

His experiments have been repeated, and his results verified by others; Poinsot accepts his explanation fully for the usual cases, and Streubel's for those of displacement backward, but Hamilton (loc. cit.), while admitting it to be probably true of many, thought others were paralytic in nature, an opinion in support of which he offers no clinical proof.

Turning now to the clinical evidence, for there have been no post-mortem examinations, it appears that the injury is common in young children between the ages of one and three years, and is rarely seen after the age of six years, and not infrequently recurs. Goyrand (loc. cit., 1861) had seen at least two hundred cases in thirty years, and quotes Chabrely (*Journal de Médecine de Bordeaux*, October, 1860, p. 481) as saying that hardly a month passed, he might say hardly a week, in which he was not called to a case, and Fougeu as having seen thirty-five cases; in the discussion that followed the reading of Goyrand's paper, Marjolin stated that he had seen about sixty cases. Snedden[1] saw ten cases in ten years in private practice; and Lindeman[2] saw twenty-four cases in two years in dispensary practice. The cause is traction upon the arm at the hand or wrist, as in lifting a child, or in holding it when it stumbles, and in two cases in drawing the arm through the sleeve of the dress. It seems to me that exaggerated pronation does not enter into the mechanism by which the lesion is produced, but that the violence is simply traction exerted upon the extended elbow, and possibly combined with adduction, for traction would tend to make the limb exactly straight, and thus overcome the normal inclination of the forearm outward; or the grasp upon the forearm may be so firm that an actual inward inclination would be

[1] Snedden: British Med. Journal, 1882, i. p. 499.
[2] Lindeman: British Med. Journ., 1885, ii. p. 1058.

produced in case the effort was not a simple traction, but was combined with a movement that tended to swing the child upward along a curve, whose centre was its wrist, and whose radius was its extended arm. At least, in lifting a living child by the arm I have not been able to make exaggerated pronation, for rotation at the shoulder is so free that the limit of pronation is not easily reached, and this is unquestionably true when the child is lifted by both hands.

The child at once cries out in pain and refuses to use the limb, which hangs motionless by its side, or is supported, with the elbow slightly flexed, across the front of the abdomen; the wrist is completely or partly pronated. Examination shows sensitiveness at the outer portion of the elbow, in some cases also at the back of the wrist, and in others exclusively at the wrist, with swelling after the lapse of from thirty to thirty-six hours. The head of the radius is sometimes slightly but distinctly displaced forward, but in most cases no other change than a slight longitudinal separation between the radius and the capitellum is recognizable; Marjolin said that in some of his cases he had found "a slight deformity" at the elbow, and in all of them pain on pressure in front or on the outer side of the head of the radius. In seven of Snedden's cases the pain and local symptoms indicated the elbow as the seat of the injury; in the remaining three the wrist; in one patient it occurred twice at the wrist and once at the elbow, and in another three times at the elbow. In both of Rendu's cases there was pain and swelling at the back of the wrist.

Although the child does not voluntarily move the joint, it can be freely moved by the surgeon in every direction except supination, and will sometimes be held by the child in such a position as may be given to it. In only one recorded case, Dugès,[1] was the limb in supination; with that exception the constant and pathognomonic symptom is the interference with supination.

These facts, taken in connection with the results of experiment, indicate that Duverney's opinion was correct and that the injury consists in the escape of the front portion of the head of the radius below the orbicular ligament, and that it is produced by traction and adduction of the extended forearm. Goyrand's last explanation—dislocation of the triangular fibro-cartilage at the wrist—cannot maintain itself against the overwhelming clinical evidence of the existence of a lesion at the elbow, supported, as it is, by experiment, especially since it has no better foundation than the impression that the click which was heard during reduction was produced at the wrist and not at the elbow. Against its correctness are the facts that although exaggerated pronation will effect such a dislocation, yet there is nothing to prove that the displacement will not immediately correct itself when the limb is released, and that there is not only no proof of the intervention of exaggerated pronation in the clinical cases, but it was, furthermore, certainly absent in some, and probably in all. The only difficulty is to explain the well-established symptoms of injury at the back of the wrist in some of the cases. Possibly such cases may be of a different character from the others, actual

[1] Dugès: Journal hebdomadaire, 1831, vol. iv. p. 196.

dislocation backward of the lower end of the ulna (*vide infra*), and Goyrand's explanation may be true of them; or the symptoms may be due to an associated sprain of the wrist.

The experience of Chassaignac, who treated his cases as paralytic and saw them gradually recover, indicates that the lesion may be spontaneously corrected; but, on the other hand, there is reason to think that some of the cases of forward dislocation of head of the radius found in adults, which had existed from childhood, were originally of this kind, and that the head had gradually become displaced further forward. All who have treated cases agree that reduction is easily effected, usually by supination; some add flexion of the elbow. Hutchinson recommends pronation and flexion of the elbow.

Dislocation of the Head of the Radius with Fracture of the Ulna.

The coincidence of a fracture of the shaft of the ulna with dislocation of the head of the radius is not infrequent, and since the discovery of either of the two injuries may lead the surgeon to overlook the other, the possibility of the coexistence should always be borne in mind. Malgaigne attached so much importance to this warning that he formulated and italicized the following two recommendations:

1. In any fracture of the ulna alone look for a dislocation of the radius.
2. In every fracture of the forearm in which the swelling extends above the elbow, remember that simple fracture is rarely accompanied by so much swelling, and carefully explore the articulation.

To complete the warning a third precaution should be added, namely, that in every dislocation of the head of the radius alone, fracture of the ulna should be sought for.

The complication has received the attention of most systematic writers upon dislocations, and has been made the subject of monographs by Malgaigne,[1] Grenier,[2] and Dörfler.[3] The latter collected nineteen cases, but the injury appears to be of more frequent occurrence than this fact would indicate, for Malgaigne saw four cases, von Pitha two or three, and Dörfler reports four cases from the practice of the surgeon under whom he was serving.

The cause in a certain number of cases—five of Dörfler's nineteen—has been direct violence, as the kick of a horse, received upon the inner or inner and posterior aspect of the upper part of the ulna, first breaking that bone and then driving the head of the radius forward and outward from its place: in others it has been a fall upon the arm, and it is uncertain whether the ulna was broken by direct or indirect violence. In Gerdy's case the patient declared that he fell upon his extended hand; and in one that came under my care in August, 1885, the patient, a boy

[1] Malgaigne: Revue médico-chirurgicale, vol. xiii. pp. 82 and 90.

[2] Grenier: Recherches sur la luxation du radius que complique la fracture du tiers supérieur du cubitus; Thèse de Paris, 1878.

[3] Dörfler: Fractur der ulna in ihrem oberen Drittel combinirt mit Luxation des Radius; Deutsche Zeitschrift für Chir., 1886, vol. xxiii. p. 338.

seven years old, had fallen from a wagon and sustained a compound fracture of the ulna at its middle, the wound in the skin being in the centre of the anterior aspect of the limb and having been produced from within outward by the sharp end of one of the fragments; the radius was displaced forward, upward, and inward so far that its concave upper surface could be distinctly felt. There was no bruise on the back of the forearm, and I thought the fracture had been produced by indirect violence. Dörfler inferred from the results of his experiments that the fracture is the primary injury and is always produced by direct violence, and that the dislocation is secondarily produced either, and more frequently, by the continued action of the original force, or by a new, indirect violence.

In ten of his nineteen cases the patients were from three to fifteen years old; the remaining nine were from thirty-five to sixty-five years old.

The only autopsical record I have found is one by Marchand,[1] and, unfortunately, it is not entirely clear. It is stated that the external lateral ligament was torn, the ulna was broken in its upper third, and the head of the radius was displaced to the outer side of the epicondyle; the annular ligament was untorn, but "no longer surrounded the neck of the radius; it seemed rather to embrace the radial capsule (cupule, head?), and the radius seemed to have escaped below it."

Dörfler's experiments showed that the parallelism of the radius and the lower fragment of the ulna was preserved, with production of an angle in the ulna at the point of the fracture; the annular and the anterior ligaments were torn. The limb was shortened, and crepitation was perceived on handling it. Clinically, a prominent feature is the marked swelling at the elbow, due in part to the displacement of the radius and in part to inflammatory reaction. The displacement of the radius is usually forward, sometimes forward and inward, forward and outward, or directly outward.

Among the complications were observed subluxation of the lower end of the ulna, wound of the integument either by the direct action of the causative violence or from within outward by the end of the fragment, making the fracture compound, fracture of the epicondyle or external condyle, and more or less paralysis of the extensor muscles of the wrist and fingers due to stretching or rupture of the musculo-spiral or posterior interosseous nerve.

The prognosis is good if the displacements are promptly corrected, and even if the dislocation of the radius persists the restoration of function may be nearly complete. Malgaigne mentions a case of such persistence after an injury received in childhood, in which extension and supination were complete, flexion almost complete, and pronation restricted about one-quarter; the head of the radius had passed upward in front of the humerus by the aid of marked deviation of the forearm outward and by an absolute ascension along the ulna which was shown by the fact that the styloid processes of the two bones were on the same level.

On the other hand, failure of union of the fracture has been noted (Norris[2]), and persistent extensor paralysis (Dörfler).

[1] Marchand: Bull. de la Société Anatomique, 1874, p. 680.
[2] Norris: Amer. Journ. Med. Sciences, vol. 31, p. 20.

Reduction in recent cases has been easy; in my own the dislocation could be readily produced and reduced by pressure on the radius when the elbow was held at a right angle. The most suitable method of reduction appears to be traction upon the extended limb, followed by direct pressure upon the radius and then by flexion of the elbow. The extended position during traction is desirable in order to avoid the interposition of the torn anterior ligament. After reduction the limb should be kept flexed within a right angle, and midway between supination and pronation.

CHAPTER XXI.

DISLOCATIONS OF THE ELBOW.—(*Continued.*)

TREATMENT OF OLD DISLOCATIONS. CONGENITAL AND PATHOLOGICAL DISLOCATIONS.

Treatment of Old Dislocations.

The loss of mobility in old dislocations of the elbow, especially of the backward ones, is often so great that the disability is serious; the patient is unable to bring the hand to the head or chest, and is able to use it only in the arc of a circle whose radius is nearly equal to the length of the extended limb, and he may, in addition, possess only such rotation as can be effected by movements at the shoulder. Although successful attempts to reduce dislocations of several months' standing were occasionally reported, yet failure was the rule, and the only means of alleviating the condition were fracture of the olecranon and excision of the joint, operations which, while they increased the range of motion, brought with them disadvantages of their own, such as loss of active extension and lack of solidity, which disinclined the surgeon to offer, and the patient to accept them.

Consideration of the anatomo-pathological conditions of an old unreduced dislocation not only freely explains the difficulty of effecting reduction but even makes it appear surprising that reduction should ever have been satisfactorily accomplished. The overriding of the bones along the back of the humerus leads to the formation of new cicatricial bonds between the olecranon and the humerus and to the establishment of new attachments by the torn lateral ligaments so far above and behind the centre of motion of the old joint that almost no flexion is possible without their rupture or elongation, and the return of the bones to their place can be effected only after a far more extensive rupture of these soft parts than that which accompanied the dislocation. In attempting to rupture these bonds by forced flexion the forearm is used as a lever the fulcrum of which is situated on the ulna below the coronoid process, and the rupturing strain is exerted through the olecranon upon the ligaments and adhesions connected with it, and it is not to be wondered at that this process should so frequently have been broken in the manipulation. In addition, the greater sigmoid cavity very promptly fills with cicatricial tissue, partly of new formation and partly furnished by the upper part of the posterior portion of the capsule which slips in between it and the back of the humerus and permanently occupies the concavity which should, after reduction, embrace the trochlea; this pad of tissue is found so firmly united to the cartilage of the olecranon that its removal in the

reported arthrotomies has required the use of the knife. The adhesion of the capsule to the articular surface of the front of the trochlea and the capitellum has not been found to be so close, and the cartilage of their surfaces has been found, even after the lapse of several months, almost entirely unaltered in appearance.

Furthermore, the injury is common in the young, in whom the osteogenic power of the periosteum is great and in whom the epiphyses are still growing. The effect of the injury, especially if the periosteum is stripped up, is, therefore, to produce new formations of bone around the joint which contract adhesions with the other bones or mechanically interfere by interposition to prevent the reduction of the dislocation; and, further, the epiphysis of the humerus, relieved of the pressure normally exerted upon it by the radius and ulna, grows more rapidly and irregularly, and its articular surface may thus lose its shape and become unfit to receive the others again. This deformity, by exaggerated growth has been especially noticed in the capitellum (see *pathological and congenital dislocations*), the extension being downward and forward. In a specimen shown by Dr. Lange to the New York Surgical Society, October 25, 1886, an incomplete outward dislocation in a child eight years old that had existed for only three months, a specimen obtained by excision, the capitellum formed an almost hemispherical protuberance upon the front and lower part of the epiphysis, the inner side of the trochlea was flattened, and the external condyle had grown outwardly so far that it presented a surface nearly half an inch broad beyond the capitellum; I interpreted the last named change as due to the stripping up of the periosteum and the attachment of the external lateral ligament, with the consequent formation of new bone on the outer side of the condyle.

These changes are clearly incompatible with successful reduction by the means employed in fresh cases, even if the force employed be sufficient to rupture the adhesions and bring the bones down to the proper level. It is true that successes have been occasionally reported, but the reports rarely go beyond the statement that reduction was accomplished, and they leave the subsequent history of the case and degree of reëstablishment of the functions unrecorded. Until quite recently the only methods employed have been forcible attempts to reduce by traction and the breaking of adhesions, sometimes aided by subcutaneous division of the tendon of the triceps, or of adhesions on the sides and back of the joint, increase of the range of motion by the same means without reduction, reduction after fracture of the olecranon by forcible flexion, and excision of the joint.

Albert says that Liston, more than forty years ago, successfully reduced an old dislocation after subcutaneous division of all tense bands, and that in 1847 Blumhardt successfully practised arthrotomy in a similar case, making two lateral incisions, and dividing through them all the adhesions that opposed reduction. This case appears to have been entirely lost sight of, and it was not until thirty years later, in 1877, that Küster,[1] in reporting a case of fracture and dislocation of the astragalus treated by excision, suggested that old dislocations of other joints might be success-

[1] Küster: Berlin. klin. Wochenschrift, 1877, p. 16.

fully treated by arthrotomy. In the following year Trendelenburg,[1] in a paper recommending temporary division of the olecranon to facilitate operations upon the elbow-joint, reported a case of incomplete outward, or outward and backward, dislocation of both bones with avulsion of the epitrochlea which he had treated by making an incision along the tendon of the biceps, and chiseling away enough bone from the lower end of the humerus in front of the coronoid process to allow flexion to a right angle; the result was good to that extent. A little later Volker[2] reported a case of incomplete outward dislocation of the left elbow of six months' standing in a boy thirteen years old, in which, after division of the olecranon, he had divided the adhesions, dissected away the new tissues in the sigmoid fossa, and had then been able to reduce; as the change in the shape of the bones favored recurrence he removed the head of the radius. He then sutured the olecranon with two silkworm-gut sutures passed from side to side of the bone, closed the wound, and obtained a good result. His incision was U-shaped, the sides extending along the borders of the triceps, and the bottom of the U crossing the olecranon at the point where it was to be divided. The position of the limb (ankylosis in almost complete extension) and the evidences of serious pressure upon the ulnar nerve were important factors in the determination to operate. He was so pleased with the result that he looked forward with confidence to the adoption of the method in all old dislocations with much disability.

Trendelenburg[3] promptly claimed priority in the suggestion of preliminary division of the olecranon, and reported a case of backward dislocation of both bones of eight weeks' standing successfully treated in the same manner. His incision was a curved transverse one, the convexity directed upward, crossing the median line well above the olecranon, and the flap was then dissected and reflected downward to the point at which the olecranon was to be divided; this division of the olecranon was done with a chisel. Because of difficulty in bringing the olecranon down the limb was dressed in extension, but after the nineteenth day, when the wound was healed, the position was gradually changed, and four weeks later the joint could be flexed to a right angle. The olecranon reunited solidly in this case and in Volker's.

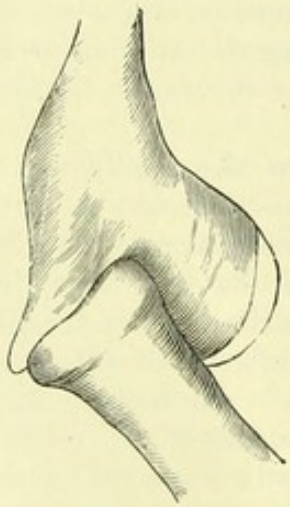
In 1885 Nicoladoni[4] published a short paper on the application of arthrotomy to old dislocations of various joints, and included in it the report of two cases in which he had practised it at the elbow. The first case was an almost complete outward dislocation of the left elbow in a lad sixteen years old, which had existed for eight months; the epitrochlea was broken off and drawn under the trochlea; the limb was in extension, flexion was entirely lost, but rotation was preserved. An incision eight centimetres long was made in front along the inner border of the trochlea, and through this the fractured epitrochlea was removed; a second incision of the same length was made on the outer side of the joint through which,

[1] Trendelenburg: Archiv für klin. Chir., 1879, vol. 24, p. 790.
[2] Volker: Deutsche zeitschrift für Chir., 1880, vol. 12, p. 541.
[3] Trendelenburg: Centralblatt für Chir., 1880, p. 833.
[4] Nicoladoni: Wiener med. Wochenschrift, 1885, p. 728.

after removal of a small piece of bone that had been broken from the condyles, the soft parts were separated from the radius and the humerus; then, through a longitudinal cut made in the tendon of the triceps, the adhesions between the olecranon and the back of the humerus were separated, and the bones were then easily restored to place. The wound healed after slight suppuration, passive motion was begun after the third week, and the patient was dismissed after seven and a half weeks with the elbow flexed and movable through an arc of 35° or 40°. Nine months later he wrote that he would flex and extend the joint freely, but that rotation was not quite so free.

The second patient was a large, powerful man, forty-one years old, with a backward dislocation that had existed for six months. The limb was almost completely extended and immovable; there was some passive rotation. The olecranon was situated unusually high. Two lateral incisions, each sixteen centimetres long, were made; through the first, over the outer condyle in front of the head of the radius, the soft parts were separated from the bone, leaving the periosteum undisturbed, into the trochlea and above the fossa trochlearis in front and behind; the separation from the cartilage was easy in front, but very difficult behind; through the second incision, on the inner side of the elbow, the flexor muscles were cut away close in front of the epitrochlea, and the separation of the soft parts from the bones completed. The greater sigmoid cavity was found filled with hard cicatricial tissue, which was cut and scraped away after separation of the posterior attachment of the orbicular ligament. Reduction was then easily made. Two drains were placed on the flexor side of the joint, and one through the tendon of the triceps; the wound was closely sutured, a Lister dressing applied, and the limb placed in a splint. Recovery took place without incident, and the patient was dismissed at the end of four weeks, the wounds being almost healed. There was good active rotation, but very little flexion; passively, there was complete extension and flexion to a right angle.

FIG. 92.



New formation of bone in an old unreduced dislocation

In a personal case the result of a similar operation was not satisfactory, and the subsequent operation which became necessary showed nutritive or inflammatory changes in the bones and cartilages, as the apparent result of the first one, which might have seriously interfered with the usefulness of the joint. The patient was a girl, eleven years old, with a backward dislocation of both bones, of five months' standing. The limb was flexed at an angle of 150°, and was immovable except for some rotation. The operation was done in April, 1886. A free incision was made on the outer side, through which a mass of bone of new formation (Fig. 92) on the back of the external condyle, extending downward to form a new socket for the head of the radius, was chiselled away; the anterior part of the capsule was easily separated from the articular cartilage of the humerus, which appeared smooth and unaltered, but the dissection behind

the humerus was made very difficult by the interposition of a mass of cicatricial tissue between it and the greater sigmoid cavity, which entirely filled, and was firmly adherent to, the latter. Dr. McBurney, who was kindly assisting me, advised the making of a second incision upon the inner side of the elbow, but, unfortunately, I preferred to divide the olecranon, being encouraged so to do by the reports of some of the above-mentioned cases, and by personal experience of the method in operations for tubercular disease of the joint. So the incision was extended across the olecranon, and this process was divided obliquely at its thinnest part. The back of the condyles was then easily freed, and the epitrochlea was found to have been broken off, and to have reunited with the humerus at some distance above its normal position. The attached internal lateral ligament was then separated from it, and the bones were then readily brought into place. The olecranon was sutured with silkworm-gut, the wound closed, with a drainage tube behind the condyle, and the limb placed in a splint with the elbow at an angle of about 145°. The remaining attachments of the olecranon made further flexion seem undesirable. Two days later the dressings were changed, and the limb enveloped in plaster-of-Paris bandages. A week later a fenestra was cut and the tube withdrawn; little or no suppuration. During the following month I was absent from the city; on my return the dressing was removed, and the wound found to be healed, but the dislocation had recurred. A second operation was done two months after the first, by a curved incision, its convexity upward, starting just below the head of the radius, and crossing above the olecranon; the ulnar nerve was exposed and drawn aside, and the joint opened by cutting through the triceps. The joint surfaces were found almost denuded of cartilage, and much changed in shape by bony and fibrous growths at their borders, so I excised the lower end of the humerus and the head of the radius; the bone was much softer than usual. I enlarged the sigmoid cavity, and cut a notch in the lower edge of the humerus to receive the olecranon; catgut drains. Close fibrous union of the former division of the olecranon was found. The wound healed without incident in thirteen days, and the patient was subsequently dismissed with flexion to within a right angle and almost complete extension. On looking her up eight months later I found complete bony ankylosis at a right angle.

I do not think the division of the olecranon directly favored the recurrence of the dislocation in this case; it was rather due to the posture of only partial flexion in which the limb was placed, but as the choice of this posture was imposed by the necessity of avoiding a strain upon the olecranon that might have prevented its reunion, the division was the indirect cause. In another case I should use the method by two lateral incisions without division of the olecranon.

The change in the cartilage could hardly have been caused by the inflammatory reaction following the operation, for that was not sensibly greater or more prolonged than after the original dislocation. I am inclined to attribute it rather to the keeping of the knife too close to the bone in the separation and freeing of the soft parts, and think, therefore, that in a similar case it would be better to divide the adhesions than to dissect them from the humerus.

The reported cases are too few to permit much generalization, but the large measure of success which they have furnished is an encouragement to further trial. In the meantime, the rules of conduct in the presence of old backward dislocations of the elbow formulated by Albert appear to be judicious. He says that in elderly patients he limits interference to rupture or subcutaneous division of the adhesions, and that if reduction then fails he forcibly flexes the elbow to a right angle, with or without fracture of the olecranon, and allows it to become ankylosed in that position.

In younger patients he makes the attempt to reduce, sometimes dividing the tendon of the triceps so as to avoid fracturing the olecranon ; reduction failing, he does an arthrotomy with two lateral incisions, and if this also fails he proceeds to resection. This advice was formulated before the publication of the method by division of the olecranon, but I should not change it in favor of resorting to the latter.

In *old incomplete outward lateral dislocations* little is to be hoped for from forcible subcutaneous rupture of the adhesions, for the common interposition of the fractured epitrochlea cannot thus be overcome, and the probabilities are decidedly against the success of an attempt to remove by this means the cicatricial obstacles on the inner side. The choice will probably lie between improving the attitude by forcible flexion, if the limb is extended, and arthrotomy, the internal incision being made in front of the trochlea rather than upon its side.

In *old dislocations of the radius alone*, in which partial or complete ankylosis renders an operation desirable, the examples quoted in the preceding chapter may serve as guides. In those cases in which the dislocation has occurred in childhood and has been followed by exaggerated growth in length of the radius excision of its head is the only suitable operation. The results in the reported cases are not very encouraging.

Sprengel[1] reports a case of dislocation backward and outward of five weeks' standing in a boy six years old in which he effected reduction and obtained a perfect functional result by arthrotomy and removal of a portion of the back of the capsule that was interposed between the head of the radius and the ulna. He made an anterior incision along the edge of the supinator longus, exposed the musculo-spiral nerve and its two branches and drew them outward with the outer flap ; by this means the capsule was freely exposed to view, and he was enabled to see that the rent was on its outer side, and then by drawing the head of the radius outward with a sharp hook the obstacle to reduction was found to be a fold of the posterior portion of the capsule (probably part of the annular ligament) interposed between the radius and ulna, and firmly adherent to the lower sigmoid cavity. After having liberated this fold he was able to replace the head of the radius and to close with catgut sutures the rent in the capsule except over a small space on the outer side.

He refers to a case of backward dislocation of the head of the radius in which he obtained a similar success by arthrotomy and separation of the capsule from the upper surface of the radius.

[1] Sprengel : Centralblatt für Chirurgie, 1886, p. 153.

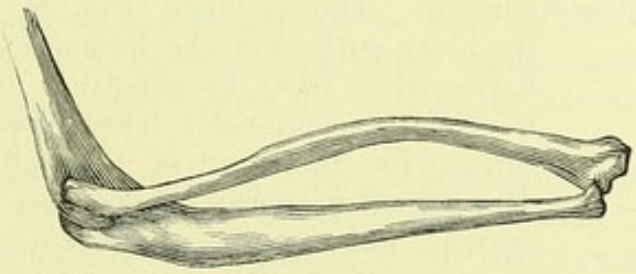
Congenital and Pathological Dislocations.

Although a considerable number of cases have been reported as congenital dislocations of the upper end of the radius, yet in all of them the proof that the deformity existed at birth is defective; in a few it was noticed at so early a period that the probability of its congenital existence is great; in others, and even in those in which both radii were affected, the displacement can be referred with equal plausibility to causes operating after birth, and the alterations in the shape of the bones to the effect of the displacement and the changed functional conditions.

To the 13 alleged cases briefly quoted and analyzed by Malgaigne, 9 of which are quoted in detail by Gurlt,[1] may be added several that have been since reported, those of Humphrey,[2] Hayem,[3] Mitscherlich,[4] Allen,[5] Hamilton,[6] Phillips,[7] Pye-Smith,[8] and Heele.[9] In addition is a case, a dislocation forward, observed and briefly mentioned by Krönlein; it is quoted in Chapter XVIII., under congenital dislocations of the shoulder.

The first 4 were examined post-mortem, the others only clinically. In 4 of them the dislocation was backward, in 3 forward; in all both radii were dislocated. Humphrey's, Hayem's, and Allen's were in adults, of whom no previous history was obtained. In Humphrey's the lower part of the left ulna was lacking evidently because of defective development; the right ulna (Fig. 93) was firmly ankylosed to the humerus

Fig. 93.



Dislocation of the head of the radius upward in consequence of arrest of development of the ulna.

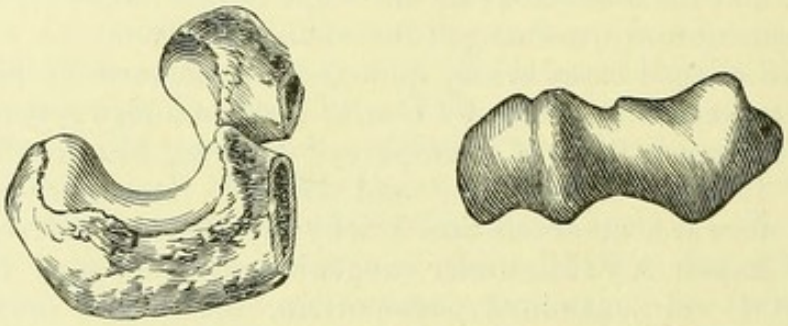
nearly at a right angle, and was eight inches long, its lower end was well formed and was on the usual level with the radius; the radius was also eight inches long, and its head was displaced upward and rested against "the forepart of the ridge that ascends from the outer condyle to the shaft," it was somewhat irregular in shape, and its extra length was developed in its shaft and not in its neck as in several of the other reported cases. The trochlea of the humerus was imperfect. The displacement upward was clearly the result of the elongation of the radius,

[1] Gurlt: Beiträge zur Vergleich. path. Anat. der Gelenkkrankheiten, 1853, p. 317.
[2] Humphrey: Med. Chir. Trans. vol. 45, p. 296.
[3] Hayem: Bull. de la Société Anatomique, 1864, p. 56.
[4] Mitscherlich: Arch. für klin. Chir., 1865, vol. 6, p. 218.
[5] Allen: Glasgow Med. Journ., 1880, vol. 14, p. 44.
[6] Hamilton: Loc. cit., p. 888.
[7] Phillips: British Med. Journ., 1883, i. p. 773.
[8] Pye-Smith: Lancet, 1883, ii. p. 993.
[9] Heele: Lancet, 1886, ii. p. 249.

whatever the cause of the original displacement from contact with the capitellum may have been.

Mitscherlich's patient was a girl six years old who had been born with clubfoot; both elbows were deformed, and this defect was thought also to have existed from birth. The head of the radius could be felt in front of the outer half of the coronoid process; extension was perfect, but flexion was limited on the right side to an angle of 70° and on the left to one of

FIG. 94.



Congenital dislocation of the left elbow. (MITSCHERLICH.)

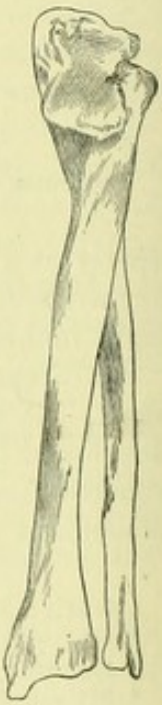
110°, both hands were supinated. The elbows were more cylindrical in form than usual; the wrist and fingers were slightly flexed but could be straightened. The child was of stunted development and rather feeble intelligence. Excision of the left elbow was done by von Langenbeck with the object of increasing its range of motion, and the child died in consequence of the operation. The specimen (Fig. 94) showed that the trochlear surface of the humerus was narrowed in front by extension upon it of the exceptionally large circular surface for the head of the radius. The articular surface of the ulna was normal, but the radius was not in contact with it.

FIG. 95.



Allen's case of cognenital dislocation of the elbow.

FIG. 96.



The same.

Allen's specimen (Figs. 95 and 96) was taken from the body of an elderly man without history. Both elbows were affected; flexion was normal, extension possible only to a right angle; rotation was entirely lost, the limbs being fixed in pronation. Both radii were displaced backward, but only the left elbow is described in detail. The specimen was not presented as an example of congenital dislocation, but only to show the changes effected in the bones in consequence of unreduced dislocation in early life. These changes modified the shape of the lower end of the humerus and of the radius. The radius crossed the front of the ulna and was united with it by bony union for a distance of about three inches at their upper part; below this part the shaft of the radius was much thickened. The neck of the radius was one and a half inches long, so that the head was carried well upward behind the humerus on the inner side of the

olecranon, and this overriding was further increased by the abnormal growth of the external condyle downward and outward, the extent downward of the growth being estimated at half an inch. The trochlear surface was deformed, mainly by the loss of much of its inner lip. The olecranon fossa was so far filled up that the septum between it and the coronoid fossa was one-third of an inch thick. The shaft of the ulna was small; its lower end was normal and preserved the usual relations with the radius. The specimen appears closely to resemble those of the earlier cases reported by Sandifort, Dubois, and Verneuil, and has as much, or as little, reason to be thought congenital as most of the others. It is of value in the interpretation of the changes observed in other specimens.

The report of Pye-Smith's case is very brief. The patient was a woman; the head of the left radius was displaced backward. She was one of a family of eleven persons, eight of whom showed abnormalities of the joints, one brother having a similar dislocation of the right radius. The father, and his father, uncle, and cousins had various deformities, club-feet, badly developed nails, etc.

Phillips's patient was a well developed girl, seventeen years old. "The head of each radius formed a well-marked prominence behind the external condyle of the humerus. The elbow-joint could be fully extended and could be flexed to almost the normal degree, but only with the hand in the semi-pronated position. This action was produced mainly by the supinator muscle; the biceps appeared to be much atrophied. The head of the radius could be rotated to a small extent; and the various prominences of the elbow-joint, as well as the head of the radius itself, were fully developed. The mother of the child stated that the deformity was noticed almost immediately after the birth of the patient." The delivery was natural and easy.

Heele's patient was a loose-jointed, choreic boy, eight years old, of very backward intelligence. The left radius was dislocated by any slight motion and was usually out of place; it was easily reduced by flexion of the elbow or by pressure upon the bone in any position of the limb. The right radius was partly dislocated and irreducible, only one-fifth of the head remaining in contact with the humerus. Both dislocations were "backward and upward." Both condyles seemed small. All movements were possible, but rotation was weak, especially supination. The displacements were noticed shortly after birth; no history of accident.

In the last three cases the histories place the appearance of the deformity at so early a period that it is not improbable that it existed at birth, or, at least, that the structure and form of the joint were such at birth that the displacement was inevitable. In none of the older cases is a similar history found; in R. W. Smith's,[1] which is one of those quoted by Malgaigne, the deformity had indeed existed from birth, but instead of being a dislocation it was an extreme malformation not only of the upper end of the radius but also of its lower end and of the ulna and carpus.

The arguments upon which the attribution of a congenital character

[1] R. W. Smith: Fractures and Dislocations, p. 247.

was based in most of the older cases and in those of Humphrey and Hayem, and which apply equally well to Alden's, are the existence of the deformity on both sides and the changes in the shape of the articular ends of the bones; in Humphrey's and in Deville's there is in addition the lack of the lower part of the ulna.

The bilateral character, even with persistence of the ligaments, is not a proof that the displacement is not traumatic, as Bartel's case, quoted above under backward dislocations of the radius, shows, for in it both radii were gradually dislocated in a weakly lad by long-repeated efforts in pushing a cart.

The irregularities in the bones may, in part at least, be fairly attributed to the change in their relations, especially the very notable one of elongation of the neck of the radius reported in several cases. This is in keeping with similar instances of overgrowth at other points where the normal conditions of pressure have been lost, and with the coincident elongation downward of the external condyle of the humerus noted in Allen's case and in one of R. W. Smith quoted by Gurlt (loc cit., p. 320). It requires only that the displacement should occur before the growth of the skeleton is complete.

In short, although the recent clinical cases approach more nearly to the character of a demonstration, Malgaigne's conclusion that a congenital dislocation, while probable, has not yet been proved to have existed may still be repeated.

The only recorded case of dislocation of both bones of the forearm at birth is one reported by Chaussier and quoted by Pingaud.[1] A young woman during the ninth month of pregnancy felt her child move so vigorously that she almost lost consciousness. The movements were repeated three times in the course of ten minutes; delivery took place normally at term. The child was weak and presented a complete dislocation of the forearm backward. Malgaigne thought it probable that the lesion was produced, not by the convulsive action of the muscles, but by the striking of the limb against the wall of the uterus.

A few instances of dislocation due to pathological changes within the joint, such as fungous arthritis or relaxation of the ligaments in the course of an acute illness, have been reported.

[1] Pingaud: Dict. Encyclopédique des Sc. Méd., art. coude, p. 606.

CHAPTER XXII.

DISLOCATIONS AT THE WRIST.

DISLOCATIONS OF THE LOWER RADIO-ULNAR JOINT; OF THE RADIO-CARPAL JOINT; OF THE CARPAL BONES; CARPO-METACARPAL DISLOCATIONS.

A. Dislocations of the Lower Radio-ulnar Joint.

These dislocations, obscurely mentioned by the earlier writers, were first described, according to Malgaigne, in 1771, by Desault, who reported five cases and said he had observed a great number of others. He spoke of the injury as a dislocation of the radius, but Boyer and Dupuytren preferred to call it a dislocation of the ulna, and their choice has been generally accepted and followed. Both *traumatic* and *pathological* forms have been described. The reported cases are comparatively few if those cases are excluded in which the injury is a complication of a fracture of the lower end of the radius, and those injuries observed in young children which are generally thought to be a subluxation of the head of the radius, but which some consider dislocations of the lower end of the ulna; few surgeons who have reported their experience have seen more than a single case. Tillmanns[1] collected 48 cases in addition to one observed by himself, of which the dislocation was forward in 16, backward in 18, and inward in 9, and in 5 the direction was not stated; but in 3 of the first group, 8 of the second, all of the third, and 1 of the fourth, there was also fracture of the radius, and in 4 others the ulna perforated the skin and there is reason to think the radius also was fractured. Excluding the cases complicated by fracture, and including only 3 of Desault's 5, there remain 12 dislocations forward and 10 backward; to these may be added 2 backward and 3 forward seen or collected by Hamilton, and 3 forward collected by Poinsot, making a total of these two varieties of 18 forward and 12 backward. The reported dislocations inward or, more strictly speaking, downward and inward, are really dislocations of the broken end of the radius and the attached carpus upward; to these may be added also the few cases of dislocation of the head of the radius (q. v.) in which the entire bone has been displaced upward along the ulna.

In the preceding chapter mention has been made of the theory advanced by Goyrand, that the injury frequently seen in very young children and generally thought to be a subluxation of the head of the radius by elongation was a dislocation backward of the lower end of the ulna. Although the theory cannot be accepted as a correct explanation of the great majority of the cases, yet it may be true of some of them—of those few in which pain and swelling are found only at the back of the wrist—and if so the list of reported cases of the injury now under con-

[1] Tillmanns: Arch. der Heilkünde, 1874, vol. xv. p. 249.

sideration would have to be increased by additions to the backward variety, which would make it the more common of the two.

Dislocations backward.—The cause in most of the cases tabulated above was exaggerated pronation of the wrist; in some the mechanism is not indicated, and in others it is not clear. A few of them, Desault, Dugès, Rendu, have been included either by the surgeon himself (Rendu) or by other writers among dislocations of the upper end of the radius by elongation, and in these the injury was produced in very young children by traction upon, or forced pronation of, the hand. As above stated, several other cases, notably some of Snedden's (see Chapter XX., p. 000), presented similar symptoms and probably belong in this group. Sometimes the exaggerated pronation has been effected by external violence, as in Boyer's case, in which a lad engaged his hand between the spokes of a moving wheel; sometimes by muscular action, as in one of Desault's, a washerwoman who was wringing clothes, or in one of Rognetta's, a carpenter who was drilling a hole in a plank; Dalechamp's patient was bitten at the wrist by a horse.

The pathology has not been shown by direct examination of either recent or old cases, and the only experiments bearing upon it are those of Goyrand, quoted in Chapter XX., and they show only that by exaggerated pronation the triangular fibro-cartilage uniting the radius and ulna could be carried so far forward as to clear the end of the ulna entirely; he did not succeed in producing by this means a dislocation that would maintain itself without the aid of pressure upon the hand. It seems probable that in the clinical cases there was also rupture of the posterior radio-ulnar ligament.

Symptoms.—The hand is slightly or markedly pronated; its adduction has been noted by some, and diminution of the transverse diameter of the wrist by others. Flexion and extension of the wrist are free; supination difficult.

The deformity consists in a marked projection of the lower end of the ulna on the back of the wrist, and a corresponding depression in front; the ulna may, in addition, slightly overlap the end of the radius, so that its axis if prolonged downward would pass to the middle finger.

The diagnosis appears to be easy, the exception being again noted of the possible cases occurring in young children, in which the only symptoms are pain and swelling at the back of the wrist. Malgaigne calls attention to the danger of mistaking the cause for the effect in old cases in which the dislocation follows a chronic arthritis, and also of overlooking an associated fracture of the radius.

Reduction has always been readily effected by direct pressure on the radius, aided sometimes by abduction or supination of the hand; occasionally supination alone has been sufficient, and this is the rule in the supposed cases in young children. Even in old cases—sixty days—reduction has been easily made.

Recurrence has been noted in three cases. In one of Hamilton's the dislocation had existed twenty years, but the movements of the limb were perfect.

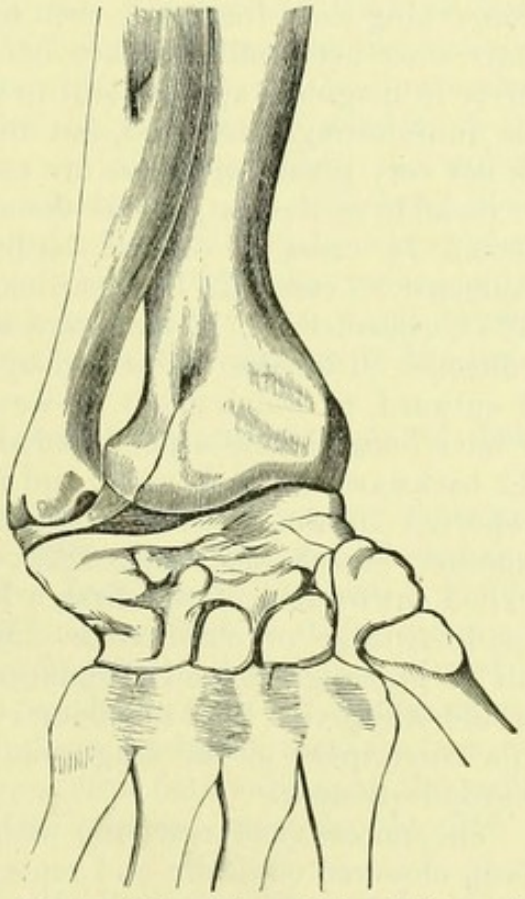
Dislocations forward.—Dislocation of the lower end of the ulna forward appears commonly to have been caused by direct violence acting in

opposite directions upon the lower ends of the radius and ulna while the hand was more or less supinated. It does not clearly appear that the cause has ever acted by carrying the movement of supination beyond its normal limit, although it is not improbable that this was the case in one or two instances.

No post-mortem examination has been reported, and the pathology of the injury can, therefore, only be inferred. Desault, however, met with a specimen of an old dislocation in the cadaver of a man sixty years old; the hand could not be extended, and rotation was very limited. The sigmoid cavity of the radius was filled with cellular tissue; the head of the ulna, situated in front of this cavity, rested on a sesamoid bone to which it was attached by a capsular ligament. Other injuries had contributed to the loss of motion. The hand was œdematous; the flexor tendons, pushed outward, adhered to one another and to the skin; the elbow could not be extended, and both shoulders were dislocated forward (Malgaigne, loc. cit., p. 688).

In an entirely unique case reported by Valleteau[1] the dislocation was compound. The patient's forearm had been caught between the spokes of a moving wheel; the ulna projected twenty-eight lines through the skin, crossing the front of the radius, which appears not to have been broken.

FIG 97.



Fracture of the radius and ulna; displacement upward of the lower fragment of the radius. (MALGAIGNE.)

Symptoms.—The forearm is partly pronated or in varying degrees of supination, the wrist flexed or extended, rotation difficult and painful. The lower end of the ulna is prominent in front, with a corresponding depression behind, and sometimes displaced toward the outer side so that it overlaps the front of the radius and its axis is directed toward the middle of the hand.

The diagnosis is easy, but search should be made, as in the preceding variety, for the possible coexistence of a fracture of the radius.

The best method of *reduction* appears to be by direct pressure upon the ulna and counter-pressure in the radius.

Dislocations inward and downward (Fig. 97) have been observed only in connection with fracture of the radius or, very rarely, with dislocation of its upper end, and are to be deemed complications or incidents of the other and more important injury.

[1] Valleteau: Gazette Médicale, 1836, p. 250.

In like manner, the serious complication of perforation of the skin by the ulna has occurred only once except in connection with fracture of the radius.

Pathological dislocations have been reported as the consequence of chronic suppurative arthritis and also of non-suppurative arthritis provoked by a sprain or by a fracture of the radius. Possibly the case reported by Rognetta[1] of a negro who suffered from an habitual dislocation backward gradually produced by the effects of his occupation as a wood-sawyer belongs in this category, the ligaments having become relaxed in consequence of an arthritis set up by the constantly repeated mechanical violence of the movement.

B. Dislocations of the Radio-carpal Joint.

These dislocations, long thought to be common because fracture of the lower end of the radius was habitually supposed to be a dislocation until Dupuytren forced a recognition of the error, are now known to be of infrequent occurrence. Dupuytren, in the vigor of his correction of the error, went to the other extreme and pronounced them unknown or of very great rarity, and this assertion has colored the general opinion concerning their frequency even to the present time. The statistics that have since been collected are not entirely trustworthy, perhaps, for the error in diagnosis appears still to be made and all reported cases cannot be unhesitatingly accepted, but there is reason to think that the rarity is not very great, and there are enough well-authenticated cases to make it possible to trace a general description of the injury. Malgaigne collected 14 cases, 8 of backward, 6 of forward dislocation. Parker[2] collected 33 cases, 23 backward and 10 forward. Tillmanns (loc. cit.), 1874, collected 24, 13 backward and 10 forward; and Servier[3] in 1880 collected 26 besides 1 observed by himself, 13 backward, 13 forward, and 1 outward, of which about 19 were not contained in Tillmanns's paper. I have found 13 cases published since 1880 and have myself observed 1, 12 backward and 2 forward, and it is worthy of note that 5 of these were reported in the *British Medical Journal* within six weeks of one another, March and April, 1880, the reports of the last 4 having been called out by that of the first. In addition, Albert speaks of 5 within his knowledge or observation. Even supposing Parker's 33 to include all of Malgaigne's and Tillmanns's, and counting 19 of Servier's, this would still give a total of about 70 cases more or less well authenticated, the correctness of the diagnosis in a number of them being entirely beyond question.

The necessity of receiving with some caution those cases that have been observed clinically and reported with scanty detail is shown by the errors in diagnosis that have been made by experienced surgeons fully aware of the difficulty. Malgaigne (loc. cit., p. 703) narrates three striking cases. At the time when Dupuytren was first questioning the

[1] Rognetta: Archives gén. de Méd. 1834, vol. 5, p. 396.

[2] Parker: Trans. South Carolina Med. Assoc. Abstract in N. Y. Med. Record, 1871, vol. 6, p. 396.

[3] Servier: Gazette Hebdom., 1880, p. 211.

correctness of the diagnosis in which fracture of the lower end of the radius was habitually taken to be a backward dislocation of the wrist, a patient presenting all the usual signs of this injury died at the Hôtel Dieu. Pelletan declared it to be a dislocation, Dupuytren a fracture, and the former did not vary from his opinion until after the last stroke of the scalpel had exposed the bone and showed the injury to be a fracture with crushing of the lower end of the radius. In 1834 Roux made the diagnosis of dislocation backward in the case of a child that had fallen from a tree; again dissection proved it to be a fracture, with separation of the epiphysis. Still more remarkable was a case reported by Chassaignac[1] in which he excised the projecting ends of the radius and ulna, thinking the case was dislocation; on careful examination it proved to be a separation of the epiphysis of the radius. The difficulty is probably not so great in dislocations of the carpus forward.

The dislocation may be complete or incomplete backward or forward, and in one case was incomplete outward; it may be simple or compound, or associated with fracture of the radius or ulna. Apparently fracture of the edge of the articular surface of the radius on the side toward which the carpus is dislocated is not infrequent; such fracture of the posterior lip of the radius is known in this country as "Barton's fracture," but it appears to me properly to belong among the dislocations, the fracture being only an incident or complication. The incomplete dislocations are mainly those in which only the outer portion of the carpus, the scaphoid and semilunaris, are dislocated from the radius, while the inner portion maintains its relations with the triangular fibrocartilage and ulna; this variety appears to be produced by a movement of rotation (pronation or supination) in which either the radius or the carpus is kept stationary while the other moves away from it; it appears to be sometimes associated with disturbance of the relations of the lower radio-ulnar joint.

In addition to the traumatic, a few pathological and congenital dislocations have been reported.

Dislocations backward.—The *causes* of this dislocation are characterized by great violence, as a fall from a height upon the palm of the hand; in some cases the wrist appears to have been flexed forward, "doubled under" the patient, in a fall while walking, or from a slight elevation: and in one case, Chapplain,[2] the injury appears to have been caused by direct violence, the wrist having been caught between the buffers of two railway cars. In the first form it appears probable that the anterior ligament yields, and that then the carpus slips backward upon the radius and ulna; in the second, the posterior ligament must be the first to rupture.

In two almost identical cases, Billroth,[3] Rydygier,[4] the mode of production is clearly shown: in the former, the patient, while pressing with the palm of his hand against a railway car in an effort to arrest its motion, was struck upon the back of the elbow by another car moving in

[1] Chassaignac: Bull. de la Société de Chir., 1868, p. 225.
[2] Chapplain: Bull. de la Soc. de Chirur., 1874, vol. 3, p. 461.
[3] Billroth: Arch. für klin. Chir., vol. 10, p. 601, quoted by Tillmanns.
[4] Rydygier: Deutsche Zeitschrift für Chirur., 1881, vol. 15, p. 289.

the opposite direction, and a compound dislocation of the wrist was produced, the articular surfaces of the radius and ulna projecting through the skin on the palmar surface. Rydygier's patient was caught in the same way between a wagon and a wall, alongside of which it was moving.

The *pathology* is illustrated by a number of post-mortem examinations, and by some cases complicated by wounds which permitted direct examination of the joint. The autopsy that has been reported with most detail is that of a case observed by Voillemier.[1] The patient was a man twenty-seven years old, who had fallen from the third story of a building, and received injuries which caused his death in four hours. The violence that caused the dislocation of the wrist was apparently received upon the palm of the hand while in dorsal flexion. The external and posterior ligaments were ruptured, the anterior was torn away from the radius, and the internal was intact but was separated from the ulna by avulsion of its styloid process. The tendons and muscles of the back of the forearm were not torn, but had been stripped off the radius, bringing with them the periosteum and small pieces of attached bone. The superficial flexor muscle was widely perforated and torn by the styloid process of the radius at its inner portion, that corresponding to the tendons of the ring and little fingers, the remainder being pushed to the outer side together with the median nerve and radial vessels.

In Servier's case, a man twenty-five years old, the ligaments were extensively torn, except those portions which bind the semilunar to the radius; all the ligaments that attach the semilunar to the scaphoid, os magnum, and cuneiform were torn, and the latter bone was in addition almost completely separated from the unciform and was fifteen millimetres distant from the styloid process of the ulna. The carpus, with the exception of the semilunar which remained solidly attached to the radius, was displaced backward about one centimetre; the radio-ulnar ligament was intact, and there was no fracture of any of the bones. The injury was caused by a fall from a great height in which the skull also was broken, the patient dying a few hours later.

Paret's[2] patient was a sailor who had received his injury in a fall from a yard to the deck; the entire anterior lip of the radius projected through the skin; the tendon of the flexor longus pollicis was torn, and the ulna broken in its lower third.

In a case reported by Colgate[3] there was a transverse wound of the skin on the front of the wrist, which apparently was not deep and did not communicate with the joint.

In a case reported by Marjolin (quoted by Servier), in which the dislocation was made compound by a wound at the level of the lower end of the radius and the patient died of purulent infection, the anterior and external ligaments were torn; the bones were intact.

In an old case dissected by Padieu (quoted by Servier) the first row of the carpus rested on the back of the radius.

In Lenoir's case a narrow fragment of the posterior articular border

[1] Voillemier: Arch. gén. de Méd., 1839, vol. 6, p. 401.
[2] Paret: quoted by Servier and Tillmanns.
[3] Colgate: Lancet, 1873, I., p. 697.

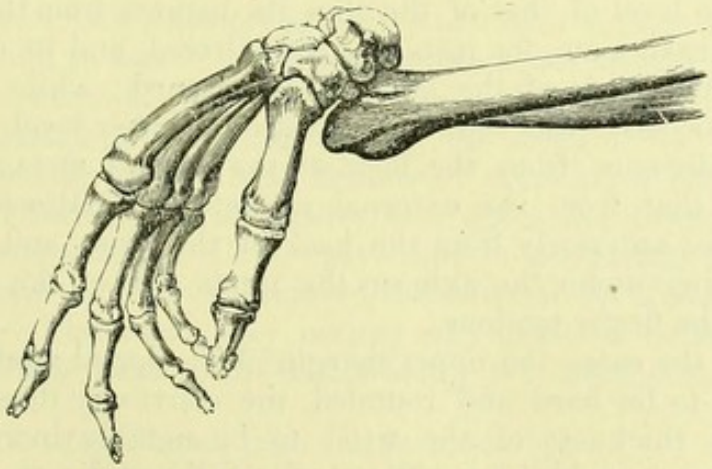
of the radius had been broken off; it remained attached to the capsule and was displaced backward with the carpus. This is the so-called "Barton's fracture of the radius" (see Fractures, p. 453). In no other autopsy of a backward dislocation has this fracture been reported, but it has been suspected to exist in some of the cases observed clinically, and a few specimens of the reunited fracture without history are in existence.

In a case quoted in the *Centralblatt für Chirurgie*, 1884, page 279, both styloid processes were broken.

Of the incomplete form, that in which only the outer portion of the carpus is dislocated, the only case given in sufficient detail is that of Dupuy:[1] the patient, a young and muscular porter, while trying to lift a cask had his hand forcibly supinated while the radius remained pronated. On examination two hours later the hand was found flexed and half supinated, while the radius was pronated. Both styloid processes could be distinctly felt, that of the ulna in its normal relations with the carpus, but that of the radius and the articular surface of the latter projecting as a ridge on the posterior aspect of the wrist. Fifteen millimetres above the posterior margin of the end of the radius was a rounded bony prominence, highest on the outer side and gradually diminishing toward the ulna. No crepitation; no shortening of the limb. Reduction was effected by traction and direct pressure.

In short, the dislocation is habitually accompanied by an extensive laceration of the ligaments, especially the anterior and external; avulsion of the posterior lip of the articular surface of the radius may take the place of rupture of the posterior ligament. The extensor tendons are lifted from their grooves but not torn; the flexors may be torn or pushed to the outer side by the projecting radius; the median nerve and radial artery have always escaped injury, even when the radius has been driven through the skin. The carpus may be displaced directly backward so as to rest upon the posterior surface of the radius, without

FIG. 98.



Dislocation of the carpus backward. (FERGUSSON.)

change in the relations of the several bones that constitute it, or with more or less separation of them from one another, the semilunar bone in

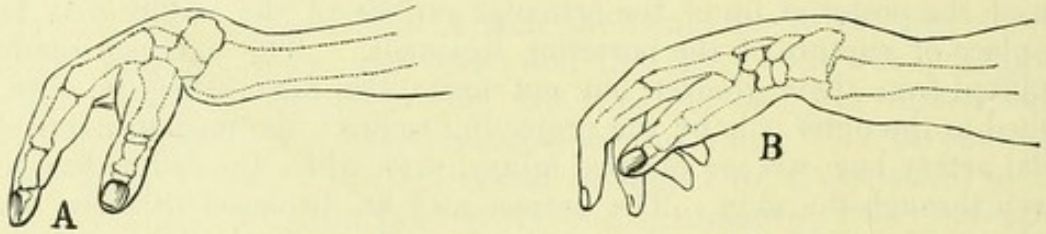
[1] Dupuy: Journ. de Bordeaux, July, 1850, quoted by Tillmanns.

one case being completely detached from the others and remaining attached to the radius; or the displacement may be complete only on the radial side, the movement being one of rotation (supination) of the carpus turning on its inner side as a centre. Fig. 98, from Fergusson, represents the position of the bones in the complete form. A superficial transverse rent in the skin on the palmar surface of the wrist observed in one case was probably caused by overstretching of the skin across the projecting end of the radius.

Symptoms.—The deformity bears a close resemblance to that of Colles's fracture, but yet the differences are such that Albert (*Chirurg.*, vol. 2, p. 440) says he was able to make the differential diagnosis at sight. These differences are that the swelling on the anterior aspect of the wrist and lower part of the forearm extends further down, nearer to the hand, in dislocation than in fracture, reaching even to the ball of the thumb, and ends more abruptly; that on the back of the wrist is more sharply outlined at its upper border (Fig. 99). In addition, the hand and wrist are commonly more flexed upon the forearm and less movable in dislocation, and may be adducted.

On palpation the styloid processes should be recognized, and their relations to each other and to the bones of the hand and wrist determined; in fracture the styloid process of the radius is displaced upward

FIG. 99



Diagrammatic, to indicate the deformity in (A) dislocation of the wrist backward, and (B) Colles's fracture of the radius.

to or above the level of that of the ulna, its distance from the head of the second metacarpal bone, for instance, is unaltered, and its distance from the external epicondyle of the humerus is lessened; while in dislocation the styloid process of the radius remains on a lower level than that of the ulna, its distance from the head of the second metacarpal bone is lessened, and that from the external epicondyle unaltered; it is also further removed anteriorly from the back of the wrist, and may perhaps be felt projecting under the skin on the inner side of the radial artery and some of the flexor tendons.

In some of the cases the upper margin of the dorsal swelling could be distinctly felt to be hard and rounded, the convexity directed upward, and the bony thickness of the wrist to be notably increased antero-posteriorly, and movable upon the shaft of the radius. The anterior swelling is hard and irregular.

Reduction has usually been easily effected by traction upon the hand, and direct pressure on the carpus, and as a tendency to recurrence is not to be anticipated, no other dressings are needed than such as will secure immobility until the arthritis shall have subsided.

In compound cases the treatment should be rigorously antiseptic, with ample provisions for drainage. Many surgeons think that a partial excision in such cases favors recovery without accident, but I believe that opinion to be a survival from the pre-Listerian days, and that cleanliness, drainage, and rest will make excision unnecessary.

The prognosis is favorable in the uncomplicated cases, and even when the dislocation has remained unreduced the reëstablishment of the functions of the joint has been satisfactory.

Dislocations forward.—The causes of the forward dislocations have commonly been a forcible bending of the hand forward or backward. In two cases it was direct violence; in one of them, Moore,[1] the fall of a heavy weight upon the wrist while the latter was resting on the ground (the account does not state whether the forearm was resting on its anterior or posterior surface); in the other, Dieu,[2] the patient was kicked on the back of the hand by a horse.

Pathology.—Six autopsies have been reported, Malle,[3] Letenneur,[4] Collin,[5] Jarjavay,[6] Boinet,[7] and Goodall.[8] In addition, there is a compound dislocation, for which Bransby Cooper[9] amputated; the position and extent of the wound are not stated, the only detail that is given being that "the flexor tendon of the thumb was torn through." These autopsies show rupture of the anterior and external lateral ligaments, and sometimes of all, the carpus being displaced well upward along the anterior aspect of the radius and ulna; in one case, Goodall, the connection between the semilunar and cuneiform was destroyed, the latter bone retaining its normal relations with the triangular fibro-cartilage, while the scaphoid and semilunar with the rest of the carpus were displaced forward and upward, so that these two bones passed over the free torn border of the ligament stretching from the styloid process of the radius to the cuneiform, which was thus left interposed between them and the articular surface of the radius, and prevented complete reduction. Apparent reduction was easily effected during life, but the displacement at once recurred; there were other wounds, and the patient died of tetanus on the eighth day. The anterior lip of the articular surface was broken off in two cases, and in one of these and another the styloid process of the radius was broken off. Fracture of the styloid process was observed clinically by Malgaigne, and fracture of the anterior lip was suspected in a case treated by me in 1882, because of crepitation perceived during reduction, and because of the facility with which the dislocation could be reduced and reproduced. Boinet says that in producing the dislocation upon the cadaver he always fractured the anterior lip of the radius.

Symptoms.—The hand may occupy any position between moderate dorsal and palmar flexion, the latter being the more common, and the

[1] Moore: N. Y. Med. Record, 1880, vol. 18, p. 96.
[2] Dieu: Bull. de la Société de Chirurgie, 1884, p. 296.
[3] Malle: quoted by Malgaigne, Tillmanns, and Servier.
[4] Letenneur: Bull. de la Société Anatomique, 1839, vol. 14, p. 162.
[5] Collin: Ibid., 1844, p. 335. [6] Jarjavay: Ibid., 1861, p. 312.
[7] Boinet: Bull. de la Société de Chirurgie, 1868, p. 211. This specimen was taken from the body of an old woman in the dissecting room; possibly the case was one of "spontaneous" dislocation.
[8] Goodall: Lancet, 1878, i. p. 937. [9] Cooper: Loc. cit., p. 422.

fingers are slightly flexed. Voluntary and passive movements of the wrist are restricted and painful. In a case reported by Roland,[1] a boy twelve years old, who had fallen five or six feet and struck upon the back of his flexed right hand, the wrist was immovable in right-angled flexion, and the fingers were flexed into the palm and could not be straightened. During the struggles of etherization the bones snapped back into place; there was no tendency to recurrence, and the boy made a prompt recovery, using the hand freely in a few days. The deformity consists in a marked depression on the back of the wrist, the upper border of which is marked by the sharply projecting outline of the radius and the end of the ulna, and in a corresponding rounded prominence on the front of the wrist, formed by the displaced carpus. The hand appears to be shortened at the expense of the wrist, and an actual shortening can be demonstrated by measurement from the styloid process of the radius to the finger. The antero-posterior diameter of the wrist is increased.

In the old cases (Collin, Jarjavay, Boinet) a new articular surface had formed on the anterior surface of the radius and ulna, in two of the cases a full inch above their lower ends. In Collin's the limb was equal in strength and freedom of use to the other, and all the movements were complete except those of abduction and adduction of the wrist, in which there was slight and greater loss respectively.

Reduction has been easily effected, with or without anæsthesia, by traction upon the hand or by direct pressure on the displaced bones, or by a combination of the two. In my case slight displacement forward persisted.

Dislocations outward.

Of this form of dislocation only one case has been reported, by Chapplain,[2] of Marseilles. The patient was a man, forty-seven years old, who had fallen from a height of four metres, the weight of his body being received upon his left hand. The hand was widely displaced to the outer side, and through a wound situated upon the inner side of the wrist the bones of the forearm projected and exposed their entire articular surface. The wound of the skin extended from the junction of the posterior and internal surfaces of the wrist, around the latter, and half-way across the anterior surface. The styloid process of the radius had been broken off, and it accompanied the carpus in its displacement. The pisiform was almost completely detached and crushed; the connections of the semilunar with the carpal bones had been ruptured, and it preserved its relations with the radius. There was no bleeding. There was, in addition, a dislocation of the elbow backward.

The fragments of the pisiform, the styloid process of the radius, and the semilunar were removed, and the dislocation easily reduced. A single suture was placed at the centre of the wound, and the hand and forearm were thickly enveloped in cotton firmly bound on (Guérin's dressing). A second dressing was applied on the eleventh day and removed on the twenty-second, when a large abscess was found on the

[1] Roland: Phila. Med. Times, 1879, vol. 9, p. 430.
[2] Chapplain: Bull. de la Société de Chirurgie, 1874, p. 479.

back of the hand and forearm, and the wound made at the time of the accident nearly healed. The abscess was opened at three points, and, at the time of the report, the seventieth day, was still discharging, but the quantity of pus was growing less, and the wounds were closing. A subsequent note, five and a half months after the injury was received, states that the wounds were all healed, the phalangeal and metacarpo-phalangeal joints had almost entirely regained their mobility, the wrist was completely ankylosed, and the elbow only slightly movable.

Pathological Dislocations of the Radio-carpal Joint.

These dislocations, so far as they are due to destructive disease of the joint, are of secondary interest, and do not readily lend themselves to a general description. Malgaigne quotes a few cases, generally reported briefly, of dislocations forward that had been slowly produced in consequence of hydrarthrosis, arthritis, permanent contraction of the flexor muscles, and the retraction of cicatricial bands; he refers also to two cases briefly mentioned by Guérin among his congenital dislocations, one in a child of six years, and the other in a girl of fourteen years with incomplete paralysis of the muscles of the forearm, in which the dislocation was backward and upward and backward and outward respectively. A more common form, one that has been seen with sufficient frequency to have received special study, is the following:

Spontaneous subluxation forward.

This affection was first described by Dupuytren[1] as a condition of the joint which might be mistaken for a dislocation, and of which he had seen a considerable number of cases, especially in men whose occupations compelled them to make repeated, sudden, and violent traction with their hands, as in working a press or dressing cloth. He said that under the influence of these efforts the ligaments of the joint became stretched so that the bones were capable of more extensive change of place than was normal; the carpus, being no longer held firmly against the bones of the forearm, yielded to the traction of the flexor muscles and shifted to a position in front of their lower ends. All the signs of a dislocation were present except pain and inflammation. The more or less considerable deformity and weakness were the only inconveniences of the condition, and were not sufficient to cause the patients to intermit their work or seek medical help. Ordinarily the deformity could be reduced by traction, but it recurred as soon as the parts were left at rest.

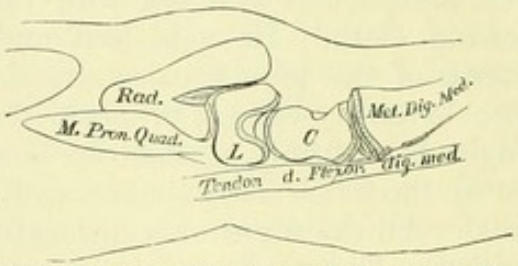
Malgaigne, referring to this description, says that he had for twenty years vainly sought an example of the condition in the largest press-rooms of Paris, and had met with only one, in a patient thirty-six years old, in whom the condition developed at about the age of twelve years apparently as the result of carrying heavy burdens; in this case the carpus was displaced forward and upward, three centimetres above the lower end of the ulna, and one centimetre above that of the radius,

[1] Dupuytren: Clinique Chirurgicale, vol. 4, p. 209.

the antero-posterior diameter of the wrist was five and a half centimetres on the ulnar side, but could be reduced to four and a half centimetres by pressure, on the radial side it was only four centimetres, but the articular edge of the radius [anterior ?] was much depressed and apparently inclined forward. Above the carpus, on the anterior surface of the radius, and apparently adherent to it, was a bony prominence. All movements were free, except dorsal flexion, which was notably diminished.

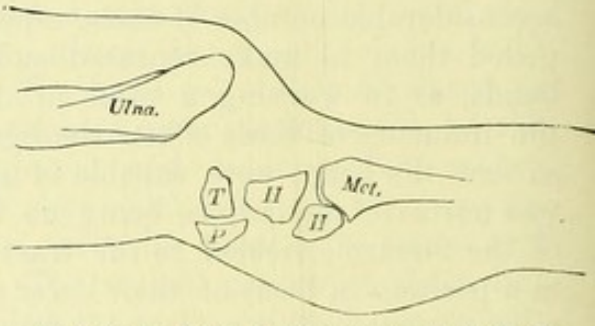
In 1878 Madelung[1] read before the Seventh Congress of German Surgeons a paper upon the subject based upon the observation of twelve cases, and the post-mortem examination of one. Of his twelve patients the dislocation was unilateral in ten (four on the right side, five on the left, and in one the side was not noted), and bilateral in two; eight patients were females, four males. The earliest age at which the condition originated was the thirteenth year; in only two cases did it begin after the twenty-third year. All but one of the patients belonged to the working class, but their occupations were not marked by great muscular efforts. The specimen was obtained from the body of a woman about twenty years old, who had died apparently a short time after confinement. The appearance of the limb was so typical that he was convinced of the correctness of the diagnosis of spontaneous subluxation, even in the absence of any history of the case. There was no sign of chronic inflammation of the bones of the arm or of any part of the skeleton. The limb was frozen and then sawn longitudinally in two places. The first section was (Fig. 100) made through the centre of the os magnum and its articulation with the semilunar, and divided the end of the radius so near its ulnar

Fig. 100.



Madelung's case of spontaneous dislocation of the carpus forward; longitudinal section through (*C*) the os magnum and (*L*) the semilunar.

Fig. 101.



The same; longitudinal section through the ulna, (*H*) the unciform, and (*T*) the cuneiform.

border that a portion of the incisura semilunaris shows in the section. The second section (Fig. 101) divides the lower part of the ulna into two equal parts and passes through the cuneiform, pisiform, and unciform bones. The sections show that the radial side of the carpus is displaced about half an inch forward and an equal distance upward by the absorption of the anterior half of the lower end of the radius, the posterior half persisting like a malleolus extended over the dorsum of the wrist, and

[1] Madelung: Deutsche Gesellschaft für Chirurgie, 1878, p. 259, and Archiv für klinische Chirurgie, 1879, vol. 23, p. 395.

the displacement forward of the ulnar side of the carpus is much more marked.

It seems probable that a case reported by Jean[1] as a double congenital dislocation forward was of this character. On the right side the cuneiform was placed well in front of the ulna; the semilunar and scaphoid not so far in front of the radius, which had formed a new articular surface by loss of its anterior lip. In the left wrist the displacement was of the same character but less marked. Possibly also, Boinet's case, quoted above, page 361, and R. W. Smith's case (loc. cit., p. 251) of supposed congenital dislocation belong in this class, and also one observed clinically and reported by Pooley[2] as a double congenital dislocation forward.

The production of the deformity in the cases observed clinically was always gradual, requiring from six months to two years for its full development, and in no case could it be attributed to a traumatism, either slight or severe, and in no case were there any signs of acute or chronic inflammation of any part of the joint. In most cases the patients attributed it to continuous hard labor with the hands, but it did not appear that this labor was more than usually prolonged or hard. The women usually attributed it to washing clothes; two of the men were farmers, one a tanner, and one a shoemaker. In the discussion that followed the reading of the paper Hirschberg said he had seen two clearly marked cases, the result of practice at the piano. The deformity in all the cases was accompanied by pain in the joint and was marked especially by the increasing prominence of the end of the ulna. After a time the pain ceased, the deformity remained stationary, and the freedom of use of the limb was unimpaired except by diminution or total loss of dorsal flexion.

After Madelung's attention had been called to the subject by observation of his earlier cases, he took pains critically to examine the wrists of people in all classes of society, and was astonished to find how frequently he encountered slight deviations from the normal shape, all of which were of the type of spontaneous dislocation forward and were characterized not only by the abnormal projection of the end of the ulna but also by change in the articular surface of the radius and the position of the carpus. He attributed the more notable changes in the end of radius found in the fully developed cases to the arrest of the growth of its anterior portion and to the overgrowth of its posterior portion stimulated by the loss of the opposing pressure normally exerted by the carpus, and he sees an analogy between this change and those observed in pes valgus and genu valgum.

Symptoms.—The most marked deformity is seen when the limb is viewed in profile from the ulnar side; the end of the ulna projects markedly at the back of the wrist under the normal, but somewhat tense, skin; the hand is displaced toward the palmar side, and the antero-posterior diameter of the wrist is greatly increased. Seen from the radial side the displacement forward does not appear so great, and

[1] Jean: Bull. de la Société Anatomique, 1875, p. 398.
[2] Pooley: American Practitioner, 1880, vol. 21, p. 216.

the depression below the end of the radius is bridged over by the extensor tendons; if these tendons are relaxed by dorsal flexion of the hand the posterior part of the articular surface of the radius can be traced with the finger, and its edge can be felt to be rounder than usual. In addition, the entire epiphysis appears to be bent forward.

By traction and pressure the carpus can be brought nearer to the ulna, but it returns at once to its former place when the pressure is removed. No change can be effected in the relations of the carpus and radius.

Sometimes the region is very painful; points that are tender on pressure are seldom found, and usually only at the upper margin of the joint. Every movement of the joint, especially dorsal flexion, is very painful.

Active and passive dorsal flexion is limited to an extent that corresponds to the degree of the subluxation, and in the most marked cases the hand cannot be carried backward beyond straight extension. The range of palmar flexion is more often increased than diminished, unless pain is present.

Treatment.—The alteration in the shape of the bones fully explains the failure of the few attempts that have been made forcibly to reduce the displacement, and the fact that the limb recovers nearly its full usefulness after the growth of the skeleton ceases and the progress of the displacement is arrested, furnishes a sound reason against operative interference. Prolonged attempts made by Madelung to improve the position by fixation in gypsum dressings and methodical manipulations did no good beyond relief of pain, and after he had learned the pathology and nature of the affection he limited his treatment to efforts to increase the strength of the arm in all its parts by methodical use and, in some cases, to the wearing of a moulded leather bracelet which could be tightened or loosened and was kept in place by a loop passing between the thumb and index finger; this prevented movements of the wrist and left the fingers free.

Congenital dislocations of the radio-carpal joint

The question of congenital dislocation of the wrist is extremely difficult and obscure, for in the great majority of the reported cases the history is so defective that the period at which the displacement took place must remain uncertain, although in most of them it was certainly during infancy or early childhood. In some the congenital origin of the malformation can hardly be called in question, because it is marked by great irregularities of shape and development extending over several bones and joints, but the propriety of classifying such cases as dislocations may well be questioned, for not only do the joint surfaces present hardly a trace of their normal form, but also one or more of the constituent bones may be entirely lacking. Such cases seem much more properly to belong among the "congenital malformations" and to require classification as "club-hands" rather than as dislocations. In most of the reported cases in which the deformity has involved only the wrist the theory of congenital origin has been based upon the absence of the history of any traumatism that could account for the deformity, upon the statements of the patient

or his friends that it had existed as long as they could remember, and upon its symmetrical occurrence in both wrists. The history of spontaneous dislocations forward shows how defective this argument is.

The only alleged example of congenital dislocation which is accepted as such by Bouvier[1] and Malgaigne is one reported by Marigues in 1755; it was observed in a stillborn child. The radius was widely separated from the ulna at its lower end, and in the interval between them were lodged the bones of the first row of the carpus which were held in place by strong ligaments. The ulna was displaced toward the outer side of the forearm, the articular surface of the radius was parallel to the first row of the carpus, the hand was hooked inward, and it was held in this position especially by a strong ligament which extended from the second row of the carpus to the end of the radius.

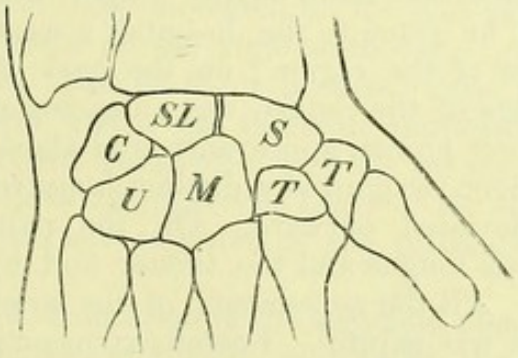
R. W. Smith[2] describes in detail several specimens of displacement and deformity which he deemed of congenital origin, and quotes a well-known case reported by Cruveilhier in the ninth livraison of his *Anatomie Pathologique*. One of these cases and two or three others which have also been reported as congenital have been mentioned in the preceding section. It may be added that J. Guérin[3] has described three varieties of congenital dislocation—forward, backward and upward, and backward and outward—and a fourth class of pseudoluxations to one side. Subsequent writers have generally thought his demonstrations insufficient or his interpretation incorrect.

C. Dislocations of the Carpal Bones.

These present themselves as isolated dislocations of the individual bones or as partial or incomplete dislocations of the medio-carpal joint.

Of the eight bones which form the carpus only the pisiform on the ulnar side and the trapezium on the radial side can be distinctly palpated. The former is felt as a small, hard lump at the junction of the palm and wrist close below the inner end of the lowest of the transverse creases that cross the wrist; it rests upon the anterior face of the cuneiform bone. The trapezium can be readily grasped between the thumb and finger just above the base of the first metacarpal bone. A line drawn straight across the back of the wrist from one end to the other of the lowest transverse crease on the palmar surface crosses the neck of the os magnum directly above the base of the third metacarpal when the hand is extended in line with the forearm, and the finger can feel a dis-

Fig. 102.



Bones of the wrist; posterior aspect. (Tillaux.)

[1] Bouvier: Dict. Encyclopédique des Sc. Méd., art. Main Bote, p. 166.
[2] R. W. Smith: Fracts. and Disloc., 1847, p. 238.
[3] Guérin: Gazette Médicale, 1841, p. 101.

tinct depression at this point, the upper margin of which is formed by the lower face of the semilunar; if now the wrist is flexed forward the hollow becomes filled by a projecting piece of bone, the head of the os magnum. The medio-carpal joint is that between the three bones of the first row above and the four bones of the second row below.

Medio-carpal dislocations. Of these, one dislocation backward, verified by autopsy, and two forward, observed clinically, have been reported. Possibly some of the cases reported as dislocations of the os magnum were of this kind.

A *backward dislocation* was reported by Maisonneuve[1] in a patient who had fallen from a height of forty feet. The hand, displaced bodily to a plane posterior to that of the forearm, was shortened several lines; behind, a few lines below the styloid processes, was a transverse bony prominence more than a centimetre high, with a depression below, opposite the transverse fold of the wrist. The fingers were flexed, and a considerable effort was required to extend them. The dislocation was not reduced during life, the patient dying soon after his admission to the hospital, but after death it could be reduced by slight traction. The bones of the second row were completely separated from those of the first, and overrode them posteriorly more than a centimetre. A small piece of the scaphoid remained attached to the trapezium, and a portion of the cuneiform, with the pisiform, accompanied the unciform. The internal and external lateral ligaments of the radio-carpal joint were completely ruptured, as were also the anterior and posterior ligaments uniting the two rows of the carpus.

An *incomplete dislocation forward* was reported by Desprès.[2] The patient was presented with his deformity to the Société de Chirurgie, and as there was a difference of opinion concerning the nature of the lesion a committee was appointed to examine and report upon it; they unanimously confirmed the diagnosis. The patient was a man twenty years old; the injury was caused by a fall from a swing, probably upon the back, the hand being caught between the body and the ground. When he came to the hospital, a week later, there was no swelling or redness of the region; on the back of the wrist, a fingerbreadth below the edge of the radius, was a depression below which the wrist and hand had their normal appearance, and above which, between it and the radius, the finger recognized a distinct bony resistance. The axis of the hand was deviated outward. On the palmar surface the tendon of the palmaris longus and the thenar and hypothenar eminences were prominent. All the movements of the wrist were preserved, and only forced flexion was painful. Forced extension increased the displacement without notably changing the form of the palmar surface of the wrist. During flexion the prominence of the head of the os magnum was less apparent than in the other wrist; the movement reduced the dislocation.

The treatment consisted in maintaining the hand in the flexed position in which the bone returned to its place by means of a spica bandage; it was begun eleven days after the accident, and by the fourth day the pain

[1] Maisonneuve: Mém. de la Soc. de Chir., quoted by Malgaigne.
[2] Desprès: Bull. de la Soc. de Chirurgie, 1875, vol. I. p. 412.

had disappeared and the wrist had regained its form and functions. The bandage was worn a week longer.

A complete dislocation forward has been reported by Richmond;[1] the patient was a man, forty-seven years old, who fell upon his hand from a height of about nine feet. The hand, from the wrist to the knuckles, was very noticeably shortened; there was a prominent transverse ridge on the back of the wrist below the ends of the radius and ulna, and below this ridge was a marked depression. On the palmar aspect the base of the hand was unduly prominent, the general direction of the metacarpal bones being quite altered by their bases being pushed forward toward the palm. Both diameters of the wrist were increased; voluntary flexion and extension were lost. The ends of the radius and ulna seemed separated somewhat from each other; the transverse dorsal ridge could be demonstrated to be the first row of carpal bones with the semilunar unduly prominent; between it and the radius and ulna flexion and extension, although restricted, could be obtained with considerable ease and without crepitus. Below the ridge the extensor tendons could be plainly felt stretching across the depression to the fingers. None of the carpo-metacarpal joints had sustained any injury. On the palmar prominence the trapezoid could be felt placed more anteriorly than, and considerably above, the level of the trapezium; and nearer the ulnar side the head of the os magnum could be felt slightly overlapping the ends of the radius and ulna, which on the palmar surface were quite obscured; and on flexion and extension of the hand the os magnum could be felt to ride on their anterior surface. The displacement of the unciform, although distinct, was much less marked. The examination showed that the second row of carpal bones was dislocated forward and upward from the first row, the displacement being most marked in the case of the os magnum and trapezoid.

To these may be added a case briefly quoted by Malgaigne from the *Gazette des Hôpitaux*, Nov. 20, 1829. A man's hand was caught in machinery, which dislocated it forward and lacerated all the soft parts of its back. Gangrene ensued, and death on the eighteenth day. At the autopsy two or three small bones, one of them broken, were found adherent to the bones of the forearm, and it was therefore supposed that the dislocation had taken place between the two rows of the carpus.

Although the *isolated dislocation of the different bones of the carpus* is a rare injury, yet instances have been reported of the dislocation of almost every one of them.

Scaphoid.—The only instances of dislocation of the scaphoid alone are two quoted by Cooper (loc cit., pp. 432 and 436), one simple, the other compound. The former was reported by a medical student who was serving as "dresser" in the hospital, and as the symptoms are not described in detail some doubt must remain as to the accuracy of the diagnosis; it was complicated by fracture through the lower articular surface of the radius. It is as follows: A woman, sixty years old, fell upon the back of her hand and "fractured the radius obliquely outward, through the lower articulating surface. The fractured portion, with the

[1] Richmond: Lancet, 1879, i. p. 844.

os scaphoides, was thrown backward upon the carpus. The wrist was slightly bent, and there was an evident projection at the back of the carpus." Crepitus was felt in moving the hand or the styloid process of the radius backward or forward.

In the other the dislocation was compound, and the wound, which was caused by machinery, was so extensive as to make it the most prominent feature of the injury; it extended through two-thirds of the circumference of the wrist; the scaphoid projected at the back part, being attached only on the side toward the joint; the radial artery and the extensor tendons of the thumb, middle, and fore fingers were torn through. The scaphoid was removed. The patient recovered.

A case of dislocation forward of the scaphoid complicating fracture of the lower end of the radius, in which the bone was removed through an incision, was reported by Cameron in the *Glasgow Medical Journal*, 1878, p. 102; it is quoted in Fractures, p. 453. Six years later Cameron[1] again reported the case, this time as one of dislocation of the semilunar bone, but made no mention or explanation of the previous statement concerning it, although he described the case in the same terms as before.

A case diagnosticated as a dislocation of the scaphoid and os magnum was reported by Dr. Morris,[2] house surgeon at Bellevue Hospital, but the symptoms on which the diagnosis was based are not described in sufficient detail to allow the diagnosis to be unhesitatingly accepted. The patient's hand had been forcibly extricated from between a heavy brush and roller; it was "strongly adducted and rotated inwardly, with an unnatural projection at the carpus anteriorly;" the semilunar was in place, but freely movable. The displacement was easily reduced under ether; it recurred as the patient was coming from under the influence of the anæsthetic, and was again reduced. The limb was placed in splints, and the patient made a fair recovery.

A case (Fayne) in which the scaphoid and semilunar were together dislocated forward is briefly mentioned in the *Revue de Thérapeutique*, March 15, 1887. The semilunar had undergone complete rotation and presented in a contused wound on the front of the wrist.

Semilunar.—Nine cases of dislocation of the semilunar bone, one of them double (Flower), have been reported, including Cameron's case above mentioned. The cases are those of Mougeot,[3] Flower and Hulke,[4] Erichsen,[5] Taaffe,[6] Chisolm,[7] Gross,[8] Buchanan,[9] and Albertin.[10] In five of them, Mougeot, Flower, Gross, Buchanan, and Albertin, the dislocation was compound, and in four of these the bone was removed; the specimen of the fourth (Flower) is preserved in the museum of St. George's

[1] Cameron: Lancet, 1884, i. p. 885.
[2] Morris: N. Y. Medical Record, 1883, vol. xxiii. p. 376.
[3] Mougeot, quoted by Malgaigne.
[4] Flower and Hulke: Holmes's Syst. of Surg., Am. ed., vol. i. p. 881.
[5] Erichsen: Science and Art of Surgery, Am. ed., 1873, vol. i. p. 421.
[6] Taaffe: Brit. Med. Journal, 1869, i. p. 335.
[7] Chisolm: Philad. Med. Times, 1870-71, vol. i. p. 335.
[8] Gross: Philad. Med. Times, 1880-81, vol. xii. p. 220.
[9] Buchanan: Med. Times and Gazette, 1885, i. p. 113.
[10] Albertin: La Province Médicale; abstract in Lancet, July 23, 1887.

Hospital. In two others, Cameron, Chisolm, the bone was removed through an incision made for the purpose. In every case the cause was a fall from a considerable height. In one case, Erichsen, the dislocation was backward, and in the other three simple cases, Taaffe, Cameron, Chisolm, and in three of the compound ones, Mougeot, Flower, Albertin, forward; in neither of the other two compound cases is the direction of the displacement stated. Gross says the wound, half an inch long, was "on the inner side of the forearm anteriorly," and that ten days after the accident "a loose bone was detected in the wound toward the radial side of the wrist;" the injury was caused by jumping from a railway train in rapid motion, and when the patient was seen, two days after the accident, the parts were so swollen that it was thought best to make no examination; there was also fracture of both bones of the forearm four inches above the wrist. The wound suppurated for three months. Buchanan says there was a "deep, lacerated wound at the lower part of the forearm, just above the wrist. At the bottom of the wound, but superficial to the bones of the forearm, a small round bone was felt, and crepitus and abnormal mobility showed that the lower part of the radius was fractured." On the sixth day the bone was removed, and ten days later the limb was amputated because of diffuse suppuration. Examination showed that "no other injury of the carpus had been sustained." Probably in both cases the dislocation was forward, and in Buchanan's also upward.

Cameron's case, in which there was also a fracture of the lower end of the radius, is quoted in Fractures, page 453; in the report from which that quotation was made the dislocated bone was said to be the scaphoid; the middle and ring fingers were strongly flexed, and the slightest attempt to extend them caused great pain. In Chisolm's the fingers were in forced flexion, and their extension was resisted and painful. In Cameron's the bone "was felt lying under the skin in the middle line of the front part of the forearm, about an inch above the flexure of the wrist;" in Chisolm's, "a large, rounded, hard, subcutaneous prominence existed on the front of the wrist, beneath the upper wrist fold, and directly over the site of the semilunar bone." The removal of the bone was made in each case because of the flexion of the fingers and the pain; Cameron's patient made a good recovery; the result in Chisolm's is not stated.

In Taaffe's case, which was first seen ten months after the accident, "there was a dislocation of a single bone of the carpus which projected forward and upward between the radius and ulna; it was not wedged between the bones, but projected in front of them on the anterior aspect of the limb. The radius and ulna were not displaced, nor was there any evidence of fracture." Reduction was effected by "strong extension and firm pressure."

In the single case of backward dislocation, Erichsen, the patient had fallen from a height, doubling his right hand under him; "a small hard tumor was felt projecting on the dorsal aspect of the wrist; it readily disappeared on extending the hand and employing firm pressure, but started up again so soon as the wrist was forcibly flexed. It was evident that the bone belonged to the first row of the carpus; and from its size, its position toward the radial side of the carpus, and its shape, which

could be very distinctly made out, there could be little doubt that it was the semilunar bone."

The frequent association of a wound on the anterior aspect of the wrist and the nature of the cause, a fall from a height, make it probable that the dislocation forward is effected while the hand is in dorsal flexion, yet in Taaffe's case it was thought the blow was received upon the back of the hand. Corresponding to this relative frequency of dislocation of the semilunar forward (in fact, it is the only bone of the first row that has been dislocated without associated fracture of the radius), is the frequency of partial dislocation of the os magnum backward, and it seems probable that the two facts have a common cause in the relation of the two bones to each other. Flexion, and especially extension of the wrist, take place largely in the mediotarsal joint, which has much the character of a ball-and-socket joint, of which the head of the os magnum is the most projecting point, and in so far as the forward movement is arrested by bony contact or ligamentous connection the semilunar would be the most likely, through its contact with the more freely moving head of the os magnum, to be affected and displaced.

The prognosis is unfavorable: in two of the three simple forward cases it was deemed necessary to remove the bone in order to relieve the disability; in the third the result is not stated. Of the five compound cases there was profuse suppuration in two, leading to amputation in one, and partial ankylosis in the other; one got well with a useful joint, one died of tetanus, and the fifth appears to have died, probably of associated injuries, as the fall was from a great height.

Unciform.—The only recorded case of dislocation of the unciform bone is one very briefly reported by Buchanan:[1] a man fell from a railway car; "he was found to have a simple luxation of the unciform bone anteriorly. It lay just beneath the skin, and its process could be distinctly outlined. Reduction was effected by direct pressure on the bone while the borders of the hand were approximated." Considering that the case, if correctly diagnosticated, is unique, the brevity of the report is to be regretted.

The *pisiform* has been reported dislocated in three cases: in two (Erichsen, Fergusson) by muscular effort; in one (Gras, *Gazette Médicale*, 1835, p. 542) by the pressure of the hand upon a flat-iron while ironing clothes. In Erichsen's case the bone was drawn up the arm for a distance of nearly an inch.

Os magnum.—Many authors speak of partial dislocation of the head of the os magnum backward as a not infrequent accident produced by prolonged, perhaps not violent, use of the hand, or by a sudden effort, or a fall. Malgaigne classifies the former as pathological dislocations; they are characterized by the appearance on the back of the wrist just above the base of the third metacarpal bone of a small, hard, round lump, especially during palmar flexion, which appears more or less completely during dorsal flexion, and can sometimes be temporarily reduced by pressure. It ordinarily causes little or no disability.

The more distinctly traumatic cases are those of Richerand (quoted by

[1] Buchanan: Philad. Med. and Surg. Reporter, 1881–82, vol. 46, p. 418.

Cooper), Cooper (loc. cit., p. 434), and Seeger (quoted by Tillmanns). Richerand's patient was a woman who grasped the side of her bed during parturition, turning her wrist forward, and felt a sharp pain in the wrist. A fortnight later, a hard, circumscribed tumor was found at the back of the carpus, formed by the head of the os magnum, which was readily replaced by making gentle pressure on it, and extending the hand. Richerand had seen another similar case, as had also Chopart and Boyer.

Cooper's patient was a young, muscular man, who had fallen upon his hand in such a way as to bring the palmar aspect of the fingers into contact with the forearm. At the point of most pain was a round, hard tumor, rather larger than a marble, which produced a most evident deformity on the back of the wrist opposite to and above the base of the third metacarpal. The hand was slightly bent, and extension caused considerable pain; the tendon of the extensor carpi radialis brevior was displaced slightly to the radial side; the forefinger was abducted from the middle one, and any attempt to approximate them gave great pain at the base of their metacarpal bones; and opposite the base of the middle one was a depression, quite evident to both sight and touch. Reduction was effected by making traction on the fore and middle fingers, while pressure was made upon the os magnum. On flexing the hand the deformity was reproduced; it was again corrected, and the hand placed in splints.

Seeger[1] saw in 1829 and 1830 two cases of dislocation of the head of the os magnum backward caused in young men by falls upon the closed fist. Reduction was effected by traction and forcible flexion of the hand, in one case easily, in the other only after several attempts. The hand was kept in splints in the extended position from six to eight weeks, with compresses in front and behind. Recovery was complete.

Trapezoid.—The diagnosis of dislocation of the trapezoid backward was made in a case reported by Gay;[2] the patient was a man, thirty-two years old, and the injury was caused by striking with the fist in play. "At the base of the metacarpal bone of the index finger was a sharp, hard, slightly movable bunch, raised one-quarter of an inch, and tender on pressure." There was no crepitus; the metacarpal bones were of the same length. It could not be reduced. Two months later the deformity was unchanged, but the hand had become nearly as good as the other.

Trapezium.—Two cases of dislocation backward of the trapezium alone have been reported by Uhde[3] and von Mosengeil.[4]

Uhde's patient was a man, thirty-three years old, who had been knocked down by a wagon. The right thumb and the region of its metacarpal bone was bruised, swollen, and painful, and "at the junction of the first metacarpal and trapezium an unusual mobility of the latter bone was recognizable, and instead of the normal depression between the tendons of the extensor secundi and extensor primi internodii on extension of the hand there was to be seen a small angular tumor corresponding to the trapezium, which projected on flexion of the first and second metacarpals

[1] Seeger: Mittheilungen der Württ ärztl. Vereins, vol. i., quoted by Tillmanns.
[2] Gay: Boston Med. and Surg. Journ., 1869, vol. 81, p. 188.
[3] Uhde: Deutsche klinik, 1850, ii. p. 539.
[4] Von Mosengeil: Arch. für klinische Chirurgie, 1871, vol. 12, p. 723.

about three and a half lines above the level of the back of the hand, and disappeared on straight extension of these bones with a creaking sound. Six months later the trapezium was found to project one and a half lines on the radial side."

Von Mosengeil's patient had a deformed hand, the thumb and its metacarpal bone having the shape and position of a finger; the displacement, half a centimetre, was produced by a blow received upon the palm of the hand; it was reduced by flexion and pressure.

Os magnum and trapezoid.—Uhde (loc. cit.) briefly describes under the title "luxatio ossis multanguli minoris et ossis capitati" a case of injury to the wrist marked by a projection on the back of the hand which he attributed to the displacement of the trapezoid and os magnum. The injury was caused by a fall upon "the anterior ends of the metacarpal bones." It does not appear from the description whether the bones were thought to be dislocated from the metacarpals as well as from the first row of the carpus. The prominence could be reduced by pressure, and reappeared on flexion of the wrist.

A case reported by Alquié, of Montpellier, has been frequently quoted; there was much displacement of the carpal bones on the radial side, but not only was its character uncertain, but in addition the region had suffered from two different accidents, one of which was accompanied by great laceration of the soft parts.

D. Carpo-metacarpal Dislocations.

Cases have been reported of the isolated dislocation of every one of the metacarpal bones except the fifth, and of the combined dislocation of two or more.

First metacarpal.—Dislocations of the metacarpal bone of the thumb are the most frequent and important; almost all have been backward.

Very little is known of *dislocations forward.* Sir Astley Cooper (loc. cit., p. 443) says, "In the cases which I have seen of this accident the metacarpal bone has been thrown inward, between the trapezium and the root of the metacarpal bone supporting the index finger; it forms a protuberance toward the palm of the hand; the thumb is bent backward and cannot be brought toward the little finger." Poinsot quotes a reference by Vidal de Cassis to a case of incomplete dislocation forward which he had easily reduced.

Albert[1] saw two cases of incomplete dislocation *outward;* one was old, the other recent. In the latter the injury was produced in a trial of strength by grasping hands. The base of the first metacarpal projected partly on the radial side, and the long axis of the bone was directed obliquely downward and outward. The displacement was easily reduced, but immediately recurred. After reduction the thumb was fixed in abduction by a silicate dressing and so maintained for six weeks. Complete recovery.

The displacement in Michon's[2] second case is not entirely clear; he

[1] Albert: Chirurgie, vol. 2, p. 445.
[2] Michon: Bull. de la Soc. de Chirurgie, 1848, vol. i. p. 11.

speaks of it as an incomplete dislocation inward, but Malgaigne describes it as incomplete backward and inward.

Dislocations backward may be complete or incomplete; of 16 cases collected by Boyer 11 were incomplete, 5 complete. The cause may be a forced flexion of the thumb into the palm of the hand, or its forced movement in the opposite direction, or direct violence received upon the thenar eminence, as in striking upon the handle of a chisel, or in striking a blow with a hammer, or in the bursting of a gun.

Specimens of old dislocation have been dissected by Foucher[1] and Gérin-Roze;[2] in the former the upper end of the metacarpal bone was displaced backward and a little inward, and was flexed at a right angle to and fused with the trapezium; in addition, the second metacarpal was displaced upward about two centimetres on the back of the wrist, retaining the insertion of the extensor carpi radialis, and the third metacarpal had been broken at its middle. The injury was caused by the bursting of a gun. In Gérin-Roze's case the displacement was directly backward, the anterior edge of the base of the metacarpal resting upon the posterior edge of the inferior articular surface of the trapezium; incomplete reduction could be made.

In the incomplete form the posterior edge of the base of the metacarpal bone can be seen and felt in the interval between the tendons of the extensor primi and extensor secundi internodii as a hard lump continuous with the shaft of the bone and reducible by pressure. The thumb is generally somewhat flexed toward the palm, but may be extended or "straight." Movement is limited and painful, and flexion increases the apparent displacement.

In the complete form the dorsal prominence is more distinct, and rests upon the trapezium which forms a recognizable lump in the ball of the thumb. The thumb is shortened by the ascent of the metacarpal bone, its first phalanx appearing in consequence to have passed upward into the thenar muscles, and it is usually flexed at the carpo-metacarpal joint.

In some, even recent, cases reduction has been impossible, but usually it has been effected without difficulty by traction on the thumb and direct pressure forward and downward upon the projecting end of the bone. Early recurrence has been noted in some cases, and in a few prevention of recurrence has been difficult or incomplete. Moulded splints of leather or gutta-percha, and pasteboard or wooden splints with compresses at the back of the joint, are ordinarily used, and have given satisfactory results. In one case, the only dressing consisted of strips of adhesive plaster, running from the back of the forearm around the ball of the thumb, and back between it and the index finger to the forearm, so as to maintain the member abducted and extended.

The restoration of function after reduction is complete, and even when the dislocation has remained unreduced some patients have been able to make good use of the thumb; in others, the movement of adduction and opposition has been much restricted.

The *second metacarpal* has been reported dislocated forward in two

[1] Foucher: Bull. de la Soc. Anatomique, 1856, p. 6.
[2] Gérin-Roze: Bull. de la Soc. Anatomique, 1858, p. 266.

cases, and backward in five cases; in one of the latter, together with dislocation of the first, and in another with dislocation of the third. An additional case, observed by himself, is mentioned by Demarquay,[1] in which the first and second were together dislocated, but the direction is not stated, and no details are given.

The forward cases are those of Bourguet (quoted by Malgaigne) and Marsh (quoted by Hamilton). In Bourguet's, the cause was excessive pressure on the upper posterior part of the bone; in Marsh's, it was an oblique blow with a hammer on the back of the clenched hand. In both cases the proximal end of the bone could be felt in the palm, and a corresponding depression on the back; in the former case, the lower end of the bone was inclined forward, and the finger appeared shortened nearly one-fourth of an inch. Both were easily reduced by traction on the finger and pressure on the end of the bone.

The uncomplicated backward cases are those of Hamilton (loc. cit., p. 724) and Humbert;[2] the former was caused in a woman, twenty-eight years old, by a fall upon the closed hand. Reduction was easily effected. Humbert's patient was a man thirty years old, who was kicked by a horse upon the hand that held the reins, the blow falling on the back of the lower end of the second metacarpal bone and the adjoining phalanx; the upper end of the bone could be felt as a hard, circumscribed prominence on the back of the hand, and the finger, measured by the adjoining one, appeared five millimetres short. Reduction was made by traction and direct pressure downward and forward. Apparently the dislocation had been caused by forced palmar flexion of the bone.

The case in which the dislocation was associated with that of the first metacarpal is that of Foucher, mentioned above.

In two cases seen by Hamilton there was incomplete dislocation backward of the upper end of the second and third metacarpals, caused by striking a blow with the fist; in both cases the dislocation was old, and had persisted in spite of attempts to maintain reduction.

Third metacarpal.—In addition to these two cases, in which the injury was associated with dislocation of the second metacarpal, dislocation backward of the third metacarpal has been observed by Blandin[3] and Roux.[4] Blandin's patient fell, while holding a roll of paper, and struck his head against a post; the blow was slight, and caused no pain at the time, but the middle finger promptly became powerless, and the hand numb and swollen. There was a linear transverse ecchymosis at the back of the first phalanx of the middle finger, close by the metacarpal joint, and, on movement, a crackling that resembled crepitation. No other symptoms are mentioned. Blandin made the diagnosis of "diastasis or incomplete dislocation" of the third metacarpal bone, but others who saw the case thought the bone was broken. The title of the report of the case is "incomplete dislocation upward."

Roux's patient had been injured in a mine explosion; a hard, circumscribed, subcutaneous tumor could be seen and felt on the back of the

[1] Demarquay: Bull. de la Société de Chirurgie, 1851, vol. 2, p. 171.
[2] Humbert: Union Médicale, 1868, vol. 5, p. 527.
[3] Blandin: Gazette des Hôpitaux, 1844, p. 552.
[4] Roux: Union Médicale, 1848, p. 224.

wrist, continuous and moving with the third metacarpal; the middle finger was shortened. The dislocation was reduced by direct pressure, but appears to have recurred, for at the autopsy the base of the bone was found resting on the back of the os magnum; the second metacarpal was broken.

An incomplete backward dislocation of the *fourth metacarpal* was reported by Maurice.[1] It was caused by the premature explosion of a cartridge which the patient was putting into a Chassepot gun; the plunger was driven backward against the palm of the hand. There was a prominence half a centimetre high on the back of the hand, corresponding to the upper end of the fourth metacarpal. Reduction was easy, and recovery prompt.

The *four inner metacarpal bones* (II., III., IV., V.) have been simultaneouly displaced in four cases, Vigouroux,[2] Hamilton,[3] Tillaux,[4] and one of my own; in the first and second the dislocation was backward, in Tillaux's and mine forward.

Vigouroux's patient was injured when eighteen years old, by the explosion of a pistol, which he held in his left hand. At his death, at the age of sixty-two years, there was found a complete dislocation backward of the last four metacarpal bones; these bones were flexed forward and the first phalanx of each of the last three fingers was incompletely dislocated backward. The index finger and the lower part of its metacarpal bone were lacking. All the joints of the carpus, including that of the trapezium and first metacarpal, were normal.

Hamilton's patient was struck at the battle of Fredericksburg by a ball which entered at the ulnar side of the hand and crossed the back of the wrist between the last row of carpal bones and the skin. When seen by Hamilton five years later "the displacement (backward) was very conspicuous; no fragments of bone had ever escaped. The movements of all the fingers, except the index and little fingers, were unimpaired."

Tillaux's patient, whom I had the good fortune to see when he was admitted to the Lariboisière hospital, was twenty years old; twelve days before admission to the hospital he had fallen backward from a window, about ten feet, striking upon the back of his flexed hand. The hand was flexed on the wrist and could not be actively extended. There was a dorsal depression corresponding to the line of junction of the carpal and metacarpal bones, sharply limited above by a transverse prominence which was evidently formed by the second row of the carpus, and on the palmar surface at the same level the ball of the hand was more prominent than usual. The relations of the first metacarpal with the trapezium were unchanged. Moderate traction with direct pressure forward reduced the displacement with a click, and by making pressure in the opposite direction it was again produced. After a second reduction the limb was immobilized for a fortnight. Complete recovery.

My patient was a lad fifteen years old who was admitted to the Pres-

[1] Maurice: Gazette Médicale, 1868, p. 587.
[2] Vigouroux: Bull. de Société Anatomique, 1856, p. 15.
[3] Hamilton: Loc. cit., p. 724.
[4] Tillaux: Bull. de la Société de Chirurgie, 1875, p. 415.

byterian Hospital in January, 1887, after having fallen down an elevator shaft, a distance of about forty feet, and received a compound fracture of the right forearm, a severe injury of the right hip, the nature of which could not be satisfactorily made out, and a dislocation of the left carpo-metacarpal joints. When I first saw the patient, three weeks later, the last-named injury had not been recognized. The hand was then in almost complete extension on the wrist and occupying a plane somewhat anterior to that of the wrist and forearm. The back of the wrist formed a rounded, resistant prominence, continuous above with the back of the radius and ulna and terminating below in a sharp, well-defined transverse ridge which extended completely across from the fifth to the second metacarpal and curved upward on the outer side toward the styloid process of the radius. The finger, passed upward along the back of the metacarpus, was arrested by this ridge, which appeared to be about one-quarter of an inch high and corresponded to the line of the carpo-metacarpal joints. The first row of carpal bones was in normal relations with the forearm and with most of the second row, but the relations of the trapezium could not be clearly made out. I was under the impression that it was displaced somewhat forward from the scaphoid, it had preserved its relations with the first metacarpal bone. The ball of the hand was abnormally prominent, and the antero-posterior diameter of the wrist appeared thereby increased; the transverse diameter was unchanged.

The deformity was easily reduced by traction and direct pressure, but immediately recurred when the pressure was removed. Reduction was maintained for ten days by keeping the limb in a plaster-of-Paris dressing; on removal of the dressing the deformity did not recur, but a few hours later the patient reproduced it while experimenting to ascertain if the reduction was permanent. It was again reduced, and the limb dressed as before. Three weeks later the reduction was complete and permanent except for some projection forward of the first metacarpal and trapezium, and the wrist and fingers had regained their mobility.

Dislocation of all five metacarpals.—Poulet[1] reported a case of incomplete dislocation forward of all five metacarpal bones; the injury was caused by a fall from a horse and was associated with a wound of the skin on the ball of the hand and slight chipping of the anterior edges of the carpal bones. The swelling and the inflammatory reaction were so great that an examination was not made until after the lapse of a month. There was then found on the back of the hand a projection formed mainly by the os magnum, and below it a depression extending from the trapezium to the unciform. On the palmar surface the ball of the hand projected forward, the palmar fold was effaced, and a deep, ill defined bony prominence could be felt. The interdigital spaces were two centimetres nearer the styloid processes than on the other hand. Partial reduction and restoration of mobility were obtained.

Erichsen gives a woodcut and description of a plaster cast in the University College Museum, London, taken from a patient in whom he thinks this dislocation must have existed; and Rivington[2] reported the

[1] Poulet: Bull. de la Soc. de Chir., 1884, p. 902.
[2] Rivington: Lancet, 1873, I. p. 270.

case of a patient who had been run over by a wagon and had sustained a compound dislocation forward of all the metacarpal bones, the base of the third projecting through a transverse wound near the centre of the palm; the first phalanx of the thumb also was dislocated, and the index finger so injured that its amputation was necessary. The base of the third metacarpal was excised and the dislocation reduced. After dangerous supination and high fever the patient recovered with a fairly useful hand.

CHAPTER XXIII.

DISLOCATIONS OF THE THUMB AND FINGERS.

THE tables in Chapter I. show that dislocations of the thumb and fingers in combined hospital and polyclinic services amount to nearly ten per cent. of all dislocations, and that only about half of them are treated in hospital. Of these the dislocations of the thumb, or even of its proximal phalanx alone, are much the most numerous, but the details of the statistics are not sufficient exactly to determine the relative numbers. Polaillon[1] gives the largest statistics of which I have knowledge, 206 cases, divided as follows:

Dislocation of the	1st (proximal) phalanx of the thumb	84
"	1st phalanx of other fingers	27
"	2d (middle) phalanx	26
"	3d (terminal) "	69
		206

He does not state whence these statistics are derived, but it is probable he made them up, as he did those of other joints, from cases reported in text-books and journals, and, therefore, they have not quite the same value in determining the relative frequency of the different varieties, as if they had been made up from the integral statistics of hospitals, dispensaries, or individual surgeons. For the same reason the mortality, 10 cases of the 206, or 4.85 per cent., cannot be accepted as that of the injury in general, since exceptional cases are more frequently reported than the commonplace ones. A special cause of danger, one that may make the rate of mortality higher than that of other dislocations, is found in the fact that compound dislocations are comparatively numerous, and are exceptionally liable to be followed by tetanus.

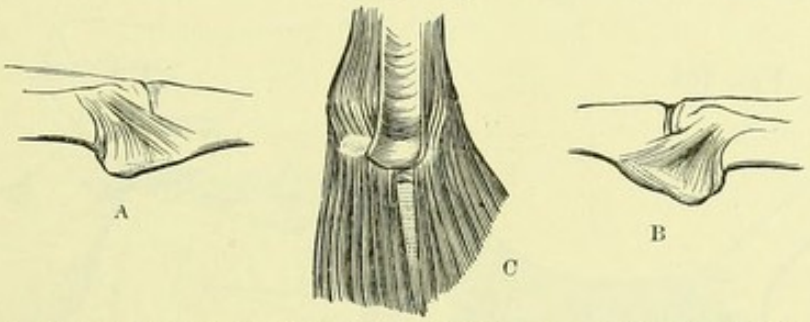
Dislocations of the proximal phalanx of the thumb.

These dislocations are not only the most frequent of those involving the phalanges, but they also derive a special interest from the frequency with which the reduction has been found to be very difficult or has entirely failed. The cause of this difficulty has been the subject of much study and experiment upon the cadaver during the last hundred years, which may be said to have culminated in an elaborate paper read by Farabeuf[2] before the Société de Chirurgie of Paris in 1875, in which the anatomy of the joint was described with much detail. This description and his explanation of the cause of the difficulty have been generally copied and accepted by writers in Germany and France.

[1] Polaillon: Dict. Encyclopédique des Sciences Méd., article Doigt, p. 166.
[2] Farabeuf: Bull. de la Société de Chirurgie, 1876, p. 21.

Anatomy.—The head of the metacarpal bone presents no expansion on the dorsum, and but little, if any, on the sides, but on its palmar aspect it projects in the form of a well-rounded tubercle or condyle covered with cartilage for articulation with the two sesamoid bones, which are developed in the combined anterior ligament and the tendons of the short muscles that are attached to the base of the phalanx. Of these two sesamoid bones the outer is the larger, and both are firmly and closely united to the phalanx by ligaments which are continuous with each other across the front of the joint, and together form the "glenoid ligament" which separates the tendon of the long flexor of the thumb from the joint, and is continued backward and upward to the palmar surface and sides of the metacarpal bone. These ligaments hold the sesamoid bones close to the phalanx and, allowing them to turn freely in the direction of flexion, prevent their movement in the opposite direction beyond a line parallel to the long axis of the phalanx, so that if the latter is separated from the metacarpal bone the sesamoid bones cannot be turned up against the articular surface of the phalanx. The arrangement has been aptly compared to that of the hinged side of a table, which can be let down but cannot be raised above the level of the top of the table. The connection

FIG. 103.



The metacarpo-phalangeal joint of the left thumb. (FARABEUF.) A. The external lateral ligament. B. The internal lateral ligament. C. Palmar aspect.

of the sesamoid bones is much stronger with the phalanx than with the metacarpal bone. In addition, there are the lateral ligaments uniting the phalanx and metacarpal bone. The head of the metacarpal bone is more prominent anteriorly on the outer than on the inner side, and the tendon of the flexor longus pollicis lies nearer the inner than the outer side. This tendon is lodged at its lower end in a firm sheath, which extends upward to, and is connected with, the sesamoid bones.

The muscles which are attached to the first phalanx are the abductor, adductor, and flexor brevis; the latter has two insertions, one upon the outer the other upon the inner side of the base of the phalanx, and the two sesamoids are developed within its tendons of insertion where they are continuous with the anterior ligament; the outer insertion spreads to each side of its sesamoid bone, and is attached also to the palmar surface of the base of the phalanx and to the external lateral ligament, covering in a large part of the palmar and external faces of the joint. The abductor is attached to the external sesamoid by deep tendinous fibres, and also to the intersesamoid ligament, and by expanded fibres to the

outer side of the phalanx and the extensor tendons, after the manner of insertion of the interosseous muscles in general. The adductor is in like manner attached to the internal sesamoid bone and the inner side of the phalanx and the extensor tendon. These attachments and muscles are made tense by abducting the thumb, and are relaxed by pressing the metacarpal bone into the palm of the hand. The long flexor and the extensors are relaxed by inclination of the hand toward the radial side. Consequently, to relax as much as possible the various muscles attached to the thumb, the hand should be held in straight extension and slight abduction, and the thumb should be pressed into the palm, adduction.

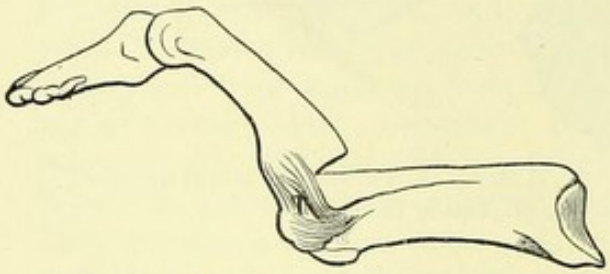
The dislocation may be forward or backward, complete or incomplete.

Backward dislocations.—This is the most frequent form, and the one in which reduction of the dislocation is often difficult.

The common cause is exaggerated dorsal flexion of the first phalanx. When the normal limit of the movement is reached the anterior ligament is put upon the stretch and, the movement being continued, yields at its attachment to the metacarpal bone, so that the sesamoid bones accompany the phalanx in its movement.

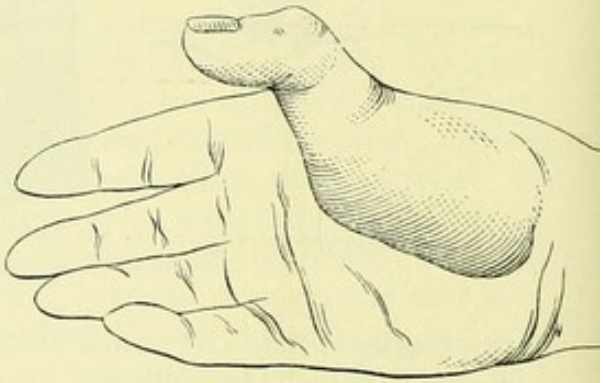
a. Incomplete form.—If this movement is not carried further than to the position shown in Fig. 104 the articular end of the phalanx rests

FIG. 104.



Incomplete dislocation of the thumb.

FIG. 105.



Incomplete dislocation. (FARABEUF.)

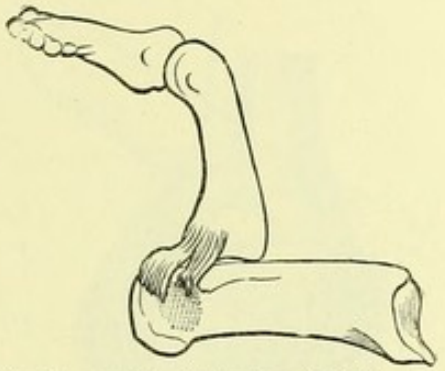
against the posterior margin of the head of the metacarpal bone, and is maintained in this position by the tension of the portions of the adductor and abductor muscles which are attached directly to the phalanx, for their line of traction is now posterior to and above the new centre of motion. The attitude of the member is represented in Fig. 105.

This incomplete form is the one which many people, especially the young, can voluntarily produce by contracting the extensor muscles. The anterior ligament and the sesamoid bones rest like an apron against the antero-inferior articular surface of the metacarpal bone, and the dislocation can be readily reduced by moderate traction upon the phalanx and flexion.

b. Complete form.—If, however, the movement is carried further, the phalanx entirely leaves the articular surface of the metacarpal bone, and

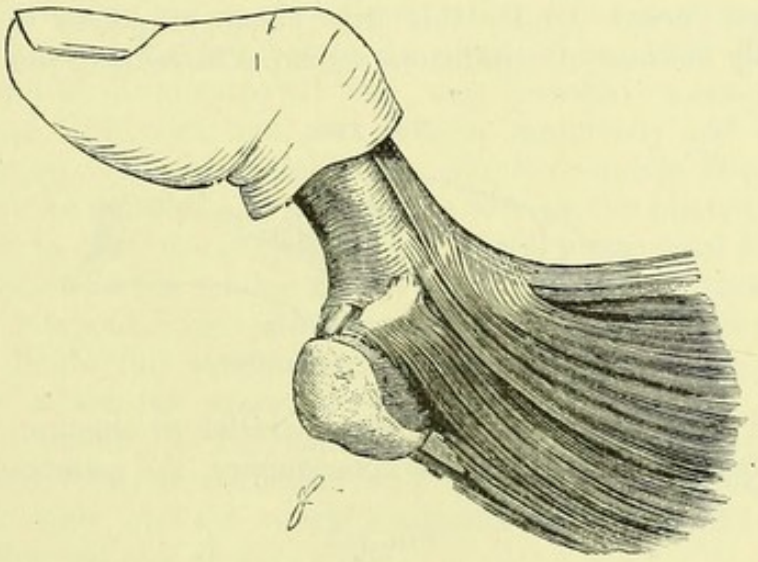
moves upward on its dorsum, being followed by the anterior ligament and the sesamoid bones (Figs. 106, 107, 108). The external lateral ligament is torn, and usually the internal one also; the tendon of the flexor longus pollicis may remain in position, and be tightly stretched across the articular face of the metacarpal bone, as has been seen in some compound dislocations (*e. g.*, Esmarch[1]), or, and more commonly, it accompanies the inner sesamoid bone to the inner side of the metacarpal; occasionally it passes to the outer side of the metacarpal bone, accompanying the external sesamoid, but probably it does so only when, in the production of the dislocation, the thumb is bent to the outer side as well as backward. The head of the metacarpal bone projects through the rent in the capsule, and the tendons of the adductor, abductor, and the two portions of the flexor brevis rest against its sides. The phalanx stands

FIG. 106.



Simple complete dislocation of the thumb. (FARABEUF.)

FIG. 107.



Simple complete dislocation; outer side. (FARABEUF.)

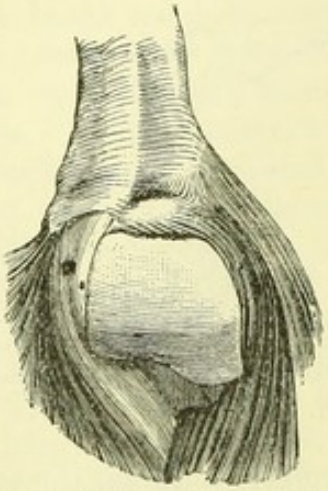
erect upon the dorsum of the metacarpal bone, being held there by the tension of the abductor and adductor. The dislocation is sometimes made compound by the rupture of the soft parts on the palmar aspect of the joint.

The appearance of the member is characteristic (Fig. 109). The phalanx is thrown back vertically upon the metacarpal bone, and the latter is adducted, the thenar eminence being consequently increased in thickness and diminished in breadth. The head of the metacarpal bone projects in front as a round, smooth prominence close under the skin, over

[1] Esmarch: Berlin. klin. Wochenschrift, 1876, p. 629, first case.

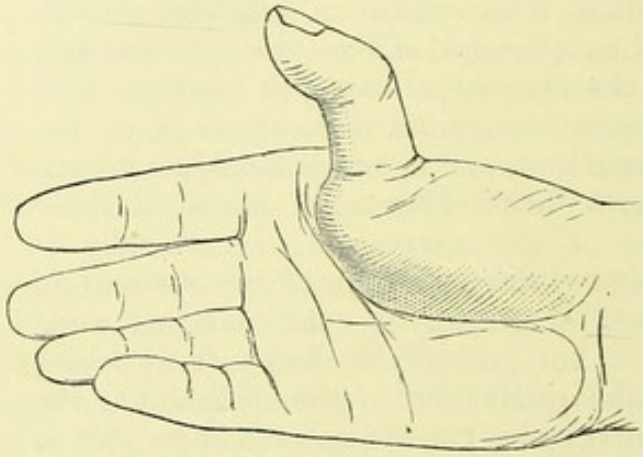
which the tendon of the long flexor may perhaps be felt. The phalanx is quite movable from side to side, and can be rotated; it can also be

Fig. 108.



Simple complete dislocation; right thumb. The long flexor tendon is displaced to the inner side (Farabeuf.)

Fig. 109.

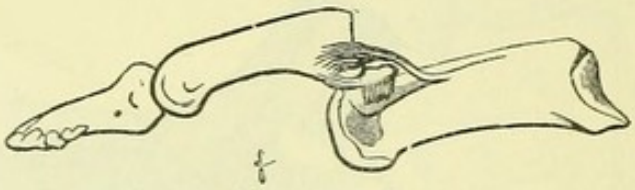


Simple complete dislocation. (Farabeuf.)

turned down so as to be parallel with the metacarpal bone, but this movement should not be made, lest it should increase the difficulty of reduction by effecting a change into the "complex" form.

c. Complex form.—Under this title Farabeuf places those cases in which, usually because of injudicious attempts to reduce, the phalanx has

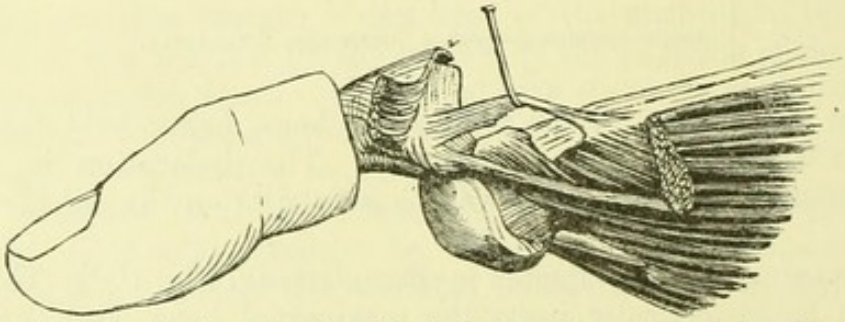
Fig. 110.



Complex dislocation. (Farabeuf.)

been lowered until it is nearly or quite parallel to the long axis of the metacarpal bone, and in which, in consequence, the sesamoid bones have

Fig. 111.

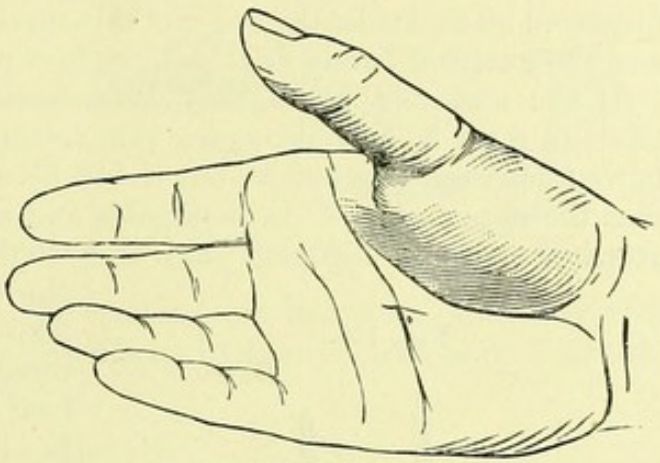


Complex dislocation of the thumb; outer side. The hook raises the periosteal continuation of the lateral ligament, exposing the reflected sesamoid bone. (Farabeuf.)

been turned upward, and lie on the dorsum of the metacarpal bone above the base of the phalanx (Figs. 110, 111). The attached muscles are correspondingly displaced along the sides of the metacarpal bone, and

grasp it more or less tightly, and the tendon of the long flexor accompanies one of the sesamoids, usually the internal one. If the phalanx is now turned back, so as to stand at right angles to the metacarpal bone, its articular surface is separated from the latter by the interposed sesamoids.

Fig. 112.



Complex dislocation. (Farabeuf.)

The appearance of the hand is represented in Fig. 112; the thumb is nearly parallel to the metacarpal bone, the base of the phalanx can be felt upon the dorsum of the latter, and the head of the latter can be felt in front as in the preceding form. The characteristic symptom of this variety is the straight extension of the thumb.

Treatment.—Although an incomplete dislocation can be readily reduced by traction and flexion, yet it is better, unless the diagnosis of the variety is beyond question, to act as if the dislocation was complete, for premature flexion—that is, flexion before the phalanx has been brought fully down to the end of the metacarpal bone, may transform a simple complete dislocation into a complex one, and thereby materially add to the difficulty of reduction. The obstacles in the simple complete form arise from the tension of the muscles attached to the side of the phalanx, by which they are made to clasp the projecting end of the metacarpal bone tightly, and to the tension of the tendon of the long flexor, when this also is displaced. In a compound dislocation treated by Wordsworth[1] it was thought necessary to divide this tendon; reduction was then easily made. In another, with a similar wound at the front of the joint, treated by Esmarch, the opening in the capsule was first enlarged by nicking at each angle, and then, as reduction still failed, a blunt hook was introduced at each angle, and the lateral ligaments and sesamoid bones drawn aside, and reduction was at once made.

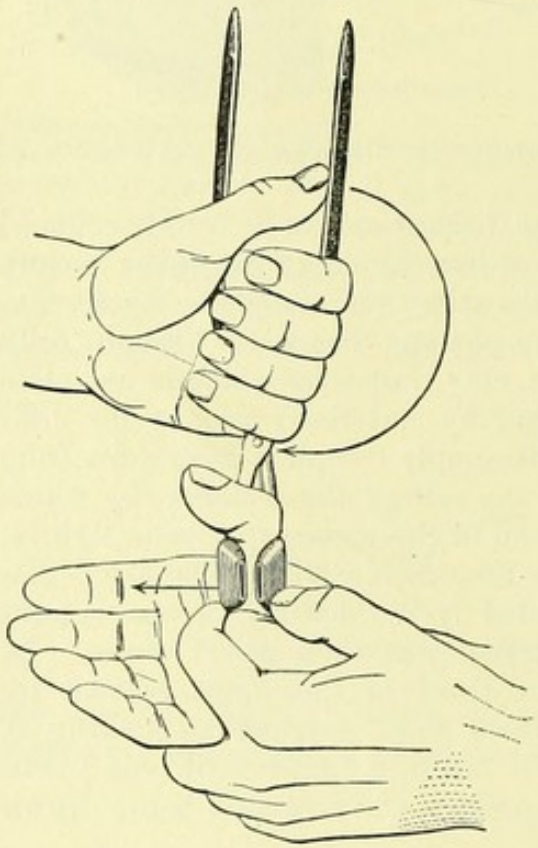
Such cases and consideration of the anatomical conditions indicate the measures to be taken in simple cases. The metacarpal bone should be pressed toward the palm to relax the short muscles, and pressure made against the front of its head while the surgeon holds the phalanx in rectangular dorsal flexion and presses its base downward with his thumbs close along the dorsum of the metacarpal bone to its head, and then gently flexes it into place. If this fails, traction with a cord passed around the back of the phalanx close to its base may be substituted for the pressure of the surgeon's thumbs, or, when the phalanx has been brought close to its place, it may be slightly moved toward the inner side and rotated, turning the palmar surface outward, so as to turn the tendon of the long flexor and the internal portion of the capsule and adductor tendon past

[1] Wordsworth: Lancet, 1863, ii. p. 443.

the inner side of the head of the metacarpal bone, and then moved toward the outer side and rotated in the opposite direction to free the outer bands. Of course, if the phalanx is displaced rather to the outer than to the inner side, so that it is probable that the long flexor tendon has been displaced on that side, the order of this successive freeing must be changed, and the external bands first brought into place.

If the sesamoid bones have been turned upward (complex form) the phalanx must be brought again into rectangular dorsal flexion, and then moved downward as before, but it will be necessary to move it further, so that the upper edge of the sesamoids and the transverse torn edge of the attached anterior ligament may be brought completely past the edge of the head of the metacarpal bone. This requires the exercise of more force, and for this purpose Farabeuf recommends a forceps which he has successfully employed in several cases, and which is sufficiently shown in Fig. 113. Levis's instruments (Figs. 114 and 115), placed against the back of the phalanx, held at right angles to the metacarpal bones, and used to push, not to pull, the thumb downward, would probably be equally efficient, and could be readily made when wanted.

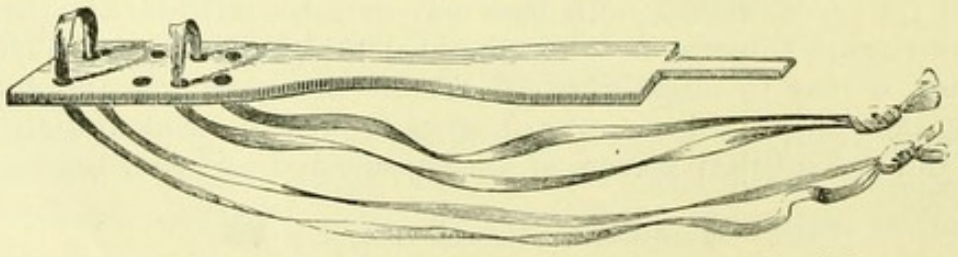
Fig. 113.



Farabeuf's instrument for reduction of dislocation of the thumb.

In the simple complete form the phalanx must be kept closely against the metacarpal bone during the manipulation in order that it shall certainly push the sesamoid bones before it; and in the complex form the position of rectangular dorsal flexion is equally necessary, in order that the resistance of the untorn soft parts may be diminished. A glance at Figs. 116 and 117 shows how great a separation between the phalanx and metacarpal bone is necessary to free the sesamoids when traction is made in straight extension, and how easily, even then, flexion of the phalanx may still leave them interposed between the joint surfaces.

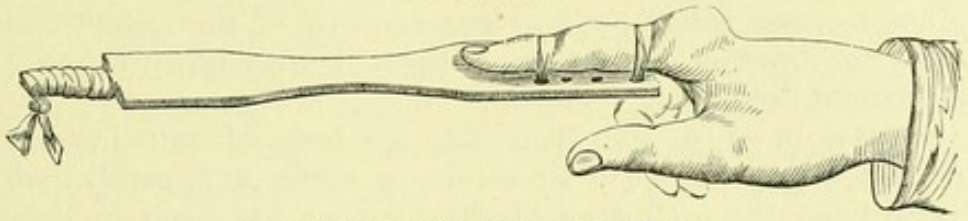
Fig. 114.



Levis's instrument for making traction in reduction of dislocations of the phalanges.

In compound cases advantage may be taken of the wound, which is in the palmar aspect of the joint, and is produced by overstretching of the

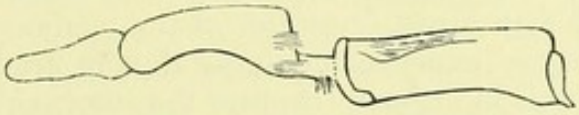
FIG. 115.



Levis's instrument; faulty method of use.

soft parts, to act directly upon the tendons and ligaments, and draw them aside from the head of the metacarpal bone by blunt hooks, as in Esmarch's case above mentioned.

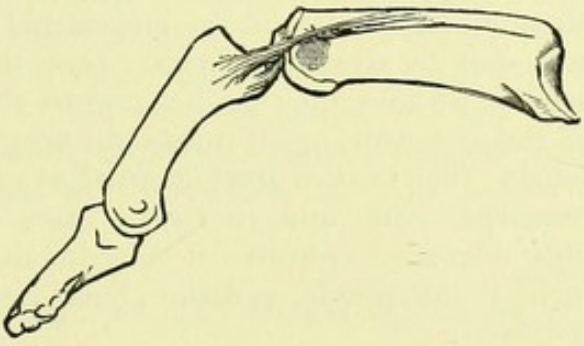
FIG. 116.



Position of sesamoid bones during forcible traction. (FARABEUF.)

In several cases surgeons have found it necessary to make subcutaneous section of the bands on one or both sides, or to do an open arthrotomy,

FIG. 117.



Interposition of the sesamoid bones by premature flexion. (FARABEUF.)

making an incision upon one side, the inner, usually, of the dorsum, or on the front in the place usually occupied by the wound in compound cases, through which the tendon of the long flexor and the sesamoids are drawn forward into place. Such cases have, as a rule, done well under antiseptic treatment, but it is to be hoped, and perhaps expected, that resort to a cutting operation will be even more rarely had in the future than in the past, and that the cases left unreduced will be fewer.

The prognosis in the past has not been favorable. Polaillon, analyzing 58 cases, found that reduction had failed in 11 and had been effected only after numerous and prolonged attempts in 16; in 8 the dislocation was compound, and in 3 of these the head of the metacarpal bone was excised. In one case (Bromfield), nearly a hundred years ago, such

violent traction was made that the terminal phalanx was torn off; the case has been persistently quoted as a warning ever since, but if it is remembered that traction is especially ill-adapted to effect reduction in difficult cases the warning will not be longer needed. In other cases the thumb has become gangrenous in consequence of the violence inflicted upon it by the traction, and in one of them (Dupuytren) pyæmia ensued and the patient died.

In the cases in which the dislocation has been left unreduced and the phalanx has been lowered to a position in which it is parallel with the metacarpal bone, the usefulness of the member has been in great part restored, although, of course, the deformity persisted and the joint was immovable.

Forward dislocations.—These dislocations, much rarer than the preceding and less difficult to reduce, result usually from a fall or blow upon the back of the flexed phalanx—that is, by exaggerated palmar flexion, but in at least one case (Lombard) from exaggerated dorsal flexion presumably combined with direct impulsion of the phalanx toward the palm; according to Foucart's[1] experiments dorsal flexion needed to be combined with forced abduction in order to rupture the internal lateral ligament.

The *pathology* has been shown by six autopsies, Wood,[2] Meschedé,[3] Foucart, two cases, Eve,[4] and one of my own not before reported. In two of these (Foucart, Eve) the injury was recent; in Meschedé's it had lasted forty-eight days; and in Foucart's second case, in Eve's, and in mine it was of long standing. The recent cases show, as is also found in experiments upon the cadaver, that the posterior and lateral parts of the capsule are torn, including the lateral ligaments, but that the connection between one or both sesamoid bones and the metacarpal bone may persist. The extensor tendons may be stretched directly over the projecting head of the metacarpal bone or they may be deviated to either side; in my case the tendon of the extensor primi internodii appeared to have been detached and retracted. The base of the phalanx lies against the anterior surface of the metacarpal bone and, in recent cases at least, does not appear to be notably displaced upward; it may lie directly in front, or be somewhat displaced to either side, and the phalanx may be in straight extension or partly flexed.

In the older cases a more or less complete nearthrosis forms between the bones, and fibrous bands and bony outgrowths give the joint sufficient solidity to make it useful.

The specimen which is in my possession was taken from a patient who died in the Presbyterian Hospital, and is without history, although plainly of very long standing. There is but little overriding of the bones, which are firmly bound together, and the phalanx overlaps the metacarpal bone on its outer side by about one-third of its breadth, is flexed at an angle of 45°, and is slightly adducted. On the palmar surface of the metacarpal is a stout overgrowth of bone forming a sort of buttress

[1] Foucart: Thèse de Paris, 1876, No. 199; quoted by Poinsot.
[2] Wood: Trans. Path. Soc. of London, 1853, vol iv. p. 250.
[3] Meschedé: Virchow's Archiv, 1866, vol. xxxvii. p. 510.
[4] Eve: Lancet, 1880, i. p. 133.

against which the upper ends and part of the posterior surfaces of the sesamoid bones rest; the tendon of the extensor secundi internodii passes obliquely downward and forward along the outer side of the metacarpal bone, lying in a deep bony groove of new formation more than an inch in length. The metacarpal articular surface is obliterated by adherent fibrous tissue; that of the phalanx preserves its cartilage, though much thinned, and forms part of a joint cavity the remainder of which is constituted by a thick layer of fibrous tissue interposed between the two bones. A similar groove lodging the extensor tendons existed in Wood's specimen, and was thought to have resulted from a fracture.

Symptoms.—The deformity is characterized by the position of the phalanx in front of the metacarpal bone, the projection of the head of the latter on the dorsum of the member, and the rather deeply placed prominence formed by the base of the phalanx at the lower part of the thenar eminence. The thumb appears in some cases to have undergone slight rotation about its long axis, and the attempt has been made to show a connection between the direction of this rotation and that of the lateral displacement of the extensor tendons; that is, it has been claimed that when the rotation is such that the nail looks outward the tendons have been displaced toward the outer side, and *vice versâ*.

In one reported case the dislocation was made compound by rupture of the soft parts covering the back of the joint; recovery was delayed by a phlegmon of the ball of the thumb.

Treatment.—Reduction is generally easy, and is effected either by traction and coaptation, or, better, by forced flexion of the thumb aided, if necessary, by impulsion downward of its base. This latter method is analogous to that recommended in the treatment of the dorsal variety, but there is not the same urgent reason for it that arises in the latter from the relations of the sesamoid bones. If any difficulty should arise from the tension of the displaced extensor tendons the phalanx should be inclined toward the side on which they lie before making the usual manœuvre.

Metacarpo-phalangeal Dislocations of the Fingers.

The shallow cavity formed by the articular surface of the base of the proximal phalanx is deepened by the thick fibro-cartilaginous anterior portion of the capsule, which forms, as in the thumb, a stout transverse band or apron which accompanies the phalanx in its displacement, and may in like manner become interposed between the bones in a backward dislocation. The resemblance is still further increased by the occasional development of a sesamoid bone in this ligament, especially at the index-finger; its next most frequent appearance is at the little finger.

Dislocations of the proximal phalanges of the fingers are much less frequent, even when taken together, than those of the thumb; and those of the index-finger are more frequent than those of the other three fingers. Of 27 cases collected by Polaillon, the dislocation in 18 was backward, and in 9 forward; grouped according to the finger and the variety, they are as follows:

TABLE XII.—DISLOCATIONS OF THE FINGERS.

Index finger	15	10 backward.
		5 forward.
Middle finger	4	2 backward.
		2 forward.
Ring finger	3	2 backward.
		1 forward.
Little finger	3	2 backward.
		1 forward.
Ring and little fingers		1 forward.
Ring and middle fingers		1 backward.
All four fingers, compound		1, direction not mentioned.

Backward dislocations.—The common cause is hyperextension (dorsal flexion) of the finger; in one case it appears to have been direct pressure upon the palmar aspect of the phalanx, forcing it directly backward. Experiment upon the cadaver and direct observation in compound dislocations or after arthrotomy in irreducible ones (Lange,[1] Willemer[2]), show that the rupture of the capsule takes place in front along its attachment to the metacarpal bone. Willemer thinks, after many experiments upon the cadaver, that simple hyperextension is not competent to produce a persistent dislocation, but that it must be combined with such rotation of the finger as will bring the flexor tendons to the side of the head of the metacarpal bone and allow the latter to slip down past them. In the case reported by Willemer the dislocation was irreducible by manipulation, and König resorted to arthrotomy, making an incision on the ulnar side of the palmar surface of the joint (index finger); he found the anterior portion of the capsule had been drawn back past the articular surface of the phalanx so that it was completely interposed between the two bones, and that a sesamoid bone was developed on it. This makes the case strictly analogous to the "complex" form of backward dislocation of the thumb, and corroborates Farabeuf's opinion that the cause of the irreducibility in the latter is to be found in the position of the sesamoid bones rather than in the tension of the tendons of the short muscles; probably in this case also the preceding attempts to reduce by manipulation had caused the interposition.

In the report of Lange's case the position of the incision is not stated, but probably it also was in the palmar surface. "The smallest possible cord of the capsule, which was torn from its attachment to the metacarpus, had interposed itself like an apron between the dorsum of the metacarpus and the border of the articular plane of the phalanx. . . . He was obliged to incise and draw outward the light lateral parts of the capsule, when reduction was effected without difficulty. A fair result was obtained."

A similar condition was observed in a case upon which Volkmann[3] operated in like manner with a good result.

The symptoms are the prominence of the base of the phalanx on the dorsum of the hand, and that of the head of the metacarpal bone in the

[1] Lange: N. Y. Med. Record, 1879, p. 100.
[2] Willemer: Centralblatt für Chirurgie, 1883, p. 566.
[3] Volkmann: reported by Ranke, Berlin. klin. Wochenschrift, 1877, p. 524.

palm, more or less shortening of the finger, and loss or diminution of function. The finger may be extended or slightly flexed upon the metacarpus; in one case the first phalanx was in rectangular dorsal flexion. The middle and distal phalanges are straight or slightly flexed.

In 5 of Polaillon's 17 cases the dislocation was complicated by a wound on the palmar aspect of the joint through which the head of the metacarpal bone projected, and in another the skin was so tightly stretched over the end of the bone that it threatened to slough. In 2 cases reduction failed (without operation) and in 5 it was difficult, and was at last effected by rectangular dorsal flexion of the phalanx and direct impulsion downward as in backward dislocation of the thumb.

Treatment.—If the dislocation is incomplete reduction may be easily effected by moderate traction followed by flexion, but in the complete cases it is certainly more prudent to act as in the similar dislocations of the thumb in order more surely to avoid the interposition of the anterior portion of the capsule.

Forward dislocations.—The cause, except in an incomplete case observed by Malgaigne, has always been notable violence received upon the finger, usually in a fall, but the mode of production is not clear. Malgaigne's patient was a shoemaker and caused the dislocation by turning in his hand the shoe upon which he was at work.

The symptoms are the presence of the base of the phalanx in the palm and the projection of the head of the metacarpal bone at the back of the hand. The finger is extended or slightly flexed, and appears usually to be deviated to one or the other side, sometimes very markedly, with displacement of the extensor tendons toward the same side. Reduction has been effected by traction and coaptative pressure. Possibly flexion would be efficient in the more difficult cases, as in the similar dislocations of the thumb.

Dislocations of the Middle Phalanges.

These dislocations may be forward, backward, or lateral.

Backward.—The usual cause is a fall upon the palmar surface of the extended finger, which produces the dislocation by hyperextension of the phalanx and sometimes ruptures the skin over the front of the joint. The phalanx may remain hyperextended upon the proximal one, even to a right angle, or may be lowered so that its axis is parallel to that of the other. The diagnosis is readily made by examination of the relations of the bones, and ordinarily reduction is easily made by direct impulsion of the hyperextended phalanx or by traction and flexion. The anterior portion of the capsule resembles that of the metacarpo-phalangeal joints in being thick and rigid, and it is quite possible, therefore, that it may become interposed as above described and make reduction difficult or impossible, as in a case treated by Polaillon (loc. cit., p. 184) in which all measures failed. It seems advisable, therefore, that the first trial should be of direct impulsion upon the hyperextended phalanx, and, this failing, the phalanx, still extended, should be pressed bodily toward the side on which the flexor tendons may be displaced and then rotated so as to carry the tendons forward past the head of the other phalanx.

A special risk associated with the compound dislocations is that of tetanus; in a patient under my care with a compound dislocation of the middle and ring fingers the wound had almost entirely healed in about a fortnight when tetanus supervened and promptly proved fatal. Some compound cases have ended in ankylosis.

In two reported cases, Langenhagen (quoted by Polaillon) and Péan,[1] the index, middle, and ring fingers were simultaneously dislocated.

Forward.—These may be complete or incomplete, according to the extent to which the base of the middle phalanx is displaced upward along the palmar aspect of the proximal one. The symptoms are the well-marked prominence of the head of the first phalanx on the back, and the less marked projection of the base of the second phalanx on the palmar surface when it is extended. With the displacement upward may be associated some lateral displacement or a lateral deviation of the axis of the second phalanx.

Reduction is said to be always easily made by means of traction and coaptative pressure, but in an old case treated by Hamilton the effort had failed, and in one treated by Thorens the aid of anæsthesia was necessary.

Lateral.—Of these but few cases have been reported; Polaillon could collect only eight, of which the dislocation was to the inner side in seven, and to the outer side in one. In a case quoted by him from Chédan the middle phalanges of the last three fingers were simultaneously dislocated toward the inner side, forming almost a right angle with the side of the first phalanx. Duplay,[2] who saw a case, says "the dislocated phalanx is markedly deviated inward so as to form almost a right angle and to cross the course of the adjoining finger. At the apex of the angle the lower end of the first phalanx can be felt; the dislocated phalanx projects on its inner side."

In Rollet's case of dislocation to the outer side the base of the second phalanx of the ring finger projected upon the outer side of the first phalanx; the second phalanx was somewhat inclined inward, and the distal phalanx was slightly flexed. The shortening was about two-thirds of a centimetre.

In two of the eight cases the dislocation was compound, but the patients recovered without ankylosis.

Reduction was easily effected in every case by traction and coaptation.

Dislocations of the Distal Phalanges.

These dislocations may be backward, forward, or lateral, the former being by far the most frequent; forward dislocations have, I believe, been encountered only in the thumb.

Backward.—Backward dislocation of the distal phalanx is commonly caused by a fall or blow upon the end of the outstretched finger; it is currently thought to be a common accident among ball-players. The dislocation may be complete or incomplete, simple or compound, and it may be directly backward or backward and to one side.

[1] Péan: France médicale, 1883, vol. 2, No. 23, abstract in Centralblatt für Chirurgie, 1883, p. 648.

[2] Duplay: Pathologie Externe, vol. 3, p. 332.

The anterior ligament is torn away from one or the other bone, in the thumb usually from the proximal phalanx, in the fingers from the distal one. The lateral ligaments remain intact, unless the dislocation is to one side as well as backward. The flexor tendon may be torn away from its attachment, or it may be displaced to one side.

Reduction is usually easy, but may be made difficult by interposition of the anterior portion of the capsule when this accompanies the distal phalanx or by the tension of the displaced tendon. In several compound cases of the thumb the obstacle created by the tendon was clearly demonstrated and was overcome by drawing the tendon aside with a blunt hook or dividing it.

The phalanx may be hyperextended, or straight, or flexed across the end of the proximal one. The coexistence of a wound on the palmar surface of the joint is frequent, thirty-two times in fifty-five cases collected by Polaillon, and has led to very serious consequences, ankylosis, gangrene, suppuration extending to the forearm, tetanus.

Although ordinarily of easy reduction, yet in one-quarter of Polaillon's cases reduction failed. As his list is made up largely of reported cases it undoubtedly contains an exceptionally large proportion of difficult and complicated ones, but still the number of failures, thirteen, is large enough to indicate that reduction may often require much care and skill. The principles controlling it are the same as in the backward dislocations of the other joints, and although simple traction has often sufficed it is prudent to refrain from it and to reduce by direct impulsion of the hyperextended phalanx, especially at the thumb. In one case Hamilton divided the lateral ligaments subcutaneously.

Forward.—These dislocations have been observed only at the thumb, and in a large proportion of the reported cases they have been made compound by a wound on the palmar surface. The cause, in the few reported cases, has been a blow upon the end of the phalanx by which it was forcibly hyperextended. In some cases the phalanx remained in this position, its dorsal surface resting against the articular face of the proximal phalanx, and its base projecting on the palmar surface; in other cases the phalanx was slightly flexed, and its base displaced upward along the anterior surface of the proximal one.

Reduction has usually been easy by traction or direct pressure.

Lateral.—These dislocations, of which only four or five have been reported, have been caused by falls, by a kick, and by violently shaking the hand while grasping it by the end of the finger. The phalanx may preserve its parallelism with the other, being simply displaced upward along its side, or it may form a lateral angle with it, its base resting against the side of the other. In Gogué's case, quoted by Malgaigne, there was a transverse wound fifteen millimetres long through which the head of the middle phalanx protruded. In Dugès's, case reduction was not attempted; in the others it was easy.

CHAPTER XXIV.

DISLOCATION OF THE PELVIS. DISLOCATIONS OF THE COCCYX.

THE union of the two innominate bones at the symphysis pubis is by a solid fibro-cartilaginous band, and without an articular cavity, and the rupture of this band, or its separation from one or the other bone, belongs more properly among fractures than among dislocations. Between the auricular surfaces of the ilium and sacrum there is usually an articular cavity, but it is often more or less obliterated by fibrous union between the opposed cartilaginous surfaces. Pure separations at these points without fracture are rare, and, except at the pubic symphysis, hardly to be diagnosticated with certainty during life. The reader is, therefore, referred for most that pertains to the subject to the chapter upon fractures of the pelvis.

Malgaigne described the lesions as dislocations, and most writers have followed his example. His classification is as follows:

Dislocations of the pubic symphysis.

Dislocations of the sacro-iliac symphysis.

Dislocations of these two symphyses, or of the ilium.

Dislocations of the two sacro-iliac symphyses, or of the sacrum.

Dislocations of the three symphyses, or of the three bones simultaneously.

Dislocations of the coccyx.

Of these, only the last is, strictly speaking, to be deemed a dislocation.

Two cases that have been recently reported deserve mention, as additions to the statistics of the injury. In one,[1] a man twenty-one years old, fell, and was struck upon the back by a heavy piece of timber; a fracture of the thigh was recognized, and, in addition, a peculiar prominence of the right hip, the nature of which was not at the time determined, although nothing abnormal in the hip-joint could be recognized. Two and a half weeks later the right os innominatum was found somewhat depressed, and separated one and a half inches laterally from the sacrum. Although the patient fell and broke the thigh twice again, four and six months after the first injury, he recovered sufficiently to walk with the help of a cane, and do light work. The union between the ilium and sacrum was firm, but some displacement persisted.

In the other case,[2] a man twenty years old fell while aiding to carry a heavy piece of timber, and was caught under it. On the following day an examination was made under chloroform, and the right ilium was found to have separated from the sacrum, and to project markedly backward, but the pubic symphysis was unchanged. The next morning the right

[1] Groner: Annals of Surgery, 1885, vol. 1, p. 463.

[2] Varrailhon: Revue de Chirurgie, 1886, p. 821.

pubis was found to project forward and upward at the symphysis, about a centimetre, although the patient had not changed his position, and the pelvis had been supported by a broad bandage. The patient recovered entirely, without deformity in three months.

Dislocations of the Coccyx.

The systematic descriptions of dislocations of the coccyx which are given by the earlier writers were called in question by those of the first half of the present century, some of whom, especially Boyer, went so far as to deny that the lesion had ever occurred. Malgaigne, however, collected six cases of dislocation forward, and described a backward form on the authority of Lauverjat. To these six may be added four that have been since reported, Roeser,[1] Bonnefont,[2] two cases, and Mouret,[3] the first of which is an example of a variety, lateral dislocation, that has not heretofore been described. It must further be said that many cases have been encountered and reported in which a group of symptoms identical with those observed in cases reported as dislocations, and following similar accidents, falls, blows upon the anal region, has been presented, and the conclusion seems to be unavoidable, either that dislocations or fractures of the coccyx are much more frequent than the number of reported cases indicates, or that the prominent symptoms which accompany the recognized cases, the excessive pain, disability, and general nervous disturbance, are due to something else than the displacement of the bone. Against the latter alternative may be urged the immediate relief and prompt recovery which have followed the reduction of the displacement. Six cases in which the general symptoms were similar to those of dislocation, but in which no displacement was recognizable, are reported by Warren,[4] and Mouret's case may perhaps be classed with them.

Of eight of the above cases in which the sex is noted, six were women, and two men; all were adults; and the obscure injury just referred to, in which the symptoms are the same, except that no displacement is recognizable, is also much more frequent in women than in men.

Dislocations forward.—The usual cause is violence received upon the region of the coccyx in a fall upon the buttocks or astride a bar, or by the breaking of a chamber upon which the patient was sitting. The two men, Ravaton, Mouret, were injured while on horseback, one of them suddenly in jumping a ditch, the other without special cause or incident, the pain coming on gradually, and increasing for twenty-four hours, and then suddenly becoming very severe after a slight change of position, with a sensation of something slipping in the rectum.

The pain at the moment of the accident is so severe as sometimes to cause the patient to faint; there is pain in defecation, and frequent calls to urinate. The pain radiates down the thighs, and sometimes over the trunk, head, and arms; the patient is unable to sit up, and the slightest

[1] Roeser: Froriep's Notizen, 1857, vol. 2, No. 10. Abstract in Brit. and For. Med. Chir. Rev., 1857, vol. 20, p. 414.

[2] Bonnefont: Union Médicale, 1859, i. p. 136.

[3] Mouret: Red. de Mém. de Med. Chir. et Pharm. militaires, 1859, i. p. 350.

[4] Warren: Surg. Observations, Boston, 1867, p. 593.

movement may greatly increase the suffering. Coughing and sneezing, and sometimes even every act of inspiration increase the local pain. If the condition remains unrelieved (Turner, a week; Ravaton, seventeen days; Bonnefont, a month) the general health suffers seriously, the patient becomes feverish, and the mind dulled.

External examination may show an ecchymosis and swelling over the situation of the coccyx and a displacement of this bone forward; the finger introduced into the rectum recognizes an angular displacement of the coccyx, in which its point is directed forward, and which is sometimes so great that the bone stands almost at right angles to its normal position, and presses the posterior wall of the rectum sharply forward.

If now the finger is hooked over the projecting end of the coccyx it can be readily drawn back into place, and the reduction is followed by immediate, instantaneous relief of all the symptoms. A marked tendency to recurrence usually exists and may make it necessary to repeat the reduction several times. In one of Bonnefont's cases a gum catheter with a stylet was bent into the shape of a hook and so placed in the anus that by traction upon the projecting portion the bone could be kept in place. In Turner's case the cure was less complete; the coccyx preserved an abnormal mobility for many years, and the patient was obliged to facilitate defecation by introducing her finger into the anus.

Dislocation backward is lightly mentioned by some writers as a not infrequent accident during parturition. Malgaigne quoted Lowenjat as follows: "The considerable deviation backward of this bone sometimes causes its dislocation. I have seen one case. The patient suffered astonishingly, and could not sit; I reduced the coccyx and she was immediately cured."

Lateral dislocation.—Of this only one case, Roeser, has been reported. The patient, a large, corpulent woman, thirty-six years old, fell astride the back of a chair. She at once suffered severe pain in the coccygeal region, much aggravated by attempts to sit, but she was able to go about for some hours. At last the pain became so severe that she took to her bed, when she found she could neither move nor turn. When seen the next day there was so much immobility and stiffness of the body as to suggest tetanus. Besides the severe pain in the coccygeal region she complained of a painful, tense, dragging sensation, extending up toward the nape, and along the arms to the fingers which felt numb. She could not bear to make the slightest movement. The head was confused, and the intellect somewhat clouded. No unnatural sensation in the lower limbs; urine and feces were passed naturally.

A small swelling was felt on the left side of the fissure of the buttocks, which proved to be the coccyx torn away from the sacrum, and carried toward the left ischium. The end of the scrotum from which it had been displaced could be plainly felt. The finger in the rectum showed the exact nature of the displacement still better, and when firm pressure was made downward and to the right against the displaced bone, it suddenly resumed its normal position. The patient declared she immediately felt quite another being, the confusion of the head and painful sensation along the spine and anus disappearing. At the end of the fifth day no inconvenience beyond a slight burning pain near the sacrum remained.

CHAPTER XXV.

DISLOCATIONS OF THE HIP.

ANATOMY. STATISTICS. CLASSIFICATION. BACKWARD DISLOCATIONS.

Anatomy.—The bony constituents of the hip-joint are the acetabulum, or cotyloid cavity of the os innominatum, and the globular head of the femur. The former is an almost hemispherical cavity, situated at the junction of the ilium, ischium, and pubis, and formed by the projection from their outer surface of a strong bony rim, which is especially thick and prominent behind and above, and is lacking below for nearly an inch at the point where the cavity adjoins the foramen ovale, the cotyloid notch. The posterior, upper, and anterior portions of the cavity are lined by articular cartilage, but the centre of the cavity and the portion between it and the cotyloid notch are uncovered by cartilage, and are occupied by fat, and, at the lower part, by the ligamentum teres. The depth of the cavity is increased by a fibro-cartilaginous rim set upon its edge, the labrum cartilagineum, or cotyloid ligament, which crosses the cotyloid notch, and is there termed the transverse ligament. The centre of the cavity lies in a line drawn from the anterior superior spine of the ilium to the lowest or most anterior part of the tuberosity of the ischium. The wall of the cavity is thin at its centre and lower part, and is elsewhere very thick and strong. Its growth takes place at the junction of the three bones which combine to form it, this junction being marked during the period of growth by a thin layer of conjugal cartilage having the shape of an inverted Y.

The head of the femur is rather more than half of a sphere, having a radius of about an inch, and is so placed upon the neck that rather more than half of its cartilage-covered surface is in front and above (in the upright position), and rather less than half is behind and below. At a point a little below that at which a prolongation of the long axis of the neck would touch its surface is a depression, within which the upper end of the ligamentum teres is attached.

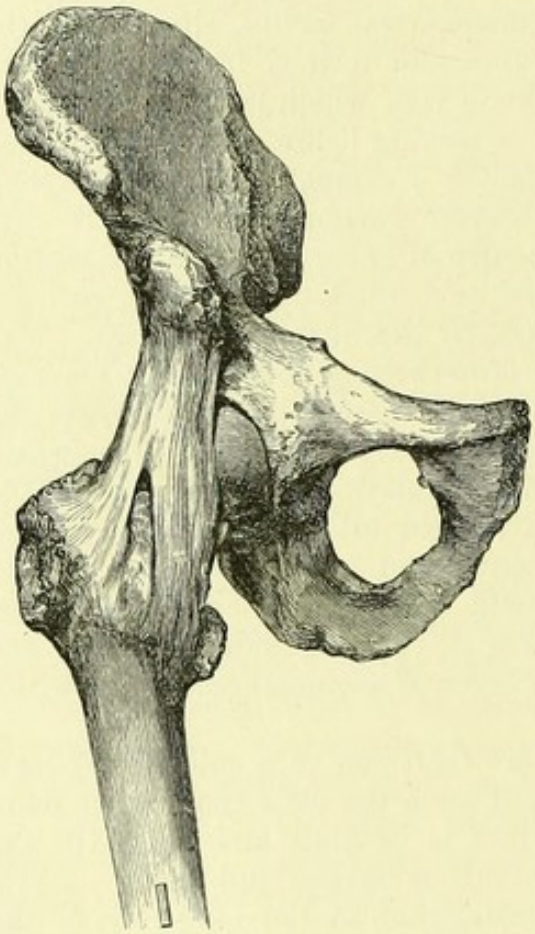
The curves of the head and the cotyloid cavity are almost, if not entirely, identical; the small gaps that are sometimes found between them are probably due to irregularities in one or the other surface, although they are attributed by some anatomists to normal departures from the exactly spherical form, or to slight differences in the length of the radii of the two surfaces.

The neck is directed inward, upward, and slightly backward from its junction with the shaft, the angle which it makes with the long axis of the latter being about 130°. The great trochanter, continuous with the outer surface of the shaft, overlaps the neck above and behind, its highest part being situated posteriorly and curved inward; the portion which is

most external and most nearly subcutaneous is about an inch below the upper margin. To this trochanter and to the digital fossa which adjoins it on the inner side above and behind pass all the outer and posterior muscles, except the gluteus maximus and quadratus femoris, which come from the hip-bone. The small trochanter is a rounded prominence upon the inner and posterior aspect of the shaft close below its junction with the neck, and gives attachment to the psoas-iliacus muscle.

The capsule is attached above along the entire periphery of the cotyloid cavity, just outside the free margin of the labrum cartilagineum, and below to the femur at or near the junction of the neck and shaft, extending in front to the inter-trochanteric line, above nearly to the root of the great trochanter in the digital fossa, behind to the neck itself a little short of its outer limit, and below to the upper part of the lesser trochanter. It is composed of fibres arranged longitudinally and circularly, and varies greatly in strength and thickness at different points. Those portions which are especially thickened by multiplication of the longitudinal fibres are known as accessory ligaments; of these the strongest and most important is the one situated in the anterior part of the capsule, and known as the ilio-femoral ligament, or the ligament of Bertin, or Bigelow's Y-ligament (Fig. 118). This arises from the anterior inferior spine of the ilium, and from the surface of the bone immediately behind it and above the edge of the acetabulum, and its fibres passing downward diverge to form two strong bands, of which the inner passes almost vertically to the lower part of the anterior intertrochanteric line, and the outer to the upper part of the same line. The ligament is about one-fourth of an inch thick at its thickest part, and is very strong, perhaps the strongest in the body, and will sustain without rupture a strain of from 250 to 750 pounds (Bigelow). Its inner portion is especially concerned in limiting extension of the limb; its outer portion in limiting eversion.

Fig. 118.



The ilio-femoral, or Y-ligament. (Bigelow.)

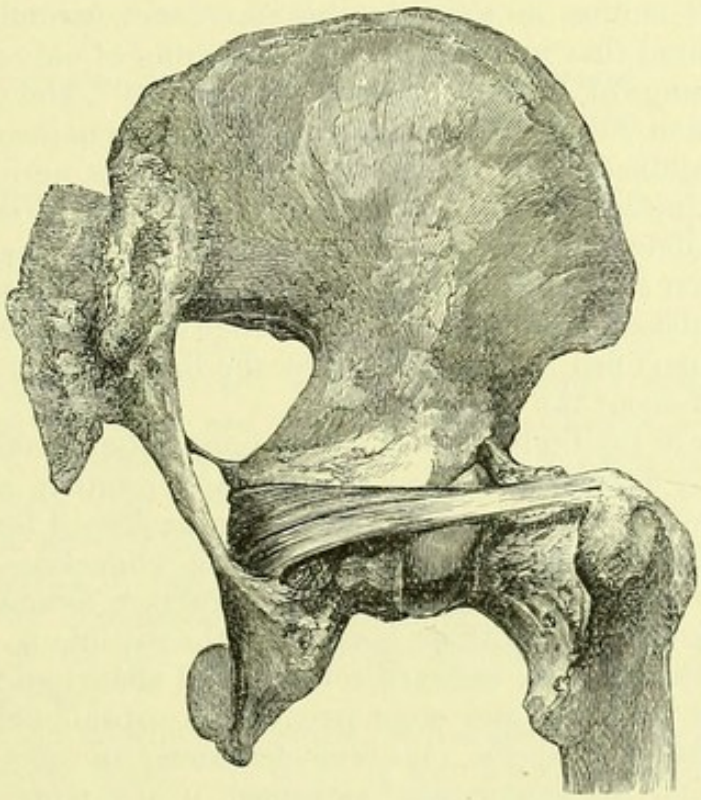
The other thickened portions of the capsule are those known as the pubo-femoral and ischio-femoral ligaments; the former arises from the anterior and inferior portion of the acetabular margin and the pubis as far inward as the pectineal eminence, and extends in the anterior and lower part of the capsule to its insertion above the small trochanter. The

ischio-femoral ligament is a strong band of fibres on the outer and posterior portion of the capsule, arising from the groove on the ischium below the acetabulum. The pubo-femoral ligament limits abduction; the ischio-femoral limits inversion. On each side of the pubo-femoral band the capsule is very thin, and through these thin portions the head of the femur passes in the pubic and obturator dislocations; outside and behind the Y-ligament, where some of the dorsal dislocations occur, the capsule is very strong, limiting adduction and inward rotation (Bigelow).

The ligamentum teres is a triangular band attached by its base to the transverse ligament and the adjoining central portion of the acetabulum, and by its apex to the depression on the inner surface of the head of the femur. It is not strong and probably is without important influence in limiting the movements of the femur; its chief function appears to be to convey bloodvessels to the head of the femur.

The cavity of the joint usually communicates through an opening in its anterior portion with a bursa under the tendon of the ilio-psoas muscle.

Fig. 119.



Relations of the head of the femur and the obturator internus. (Bigelow.)

The joint is thickly covered in by muscles, of which it is desirable here to mention only one, the obturator internus, which plays an important part in the backward dislocations. This muscle, arising from the inner surface of the obturator foramen and the surface of bone between it and the great sacro-sciatic notch, passes outward through the small sacro-sciatic notch, turns sharply forward, and is inserted upon the front part of the inner surface of the great trochanter in conjunction with the two gemelli which arise respectively from the spine and tuberosity of the ischium. Bigelow found it to be the strongest of the external rotators,

rupturing under a strain of forty and four-fifths pounds,[1] and this greater strength he attributed to the mingling with its muscular belly of tendinous fibres, some of which extend to a bony attachment within the pelvis and thus become actual restraining ligaments when the muscle is fully extended. Its action is to evert the extended, to abduct the partly flexed thigh. Above it is the pyriformis, below it the quadratus femoris.

The centre of the head of the femur lies about two inches directly below the anterior inferior spine of the ilium, and at about the same distance downward and outward from the centre of, and in a direction at right angles to, a line drawn from the anterior superior spine of the ilium to the spine of the pubis. When the bones are normal and in place, and the limb is partly flexed, a line drawn across the outer aspect of the thigh from the anterior superior spine of the ilium to the lowest part of the tuberosity of the ischium will cross the upper part of the great trochanter. This is known as Nélaton's, or the Nélaton-Roser, line; its relations to the trochanter have great diagnostic importance. In the child, according to Hueter, the trochanter is brought somewhat higher by the relative shortness of the neck of the femur.

The range of motion of the joint has been very carefully studied by Albert;[2] he found that in a preparation consisting of only the bones and ligaments the range of flexion and extension was 140°, and that of abduction and adduction 90° to 100°, of which abduction (from the sagittal plane) was 60°, and adduction 30° or 40°. If the muscles were left in place flexion was diminished 30°, and adduction reduced to 20°. In other words, extension and abduction are checked in the living by the ligaments of the joint, flexion and adduction by the muscles or by the contact of the limb with the abdomen in flexion. The range of abduction and adduction is further modified by the position of the limb as regards its flexion and its rotation about the long axis.

The position of the limb in which dislocation of the hip most frequently occurs is that of flexion, adduction, and inward rotation, and the dislocation which then occurs is usually one of the backward forms, although after the head of the bone has left the socket abduction and outward rotation of the limb may lodge it in the obturator foramen. In this position the posterior and inferior portion of the capsule is put upon the stretch and ruptured. By outward rotation and abduction the head may be forced out at the lower and inner part of the capsule below the pubofemoral ligament, toward the obturator foramen; in each case a new centre is found for the exaggerated movement in the more or less direct contact between the neck of the femur and the margin of the acetabulum or in the tension of part of the Y-ligament. The force which produces the dislocation, therefore, almost always acts indirectly, either by moving the limb upon the fixed trunk or by moving the trunk upon the fixed limb. In the great majority of cases the Y-ligament remains untorn, and by the restraint which it exerts upon the movements of the displaced femur it determines in a large measure the character of the secondary displacement, the attitude in which the limb comes to rest, and the manipulations by which the dislocation can be reduced. This influence is so

[1] Bigelow: The Hip, 1869, p. 22.

[2] Albert: Chirurgie, vol. 4, p. 248.

great that Bigelow based upon it the distinction which he made between "regular" and "irregular" dislocations, the former including those cases in which the ligament remained untorn and the attitude of the limb was in consequence characteristic; the latter those in which the ligament was more or less torn and the attitude and displacement variable. The distinction has sometimes an important bearing upon the treatment and deserves to be preserved.

Statistics.—The tables in Chapter I. show that the percentages of dislocation of the hip, compared with all dislocations, vary from 2 per cent. (Krönlein) to 9.76 per cent. (Prahl) and that the percentages in the combined hospital and polyclinic 1432 cases is the same, 8.8 per cent., as in the 964 hospital cases. Agnew[1] says that of 912 dislocations admitted to the Pennsylvania Hospital 89 (9.75 per cent.) were of the hip. Of Krönlein's 8 cases 4 were in patients not more than ten years old, and of Prahl's 41 cases 12 were of the same age, 8 were between eleven and twenty, and 11 were between twenty-one and thirty years old. This preponderance in youth is, however, not found in Agnew's list or in the 41 cases collected by Malgaigne or the 84 cases collected by Hamilton. The latter were divided as follows:

Under 15 years . .	15	45 to 60 years . .	7
15 to 30 " . .	32	60 " 85 " . .	1
30 " 45 " . .	29		

Agnew's 89 cases are thus divided:

15 to 25 years . .	39	45 to 55 years .	6
25 " 30 " . .	26	55 " 65 " .	5
35 " 45 " . .	12	65 " 75 " .	1

Although the numbers are larger in Hamilton's collection than in Prahl's, yet, as the latter are the integral statistics of a single hospital and dispensary, I think its percentages are more likely to represent the actual proportions than those of a collection of published cases are. It is true that the general impression of the profession is that the injury is especially frequent in early middle life, but this impression may have been created by Malgaigne's and Hamilton's statistics. I do not know how to account for the absence from Agnew's list of patients under fifteen years of age.

The earliest age at which a dislocation has been reported is six months (Powdrell, *Lancet*, 1868, i. p. 617), it was a dislocation upon the obturator foramen, and was caused by the fall of a chair in which the child was tied. In the report by W. A. Johnson,[2] of a clinical lecture by Prof. Gross, it is said, "upward of six years ago this child, M. S., aged seven years, had a fall," and received a dorsal dislocation of the hip. The note is entitled "Dislocation of the hip-joint in a child six months of age." Bartels[3] reported a dorsal dislocation at eleven months caused by the effort made to put on a shoe. Several others have been reported between the ages of eighteen months and five years.

[1] Agnew: Surgery, vol. 2, p. 89.
[2] Johnson: Phil. Med. Times, 1876–7, vol. 7, p. 5.
[3] Bartels: Arch. für klin. Chir., 1874, vol. 16, p. 650.

The oldest patient is one reported by Kennedy,[1] a woman, aged ninety-one years and five months, who received a dorsal dislocation of the right hip by a fall, while walking across a smooth floor; it was reduced on the twelfth day by manipulation, and two days later the patient died. The autopsy verified the diagnosis. The next oldest patient, eighty-six years, was also a woman (Gauthier, quoted by Malgaigne, loc. cit., p. 805); and the next, a man eighty-one years old, whose dislocation was suprapubic and was verified by autopsy four years later, the neck of the bone was broken by an attempt to reduce while the injury was recent; the case was reported by Verneuil.[2] Agnew says he found in the records of the Pennsylvania Hospital five cases between the ages of seventy-five and eighty-five years. They do not appear in the tabulation above quoted.

The injury is much more common in males than in females: of Agnew's 89, 11 were women; of 115 cases collected by Hamilton, 104 were males.

Concerning the relative frequency of the different varieties it can be said that those in which the head of the femur is found resting upon the lower part of the ilium behind the outer posterior half of the acetabulum, the so-called "iliac" dislocation, to preserve for the moment the old classification, or still lower down on the upper part of the ischium, "ischiatic" dislocations, are much more frequent than those in which it rests in front or on the inner side of the acetabulum, the suprapubic and obturator dislocations. The dislocations upon the dorsum of the ilium are generally thought, on clinical evidence, to be more frequent than the ischiatic, but a comparison of the cases examined after death does not corroborate this view; Malgaigne collected 10 autopsies of ischiatic dislocations, and only 6 of the iliac, one of these being primarily ischiatic, and Lossen,[3] taking only cases reported since 1855, found 19 ischiatic, and only 5 iliac. Probably Malgaigne's supposition is correct that many ischiatic cases observed clinically are thought to be iliac; indeed, it will further appear that in many "iliac" dislocations the head of the femur has primarily passed downward and backward, and that its presence upon the dorsum of the ilium is due to a secondary displacement upward. Roser goes so far as to claim that the iliac dislocations, in which the head of the femur has left the cotyloid cavity by its upper posterior portion, are the rarest of all the principal forms. Of the two anterior forms the obturator seems to be more frequent than the suprapubic, but the reported cases are too few to justify a positive assertion.

Simultaneous dislocation of both hips has been reported in several cases. Two of them, Boisnot and Schinzinger, have been quoted in Chapter I.; Malgaigne quotes two, and Gibson, Crawford, Steiner, Roberts, James, Jung, Wood, Pollard, Bigelow, Fischer, Kunschert, Barker, Prichard, Allis, Packard, and Bourrienne have each reported one.

Compound dislocations are very rare, as might be expected from the thickness of the soft parts, which everywhere cover in the joint. The

[1] Kennedy: Cincin. Lancet and Clinic, 1878, i. p. 256.
[2] Verneuil: Bull. de la Soc. de Chir., 1865, vol. 6, p. 495.
[3] Lossen: Deutsche Chirurgie, Lief. 65, p. 30.

recorded cases are those of Walker,[1] Bransby Cooper,[2] Macouchy,[3] Moxon,[4] a German military surgeon,[5] Taylor,[6] and Woodward.[7] The first and fifth have been quoted in Chapter III., p. 39. The second is not spoken of by Cooper as a compound dislocation, but the history indicates that it probably was one; the patient, a lad seventeen years old, was run over by a wagon, the wheel passing across the back of his thigh and producing a dislocation forward and inward, the head of the femur lying to the inner side of the great vessels. A rather large lacerated wound was situated just below Poupart's ligament, a little to the inner side of its centre. Profuse suppuration followed, and the patient died on the twentieth day.

Macouchy's patient was a boy fourteen years old, who fell from a mast to the deck, a distance of sixty feet, and received, in addition to the dislocation, a fracture of the base of the skull. When seen, he was sitting on the deck with the head of the femur appearing between his legs, through his pilot-cloth trousers, as if protruded from his anus. The head, neck, and great trochanter protruded through the integuments covering the posterior third of the ischium, the head of the bone resting on the posterior part of the tuberosity of the ischium of the opposite side. The head was sawn off, and the shaft replaced. The patient died two days later.

Moxon's patient, a railway porter, was injured by a moving train and died shortly afterward in Guy's Hospital. The position of the limb was that of dislocation on the dorsum ilii. There was a large irregular rent in the skin corresponding to the junction of the left sacro-sciatic ligament with the tuber ischii. On passing three or four fingers into the hole a way was found through a pulp of torn muscles and bloodclot, till the fingers rested on the naked head of the thigh bone. The gluteal muscles were much torn up and infiltrated with blood. The head of the thigh bone lay half an inch outside the great sciatic nerve, free under the remains of the glutei. It had escaped through the muscles immediately around the joint by passing between the quadratus femoris and obturator internus. A portion of the head of the bone remained in the socket, attached by the round ligament.

Taylor's patient was a lad seventeen years old who was overthrown by a falling tree and received a dislocation into the obturator foramen together with an irregular wound nearly two inches long in the perineum through which the head of the femur could be distinctly felt. Most of the muscles had been separated from the descending ramus of the pubis and the ascending ramus of the ischium. Reduction was made with some difficulty, and the limb immobilized on a long side splint. The wound healed promptly, and at the end of nine weeks the splint was removed, but on the next day inflammatory symptoms appeared on the side of the hip, and an abscess formed and was opened. Eight months later Taylor met the patient riding on horseback.

[1] Walker, quoted by Cooper: Loc. cit., p. 80. [2] Cooper: Loc. cit., p. 76.
[3] Macouchy: Dublin Hosp. Gaz., 1872, i. p. 21.
[4] Moxon: Med. Times and Gaz., 1872, i. p. 96.
[5] Centralblatt für Chir., 1880, p. 504. [6] Taylor: Lancet, 1881, i. p. 732.
[7] Woodward: Boston Med. and Surg. Journ., 1883, vol. 108, p. 129.

Woodward's patient, a boy twelve years old, was caught under a freight car and rolled over and over, receiving several fractures in addition to the dislocation. The wound was a longitudinal slit about two inches long on the inner side of the thigh two and a half inches below the angle of the pubes. The limb was abducted, making an angle of nearly 45° with the line of the body, and the foot was everted. The head of the femur, together with the great trochanter entirely stripped of its muscles, projected completely through the opening for about four inches and lay across the scrotum. Its point of exit was just anterior to the adductor longus. No fracture of the femur or pelvis was detected, and the great vessels were uninjured. The patient died in five hours, and after death reduction could not be made.

Classification.—The classifications adopted by the earlier writers were necessarily faulty and deficient because of the lack of recorded experience and post-mortem examinations. That of Hippocrates, containing four principal forms, outward, inward, forward, and backward, was employed, according to Malgaigne, until the seventeenth or eighteenth century, although the terms do not seem always to have been applied in the same sense. Petit, in the eighteenth century, made two main groups, inward and outward, each with two subdivisions, the four being upward and inward, downward and inward, upward and outward, and downward and outward, but he thought it impossible that the latter form could occur. Verduc, about the same time or a little earlier, sought to substitute a classification based upon the place at which the head of the femur came to rest, and in this he was supported by Duverney and Bertrandi, and thus arose the terms *dislocation upon the ilium*, *upon the ischium*, *upon the pubes*, *into the foramen ovale.* Sir Astley Cooper gave us *dislocations upward, or on the dorsum ilii*, *downward, or into the foramen ovale*, *backward, or into the ischiatic notch*, and *dislocation on the pubes ;* and Gerdy followed with *supra-pubic*, *sub-pubic*, *iliac*, *sacro-sciatic*, and *ischiatic*, the latter being directly downward.

Malgaigne was the first to bring to the subject the results of careful study of many pathological specimens; he showed that in the backward dislocations the head of the femur did not go so far as the anatomical terms used in Cooper's classification, for example, would indicate, but that on the contrary it usually remained so near the cotyloid cavity that it partly overlapped it, "incomplete" dislocations, as he called them, and he proposed a classification in four groups, of which the first two were the same as Petit's, though the names are different, as follows:

Dislocations backward	{ iliac, complete, incomplete. ischiatic, complete, incomplete.
Dislocations forward	{ ilio-pubic. ischio-pubic.
Dislocations upward	supra-cotyloid.
Dislocations downward	{ sub-cotyloid. sub-perineal.

The names ilio-pubic and ischio-pubic were taken from those of corresponding depressions on the margin of the cotyloid cavity along which the head of the femur was thought to pass, and, acting on the same plan,

Nélaton gave the name ilio-ischiatic to all the backward dislocations, which Malgaigne preferred to divide into two groups.

In Germany Roser and Busch adhered to the method of classification according to the direction taken by the head of the femur, Roser making :

Dislocations outward and backward (outer posterior margin of the acetabulum).
Dislocations downward and backward (between the spine and tuberosity of the ischium).
Dislocations forward and upward (anterior margin of the pelvis).
Dislocations inward and downward (toward the foramen ovale).

and Busch :

Dislocations forward . . { forward and upward. / forward and downward.
Dislocations backward . . { backward and upward. / backward and downward.

Of the latter German writers Albert makes three groups: *backward*, *forward and upward*, and *forward and downward*; König and Lossen make four, as follows:

Backward { iliac. / ischiatic.
Forward { supra-pubic { pubic. / ilio-pectineal. / infra-pubic { obturator. / perineal.
Supra-cotyloid.
Infra-cotyloid.

In England Sir Astley Cooper's classification has been more or less completely retained, although some surgeons (Erichsen) place the backward dislocations, those "upon the dorsum ilii" and "into the sciatic notch," in one group and call them "dislocations backward and upward."

In America Hamilton used Cooper's classification; and Agnew does the same, although he groups the iliac and ischiatic together as varieties of a single form "upward and backward."

Bigelow,[1] to whose researches and writings so much of the recent advance in the knowledge of the subject and in the treatment of the injury is due, made a classification of seven regular and principal forms, which he based not merely upon the direction in which the bone had been dislocated or the point at which it came to rest, but also upon the integrity of the Y-ligament or the rupture of its outer branch, and the changes in the attitude of the limb which arise from such rupture. Such a classification was open to the objection that it gave equal rank to forms which were only variations of others, and a few years later he modified it[2] by grouping all under four heads and by suppressing the distinction between the "dorsal" and the "dorsal below the tendon," which latter name he had previously given to the lower of the two dorsal varieties, the "dislocation into the sciatic notch" of Cooper. His new classification, then, was the following:

External to the socket; comprising the dorsal and the dorsal with eversion.

[1] Bigelow: The Hip.

[2] Bigelow: Lancet, 1878, I. p. 894.

Internal to the socket; on the perineum, the thyroid foramen, and the pubes.

Below the socket; dislocation toward the tuberosity of the ischium.

Above the socket; the subspinous, the supraspinous, and the anterior oblique.

This also was open to the serious objection that varieties which were alike in their mode of production, in the point at which the head of the femur left the socket, in the direction it afterward took, and in treatment were placed in different main divisions, and Professor Bigelow, therefore, went further and presented in the same paper the following classification which he recommended as a sufficient "practical grouping."

Dorsal, comprising the dislocation on the tuberosity of the ischium, the dorsal, the everted dorsal, the anterior oblique, and the supraspinous.

Thyroid, comprising that in the perineum and that on the thyroid foramen.

Pubic, comprising the pubic and the subspinous.

Turning now to the results of the examination of specimens and of experiments upon the cadaver, it appears that in the more frequent forms the head of the femur passes over the outer, posterior, margin of the cotyloid cavity, usually at or below its horizontal diameter, while the limb is flexed, adducted, and rotated inward; then by the sinking of the knee the femur turns upon its attachment to the Y-ligament as a centre, and the head rises to a higher level along the outer surface of the acetabulum or further backward on the flat surface of the ilium in front of, and seldom higher than, the apex of the great sciatic notch. It is to be borne in mind that this apex is not very much above the level of the highest part of the cotyloid margin. In this movement the head of the femur frequently passes behind the untorn tendon of the obturator internus, leaving that tendon between itself and the acetabulum. Or, if it crosses the margin of the cotyloid cavity at or above its horizontal diameter it may tear the obturator internus and pyriformis or pass between these muscles and come to rest at the same point as before. The former is the dislocation "below the tendon," the latter the "dorsal" or the dislocation "upon the dorsum ilii," as these terms were originally used, but the distinction appears to be one which cannot often be made clinically. The important difference between them is in the situation of the rent in the capsule, which is higher in the latter than in the former and will probably permit reduction by traction downward.

Exceptionally, if, after the dislocation has occurred, the knee is still further lowered and the limb abducted and rotated outward, the outer branch of the Y-ligament ruptures and the head of the femur passes forward along the ilium toward its anterior inferior spine or the interval between the two spines, the "everted dorsal" of Bigelow, the "supraspinous" or part of the "supra-cotyloid" of others. The attitude of the limb in this is very different from that of the common backward dislocation of which this is a variety by secondary displacement.

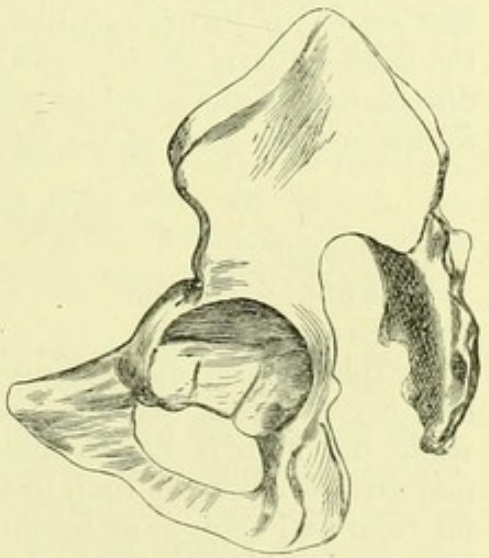
But the head of the femur may not only come to rest directly above the cotyloid cavity by a secondary displacement forward and inward; it may also reach nearly the same point by a secondary displacement outward and backward from a primary dislocation forward upon the pubis.

The distinction between the two is radical, for in the former the root of the Y-ligament lies on the inner side of the head, which must be returned to its socket by passing backward behind the acetabulum; and in the latter the Y-ligament lies to its outer side and the head must be returned along the front or inner side of the acetabulum. There is still a third way in which the head may be placed above the acetabulum, although at a somewhat lower level, and that is by direct displacement upward, with rupture of the upper part of the capsule and of the Y-ligament, but this is extremely rare, and the cases belong among the "irregular" dislocations.

The dislocations forward (or inward) and upward and inward and downward offer no difficulties in classification; each has its characteristic symptoms, although the perineal variety of the latter is somewhat sharply distinguished from the obturator or thyroid variety by the flexion, almost at a right angle, of the limb. Bigelow thinks the supra-pubic can be produced by a secondary displacement upward after the head has escaped at the lower part of the capsule during flexion of the limb, in a similar manner and by the same mechanism (lowering of the knee) as a secondary "iliac" dislocation is produced from a primary "ischiatic" one. In short, he thinks (*Lancet*, 1878) that in most cases the head of the femur escapes over the lower margin of the acetabulum and then passes upward as the limb is lowered, and either behind or in front of the acetabulum according as the limb is adducted or abducted, and upon this theory he bases a simple rule of treatment applicable to both anterior and posterior dislocations, namely, flex the limb at a right angle to bring the head below the socket, and then lift it into place.

Finally, the head may be displaced downward upon the adjoining branch of the ischium, and rest there (subcotyloid); the position is one from which the head can be easily displaced, either backward or forward, and the dislocation thereby transformed into a dorsal or obturator one.

FIG. 120.



The left hip-bone viewed from a point directly opposite the acetabulum.

The distinction between the two backward forms, upon the dorsum ilii and toward the sciatic notch, which has already been abandoned by eminent surgeons (Bigelow, Erichsen, Albert), does not appear to deserve to be retained, except, perhaps, to establish corresponding varieties in the group, and the anterior oblique, everted dorsal, and supraspinous clearly belong in the same class by their mode of production and treatment. The class of supracotyloid dislocations, made by some writers to contain the two last mentioned, the rare dislocations directly upward, and some of the suprapubic, will be limited to those in which the head appears to have moved directly upward. The corresponding class and term of

"subcotyloid" must be retained for the rare dislocations downward "upon the tuberosity of the ischium."

The terms upward and downward must not be taken too literally. They appear to have been rather carelessly used at first without strict regard to the normal position of the pelvis. When the body is upright, the upper border of the symphysis pubis lies a little below the level of the centre of the cotyloid cavity, and the tuberosity of the ischium lies not directly below this cavity, but below and behind. The classification, then, which will here be used is as follows:

- Dislocations backward
  - dorsal, comprising the "iliac" and "ischiatic," or those "upon the dorsum ilii" and "into the ischiatic notch" of the writers.
  - anterior oblique.
  - everted dorsal, comprising the "supra-spinous" and some of the "supra-cotyloid."
- Dislocations downward and inward
  - obturator.
  - perineal.
- Dislocations forward and upward
  - supra-pubic
    - ilio-pectineal.
    - pubic.
    - intra-pelvic.

Dislocations directly upward (supra-cotyloid or sub-spinous).
Dislocations downward on the tuberosity of the ischium.

As in the classification of dislocations of the shoulder, the names of the principal groups indicate the direction of the primary displacement and, consequently, the position of the rent in the capsule, and the names of the varieties show either the place at which the head of the femur comes to rest, or the special symptomatic feature which marks the variety. Kocher,[1] in an interesting and valuable paper, sought to establish a close analogy between the forms of shoulder and hip dislocations, but did not thereby, in my opinion, add anything to the precision of our knowledge, or the fulness or facility of comprehension. The only analogy that seems to justify mention is one created by the varying relations of the subscapularis muscle and the head of the humerus in the forward dislocations of the shoulder and those of the obturator internus and pyriformis and the head of the femur in the backward dislocations of the hip.

Backward Dislocations.

1. Dorsal.
2. Anterior oblique.
3. Everted dorsal.

In this class of dislocations the head of the femur in leaving the cotyloid cavity passes over its posterior margin at a higher or lower point while the limb is flexed, adducted, and rotated inward. In the great majority of cases the limb preserves this attitude, and the head rests not far from and behind, or behind and above, the margin of the acetabulum, between it and the great sciatic notch, or it may lie a little higher upon the concave surface of the ilium; these constitute the dorsal variety, and include the "iliac" and "ischiatic" of other writers. In other cases external rotation of the limb takes place with or without abduction and

[1] Kocher: Volkmann's Sammlung klinische Beiträge, No. 83.

extension; in the latter case the limb crosses the opposite thigh and the toes are everted, the head of the femur lies above the socket, and the lower part of the neck corresponds to the upper and posterior margin of the acetabulum, the anterior oblique variety; in the former case (with abduction and extension) the outer branch of the Y-ligament is ruptured, the head of the femur lies above the socket, and the everted limb lies parallel to its fellow, or slightly abducted—the everted dorsal variety. The class includes all the backward dislocations of other authors, and most of those that have sometimes been grouped under the term "supracotyloid."

1. *Dorsal dislocations.*

In these dislocations, which are, by far, the most common of all dislocations of the hip, the head of the femur lies behind and above the cotyloid cavity, either close to and overlapping its edge (Malgaigne's "incomplete" form), or further away upon the ilium. It may pass below the obturator internus and rise behind it, or between it and the pyriformis, or above the latter, or both muscles may be completely torn across. The group, therefore, includes the dislocations "upon the dorsum ilii" and those "into the ischiatic notch" of Cooper, or the "dorsal" and the "dorsal below the tendon" of Bigelow's first classification, or the "iliac" and "ischiatic" of others.

Causes.—Dorsal dislocations are commonly caused by violence that approximates the knee and the pelvis while the thigh is flexed, adducted, and rotated inward, as in a fall from a height, or in the fall of a heavy body upon the back of the patient while he is stooping forward. Less frequently but little or no violence acts to cause the over-riding of the femur upon the pelvis, and the dislocation is produced mainly or solely by flexion, adduction, and inward rotation, one of the three movements being exaggerated. Thus, in a case reported by Moffat,[1] the patient was drawing a railway carriage along the track; he fell forward and rolled upon his back outside the rail to escape the car, but, as it passed, the end of the foot-board caught his leg and bent it upon and across his belly (flexion and adduction). The car had to be raised with a jack-screw to free him, and when released he was lying upon his back with the limb in the position described. When examined at the hospital, the thigh was slightly flexed and rotated inward, the toes overlapping those of the other foot, and there was shortening of half an inch.

In a case reported by Dupuytren, exaggerated adduction appears to have been the chief factor. A delicate man, twenty-one years old, was thrown, while wrestling, upon his left side, and in the fall the left thigh was forcibly carried across the front of the other by the contact of the side of the knee with the ground. In a case observed by Malgaigne, and in another quoted by him from Mercier, exaggerated inward rotation appeared to be the principal cause; both patients were women who slipped and twisted the foot inward while walking.

A case, exceptional not only by its mode of production but also by the age of the patient, was reported by Bartels and has been referred to above.

[1] Moffat: Lancet, 1878, ii. p. 251.

The patient was a child eleven months old, and the dislocation was caused by the effort of a shoemaker to put on its shoe while it was sitting on its nurse's knee.

In two cases in which the head was split into two pieces, one of which remained in the socket attached to the ligamentum teres (Moxon, p. 403, and Birkett, Chap. III., p. 31), it is evident that the flexion, adduction, and rotation were not carried far enough to turn the head out of the socket, and the dislocation, strictly speaking, was a complication of a fracture of the head produced by violent pressure of the inner segment against the outer and upper margin of the cavity; in like manner the dislocation may be facilitated by the breaking off of a considerable portion of the acetabular ring. There is reason to think that some dislocations are produced in this manner by violence acting directly upon the upper part of the thigh, as in the passage across it of the wheel of a heavy wagon.

It is by no means uncommon for a dorsal dislocation to be produced by the transformation of one downward and forward (obturator) during manipulations made to effect reduction, the head passing below and behind the acetabulum during flexion and adduction of the limb, and, in like manner, a dorsal may be transformed into an obturator dislocation.

Occasionally dorsal dislocation takes place gradually while the patient is confined to bed by illness, especially by acute articular rheumatism and the infectious or eruptive fevers. These "spontaneous" dislocations will be considered in Chapter XXVII.

Morris[1] expressed the opinion, formed after he had made a number of experiments upon the cadaver, that dorsal dislocation always took place while the thigh was abducted; but although he showed that the capsule can be more easily ruptured by exaggerated abduction than by flexion, adduction, and inward rotation, yet that fact cannot for a moment support his opinion in the face of the overwhelming testimony that proves the common occurrence in the position of adduction and flexion. Indeed, Moffat's case, just quoted, was published to controvert Morris's opinion, and it seems to have passed without a reply from him. A similar opinion appears to have been published by Fabbri many years before; but no author, so far as I have read, mentions the opinion except to express his disagreement with it.

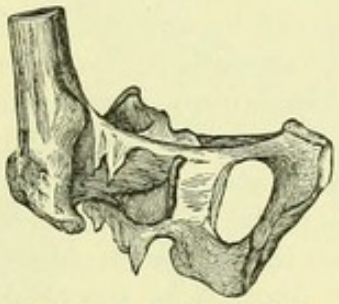
Pathology.—The condition of the capsule and of the muscles about the joint and the position of the head of the femur have been clearly shown by direct examination of a considerable number of specimens of recent dislocation, and by old ones, and by experiment upon the cadaver. Among the autopsies of fresh dislocations recently reported may be mentioned those by Moxon, above quoted, MacCormac,[2] Adams,[3] Morris (loc. cit.), Lee,[4] and Humphrey,[5] who describes three recent cases.

The capsule is torn always in its lower posterior part, and usually also in its under part, but the rent varies greatly in extent and shape.

[1] Morris: Med.-Chir. Transactions, 1877, vol. 60, p. 161.
[2] MacCormac: St. Thomas's Hosp. Reports, 1871, vol. 2, p. 143.
[3] Adams: Trans. Path. Soc. of London, 1870, vol. 21, p. 305.
[4] Lee: St. George's Hosp. Reports, 1872–74, vol. 7, p. 169.
[5] Humphrey: Lancet, 1886, ii. p. 1011.

Frequently it lies about midway between the upper and lower posterior insertions of the capsule; sometimes the capsule is torn away from the femur, and, rarely, away from the acetabulum. In Humphrey's three cases the rent had three branches radiating from a point "opposite the tuber ischii." Thus, he describes one as "a valvular rent in the under and back part of the capsule, commencing just behind the pubo-femoral ligament, midway between the acetabular and femoral attachments, as a single tear which divided and extended upward and backward to the tuber ischii, and upward and forward to the trochanter near the attachment of the obturator externus;" the rent in his second case was almost identical with that in the first; and that in the third is described as a "great vertical rent along the back of the capsule, nearer to its femoral than to its acetabular attachment, extending from the pubo-femoral ligament to the level of the fore part of the great trochanter, and there is a transverse rent under the position of the gemellus inferior running from the vertical rent to the cotyloid ligament."

FIG. 121.



Morris's case of dorsal dislocation; femur flexed and abducted to show the rent in the capsule.

In Morris's case (Fig. 121), "the capsule was ruptured on its lower and inner side, and was clearly peeled up from off the back of the neck of the femur as far as the digital fossa. The rent commenced below the pectineo-femoral band, midway between the acetabulum and the femur, and ran (1) outward and backward to the neck of the latter, which it reached just above and behind the small trochanter, and (2) inward and backward across the thin portion of the capsule toward the acetabulum which it nearly reached a little behind the ischial border of the cotyloid notch. It thus formed two sides of a large opening which was made quadrilateral in form by the detachment of the flap from the back of the femoral neck."

In Lee's case the capsule was "freely lacerated all around, a small portion remaining attached to the femur in front and behind." This was, therefore, an "irregular" dislocation, and to the extensive laceration of the capsule corresponded a variation in the symptoms which fully corroborates Prof. Bigelow's views; the report says: "Two of the main signs of dislocation were absent, namely, the advanced position of the knee with the foot resting upon the opposite one, and marked shortening." The head of the femur was below the pyriformis muscle and immediately behind the acetabulum.

The preservation of the anterior portion of the capsule, the ilio-femoral ligament, is constant, as has been said, in the cases which Bigelow terms "regular," those which are marked by the common and characteristic symptoms of the dislocation, and, as he also pointed out, the strong portion of the capsule at its upper and posterior part is also usually untorn and opposes the ascent of the head upon the ilium.

The ligamentum teres is usually torn from its attachment to the femur, but sometimes is ruptured.

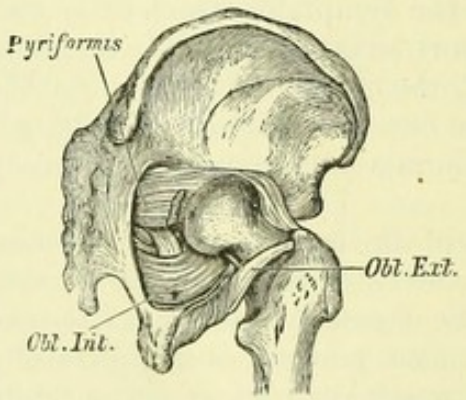
Of the muscles, the quadratus femoris is usually completely torn across, but sometimes (Humphrey's third case) is intact; the gemelli commonly

are torn, but the obturator internus which is so closely associated with them frequently escapes or is only partly lacerated, probably because of its greater length. The pyriformis and obturator externus are sometimes torn partly or entirely across; the glutei usually escape injury entirely or are only slightly lacerated.

The head of the femur may lie close to the margin of the acetabulum, even overlapping the cavity, or it may be displaced to a variable distance backward or backward and upward. The lowest point at which its centre rests is the base of the spine of the ischium (Adams, loc. cit., and Quain[1]) overlapping both sciatic notches; and the highest, except perhaps in exceptional cases, appears to be opposite the apex of the great sciatic notch, which, in the recumbent position, is directly below the anterior superior spine of the ilium, the line uniting the two passing about an inch above the margin of the cotyloid cavity. Forty years ago Quain demonstrated by his autopsy (Fig. 127) the error contained in the name given by Sir Astley Cooper to the lower form of dislocation "into the sciatic notch," and formally called attention to it; and a few years later Malgaigne showed that the head of the bone was much less upon the ilium in the higher form than was supposed, and further that in many, perhaps a majority, of the dislocations "upon the dorsum ilii" the femur left the socket at its lower posterior part and subsequently passed upward, so that in such cases the primary dislocation was "ischiatic," and the "iliac" was secondary. This view has been amply confirmed. In 11 specimens of old dislocations which Malgaigne examined, the head of the femur rose in 5 only to the level of a line drawn from the anterior superior spine of the ilium to the apex of the great sciatic notch, in 2 it rose half a centimetre above this line, in 2 one centimetre, in 1 one and a half centimetres, and in 1 two centimetres. There is no reason to suppose that in old dislocations the head is at a lower level than in recent ones, indeed it is probably somewhat higher.

When the head of the femur leaves the socket at its lower part it passes usually below the obturator internus and then rises behind it, so that this muscle is interposed between it and the acetabulum (Figs. 122 and 123). Or it may be immediately beneath the obturator internus and press it forcibly upward, as in Adams's case (Fig. 124), which remained unreduced until the patient's death on the fourteenth day, and in which the muscle was so tightly stretched over the upper part of the head that a deep groove had formed in the articular cartilage of the latter exactly corresponding in size and direction to the tendon; the head rested on the spine of the ischium, and the obturator externus and quadratus femoris were ruptured. Or the head may pass above the obturator internus, between it and the pyriformis, as in MacCormac's case (Fig. 125) in

FIG. 122.

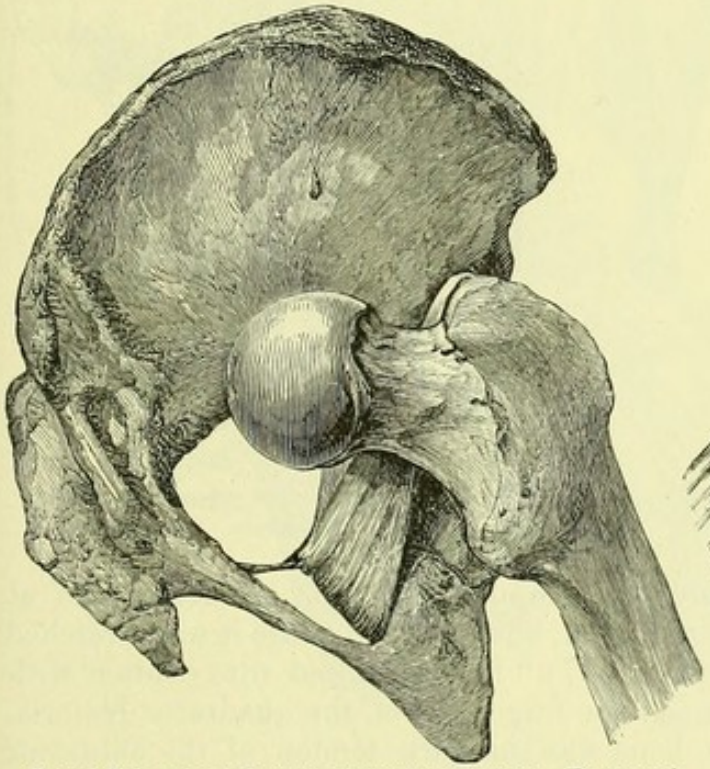


Dislocation below and then behind and above the obturator internus.

[1] Quain: Med. Chirurg. Trans., 1848, vol. 31, p. 337.

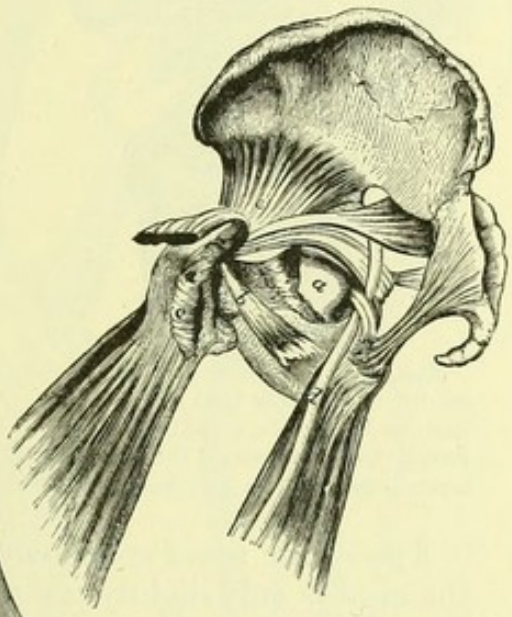
which it rested "behind the acetabular ridge opposite the middle and upper part of the great ischiatic foramen, behind the posterior border of the gluteus medius, and only covered by the gluteus maximus and the integument." This is an example of a real primary "iliac" dislocation, and the rent in the capsule was "merely on the back part, and the neck was as it were locked over the acetabular ridge, and the strong anterior part of the capsule was tightly stretched." Figure 126, representing a specimen obtained experimentally by Bigelow shows the untorn anterior and lower portion of the capsule in this form.

FIG. 123.



Dorsal dislocation below the obturator internus (BIGELOW.)

FIG. 124



Adams's case; *a*, head of femur; *b*, obturator externus ruptured; *c*, quadratus femoris ruptured; *d*, sciatic nerve.

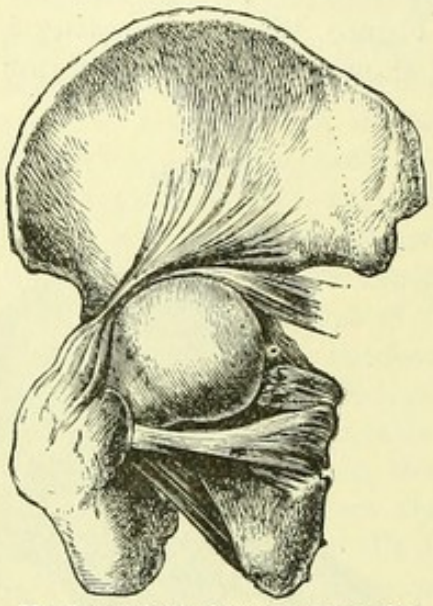
The edge of the acetabulum is sometimes chipped, and in two of the cases above quoted (Quain, Morris) there was a fracture through the ilium into the cotyloid cavity, and in the latter there was also a fracture of the ramus of the ischium. In both cases the injury was caused by great violence.

In a case reported by Birkett, and quoted in Chapter III., the head of the femur was split vertically, the inner half remaining in the acetabulum and still attached to the ligamentum teres, and the other, continuous with the neck, being displaced backward above the obturator internus. A similar case, quoted above among compound dislocations, p. 403, was reported by Moxon; and in another reported by Riedel and also quoted in Chapter III., p. 32, the head and neck were split longitudinally, both fragments being displaced from the socket. In a case seen by Lossen[1] the neck of the femur had been broken at the moment of dislocation, but doubtless after the head of the bone had left the socket. In several reported cases the neck has been broken during an attempt to reduce,

[1] Lossen: Deutsche Chir., Lief. 65, p. 55.

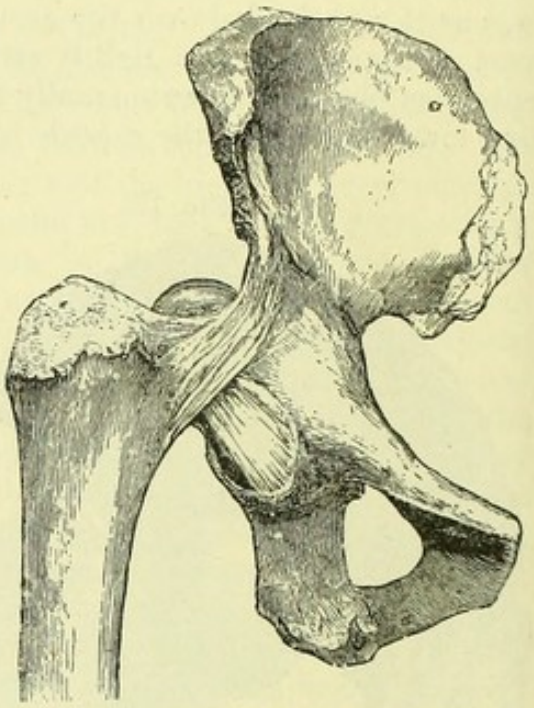
and in a few in which fracture has been recognized it has remained uncertain whether it occurred simultaneously with the dislocation or was caused by the surgeon. (See Chapter XXVII.)

FIG. 125.



MacCormac's specimen of recent dorsal dislocation. The head of the femur lies just behind the acetabulum, below the pyriformis and above the obturator internus and the torn gemellus muscles.

FIG. 126.



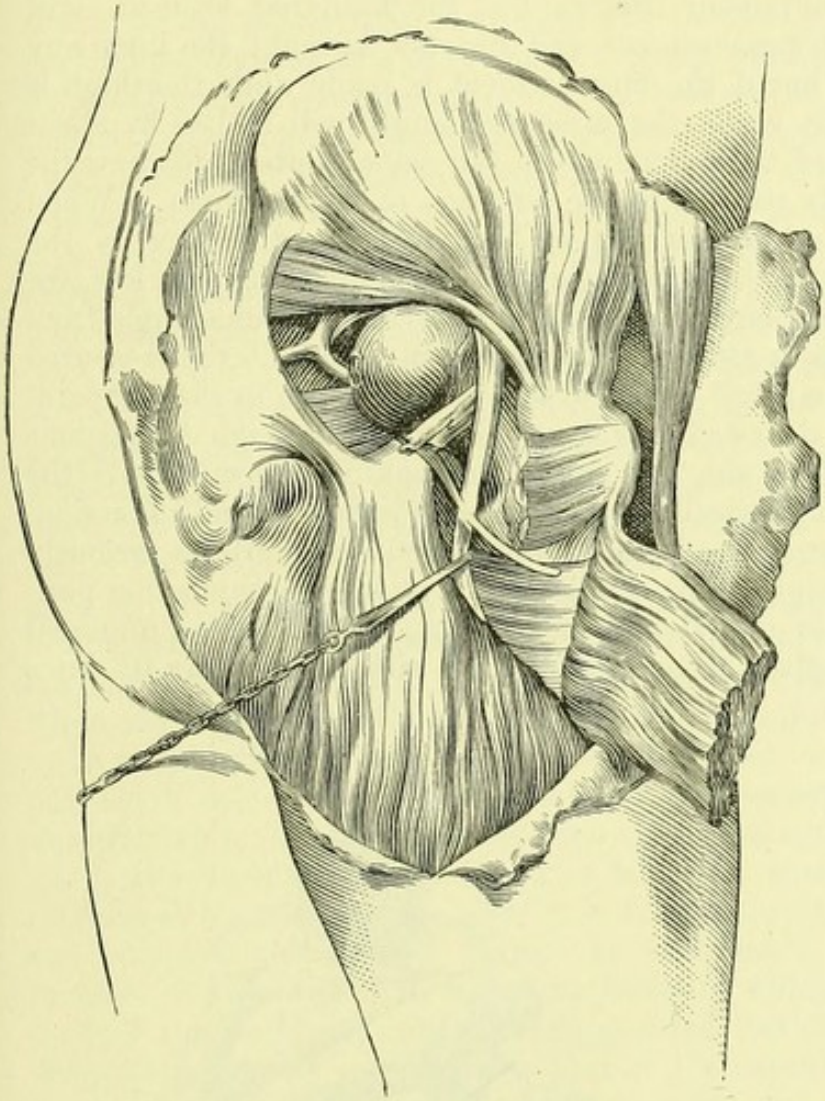
Dorsal dislocation; showing the anterior part of the capsule. (BIGELOW.)

The sciatic nerve commonly lies behind the head of the femur and at the most is only slightly pressed upon, but in Quain's case it was stretched over the neck of the femur (Fig. 127) "having passed into contact with the bone in the interval between the fragments of the quadratus femoris. Between the nerve and the bone was the torn tendon of the obturator externus." The nerve has been found in a similar position in some experiments upon the cadaver.

Symptoms.—The patient is unable to bear his weight upon or voluntarily to move his injured limb; if he stands upright it shows moderate flexion and adduction, marked inversion, and more or less shortening, the toes resting on those of the other foot. When he is placed upon his back the apparent adduction and flexion are increased, the knee resting just above the other patella or crossing the thigh at a higher point. The contours of the outer and posterior regions of the hip are changed by loss of the normal depression behind the trochanter, elevation of the gluteal fold, and abnormal fulness due to the approximation of the insertions of the gluteal muscles. The trochanter rises to a variable distance above the line drawn from the anterior superior spine of the ilium to the tuberosity of the ischium, and its distance from the first named prominence is increased. The head of the femur can be obscurely felt through the gluteus maximus and recognized by its movement when the limb is flexed or rotated. The empty socket cannot be felt from in front, because it is covered by the anterior portion of the capsule and the psoas and iliacus, but the depressibility of the soft parts in Scarpa's space is as great as, or

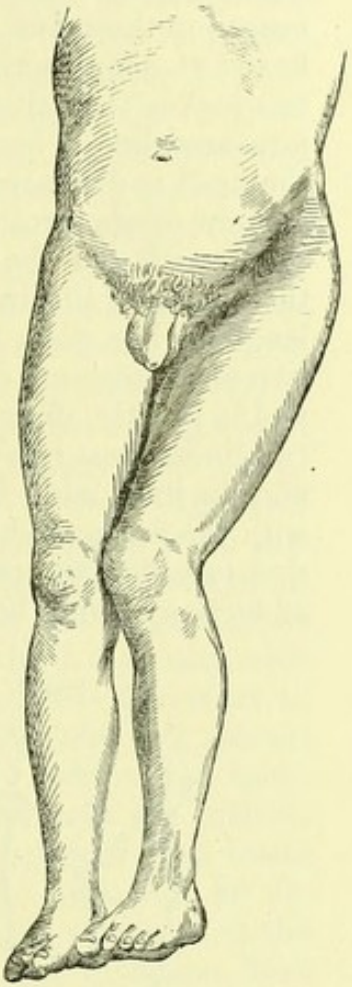
greater than, that on the opposite side, whereas in fracture of the neck of the femur this depressibility is diminished.

Fig. 127.



Quain's case of dorsal dislocation below and then behind the obturator internus; the sciatic nerve, held by the hook, is stretched over the neck of the femur.

Fig. 128.

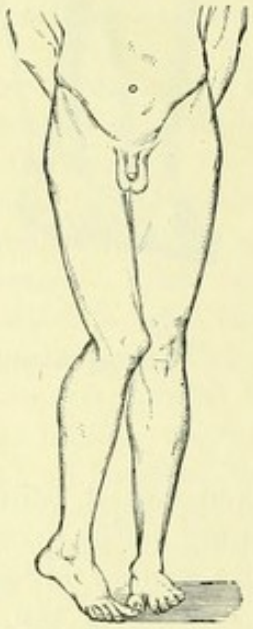


Dorsal dislocation.

The limb can be still further adducted and flexed, but it cannot be abducted or rotated outward. The apparent shortening varies greatly in degree in different cases, and the actual shortening cannot always be determined with accuracy because of the difficulty of placing the limbs symmetrically. Concerning this shortening the most contradictory statements have been made; some surgeons, relying solely upon the appearance of the limb and seeing that the knee lay well above the opposite one, have described the shortening as great; others, looking only to the new relations of the bones as shown upon the skeleton, have described the shortening as moderate, or even as absent in the lower forms. The error in the first arises from not taking into account the effect of adduction to create an apparent shortening of the adducted limb when compared with its non-adducted, still more with its abducted, fellow; that in the second

arises from considering the question only with reference to the position of extension. If the head of the femur is displaced backward toward the spine of the ischium, the length of the limb measured in extension from the anterior superior spine of the ileum to the knee or ankle will not be diminished, for the movement backward of the head has been at right angles to the line of measurement and has not brought the knee any nearer to the pelvis; but if the measurement is made while the thigh is flexed at about a right angle the measured length will be less by about two inches than that of the other limb in the same position, for now the measured line is nearly parallel to the direction of displacement. When the head is displaced upward as well as backward the difference in the amount of shortening in these two positions of the limb is much less, for the direction of the displacement deviates at about the same angle from the measured line in each attitude. Of course, in each limb the measured length is less when the thigh is flexed, but the difference in the comparative measurements of the two limbs is not affected in the high dislocations and is greatly affected in the low ones. In making measurements the two limbs must be symmetrically placed as regards flexion and adduction, and the fixed adduction of the injured limb sometimes interferes seriously with the accomplishment of this condition, for its knee occupies the position to which the other one should be brought, and, therefore, an equal adduction cannot be given to the sound limb without carrying its knee

FIG. 129.



Dorsal dislocation below the tendon. The flexion is greater when the patient is recumbent. (BIGELOW.)

FIG. 130.



"Dorsal dislocation, downward and outward toward the tuberosity. . . A first step to luxation behind the tendon, which it inclines to become when the patient is upright." (BIGELOW.)

across at a higher or lower level, and thus giving it an unsymmetrical flexion. It must also be remembered that apparent symmetry of position is not sufficient, the symmetry must be real in that the angles of flexion and adduction *on the pelvis* are the same. Fortunately the exact determination of the shortening is not necessary to the diagnosis of the dislocation.

When the head passes below the tendon of the obturator internus and

does not secondarily rise upon the ilium the inversion and flexion of the limb are greater than when the head comes to rest at a higher point (Fig. 129) and may be so great that the limb crosses the opposite thigh as high as its middle (Fig. 130). The flexion may be so masked by the tilting of the pelvis that the thigh will lie nearly alongside the other, parallel to the long axis of the body, but the condition can be recognized by attention to the compensatory curve (lordosis) of the lumbar vertebræ; indeed, Syme[1] said he made the diagnosis of ischiatic dislocation without other handling of the patient than that necessary to recognize the lordosis.

The cause of the comparative fixation of the limb, of its attitude, and of the loss of even passive abduction and external rotation was first clearly shown by Prof. Bigelow in his classical monograph upon the *Hip*. Others had recognized, in a measure, the part taken by the strong anterior portion of the capsule in determining the attitude of the limb, but he was the first to study the subject in all its bearings and to present a complete account of the relations and influences of the Y-ligament in all forms of dislocation, one which was at once and everywhere accepted and has been made the basis of the present methods of reduction. He says (loc cit., p. 38), "The inversion is chiefly due to the outer branch of the Y-ligament, as is shown by the fact that the characteristic sign disappears when this branch is divided. But other parts of the capsule, varying with its laceration, may assist the inversion of the limb, and when the latter is exaggerated, as when one thigh crosses the other at its middle or upper third, they may seem to be largely concerned in it; thus, if the dorsal luxation is secondary to one below the socket, only the anterior and superior fibres will remain untorn; while, if the femur has been thrust obliquely upward and backward, attachments may be found at both the anterior and the inferior margins of the acetabulum. But it is unnecessary to consider these lesser and comparatively slender fibres. In such cases, the knee can be depressed, as indeed it often is, by the forces to which it is subjected at the time of the accident, until the exaggerated flexion and inversion have disappeared, and if even a large part of the capsule, as in the annexed figure [Fig. 126] is stretched tense across the socket, it may then be ruptured without diminishing the inversion, which, for all practical purposes, is due to the outer branch of the Y-ligament."

Diagnosis.—The recognition of the character of the injury is rarely difficult. The group of prominent symptoms—loss of function, adduction, inversion, and flexion of the limb, resistance to abduction, extension, and outward rotation, elevation of the trochanter above Nélaton's line—are not found in any other affection except perhaps hip-joint disease of long standing. The mistake most frequently made is that of confounding it with a fracture of the neck of the femur, or, to speak more definitely, is that of supposing a fracture of the neck to be a dislocation. I have met with several instances of this, some of which led to litigation. The differences between the symptoms of the two injuries are striking and usually sufficient to make the mistake impossible if ordinary attention is paid to them; the fixity of the limb in dislocation, with the knee thrown forward and inward against or upon the opposite thigh, the

[1] Syme: Lond. and Edinb. Monthly Journal, 1843, vol. 3, p. 498.

prominence of the trochanter, and, usually, its increased distance from the anterior superior spine of the ilium, contrast strongly with the straight, everted, powerless limb and flattened hip of fracture of the neck. Fractures with inversion and dislocations with eversion are entirely exceptional. When the two injuries have coexisted the diagnosis has sometimes been made by recognizing that the head, which could be felt out of its place, did not share in the movements communicated to the shaft,[1] and sometimes by the splitting and enlargement of the great trochanter.

2. *Everted dorsal dislocations.*

In this class, of which there are but few recorded cases, are here included Bigelow's anterior oblique, everted dorsal, and supraspinous. It is characterized, as the name indicates, by eversion of the limb in place of the inward rotation which is so prominent a feature of the common dorsal dislocation, and this symptom is due in all cases, except perhaps the very rare anterior oblique, to rupture of the outer branch of the Y-ligament. In the supraspinous variety the head of the bone lies above the anterior inferior spinous process of the ilium in the notch between it and the superior spine.

Although occasional cases had been previously reported, the variety was not described by systematic writers before Prof. Bigelow, and was not even mentioned by Malgaigne, although possibly one or two of the cases classed by him as supracotyloid may have been of this kind. In a paper by Blasius[2] on supracotyloid dislocations several cases of this variety (everted dorsal) are included, together with others in which the head had reached nearly the same position by passing outward after primary dislocation forward and upward upon the pubis, and a few in which the dislocation was primarily directly upward. The same grouping has been followed by other writers, and in no reported case previous to 1850 does it appear to have been recognized that the head had reached this position by a secondary displacement after dislocation backward and upward. Blasius's paper, although published in 1874, must be classed with those of an earlier period, for it is really the republication of researches made some time earlier by his son in a graduating thesis, and it makes no mention of Prof. Bigelow's work. It is, in one respect, a publication to be regretted, for the authority of its writer and its date combine to further the acceptance without examination of the grouping, or classification, which cannot properly be accepted in view of the important pathological differences between the individual cases of which it is made up.

The earliest recorded case I have found is a doubtful one reported by Morgan[3] in 1836; the patient was a man sixty-six years old, who had fallen backward down-stairs while helping to carry a heavy object. "The left leg was shortened to the extent of at least two inches; the foot excessively everted, so as almost to give the toes a direction backward. The injured limb had a tendency to cross that of the opposite side, so as to throw the heel over the instep of the opposite foot; nevertheless, when

[1] Koch: Berlin. klin. Wochenschrift, 1882, p. 492.
[2] Blasius: Arch. für klin. Chir., 1874, vol. 16, p. 207.
[3] Morgan: Guy's Hosp. Reports, 1836, vol. 1, p. 79

they were placed side by side they remained in that position. The leg was susceptible of all the natural motions to some extent, with the exception of rotation, but the man complained of great pain while under examination. The projection of the great trochanter was entirely lost; whilst the luxated head of the bone might be felt under Poupart's ligament, just below and to the inner side of the anterior and superior spinous process of the ilium, and apparently lying between the anterior inferior spinous process of the ilium and the junction of that bone with the pubis." It was reduced by traction, flexion, and rotation inward.

Other cases were reported during the next following ten years by Travers,[1] a pupil in St. George's Hospital,[2] and Gordon.[3] The report of the second of these was accompanied by an account of the autopsy, and Cadge[4] subsequently reported the autopsy in Travers's case. This case is quoted twice by Sir Astley Cooper, once (loc. cit., p. 79) as a dislocation on the pubes, which was also Cadge's diagnosis, and once (loc. cit., p. 88) as a dislocation directly upward, quoting Travers. Bigelow also quotes it as two cases (loc. cit., p. 96), and reproduces Cadge's plate of the os innominatum, showing the new socket (Fig. 131). There is some reason to think the dislocation may have been directly upward. There are a few other cases variously reported either as dislocations upon the pubis or as dislocations directly upward, which may be of the same character, but the descriptions do not permit a positive diagnosis.

In 1850 the possibility of the production of this form by transformation of a dorsal dislocation was shown in an attempt made in the New York Hospital to reduce a dislocation "into the sciatic notch." The case is reported by Lente;[5] after traction had been made and suddenly relaxed the thigh was abducted and rotated outward, and this brought the head of the femur above the acetabulum, and below the anterior superior spinous process; the shortening was then about two inches; the limb very much rotated outward, the rotundity of the hip greater than that of the other, and the trochanter major one inch further from the anterior superior spinous process.

Five years later Van Buren[6] observed in the same hospital a case which, so far as I know, was the first in which the absence of inversion and marked adduction was noted in a case recognized as a dorsal dislocation. The limb "was shortened about an inch; the foot and leg were slightly everted. This eversion, it was afterward ascertained, could be readily increased by manipulation; but there was an evident obstacle at the hip to *inversion* of the foot. The knee was slightly flexed, so that the width of the hand could be readily passed between its popliteal aspect and the surface of the bed. The obliquity of the femur toward its fellow was very slightly increased. Upon the front of the thigh at its upper third a very manifest concavity or sinking in was noticeable, the usual

[1] Travers: Med. Chir. Trans., 1837, vol. 20, p. 112.
[2] Lancet, 1840–1, vol. 2, p. 281.
[3] Gordon: Dublin Hosp. Gazette, 1844–5, vol. 2, p. 85.
[4] Cadge: Med. Chir. Trans., 1855, vol. 38, p. 88.
[5] Lente: N. Y. Journal of Med., 1850, p. 314.
[6] Van Buren: N. Y. Med. Times, 1856, vol. 5, p. 126, and reprinted in his Contributions to Practical Surgery, p. 157.

anterior convexity of the limb being lost. The trochanter was about an inch and a half behind and above its usual position, and, during etherization, it was quite movable on attempting rotation of the limb. Finally, the head of the femur could be felt obscurely but pretty certainly rotating in the ischiatic notch, low down, and in contact with its posterior margin. The anterior convexity of the spine at the loins was also very much increased, so that under ether more than the width of the hand could be passed between it and the surface of the bed. Thus the case presented all the classical features of luxation into the ischiatic notch, and more than usually well marked, with the exception of adduction of the lower end of the femur and inversion of the foot." After several failures to reduce by manipulation and traction downward, reduction was effected by traction while the limb was flexed at right angles to the pelvis, followed by abduction and extension.

In 1864 Symes[1] reported a case, and suggested for the variety the name of "dorsal with eversion." This was subsequent to Bigelow's researches but previous to his publication of them, except in his lectures. The limb was shortened two inches, the foot extremely everted, the buttock flattened, and the head of the femur two inches below the anterior superior spine of the ilium. By flexion of the limb the dislocation was made dorsal, and a feature of special interest is that then, as the limb lay untouched upon the table, eversion gradually took place under the influence of gravity, and the head returned to its former place.

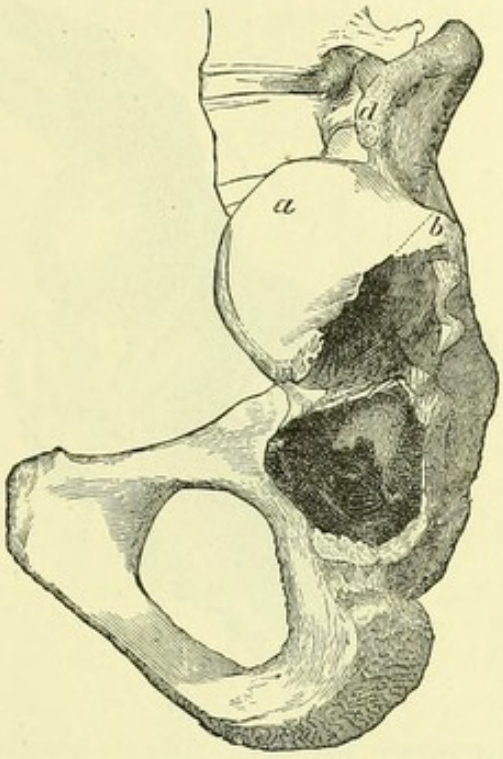
In 1874 Kocher[2] observed a similar case in a woman, forty-nine years old; the limb was fully extended, markedly everted, and shortened three centimetres; the head could be felt below and to the outer side of the anterior superior spine of the ilium. By flexion and inward rotation the dislocation became dorsal with the characteristic symptoms, and then by extension and outward rotation the original symptoms were reproduced.

Pathology.—At the autopsy in the fresh case observed at St. George's Hospital, the head of the femur lay about an inch below and to the outer side of the anterior superior spinous process of the ilium, and the trochanter was still further to the outer side and behind, resting on the dorsum of the ilium, so that the toes pointed outward and slightly backward. The gluteus medius and minimus were extensively lacerated and nearly torn through at about two inches from their attachment to the trochanter; the gemelli and quadratus femoris were slightly lacerated; the capsular ligament was extensively lacerated at its upper part, and the ligamentum teres ruptured. The trochanter minor rested on the outer edge of the acetabulum. In a case which I reported to the New York Surgical Society, December, 1887, and January, 1888,[3] which had been subjected to many attempts to reduce, the outer branch of the Y-ligament was ruptured and the muscles behind the trochanter extensively lacerated. Complete reduction was prevented by interposition of the antero-inferior part of the capsule. In Cadge's autopsy of Travers's case (Fig. 131), the head of the femur lay in the interval between the anterior superior

[1] Symes: Dublin Quart. Journ. Med. Sci., 1864, vol. 38, p. 272.
[2] Kocher: Volkmann's Sammlung klin. Vorträge, No. 83, p. 631.
[3] Stimson: N. Y. Med. Journ., Jan. and Feb. 1888.

and anterior inferior spinous processes of the ilium, and was covered by a complete bony cap lined with a dense, pearly white tissue resembling fibro-cartilage. The edge of the new cavity was connected with the neck of the thigh bone by a thick capsular ligament. The rectus muscle, which had been torn from its origin, was inserted upon the edge of the new cavity, a condition which, as Bigelow says, suggests the ascent of the bone above the inferior spinous process of the ilium at the time of the injury, with rupture of the Y-ligament.

Fig. 131.



Old everted dorsal dislocation. Cadge's case. *a*, new bony cap, with its fractured margin, *b*.

Van Buren's case, and a very similar one reported by Annandale,[1] show that the head may lie much further to the outer side, at or near the sciatic notch.

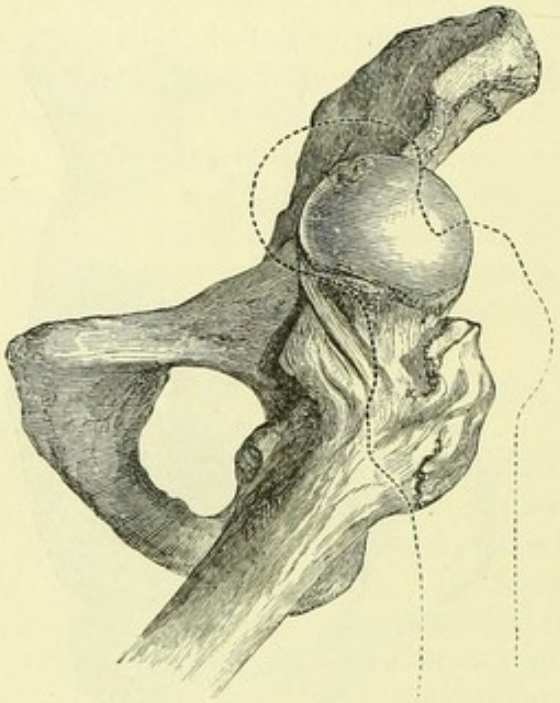
Bigelow's experiments show that this eversion depends upon the rupture of the outer branch of the Y-ligament. The head of the femur escapes at the back of the joint while the limb is flexed, adducted, and rotated inward, and then by external rotation the outer branch is torn; if, then, the head remains in its position opposite or below the sciatic notch, the position and symptoms are such as are noted in Van Buren's and Annandale's cases, the flexion and slight adduction being due to the remaining untorn branch of the ligament. The change in the position of the head noted in the other cases Bigelow was able to reproduce experimentally from a common dorsal dislocation by carrying the limb "across the symphysis, so that the outer and convex surface of the socket shall correspond to the hollow beneath the neck of the femur. With some force the thigh can now be everted, and afterward brought down across the upper part of its fellow." (This is the form to which he gave the name "anterior oblique.") "If, in this position, it is desired to bring the limb toward a perpendicular, the outer branch of the Y-ligament must be ruptured. Thus liberated, it hangs suspended by the inner ligament, and becomes capable of lateral motion and of rotation; and this is probably the condition under which supra-spinous luxation, although rare, usually occurs." Fig. 132 shows in the dotted lines the head of the femur thus hooked over the remaining part of the ligament.

The *anterior oblique* is a variety which I feel some hesitation in preserving, because Bigelow appears to have observed it only in experiments upon the cadaver, and to have known of only one recorded case (Oldnow,

[1] Annandale: Lancet, 1876, i. p. 208.

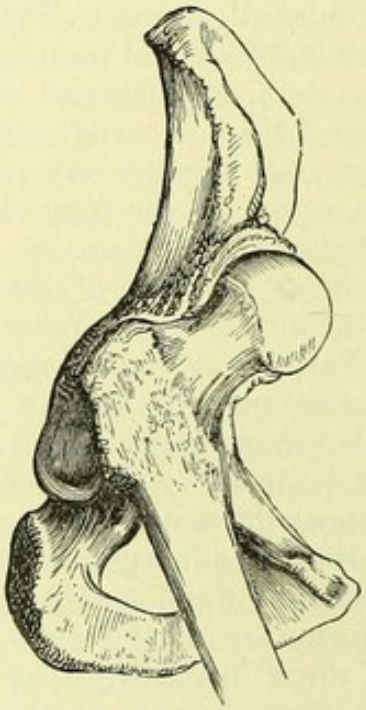
in *Guy's Hospital Reports*, 1836, vol. i. p. 97) in which the attitude resembled that found in his experiments. The specimen in that case

Fig. 132.



Supraspinous dislocation. When the femur takes the position indicated by the dotted line, only the inner branch of the Y-ligament remains untorn. (Bigelow.)

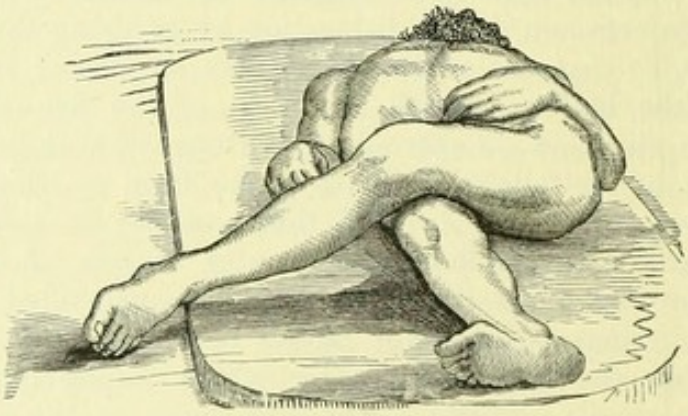
Fig. 133.



Anterior oblique dislocation. Oldnow's case.

is represented in Fig. 133. Figs. 134 and 135 show the attitude and specimen obtained from the cadaver; the mode of production has been quoted in the preceding paragraph. The Y-ligament is untorn. If the

Fig. 134.



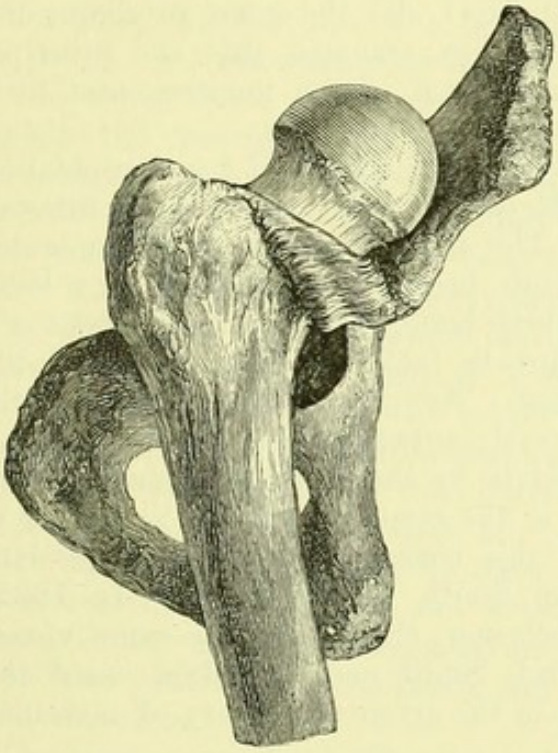
Anterior oblique dislocation. (Bigelow.)

primary dorsal dislocation has been below the tendon of the obturator internus, this muscle is ruptured in the subsequent change of place.

The *symptoms* of the everted dorsal may be the same as those of the common dorsal dislocation, with the exception that there is marked or

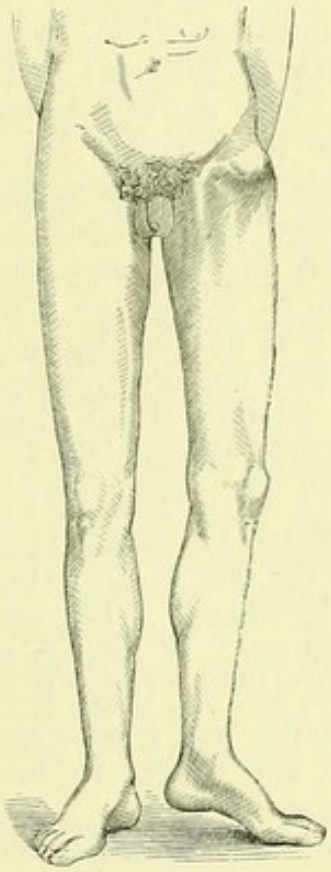
slight eversion of the limb instead of inversion; or, if the head of the femur has moved forward above the anterior inferior spinous process, they may differ widely, for the limb is then shortened about two inches, slightly abducted, more or less everted, and fully extended (Fig. 136). The eversion of the limb is liable to lead to the mistake of supposing the injury to be a fracture of the neck of the femur, especially in the cases in which the head is brought forward above the acetabulum and in

FIG. 135.



Anterior oblique dislocation. (BIGELOW.)

FIG. 136.



Everted dorsal dislocation. (BIGELOW.)

which the limb is also extended. The greater fixation of the limb and the recognition of the position of the head and of its continuity with the shaft, as shown by its sharing in the movements communicated to the latter, will establish the diagnosis.

The rupture of the outer branch of the Y-ligament is the explanation of the failures noted in some of the cases to reduce by manipulation alone; traction in the flexed position is needed to bring the head forward into the socket; abduction fails to do it because of the loss of the support of the outer branch of the ligament.

Treatment.—The method of reduction so long in use, and which left so many dislocated hips unreduced, that in which it was sought to draw the bone into place by traction upon it with compound pulleys while the limb was almost as fully extended as possible, has at last been abandoned in favor of the methods of simple manipulation or of moderate traction in the flexed position, or of a combination of the two. The advantages of

the flexed position, the possibility of reducing by the aid of moderate traction when the thigh is flexed at a right angle with the trunk, were repeatedly pointed out by different writers during the last century and the first half of the present one, and the possibility of reducing by manipulation alone (flexion, outward rotation, and abduction) was also demonstrated, but neither seems to have had any influence in modifying the general practice, although some surgeons, notably Prof. Nathan Smith, of New Haven, taught and habitually practised traction with the limb flexed at a right angle, and he also, in 1831, formulated a method by manipulation alone.

Desprès,[1] in 1835, independently formulated the method by flexion and outward rotation; and Reid,[2] in 1851, did the same, preceding the flexion with marked adduction; but they assumed that the principal obstacle to reduction lay in the resistance of the muscles, and their manipulations were designed to overcome or avoid this.

Bigelow[3] quotes Smith's description of this method by manipulation from his *Medical and Surgical Memoirs*, edited in 1831 by his son, Nathan R. Smith, as follows: "The first effort which the operator makes is to flex the leg upon the thigh, in order to make the leg a lever with which he may operate on the thigh bone. The next movement is a gentle rotation of the thigh outward, by inclining the foot toward the ground, and rotating the knee outward. Next, the thigh is to be slightly abducted by pressing the knee directly outward. Lastly, the surgeon freely flexes the thigh upon the pelvis by thrusting the knee upward toward the face of the patient, and at the same moment the abduction is to be increased." Bigelow adds "this covers the ground of priority of invention. It belongs to Nathan Smith. . . . . In 1835, Desprès, and in 1852, Reid, of Rochester, enunciated the same views, the practice was good, but both Prof. Smith and Dr. Reid based the method and sought its mechanism in the erroneous theory of muscular resistance."

After 1850 the attention of surgeons and anatomists began to be directed more specifically to the opposition offered by the untorn portions of the capsule and to the position of the rent in it, and many experiments were made upon the cadaver to obtain a more accurate knowledge of the matter. Among these may be mentioned those of Meyer,[4] Gunn,[5] Roser,[6] Bigelow,[7] Gellé,[8] Busch,[9] and Tillaux.[10] Of these Bigelow's researches were by far the most complete and accurate, and to his classical work must be referred the popularization and general acceptance of the views now held and the methods of treatment based upon them. The importance of the anterior portion of the capsule, the Y ligament, had

[1] Desprès: Bull. de la Soc. Anatomique, Sept. 1835, p. 4.
[2] Reid: Buffalo Med. Journal, Aug. 1851.
[3] Bigelow: Lancet, 1878, I. p. 861.
[4] H. Meyer: Zeitschrift für rat. Med., 1850, vol. 9, p. 250.
[5] Gunn: Penins. Journ. of Med., 1853–4, vol. i. p. 97.
[6] Roser: Archiv für Phys. Heilkünde, 1857, vol. i. p. 42.
[7] Bigelow: The Hip, 1869. Experiments made in 1860.
[8] Gellé: Arch. gén. de Méd., 1861.
[9] Busch: Arch. für klin. Chir., 1863, vol. iv. p. 11.
[10] Tillaux: Bull. de la Soc. de Chir., 1868, p. 274.

indeed been specifically pointed out by one or two earlier writers—it is mentioned in Hyrtl's *Topographische Anatomie*, in Meyer's paper in 1850, and by von Pitha[1] in 1863—but Bigelow was the first to study its influence in detail, to show its constant action in all typical forms, and to base upon it methods of reduction for the different forms, and to him belongs the credit not only of independent discovery but also of the still more important benefit conferred by impressing the facts upon the profession by his careful, thorough investigations and his clear exposition of the facts and principles.[2]

It is now generally recognized that the chief obstacle to reduction is created by the tension of the Y-ligament in the partly extended position of the limb, and that this is to be removed by flexion of the limb upon the trunk. At the same time the movement of flexion brings the head of the femur down along the back of the acetabulum so that it lies opposite the opening in the capsule if, as is usually the case, it has left the socket at its lower posterior part and has risen to a higher level by the subsequent extension of the limb, enlarging the rent upward in the movement; if, more rarely, the head has left the socket at a higher level while the limb was only slightly flexed, this movement of flexion in reduction, unless carried beyond a right angle, does not place the head below the opening, or at least, if it does so, the movement enlarges the rent downward so that the way is still open for the return of the head to its place. Another reason for making this movement is found in some cases in the interposition of the obturator internus between the head and the socket, the cases, so-called, of "dislocation below the tendon" in which the head has secondarily risen toward the dorsum ilii. During the movement the adduction and internal rotation of the limb are preserved or even somewhat increased in order to lift the head of the femur away from contact with the pelvis and from behind the projecting rim of the acetabulum.

The directions given by Bigelow in his first publication (loc. cit., p. 46) are as follows:

"*By Traction.* Lay the patient, when etherized, on his back upon the floor, bend the limb at the knee, flex the thigh upon the abdomen, adduct and rotate it a little inward, to disengage the head of the bone from behind the socket. The Y-ligament is then relaxed.

"If the bone can now be abducted beyond the perpendicular, the capsule and other tissues are probably so torn or relaxed that reduction may be accomplished without much difficulty: the thigh need only be forcibly lifted or jerked toward the ceiling, with a little simultaneous circumduction or rotation outward, to direct the head of the bone toward the socket."

In his later paper, in the *Lancet*, 1878, he gives them more briefly in the following terms:

"1. Flex and forcibly lift. If this fails,

[1] Von Pitha: Pitha and Billroth's Chirurgie, vol. iv. part 2, B, p. 161.

[2] The claim of priority in the discovery of the part played by the anterior portion of the capsule made for Prof. Gunn, of Chicago, is, I think, sufficiently answered by Prof. Bigelow in a letter published in the Chicago Medical Examiner, January, 1870, p. 25.

"2. Flex and lift while abducting. If this fails, it will be found that the rent in the capsule has been so enlarged that the first method may now prove successful."

Bigelow adds to his first description three other methods of making the manipulation and applying the force, and, although the mechanism is the same in all, the multiplicity of the directions has been criticised by recent German writers, who seem to regard the four as essentially different from one another.

Kocher,[1] after making this criticism, describes what he calls his own method, and this is quoted approvingly by Albert and König. Its identity with Bigelow's appears to me to be complete, although it combines his two methods by traction and by manipulation. It is as follows:

1. *Inward rotation* to relax the capsule and lift the head from the posterior surface of the pelvis.

2. *Flexion*, to a right angle and gently, preserving the existing adduction and inward rotation.

3. *Traction*, to make the capsule tense, so that it can be utilized in the following movement, and to raise the head to the level of the acetabular margin, thus overcoming the action of gravity.

4. *Outward rotation;* this makes the posterior part of the capsule and outer band of the Y-ligament tense, and turns the head forward into the socket.

Bigelow's directions for reduction *by manipulation* are as follows (loc. cit., p. 48):

Flex the thigh and abduct or circumduct it outward, at the same time rotating it outward. The head of the bone, revolving about the great trochanter which is fixed by the outer branch of the Y-ligament, rises over the edge of the socket into its place, unless the capsule is interposed, in which case the opening must be enlarged by making the limb form a large angle laterally with the trunk, a movement which will probably convert the dislocation into a thyroid one, by causing the head to pass below the acetabulum to the obturator foramen; if it is then restored to its former position by reversing the manipulation, a second attempt may succeed. Care must be taken not to rotate outward before the abduction is complete, so as to avoid the needless passage of the head below the socket to the obturator foramen.

The following is his explanation of the mechanism by which reduction is thus effected. "When the thigh is forcibly flexed upon the abdomen, the head of the bone is lifted out from beneath the socket. A little inward rotation favors the same result. If the thigh be now slowly abducted or depressed outward, it is plain that the head of the bone, suspended by the Y-ligament, must rise toward the socket, and that, when the shaft is thus abducted, outward rotation assists the entrance of the head. If the head of the bone is above the tendon of the internal obturator, this outward circumduction also ruptures the small rotator muscles. It may be needless to say that, were the head of the bone suspended by the dissected Y-ligament alone, a lateral movement of the knee would perhaps cause the head of the bone to swing from side to

[1] Kocher: Volkmann's klinische Vorträge, No. 83.

side, instead of giving to it the desired upward tilt. This movement is hindered by the unruptured fibres on each side of the Y-ligament, which continue to a greater or less extent in the different dislocations, and contribute to the varying facility with which different cases are reduced. This is especially true of the dislocation behind the tendon of the obturator internus, where the posterior part of the capsule not unfrequently remains uninjured."

There are a number of practical points connected with the carrying out of these directions which require attention. The pelvis may need to be steadied or immobilized during traction, in order that the limb may not be too soon or unwittingly abducted, and this may be done either by the hands of assistants or by the pressure of the surgeon's foot upon the anterior superior spinous process of the ilium of the injured side while he is lifting the thigh.

The traction upon the thigh may be made by the hands of the surgeon, but if the patient is a muscular adult the force that can be thus exerted may be insufficient, and it can then be conveniently supplemented by making the two ends of a bandage fast to the thigh above the knee and placing its loop over the surgeon's neck upon his shoulders.

Or the patient may be placed face downward upon a table in such a way that the injured thigh will hang down at the end, the sound thigh being supported horizontally by an assistant or resting on another table brought up against the foot of the first one. In this position the weight of the limb furnishes the necessary traction, which, if need be, can be supplemented by pressure with the hand upon the calf of the flexed leg, and the required rotation and abduction can be easily made. In this manner I once quickly and easily reduced, without anæsthesia, a recent dislocation in a very muscular young man.

External rotation must be carefully avoided during the first steps, lest it should convert the dislocation into an everted dorsal by throwing the head forward above the socket; and extreme flexion and abduction without simultaneous traction are also to be avoided in order to escape the conversion of the dislocation into one upon the obturator foramen by the passage of the head below the socket. This accident has been frequently observed, and, when it has occurred, traction upon the flexed thigh should, I think, always be preferred to pure manipulation.

The *everted dorsal* and *anterior oblique* dislocations are reduced after first converting them into the dorsal form. This conversion is effected in the former by flexion and inward rotation, with adduction, if necessary, to make room for the head of the bone to slide upon the ilium; the rupture of the outer branch of the Y-ligament deprives the operator of much of the advantage of rotation, and the dislocation must, therefore, be reduced by direct traction toward the socket, with local guidance of the head. In my own case, in which, after conversion into the dorsal form the tendency of the head again to pass forward above the acetabulum was very marked, outward rotation had to be carefully avoided. The anterior oblique is transformed by inward circumduction of the extended limb across the symphysis, with a little eversion, if necessary, to disengage the head of the bone, and then by inward rotation (Bigelow).

The possibility of fracturing the neck of the femur during manipulation must be borne in mind (see Chapter XXVII.).

CHAPTER XXVI.

DISLOCATIONS OF THE HIP.—(*Continued.*)

DISLOCATIONS DOWNWARD AND INWARD. OBTURATOR. PERINEAL. DISLOCATIONS FORWARD AND UPWARD. SUPRAPUBIC. ILIO-PECTINEAL. DISLOCATIONS UPWARD. SUBSPINOUS (BIGELOW) SUPRACOTYLOID. DISLOCATIONS DOWNWARD ON THE TUBEROSITY OF THE ISCHIUM.

Dislocations Downward and Inward.

1. Obturator or thyroid dislocations, or dislocations upon the thyroid foramen; and 2, perineal dislocations.

In this class of dislocations the head of the femur leaves the socket at its lower, or lower and inner, part, and passes forward and inward to rest upon the obturator foramen (obturator dislocation), or passes still further, and, crossing the ischio-pubic ramus, projects in the perineum (perineal dislocation). The limb is flexed, abducted, and usually rotated outward.

1. *Obturator dislocations.*

These dislocations, although infrequent, are apparently the second in order of frequency of those of the hip, and it seems not improbable that this form, in part at least, is the first stage in the production of some of the suprapubic, and even some of the dorsal dislocations; that is, the head of the bone, having left the socket at its lowest part in forced flexion of the limb, may either be turned backward behind the acetabulum by adduction, internal rotation, and diminution of the flexion, or forward and upward upon the pubis by external rotation and extension; the obturator form is produced by its passage more directly forward and inward upon the obturator foramen by abduction and external rotation.

The commonest *cause* appears to be great violence acting upon the back of the pelvis while the limb is flexed and abducted, as in the fall of a heavy object upon the back of a man who is stooping forward with his legs separated. Simple abduction of the extended limb is apparently sufficient to produce the injury, as is shown by a case reported by Corne,[1] in which the thigh of a drunken soldier was forcibly abducted by his comrades. In a case reported by Keate,[2] and another by Barker,[3] the mechanism was apparently the same; in the former the patient, while riding, fell into a ditch, his horse falling upon him and widely separating his legs; the head of the femur lay close to the tuber ischii. In the latter the patient fell from a height of about thirty feet, striking

[1] Corne: Recueil de Mém. de Méd. Mil., Feb. 1867, quoted by Lossen.
[2] Keate: Lond. Med. Gaz., vol. x. p. 19, quoted by Bigelow.
[3] Barker: Amer. Journ. Med. Sci., 1854, vol. xxvii. p. 412.

upon a sandbank and having his legs widely separated; both thighs were dislocated, and the head of one femur was thought, on rectal examination, to have passed through the obturator membrane into the interior of the pelvis; reduction was effected after several unsuccessful attempts under ether.

In another set of cases it is difficult to determine whether the cause has been direct impulsion of the head of the femur downward and inward by a force acting on the outer side of the great trochanter, or whether it has been exaggerated abduction by pressure forward of the outer part of the pelvis, as in a case reported by Treub,[1] in which a man while lying on his face was run over by a wagon, the wheels passing obliquely across his left hip at the level of the trochanter and the pelvis from left to right, and received a dislocation of the left hip.

Pathology.—The reported autopsies in recent cases are very few. Verhaeghe[2] examined the body of a patient who died five days after having received multiple injuries in a fall, one of which was an obturator dislocation and had been reduced previous to death, and found the position which had been occupied by the head marked by an extravasation of blood between the obturator externus and the pectineus, both of which were much bruised. The capsule was torn on its inner side, and the ligamentum teres was ruptured. In a case examined by Schinzinger,[3] the patient having died on the day following the accident, the condition of the parts was almost identical, but the obturator externus and pectineus were in part reduced to pulp; the rent in the capsule occupied its inner and lower part, was two inches long, and was prolonged upon the anterior face of the neck.

Curling[4] reported an autopsy in a case in which death followed three days after the injury. The patient was a muscular man thirty-eight years old, who had been knocked down by a beam. Spontaneous reduction took place while he was being turned in bed. The upper part of the adductor magnus and lower border of the obturator externus were much ecchymosed. "There was a large rent in the front aspect of the capsular ligament, which passed from above downward in a direct line from the ilio-pectineal eminence to the upper border of the obturator externus, the ligament being for this extent torn from its pelvic attachment." When the dislocation was reproduced the head of the femur "pushed the belly of the obturator externus muscle before it, rendering it tense and bulging," and the pyriformis and glutei muscles were put on the stretch. The ligamentum teres was ruptured close to the femur.

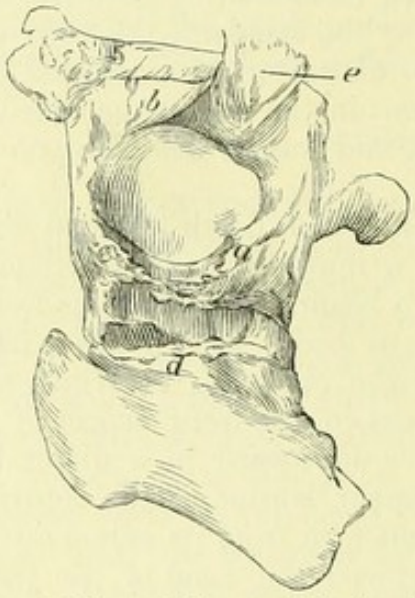
Duboué[5] examined the body of a man who had been killed by the fall upon him of a heavy block of stone which struck against his left side, broke several ribs, produced a dislocation of the left hip, and fractured the pelvis at the junction of the ilium and pubis, but without displacement. The head of the femur rested upon the ischio-pubic branch of

[1] Treub: Centralblatt für Chirurgie, 1882, p. 729.
[2] Verhaeghe: Gazette des Hôpitaux, 1851, p. 283.
[3] Schinzinger: Wiener med. Presse, 1880, No. 3, quoted by Poinsot.
[4] Curling: Med. Times and Gazette, 1853, ii. p. 423.
[5] Duboué: Bull. de la Société Anatomique, 1858, p. 496.

the pelvis, rather below than upon the obturator externus. The femoral vein was ruptured.

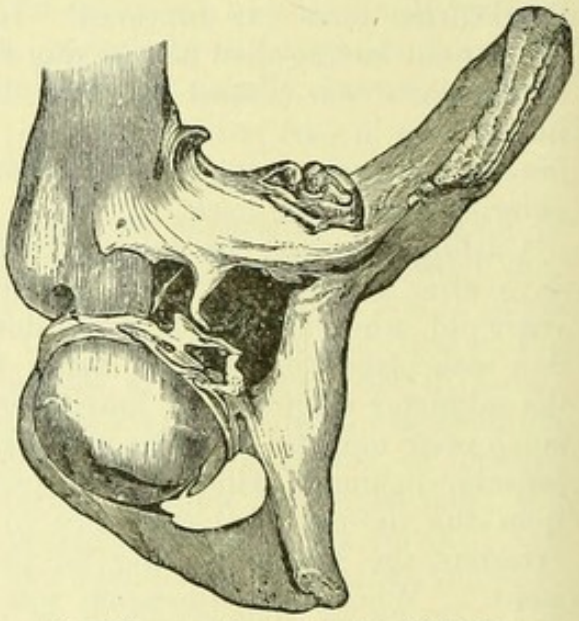
Annandale[1] reported the case of a strong, healthy man, nineteen years old, who had been severely injured on a railway, receiving compound fractures of the right leg and left forearm and hand, a comminuted fracture of the right arm, and a thyroid dislocation of the left hip. "The symptoms of the dislocation were well marked, and consisted of slight flexion of the thigh and abduction of the whole limb, which was fixed in this position." The dislocation was easily reduced by manipulation; the patient died two hours after admission to the hospital. "There was slight extravasation of blood among the muscles on the anterior, outer, and posterior aspects of the joint; and extravasation of blood and severe bruising and laceration of muscles on the inner aspect of the joint, more particularly of the fibres of the obturator internus (*sic*), portions of which had been forced into the acetabulum. The tendon of this muscle was not ruptured. The head of the femur lay in the acetabulum, and the capsular ligament was extensively torn on its inner and lower aspect, as is shown in Fig. 137, *a*, *b*, *c*, *d*, being the edges of the torn

FIG. 137.



Annandale's case of obturator dislocation, showing rent in the capsule, *a*, *b*, *c*, *d*; the head of the femur has been returned to the socket. *e*, the ligamentum teres.

FIG. 138.



Stanski's case of old obturator dislocation. (MALGAIGNE.)

capsule. The round ligament, *e*, was completely torn away from the head of the femur, and attached to it was a thin layer of articular cartilage, and some small particles of bone. The anterior and a greater part of the posterior portion of the capsular ligament were entire, and a careful dissection of them showed, most distinctly, Professor Bigelow's Y-ligament uninjured."

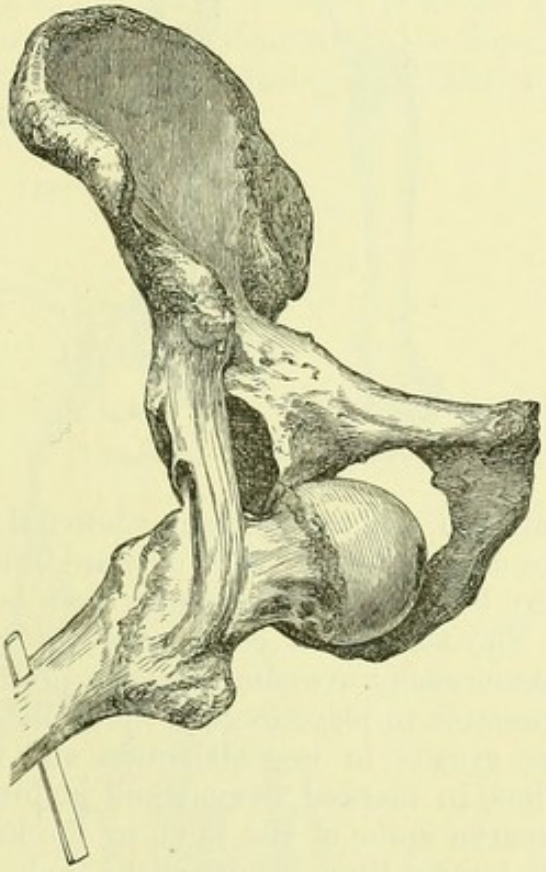
Several specimens of old dislocation have been examined; those of Moreau and Stanski, quoted by Malgaigne, Cooper (loc. cit., p. 50), and

[1] Annandale: British Med. Journ., 1870, i. p. 101.

Sédillot.[1] In these the head occupied the foramen ovale more or less completely, and a new socket had been formed by the growth of bone around it; in Cooper's case the head was so completely enclosed by this new socket that it could not be removed from it without breaking its edge, and yet it was freely movable and was covered with articular cartilage. In Stanski's (Fig. 138) the Y-ligament had been completely transformed into bone, and the head of the femur lay near the tuberosity of the ischium, the limb being much flexed and abducted. In Sédillot's the head of the femur was atrophied and irregular, but the limb was so serviceable that the patient was a professional soldier, and shared in all the campaigns of the army.

Experiments upon the cadaver corroborate the clinical and post-mortem data concerning both the pathology and the mode of production. If the dislocation is produced by abduction of the extended limb the rent in the capsule is found to lie on the inner side of the joint, while, when it is produced by abduction and outward rotation following flexion, or by transformation of a primary dorsal dislocation, the rent is mainly on the under side, and its extension in front and upward is effected by secondary displacement of the head. The Y-ligament, remaining untorn, keeps the limb partly flexed, abducted, and everted (Fig. 139), the head of the femur rests against the inner and under side of the acetabulum, and is prevented from rising by its pressure against this part of the bone and by the untorn portion of the capsule above.

FIG. 139.



Obturator dislocation. (BIGELOW.)

A case of compound dislocation has been quoted in Chapter XXV.

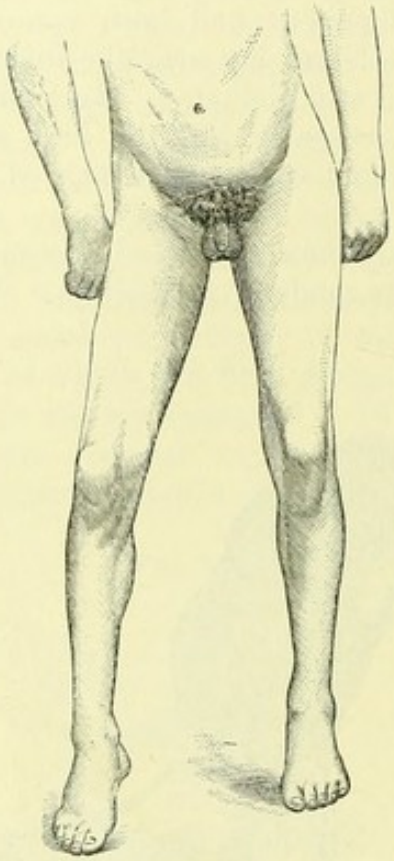
In a case reported by Cooke[2] the shaft of the femur was also broken just below the trochanters; the patient was a boy nine years old, and the injury was caused by a fall. Probably the dislocation was first produced, and then the bone was broken by a continuation of the force, or by a second blow. Reduction was easily effected by direct pressure on the head, and the patient made a good recovery.

Symptoms.—The limb is flexed, abducted, and usually rotated outward,

[1] Sédillot: Gaz. des Hôpitaux, 1861, p. 94.
[2] Cooke: Lancet, 1864, i. p. 37.

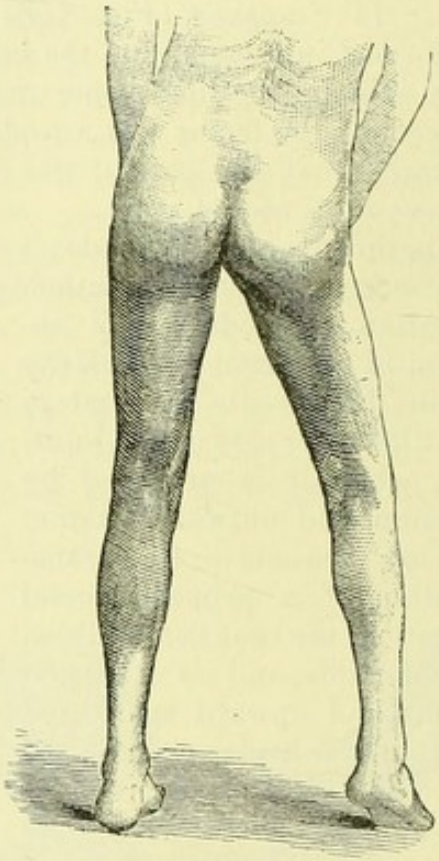
and it appears to be elongated because the foot is projected and brought to the ground by a compensatory tilting of the pelvis forward and downward on the same side (Figs. 140, 141). The trochanteric region is

Fig. 140.



Obturator dislocation. (Bigelow.)

Fig. 141.



Obturator dislocation. (Bigelow.)

flattened, and the trochanter lowered and displaced inward; the adductors are usually tense. The outward rotation of the limb is not marked and may be absent, or there may even be some inward rotation.

The statements concerning the comparative length of the limbs on measurement are contradictory, presumably because of the failure of some observers to place the two limbs in symmetrical positions, or because of the greater or less abduction and flexion of the limb when measured. Thus, in marked flexion and abduction measurement from the anterior superior spine of the ilium to the knee or ankle will show shortening of the injured limb; while, if the limb is extended and but slightly abducted the measurement may show an actual elongation.

The head of the femur may be more or less distinctly felt on deep pressure over the obturator foramen, and Treub (loc. cit., supra) observed that it could be plainly felt through the obturator membrane by the finger in the rectum. The same observation was made by Barker in the case quoted above, but he thought that the membrane had been ruptured and the head of the femur had passed inside the pelvis.

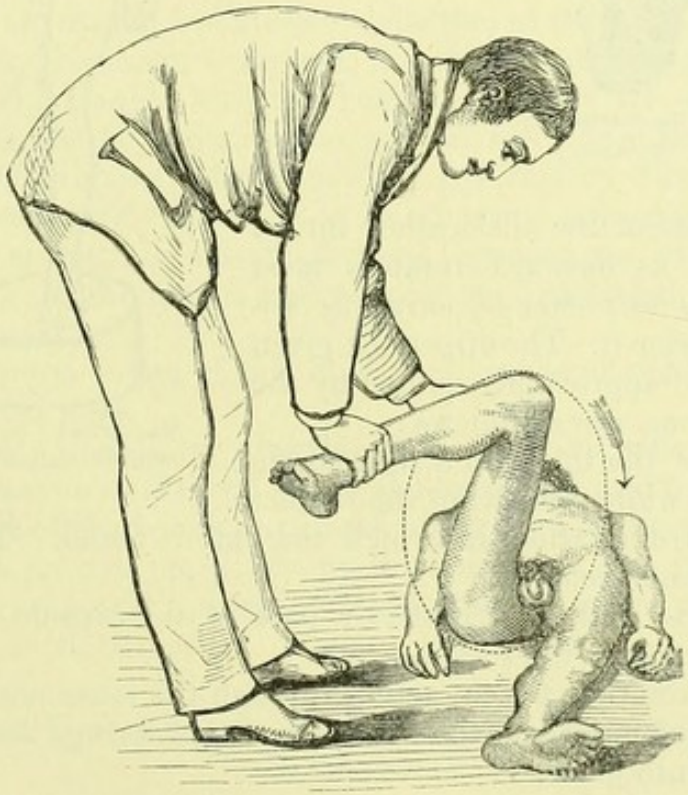
In a considerable proportion of cases the patients have been able to walk quite well immediately after the accident, and some of them have not sought advice until after the lapse of several days, even a fortnight. Sédillot states that this was so in three of the five cases which he had

seen, and one of the patients came to him only because he noticed that he could not completely adduct the limb. Similar freedom in the use of the limb has been noticed in only one other variety of dislocation of the hip, that in which the displacement is directly upward; it is important because it may so easily lead the surgeon to overlook the nature of the injury.

The diagnosis of the dislocation and of the variety is made by attention to the attitude and fixation of the limb, the impossibility of completely extending and adducting it, the elongation in the extended position, the depression of the trochanter, and the presence of the head of the femur in its new position.

Treatment.—Bigelow, in his original paper, gives ten procedures for reducing thyroid and downward dislocations, which may be grouped as four different methods: 1, manipulation; 2, traction in the axis of the flexed and abducted limb; 3, traction outward upon the upper part of the thigh; 4, transformation into a dorsal dislocation, and reduction as such In his last paper (*Lancet*, 1878, i. p. 861) he seems to prefer the last method, adducting the thigh in order to carry the head to the dorsum and enlarge the opening in the capsule, and then reducing by flexion and forcible lifting of the head toward the socket.

FIG. 142.



Reduction of obturator dislocation by rotation and circumduction inward. (BIGELOW.)

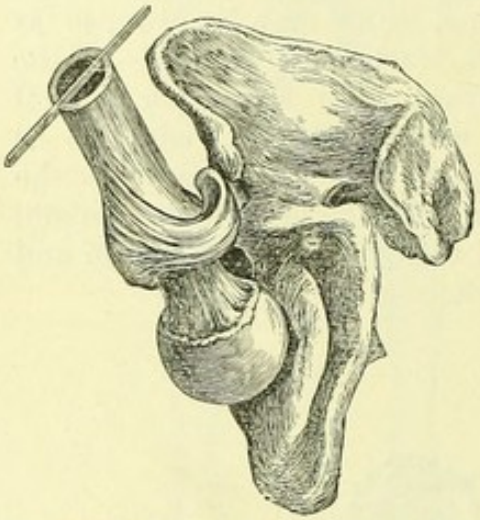
His directions[1] for reducing by manipulation are: "Flex the limb toward a perpendicular, and abduct it a little to disengage the head of

[1] Bigelow: The Hip, p. 79.

the bone; then rotate the shaft strongly inward, adducting it, and carrying the knee to the floor (Fig. 142). The trochanter is then fixed by the Y-ligament and the obturator muscle, which serve as a fulcrum. While these are wound up and shortened by rotation (Fig. 143), the descending knee pries the head upward and outward to the socket. . . . In this manœuvre the action of the ligament may be aided, if necessary, by a towel passed round the head of the femur to draw it upward and outward. Rotation outward may be substituted for inward rotation."

The clinical histories show that both inward and outward rotation have succeeded, each after the other has failed, and that the former is quite

FIG. 143.



The same; showing the mechanism of the manœuvre. (BIGELOW.)

FIG. 144.



MacCormac's case of old obturator dislocation of the left hip.

likely to transform the dislocation into a posterior one; as outward rotation most surely prevents this change, surgeons appear now to prefer it. The directions given by Kocher,[1] and approvingly quoted by the German surgeons, are as follows:

1. Flexion of the thigh to a right angle with the pelvis, while preserving the abduction and outward rotation in which the limb is found. This leaves all parts of the capsule relaxed.

2. Traction, to make the posterior part of the capsule tense, and to bring the head nearer the socket.

3. Outward rotation, which, acting through the tense posterior portion of the capsule and outer branch of the Y-ligament, brings the head upward and backward into place.

Direct pressure or traction outward upon the upper part of the thigh has often proved a valuable aid, either by directly moving the head of the femur toward the socket or by furnishing a fulcrum by means of which the head could be moved in this direction by adducting the knee. One of Bigelow's procedures, for example, is to place the patient "in a

[1] Kocher: Volkmann's klin. Vorträge, No. 83.

sitting posture with a log, or post, or bedpost between his thighs, and pry the head outward over this fulcrum by means of the long shaft of the femur."

Kocher (loc. cit., p. 620) reduced a dislocation of four weeks' standing, which had resisted all other methods, by making continuous traction in the axis of the limb and combining with it elastic traction laterally on the upper part of the thigh. On the morning of the fourth day reduction was found quietly to have taken place.

In a case in which the dislocation had existed for twenty months and the disability was great (Fig. 144), MacCormac excised the head and trochanter with a good result. The patient was a sailor nineteen years old. For details of the case see Chap. XXVII.

2. *Perineal dislocations.*

The recorded cases of this form are not numerous. It is characterized by the presence of the head more superficially placed than in the obturator variety and displaced to a greater distance from the socket, so as even in one case to press upon the urethra and interfere with the voiding of the urine. In Taylor's case, quoted above in compound dislocations of the hip, page 403, the dislocation was made compound by a rent in the integument of the perineum nearly two inches long; and, possibly, Woodward's case, quoted in the same section, may be looked upon as an extreme form of this variety.

The cause appears to be extreme abduction of the limb, and this abduction is also a prominent symptom, the thigh being usually found at or nearly at a right angle with the body. Probably the capsule is widely torn, and thus may be explained the varying attitude of the limb in respect of inversion or eversion. In an autopsy reported by Shaw[1] not only was the capsule extensively detached at its inner and posterior insertion upon the acetabulum, but also the ilio-femoral ligament was partially separated from the neck of the femur, and a small rent extended from that point into the capsule.

Varick[2] reports a case of this kind, and speaks of the head as lying in the ischio-rectal fossa.

Theoretically it appears probable that reduction will be most readily effected by traction in the axis of the abducted limb and by direct pressure upon the head of the bone or upon the upper part of the shaft, anæsthesia being used to prevent opposition by the muscles. The extensive laceration of the capsule and ligaments would probably make purely manipulative methods ineffective.

Dislocations Upward and Forward, and Inward and Forward. Suprapubic.

I. *Iliopectineal.* II. *Pubic.* III. *Intrapelvic.*

In these dislocations the head of the femur comes to rest upon the superior ramus of the pubis, either at the iliopectineal eminence above

[1] Shaw: Trans. Path. Soc. London, 1859, vol. x. p. 211.
[2] Varick: N. Y. Med. Record, 1883, vol. xxiv. p. 38.

and a little to the inner side of its normal position (iliopectineal), or, more rarely, nearer the symphysis pubis (pubic). On the one side the dislocations merge into the supracotyloid, and on the other into the obturator. Many of the iliopectineal, in which the head has remained very close to and even a little under the anterior inferior spine of the ilium, have been described by their reporters and others under the name *supracotyloid*, and some writers describe the pubic variety as a variety of the obturator, or, rather, of a class to which they give the name *præglenoid* or *dislocations forward and inward*. Exceptionally the head may pass under or through Poupart's ligament and rest in the iliac fossa, the *intrapelvic* or *suprapectineal* dislocation.

The head of the bone may leave the socket at its upper and inner part, and in this case it appears probable that the head rests on the iliopectineal eminence, or it may leave it at a somewhat lower point and pass inward and forward toward the symphysis, or it may pass at first inward and downward across the obturator foramen while the limb is flexed, and then move upward to rest upon the upper and front surface of the superior ramus of the pubis as the limb is subsequently lowered. It is to be remembered that the upper border of the symphysis pubis is a little below the level of the centre of the cotyloid cavity in the upright position.

In correspondence with these differences in the position taken by the head are found differences in the mode of production, according as the head is moved more directly upward, upon the ilio-pectineal eminence, by hyperextension of the limb, or is first turned more directly forward by outward rotation and abduction and then, after rupture of the anterior and inner part of the capsule, is pressed upward or inward. Of the former there are a number of clinical examples in which the limb itself has been hyperextended, or, more commonly, the trunk has been violently pressed backward while the limb was fixed; thus, a man steps into a hole and falls backward; another, wrestling, is forcibly bent backward by his antagonist. Of the latter, outward rotation and abduction, the clinical instances are not so clear, but the possibility of the production in this manner has been fully proved by experiment upon the cadaver; a muscular woman,[1] carrying a keg of potatoes on her back, stumbled and, to avoid a fall forward, threw her body with a twisting movement backward; a man[2] while swimming made a vigorous thrust with his legs and felt a sharp pain in the groin; he was still able to walk, though with much difficulty, and on examination a dislocation upon the pubis was found.

Pathology.—The pathology has been shown by several autopsies in recent and old cases. Aubry[3] found the capsule torn along its anterior half near its insertion upon the acetabulum; the psoas and the crural nerve crossed the front of the neck; the head of the femur lay between the psoas and pectineus, raising the latter and the vessels; there was an interval of two centimetres between it and the anterior inferior spinous

[1] Albert: Chirurgie, vol. iv. p. 274. [2] Ure: Lancet, 1857, ii. p. 470.
[3] Aubrey: Bull. de la Société de Chirurgie, 1853, vol. iii. p. 377.

process of the ilium. Roser[1] found the rent in the front of the capsule extending from the anterior inferior spinous process down to the notch; the psoas and iliacus were pushed outward, and the vessels crossed the head; the small external rotators were drawn inward and pressed into the acetabulum by the great trochanter. Albert (loc. cit., p. 276) found the head resting against the outer side of the ilio-pectineal eminence and covered on its inner half by the psoas and iliacus; when it was pressed further upward the muscle lay across its neck. The ilio-pectineal fascia (the deeper part of the sheath of the vessels) was untorn, but nevertheless the artery was displaced outward by the head so that it rested across its centre and curved outward immediately below Poupart's ligament; the capsule was torn above and in front for about one-third of its circumference, the greater part of the ilio-femoral ligament being uninjured; the ligamentum teres was torn away at its insertion upon the head, and the cartilaginous rim of the acetabulum was entirely uninjured; the posterior rotators were relaxed. Kocher (loc. cit., p. 616) found the capsule torn along its anterior half close to its insertion upon the femur, the portion which remained attached to the acetabulum hanging as a flap between the head and the socket; the psoas and iliacus were stretched across the neck of the bone, and the vessels lay to the inner side of the head; the ligamentum teres was torn away near its attachment to the acetabulum, and the cartilaginous rim of the socket was uninjured.

In a case reported by Stokes[2] in which the head had passed over the brim into the pelvis, the superior ramus of the pubis had been fractured and much comminuted. The patient died on the table immediately after reduction, by pulmonary embolus, it was thought.

Two cases in which the dislocation was compound have been quoted in Chapter III., p. 39; in one of them the femoral vein was ruptured. In a case reported by Goldsmith[3] and also quoted in Chapter III., p. 35, in which the dislocation had remained unreduced for two months when the patient came under observation, there was found a diffused pulsating swelling occupying the iliac fossa and extending down to the middle of the thigh, which had appeared a few days after the accident; the external iliac artery was tied, and at the patient's death, five days later, the femoral and external iliac arteries were found to be perforated for the distance of an inch on their postero-external aspect, and the head of the femur lying in the cavity of the aneurism.

In one or two cases pressure upon the anterior crural nerve has been manifested by numbness in its area of distribution.

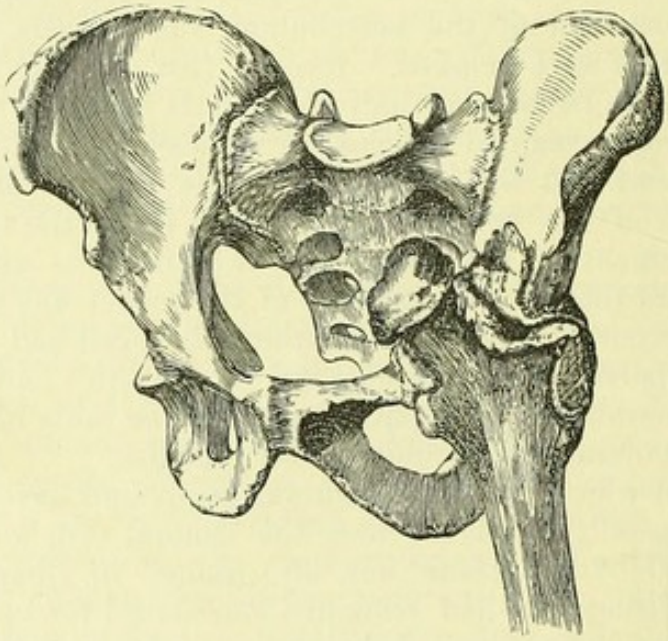
A case treated by Bransby Cooper[4] and examined after death at the end of three weeks is reported in detail, but it is not clear how much of the laceration of the muscles was due to the dislocation and how much to the repeated attempts to reduce it. The case is also entirely exceptional as regards the rent in the capsule, which is said to have occupied its posterior portion, "the anterior part, where crossed by the tendons of the

[1] Roser: Arch. für phys. Heilkünde, 1857, vol. i. p. 58.
[2] Stokes: Brit. Med. Journ., 1880, ii. p. 916.
[3] Goldsmith: Amer. Journ. Med. Sci., July, 1860, p. 30.
[4] Cooper: Loc. cit., p. 78, and Guy's Hosp. Reports, 1836, vol. i. p. 82.

psoas and iliacus muscles" being the only part not torn through, and I am unable to harmonize this statement with the reported position of the head of the femur in the groin on the inner side of the great vessels and above the internal circumflex artery.

In an old case examined by Sir Astley Cooper (loc. cit., p. 71) "the head of the thigh bone had torn up Poupart's ligament, so as to penetrate between it and the pubes. . . . Upon the pubes a new acetabulum is formed for the neck of the thigh bone, the head of the bone being above the level of the pubes (Fig. 145). . . . The femoral artery and vein were placed on its inner side, so that the head of the bone rested between the crural sheath and the anterior inferior spinous process of the ilium."

FIG. 145.



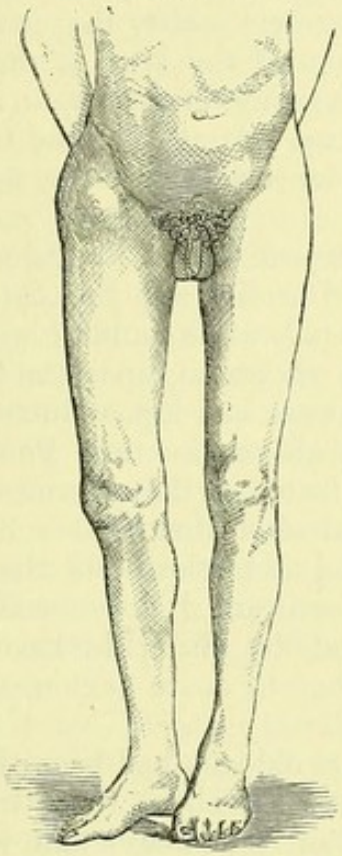
Old unreduced suprapubic dislocation of the hip. (COOPER.)

Verneuil,[1] in attempting to make reduction thirty-six hours after the accident in a patient eighty-one years old, fractured the neck of the femur. Four years later the patient died; the head was found lying in the notch between the anterior inferior spinous process and the ilio-pectineal eminence, between the psoas and rectus. While in another old case reported by Douglas[2] in which there was also a fracture of the neck of the femur the head was on the inner side of the vessels; the history of the case did not show when the fracture had been produced.

Symptoms.—The cases in which the head of the femur lies upon the ilio-pectineal eminence appear to be the more common, and this may, therefore, be taken as the typical form; in it the limb is but slightly, if at all, abducted, markedly everted, and somewhat shortened (Fig. 146), and the head of the femur can be felt more or less distinctly in the groin, with the artery pulsating directly in front of it or to its inner side. When

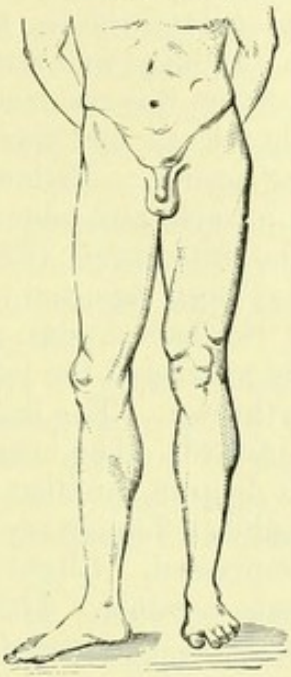
[1] Verneuil: Bull. de la Société de Chirurgie, 1870, vol. 11, p. 245.
[2] Douglas: Lond. and Edinb. Month. Journ. Med. Sci., 1843, vol. 3, p. 1064.

Fig. 146.



Ilio-pectineal dislocation. "The limb is usually a little more advanced and abducted." (Bigelow.)

Fig. 147.



Suprapubic dislocation. (Bigelow.)

the head is displaced further toward the median line the limb is abducted and flexed as well as everted (Fig. 147), and its position is more like that of an obturator dislocation; the capital difference is the position of the head on the pubis where it can be distinctly felt and perhaps even seen. The vessels lie on its outer side. In both forms the outer and posterior portions of the hip are flattened, and the trochanter can be felt covering the cavity of the acetabulum.

Adduction is difficult or impossible; abduction and flexion usually easy. Some patients have been able to walk immediately after the accident, but none appear to have done so so freely as some with obturator or supracotyloid dislocations.

These symptoms may be present in varying degrees, and, as in other dislocations, may be masked by the tilting of the pelvis. In measuring the length of the limb the same care must be taken to place the two limbs symmetrically, and this can, as a rule, only be done by flexing and abducting the sound limb; distinct shortening will then be found on measuring from the anterior superior spinous process or from the symphysis pubis. The attitude of the limb is like that found after fracture of the neck of the femur, and the differential diagnosis is made by attention to the presence of the head in the groin, the flattening of the outer aspect of the hip, and the depression of the trochanter.

Gosselin[1] reported a case in which suppuration near the groin ensued a few days after reduction, and death followed on the forty-third day; at the autopsy the abscess was found to communicate with the joint through the unhealed rent in the capsule.

[1] Gosselin: Gaz. des Hôpitaux, 1853, p. 516.

In a case reported by Rothe[1] the patient, a girl, fifteen years old, was unable to extend the leg upon the thigh three weeks after the accident, and the disability was attributed to overflexion of the knee at the time the dislocation was received. While pushing a swing forward she tripped, fell on her knee, and was then pressed backward to the ground by the returning swing. Reduction was made under chloroform by flexion, rotation inward, and adduction.

Of the *intrapelvic* (Scriba) or *suprapectineal* (Bartels) dislocation cases have been reported in detail by Scriba,[2] Bartels,[3] and Stokes (above quoted). Scriba's patient, a boy thirteen years old, while standing with his legs wide apart and the left one thrown back, was struck upon the breast and overthrown. The limb was flexed at the knee and hip, adducted and rotated inward. The head of the femur lay above the torn Poupart's ligament deep in the iliac fossa, and the neck rested on the superior ramus of the pubis. The artery, vein, and nerve crossed the head and were fully compressed. Slight inward rotation and adduction were the only movements possible. During manipulation outward rotation suddenly took place and persisted. Reduction was made by lifting the head with the fingers until it rested on the ramus, and then by acute flexion, adduction, inward rotation, and finally extension.

Bartel's patient was a man forty-seven years old who had been thrown down by a heavy weight. The limb was shortened about three inches, fully extended, parallel to the median line of the body, and widely rotated outward. The fold of the groin was obliterated by a diffuse swelling extending to the upper limit of the left hypogastrium; the head could be distinctly palpated through the abdominal wall, which it slightly raised; the great trochanter was directed backward and could not be felt. Flexion was impossible; inward rotation very limited.

Treatment.—The rule, of which the application is so general, that in attempting reduction the limb should first be placed in the position which it occupied when the dislocation occurred, is not suitable to those suprapubic dislocations in which the dislocation takes place while the limb is extended. Traction upon the fully extended, abducted, and everted limb has indeed been sometimes successful, but it has oftener failed and has led to various accidents. The method was early abandoned because of the risk of injury to the vessels by overstretching across the projecting head of the femur, and flexion was resorted to to diminish this risk and to remove what was thought to be the principal obstacle, tension of the psoas and iliacus. Of the six procedures given by Bigelow almost all include traction upon the flexed thigh and rotation inward; in some, direct pressure downward and outward upon the head of the bone or the upper part of the thigh is recommended, and outward rotation is mentioned in one as an equally good substitute for inward rotation.

Kocher's method is the same as one of those given by Bigelow, and I reproduce it here because of its more detailed account of the obstacles to be overcome and the means by which the manipulation accomplishes it.

[1] Rothe: Deutsche Klinik, 1868, p. 343.
[2] Scriba: Centralblatt für Chirurgie, 1879, p. 703.
[3] Bartels: Arch. für klin. Chir., vol. 16, p. 651.

Flexion relaxes the Y-ligament, but nevertheless by tightening the posterior part of the capsule it presses the head more firmly against the brim of the pelvis or even pushes it further upward under Poupart's ligament; it is therefore necessary that the movement should not be allowed to take place upon the head as a centre, but that the head should be enabled or forced to descend along the anterior surface of the pelvis as the knee is raised before the tightening of the posterior portion of the capsule has made this descent impossible. This can be effected by traction in the axis of the limb or by direct pressure downward and backward upon the head. The steps of the method, then, are:

1. Traction in the axis of the limb as it lies, in order to bring the head over the brim of the pelvis; it is rarely necessary to aid this by increasing the extension, abduction and outward rotation of the limb. By this means the posterior portion of the capsule is made tense, and its point of attachment to the back of the neck of the femur is thereby made the centre for the following movements:

2. Pressure with the hand upon the head of the femur to prevent its return upward during flexion. Sometimes this is sufficient to make reduction.

3. Flexion, in order to relax the Y-ligament; it should not be carried to a right angle, otherwise too much strain will be made upon the posterior portion of the capsule.

4. Rotation inward, by which the head is returned to the socket.

In cases in which the head lies nearer the symphysis abduction of the limb during traction is necessary to relax the Y-ligament and the untorn portion of the capsule and thus allow the head to approach the acetabulum; and in those, possibly rare, cases in which this position is secondary to a primary displacement downward and inward (obturator) the flexion will be seen to bring the head back to the obturator foramen, and then the final steps should be those suitable to that form of dislocation.

Dislocations Directly Upward. Subspinous (Bigelow). Supra-cotyloidea. Sus-cotyloidienne (Malgaigne).

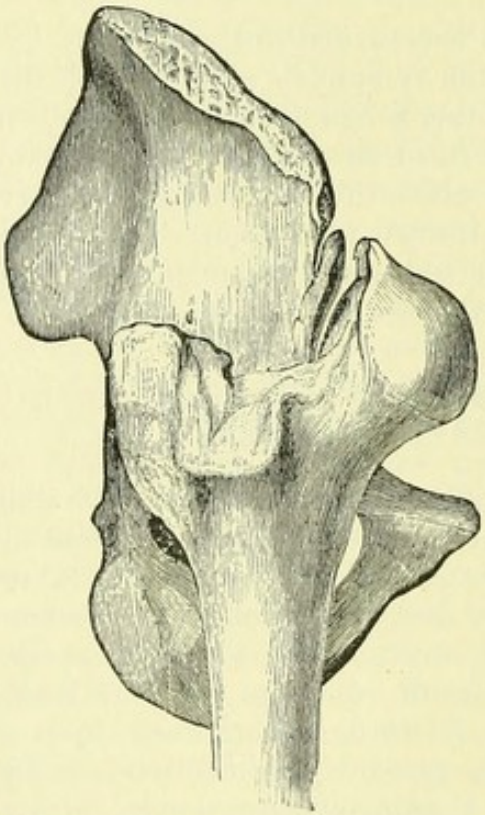
Concerning no other class of reported cases of dislocation of the hip is the uncertainty as to the nature and extent of the lesion, the point at which the head has left the socket, and the mode of production so great as in those in which the head is found more or less directly above the socket. As has been above said, Blasius grouped under one head—*supra-cotyloidea*—cases in which the head of the femur comes to rest above the socket either by secondary displacement forward and upward from a primary dorsal (the everted dorsal of the present classification), or by secondary displacement backward from a primary suprapubic, or by direct dislocation upward, and this grouping, which, while very proper in a monograph, seems to me objectionable in a systematic description of all the forms, has been accepted and followed by several of the later German writers, Albert, König, Lossen. Malgaigne included in his six alleged examples of displacement directly upward two (Cummins and the St. George's Hospital case) which I have placed among the everted dorsal. Bigelow groups Malgaigne's variety with those cases in which the head

lies further to the inner side (suprapubic), and makes them all a subvariety under the name *subspinous*. Hamilton makes no formal classification of them, but contents himself with citing a few cases, mainly as "anomalous dislocations," some as subspinous, others as supraspinous.

The incompleteness of many of the descriptions is such that the material for a positive opinion upon the character of the displacement is lacking, and such cases must, therefore, be passed by without definite classification, but there remain a few which sufficiently establish the existence of a variety in which the head is displaced directly upward toward or a little behind the anterior inferior spinous process of the ilium, a variety which presents important peculiarities in the symptoms and in the manipulations necessary to effect reduction. Although few in number, they are nevertheless numerous and distinct enough to justify their recognition as one of the regular dislocations, although a rare one, of the joint.

The cases in which the position of the head of the femur has been verified by autopsy are those of Wormald[1] and Gerdy,[2] and the doubtful ones of Cruveilhier,[3] Gély,[4] and Deville.[5] Wormald's patient was a man forty years old, who had received his injury at the age of fourteen, by a fall from a ladder, and had since had good use of the limb. The head of the femur lay between the edge of the acetabulum and the anterior inferior spinous process, and was surrounded by the capsule. The ligamentum teres was not ruptured. Gerdy's patient was caught in a revolving shaft, and whirled around by it many times; the injury was supposed to be a fracture of the neck of the femur, and its true character was only recognized when reduction took place during flexion of the limb. He died on the following day. The head of the femur lay on the outer third of the upper border of the acetabulum, below and just outside of the anterior inferior spinous process; the capsule was torn along the upper edge of the cavity, and the centre of the head was eight lines above that of the latter.

FIG. 148.



Gély's case of old supracotyloid dislocation. (MALGAIGNE.)

Cruveilhier's specimen was taken from the body of an old woman who was supposed to have a fracture of the neck of the femur. The head occupied a new cavity formed at the level of the anterior inferior spine, and including

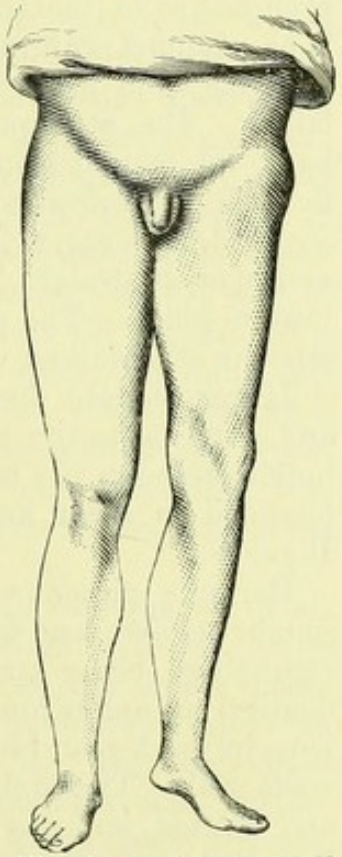
[1] Wormald: London Med. Gazette, 1837, vol. 19, p. 658.
[2] Gerdy, reported by Baron, Gaz. Médicale de Paris, 1838, p. 630.
[3] Cruveilhier: Bull. de la Soc. Anatomique, 1837, p. 164.
[4] Gély: Ibid., 1840, p. 303.
[5] Deville: Ibid., 1843, p. 264.

the upper part of the old one. The interpretation was disputed by Desprès, who thought the changes were not of traumatic origin.

In Gély's (Fig. 148) the injury was received a long time before death; the neck of the bone lay across the anterior inferior spinous process, and it was thought the weight of the body in walking was borne by the upper part of the capsule reinforced by the tendon of the rectus muscle.

Deville's specimen was taken from the body of a girl eighteen years old. The head of the femur was directly above the acetabulum, in the most anterior part of the external iliac fossa, immediately above the depression in which the reflected portion of the tendon of the rectus is inserted. The capsule was thick and distended, and formed an elongated sac, which separated the head from the fossa, and allowed the neck of the femur to support, by its aid, the weight of the body. No new cavity had formed in the fossa, and the acetabulum was almost completely filled with fat. The limb was everted and shortened six centimetres. There is reason to think this may have been a secondary displacement after a posterior dislocation.

FIG. 149.



Milner's case of supracotyloid dislocation.

Of the cases observed clinically those reported by Milner[1] and Barker[2] are given in the greatest detail and are the most satisfactory. The others are the cases of Barrier (quoted by Malgaigne), Cock,[3] and Mason,[4] and possibly also one observed by Hamilton, another by Allin (quoted by Hamilton), and a third reported by Tiffany.[5]

Milner's patient was a man twenty years old who was thrown down by a horse and fell upon his trochanter. There was severe pain in the hip for a short time, but he continued at his work and did not seek advice until a week later. He could then walk with a slight limp and very little pain, on the toes of his left foot, the heel when he stood upright being about an inch and a half from the ground. The legs were parallel to one another, and the foot was everted at an angle of 60°. The left leg was shortened one and one-eighth inches. The left hip was absolutely fixed, and the attempt to move it caused great pain. The left trochanter major was more prominent than the right (Fig. 149) and displaced upward and backward, its top being half an inch higher than that of the other; its distance from the anterior superior spinous process was the same as on the other side, the elevation compensating for the displacement backward. The distance from the centre of the symphysis pubis to the anterior edge of the trochanter was five-eighths of an inch greater than on the right side. The

[1] Milner: St. Barth. Hosp. Rep., 1874, vol. 10, p. 316.
[2] Barker: Lancet, 1877, ii. p. 455.
[3] Cock: Guy's Hosp. Reports, 1855, I. p. 282.
[4] Mason: Reported by Hamilton, loc. cit., p. 785.
[5] Tiffany: Maryland Med. Journ., 1883–84, vol. 10, p. 525.

head of the femur could not be felt, nor was there any swelling to indicate its presence, except that the femoral artery seemed to be rather more superficial on the left than on the right side. There was also a slight general fulness in the groin. On turning the patient on his face a hollow was observed behind the great trochanter. The distance from the spinous processes of the vertebræ (sacral) to the posterior edge of the great trochanter was nearly an inch more on the left than on the right side. No crepitus could be felt.

The patient having been put under chloroform, an attempt was made by Mr. Savory to reduce the dislocation by manipulation, but it was found impossible to flex the thigh upon the abdomen. After a trial of traction by the pulleys, manipulation was again resorted to; there was much more freedom of movement, and when flexion, adduction, and rotation outward were made the head of the bone could be distinctly felt to move from its position. It seemed as if it worked around the outer rim of the acetabulum. This, when the limb was straightened, did away with the shortening, but rotation inward was still impossible and the prominence of the trochanter remained. On further manipulation the bone resumed its former position. This was repeated four times. Traction was then made with the thigh flexed at a right angle, and it also failed. The attempt was then temporarily abandoned. Eleven days later, the patient being again under chloroform, Mr. Savory followed the formula of Professor Busch, viz: "Abduct the thigh, rotate it somewhat outward, and carry it into hyperextension, then rapidly rotate inward, and place it straight." At the second attempt the bone passed noiselessly into its place. The patient made a good recovery, although three months later he still walked with a slight limp.

It was thought that the head of the bone, while displaced, "was below and external to the anterior inferior spine of the ilium, resting in the hollow between the latter and the projecting rim of the acetabulum, and bounded in front and strapped down by the Y-shaped ligament of Bigelow."

Barker's patient was a boy nine years old who, six days before he sought advice, had fallen while trying to jump on another's back, his right thigh being strongly abducted and somewhat flexed, and his left doubled up under him as he fell on his nates. After the fall he felt some pain in the hip and his mother noticed the deformity, but he was able to walk well. The right thigh was strongly abducted and slightly flexed and everted, and was immovable; the region of the great trochanter was flattened, and the fold of the nates obliterated. Two carefully made, independent measurements showed shortening of from one-quarter to one-half an inch. The adductor longus was very tense. The head of the femur could not be felt, but it was clearly not in the thyroid foramen or on the pubis. After chloroform had been administered the thigh became freely movable, and an attempt was made and repeated to reduce by the manipulation commonly used in dorsal dislocations, adduction, flexion, circumduction, and outward rotation, but both failed. He then "drew the limb gently downward in its long axis, and again adducted, flexed, and then circumducted the thigh as before, downward traction being kept up all the time on the head, but this time rotated the thigh *inward*.

This effort was perfectly successful, but as reduction was effected without the slightest start or jerk of the bone as it returned to the socket, the fact was not apparent for a moment or two, when I noticed that the limb was of its normal length and now lay flat on the table like its fellow. The usual prominence of the trochanter was now well marked, as also the fold of the nates, and all the motions of the limb were perfectly restored. The obliquity of the pelvis had completely disappeared, and measurement showed the two limbs now equal in length. The trochanter had also come forward again, as indicated by its relation to the apex of the well-known triangle drawn with pen and ink before any attempt at reduction had been made. After reduction the tip of the trochanter was considerably anterior to the apex of the triangle to which it had previously corresponded."

His opinion was "that the head of the femur was forced directly upward, and lay just below, and a little outside of, the anterior inferior spinous process of the ilium, and immediately above, or upon, the brim of the acetabulum."

Hamilton's case I consider doubtful because the brief description would apply equally well to a dislocation downward upon the obturator foramen, except for the shortening of half an inch, and that is a point upon which the possibility of an error of observation is great; thus Malgaigne (loc. cit., p. 843, note) mentions a case reported by two surgeons, one of whom found shortening of half an inch while the other found lengthening to the same extent. Hamilton's patient was thrown backward while wrestling, and on rising found his thigh moderately abducted; he was able to walk with a limp. Three years later he jumped from his wagon, felt a snap in the joint, and found he could walk without pain or limping and could bring his knees together. Three months later, while carrying a heavy weight up-stairs, his foot slipped and the dislocation was reproduced. When seen by Hamilton fifteen years later the limb was moderately abducted and everted, and all the motions of the joint were restricted.

Of Mason's case it is said the limb was shortened one-quarter of an inch, strongly everted, parallel with the other, and slightly flexed. The head of the femur could be seen and felt a little below and to the inside of the anterior superior (*sic*) spinous process. The trochanter major was turned back, and there was a deep depression over it. The limb could be slightly adducted, but in all other respects it was immovable. After several ineffectual attempts at reduction under ether it was finally reduced by simple extension (traction). As the shortening was so slight I think it may properly be assumed that the above is a misprint for anterior *inferior* spinous process, and then the case would closely resemble the others, except that the head was on the inner side of the process.

Similar statements, containing the same possible error, are made by Hamilton about Allin's case—namely, shortening of half an inch, and the head directly below the anterior superior spinous process. The limb was everted, slightly flexed, and nearly parallel with the other; it could be adducted quite freely, but motion in other directions was more limited. After the failure of several attempts by manipulation and traction with

the pulleys the dislocation was finally reduced, after the sudden release of forcible traction, by slight flexion and rotation inward.

These cases seem sufficient to prove the occurrence of a dislocation upward in which the head moves but a short distance from its normal position and lies close against the upper brim of the acetabulum, resting presumably against the untorn tendon of the rectus muscle, and probably not associated with much laceration of the capsule, for the persistence of the immobility of the limb under anæsthesia indicates a ligamentous rather than a muscular cause. In Bigelow's experimental reproduction of this form the head of the bone appears always to have been thrown to the inner side of the inferior spinous process, and he treats of the variety in common with the suprapubic dislocations. The observation of other cases in which the head lies to the outer side of the process makes a clear distinction between the two forms necessary.

The diagnosis, as the histories plainly show, is beset with difficulties. Some of the patients were able to walk so easily and with so little pain after the accident that so serious an injury would not have been suspected; and in others the eversion, shortening, and absence of the head of the femur from the pubis would very naturally have led, as in some cases they did, to the diagnosis of fracture of the neck. An additional difficulty lies in the inability in some cases to recognize the position of the head of the bone; these are the ones in which the patient was able to walk, and in which, therefore, there would be no probability of fracture, and the diagnosis of dislocation would be made on the abduction, eversion, shortening, and fixation of the limb.

The histories throw no clear light upon the mode of production; the cause has usually been a fall, but the attitude of the leg and the direction of the violence are not known. In the cases in which the patients have been able to walk immediately after the accident it seems probable that the head was displaced by a force acting upon the upper end of the shaft to press it forward while the joint was partly flexed. In those cases in which the upper part of the capsule is torn in front the head may have been forced out by hyperextension.

Dislocation Downward upon the Tuberosity of the Ischium —Infracotyloid.

In this form of dislocation the head escapes over the lower edge of the socket and rests just below it upon the outer surface of the body of the ischium. The reported cases are very few, but it seems probable that the dislocation is much more frequent as a primary, transitory, one leading to either a dorsal or an obturator dislocation, being converted into the former by inward rotation and adduction, or into the latter by outward rotation and abduction; and, furthermore, some of the cases have probably been reported as obturator dislocations, for the dividing line between them is somewhat arbitrary; thus, Keate's case, referred to above in the paragraph on the causes of obturator dislocations, is quoted by Malgaigne as a subcotyloid dislocation. The form was first described by Bonn in 1800 (quoted by Lossen), and again by Ollivier.[1]

[1] Ollivier: Arch. gén. de Méd., 1823, vol. 3, p. 505.

The cause is the same as that of many dorsal and obturator dislocations, namely, forcible flexion of the thigh, but exaggerated abduction followed by slighter flexion appears also to be capable of producing it. Thus, in a case reported by Roux[1] the patient fell with his right leg in a hole; the left one remained stretched out on the ground in abduction and was dislocated; and Ollivier's patient, a man, seventy-two years old, was knocked down by a branch of a falling tree which struck against the lower inner part of his right thigh and forcibly abducted it. Pitha (loc. cit., p. 163) speaks of a case in which the dislocation was caused by the forcible bending of the body backward, but, as Albert points out, not only is his description of the symptoms unintelligible, but it also does not appear how a rent in the lower part of the capsule could be produced in this way. He describes the supracotyloid and infracotyloid together as "vertical dislocations," and possibly has placed this case in the wrong paragraph.

The only autopsy is one reported by Luke;[2] the patient, a man, fifty years old, died in consequence of associated injuries; the dislocation, which had been easily reduced, was reproduced at the autopsy, and as the bone could be made to take no other position it was thought that the reproduction was exact. The head of the femur was situated "midway between the ischial notch and the thyroid hole, immediately beneath the lower border of the acetabulum;" the gemellus inferior and quadratus femoris had been torn, and the ligamentum teres completely detached; the capsule was torn in its lower part.

Experiment upon the cadaver shows that the Y-ligament remains untorn and compels flexion of the thigh upon the pelvis which, however, may be masked, as in other forms, by inclination of the pelvis. The retention of the head upon the tuberosity is due to the narrowness of the rent in the capsule and to the support given by the untorn portions, and as the laceration can be easily extended on either side the easy transformation into a dorsal or obturator dislocation is intelligible.

FIG. 150.



Infracotyloid dislocation. (BIGELOW)

The flexion may be even to a right angle (Fig. 150), Ollivier's patient was brought to the hospital seated in a chair; the limb is more or less abducted, and may be slightly inverted or everted. Measurement in Ollivier's case, when the other thigh was brought into a similar position, showed no difference in length, and by the lengthening which has been noted in other cases was probably meant only an apparent elongation due to the abduction and the consequent inclination of the pelvis. The buttock appears rounded and more prominent, especially when looked at from below when the patient is lying on his back with both thighs flexed, and the adductors of the thigh and the flexors of the leg are very prominent at the upper part. The great trochanter is further

[1] Knox: Revue Médico-chirurgicale, 1849, vol. 5, p. 364.
[2] Luke: Med. Times and Gaz., 1858, i. p. 12.

from the crest of the ilium, and the head of the femur can sometimes, but rarely, be felt in its new position.

Movements of the limb are restricted and more or less painful; flexion to a right angle is usually possible, abduction comparatively free, adduction limited; but in Roux's case the thigh could be carried across the other one. Both of Gurney's[1] patients could walk fairly well immediately after the accident, and Roux's could walk a little at first but was soon completely disabled by the pain.

Reduction has always been easy (Roux was unsuccessful on the thirty-fifth day with the aid of chloroform) and has usually been effected by traction in the axis of the limb, with or without direct pressure upon the head of the bone; sometimes the dislocation has been first transformed into a dorsal or obturator and then reduced.

A suitable method would be: Flexion, if not already present; traction; correction of the existing rotation, if any; to be aided by direct pressure upon the head of the femur from behind.[2]

Dislocation into the pelvis through the fractured floor of the acetabulum has been described in Fractures, p. 479. A brief reference is made by Kronlein[3] to a unique case observed by him in which, by a fall upon the feet, the head of each femur was driven through the floor of the acetabulum.

[1] Gurney: Lancet, 1845, vol. 3, p. 412.

[2] A paper by Chapplain in the Bulletins de la Société de Chirurgie, 1874, p. 461, containing a detailed report of a case observed by himself and an analysis of several others, may be advantageously consulted by those especially interested in the subject.

[3] Krönlein: Deutsche Chirurgie, Lief. 26, p. 25.

CHAPTER XXVII.

DISLOCATIONS OF THE HIP.—(*Continued.*)

COMPLICATIONS. DOUBLE DISLOCATIONS. ACCIDENTS IN REDUCTION. PROGNOSIS AND AFTER-TREATMENT. TREATMENT OF OLD DISLOCATIONS. CONGENITAL DISLOCATIONS. PATHOLOGICAL DISLOCATIONS.

Complications of Dislocations of the Hip.

Among the complications of dislocations of the hip are unusually extensive injuries to the soft parts, rupture of, or dangerous pressure upon, large nerves and bloodvessels, and fracture of bones. Mention has been made of all in connection with the different varieties of dislocation, and it is necessary only to group and briefly summarize them.

Rupture or laceration of the muscles about the joint is doubtless present in some degree in all cases, and is rarely so extensive as to deserve to be looked upon as a complication. In the dorsal dislocations the head of the femur may be so far displaced that the gluteus medius, and even the gluteus maximus may be in part ruptured, and in the thyroid dislocations the adductors may be extensively torn from the inferior ramus of the pubis and the adjoining part of the ischium, as observed in Taylor's compound case above quoted. In the suprapubic form the pectineus may be torn, and in the extreme variety known as "intrapelvic," in which Poupart's ligament is ruptured, the attached muscles forming the anterior wall of the abdomen must also suffer some injury. The extension of the bruising and laceration of course increases the shock and inflammatory reaction, but calls for no special treatment beyond a more rigid and prolonged confinement to bed, and avoidance of movement.

For *compound dislocations* see Chapter XXV.

Rupture or injury of the femoral vessels has been observed only in suprapubic and obturator dislocations. The suprapubic ones are those of a German military surgeon (*Centralblatt für Chirurgie*, 1880, p. 504) and Goldsmith (*American Journal Med. Sciences*, July, 1860, p. 30), both quoted in Chapter III.; the obturator case is that of Duboué (*Bull. de la Soc. Anatomie*, 1858, p. 496). In the first mentioned the femoral vein was torn across and the patient died promptly; in Goldsmith's an aneurism involving the external iliac and femoral arteries formed, and was treated two months after the accident by ligature of the external iliac; the patient died. In Duboué's case there was also fracture of the pelvis at the junction of the ilium and pubis, but without displacement; the head of the femur rested upon the ischio-pubic branch of the pelvis rather below than upon the obturator externus; the femoral vein was torn. The patient died.

The *sciatic nerve* in the autopsy of one dorsal dislocation[1] has been found stretched across the front of the neck of the femur, and in several dislocations produced experimentally upon the cadaver it has been found in the same position, but the only recorded instance within my knowledge in which symptoms of injury to it have been present is a case reported by Jonathan Hutchinson[2] in which the muscles supplied by it were paralyzed and remained so at the time of the report several months after the accident.

In a case of dorsal dislocation reported by Syme[3] the bladder was ruptured, but there was also a fracture of the opposite side of the pelvis to which this complication is probably to be referred.

Associated *fractures* of the head, neck, and shaft of the femur, of the rim and floor of the acetabulum, and of different parts of the pelvis have been reported.

Fracture of the *head of the femur* has been reported in three cases of dorsal dislocation. In two of these (Birkett, quoted in Chapter III., p. 31, and Moxon, quoted in Chapter XXV., compound dislocations) the head was split vertically, and the inner half remained in the cotyloid cavity still attached to the ligamentum teres. In the remaining case (Riedel, quoted in Chapter III., p. 32) the head and neck were split longitudinally, both fragments being displaced from the socket, and the upper and posterior portion of the rim of the acetabulum being also crushed.

Fracture of the *neck of the femur* occurring coincidently with the dislocation or subsequently during an attempt to reduce has been observed a number of times. Wippermann[4] reported one case and collected thirteen others of which he gives abstracts, but his list includes one case (*Hervez de Chegoire*) which was probably a simple fracture without dislocation, and Birkett's, above mentioned, in which the fracture was of the head, and does not include a number of other reported cases; thus, Hamilton quotes no less than twelve cases in which fracture was caused during an attempt to reduce, and of these Wippermann's paper contains only one. The only cases of which I have knowledge in which the neck appears certainly to have been broken at the moment of dislocation are one reported by Tunnecliff,[5] one by Post[6] in which both hips were dislocated, and one by Lossen,[7] and even in the latter the patient was not seen by the reporter until six weeks after the accident; the patient, an old man, was standing on a ladder when it fell, he struck upon his feet and then, with the injured side, against the underlying ladder, and Lossen supposed the dislocation to have been produced by the second blow. The dislocation was dorsal.

Tunnecliff's patient was a man thirty years old who was struck on the left shoulder by a falling tree and crushed to the earth, his feet being

[1] Quain: Medico-Chir. Trans., 1848, vol. 31, p. 337.
[2] Hutchinson: Med. Times and Gazette, 1866, I. p. 194.
[3] Syme: London and Edinburgh Monthly Journal, 1843, vol. 3, p. 498.
[4] Wippermann: Arch. für klin. Chirurgie, vol. 32, p. 440.
[5] Tunnecliff: Amer. Journ. Med. Sci., 1868, vol. 56, p. 123.
[6] Post: N. Y. Med. Record, 1878, vol. 13, p. 366.
[7] Lossen: Deutsche Chirurgie, Lief. 65, p. 55.

driven through the ice on which he was standing. As he fell his body inclined to the right, and the right trochanter major struck with great force on the ice. The surgeons found "dislocation of the right femur into the ischiatic notch with fracture. The exact point and line of fracture they could not determine. The limb was shortened one and a half inch. The right knee was inclined to take position toward its fellow and above it. The right foot was inverted, and pointed to the ankle of the left foot. The limb was quite movable. Rotation, abduction, adduction, or even extension could be readily made, and with but little pain. Crepitus was distinctly felt. Luxation was evident, for the head of the bone could be distinctly felt in the ischiatic notch, and yet by extension the foot could, with facility, be brought down to the side of its fellow, and when the force was withdrawn it readily took the position first described. The right trochanter was about one and one-half inch above the level of the left, and when the limb was rotated while in a quiescent state the head of the bone could be distinctly felt rotating in unison with it." No attempt to reduce.

When Dr. Tunnecliff saw the patient a month later he was inclined to doubt the existence of a fracture, but felt forced to accept the evidence as conclusive. He found "the same shortening and oblique position of the limb as described above." On the thirty-eighth day after the accident reduction was effected by free manipulation to break up the adhesions, followed by flexion and abduction with direct pressure on the head; the bone returned to the socket with an audible snap, but as crepitus was felt it was thought that the union of the fracture had been destroyed. Five weeks later the patient "could walk with one crutch, and measurement showed but half an inch shortening of the limb. He has progressed favorably since that time."

Post's patient was a girl thirteen years old who, six months before admission, had received a blow upon the back with "a twisting of the body to the right and the lower extremities to the left." Both hips were dislocated, and there was also fracture of the neck of the left femur, the head of which had become necrosed; a sinus communicated with it as it lay on the dorsum ilii. The head was removed through an incision, and the limb straightened. The right dislocation was reduced by manipulation, and the patient became able to walk with crutches, the function of the right limb being fully restored, the left being shortened four and one-half inches.

Two cases in which the neck of the femur was broken during an attempt to reduce while the dislocation was still recent may be considered in connection with the preceding; they are Verneuil's, quoted in the preceding chapter, and Lisfranc's. In both the dislocation was suprapubic. Verneuil's patient was eighty-one years old, and the fracture took place while he was flexing, abducting, and rotating inward with only moderate force; union failed.

Lisfranc's case is quoted by Wippermann; the patient was seventy years old; the head of the femur lay on the superior ramus of the pubis, pressing the artery inward and somewhat raising it. Reduction was attempted by traction by ten assistants; "suddenly a crack was heard in

the joint, the tumor in the groin disappeared (?), and the positive signs of a fracture of the neck of the femur appeared."

Possibly reduction might be effected by direct pressure upon the head under anæsthesia, as was done in Cooke's case of obturator dislocation with fracture below the trochanter, and I think it should be tried; if it fails, the practice followed in Tunnecliff's case seems judicious; to await consolidation, and then to attempt reduction. The alternatives would be to seek a pseudarthrosis at the seat of fracture, or to correct the flexion and adduction of the limb (in a dorsal dislocation), and seek union with a view to the formation of a new socket for the head on the ilium.

Necrosis of the head followed in one case of coincident fracture (Post), and in two cases of fracture during an attempt to reduce an old dislocation (Czerny, reported by Wippermann, and Bryck[1]), and it seems that the same complication would be more likely to follow in either of the two last-named alternatives than in the plan followed in Tunnecliff's case, for the vitality of the head would be preserved, if at all, only through the integrity of the vessels in the untorn portion of periosteum uniting it with the shaft, and the correction of the attitude of the limb, or the manipulations necessary to secure a pseudarthrosis might easily obstruct these vessels, or rupture the remaining strip of periosteum.

Fracture of the shaft of the femur, occurring coincidently with its dislocation, has been observed a few times. Hamilton collected four cases, those of Bloxham, 1833, Thornhill, 1836, Etéve, 1838, and Markoe, 1853, in all of which it is claimed that reduction was effected. He rejects Thornhill's claim as "altogether incredible," and doubts if a dislocation existed in Markoe's. In Bloxham's and Etéve's the fracture was near the middle of the shaft, in Thornhill's in its upper third, and in Markoe's the site is not mentioned. In Bloxham's the dislocation was on the pubis, and was reduced on the seventh or eighth day by traction with pulleys, the limb having been secured with splints, and by direct pressure on the head of the bone. In Etéve's the dislocation was backward, and reduction was effected by making slight traction upon the upper part of the flexed thigh, and by direct pressure on the head of the bone.

To these may be added Cooke's case of obturator dislocation with fracture just below the trochanter, quoted in Chapter XXVI., Cooper's of dorsal dislocation with fracture at the middle of the shaft, and Delagarde's of backward dislocation with double fracture of the shaft. Cooke's patient was nine years old, and reduction was easily effected by direct pressure on the head. Cooper's[2] patient was a lad sixteen or eighteen years old; "as the reduction of the hip was, of course, impracticable," union of the fracture was alone sought at first, and after five weeks, the bone appearing tolerably firm, careful extension by pulleys was made for half an hour, and was successful. He also quotes (loc. cit., p. 41) another case in which reduction was not made.

In Delagarde's[3] case the dislocation was backward, and the shaft was broken in two places. The dislocation remained unreduced, and the head was subsequently excised.

[1] Bryck: Archiv für klin. Chirurgie, 1873, vol. 15, p. 279.
[2] Cooper: Dis. and Fracts., Amer. ed., 1844, p. 40
[3] Delagarde: St. Barth. Hosp. Reports, 1866, vol. 2, p. 183.

It would certainly be injudicious, and probably ineffectual, to attempt to reduce by traction, but it seems advisable to try direct pressure upon the upper fragment, under anæsthesia, in recent cases, rather than to await consolidation of the fracture, and during the attempt the limb should be placed in the position in which, if the bone were unbroken, the Y-ligament would be relaxed, for it is probable that the upper fragment will share in the movements of the limb.

For *fractures of the floor and brim of the acetabulum*, see Fractures, pp. 479 and 486.

Associated *fracture of the pelvis*, usually of the rami of the pubis and ischium, and sometimes extending into the acetabulum, has been reported. It has always been caused by great violence acting directly upon the patient, and has usually been combined with other injuries which have proved fatal. Illustrative cases have been quoted in the preceding chapters. In Stokes's case of suprapubic (intrapelvic) dislocation, in which the superior ramus of the pubis was broken, the patient died upon the table after reduction, in consequence, it was thought, of pulmonary embolism.

Detachment of the labrum cartilagineum.—Zinner[1] reports a case of dorsal dislocation complicated by a double vertical fracture of the pelvis extending from the pectineal eminence through the margin of the acetabulum to the tuber ischii and through the inner border of the inferior ramus of the pubis, and by detachment of the labrum cartilagineum; the latter was entirely torn away, with the exception of a small piece at its upper outer part, and, with its ends twisted about each other, was wedged between the outer margin of the acetabulum and the neck of the femur and prevented reduction. The ligamentum teres was torn from the acetabulum and remained attached to the head of the femur and to the labrum.

Simultaneous dislocation of both hips has been reported in twenty cases (see Chapter XXV.). Usually the dislocation is not the same on both sides, but if backward upon the ilium in one it is forward upon the obturator foramen or upon the pubis in the other. The common cause is a heavy blow received upon the back or side while the patient is bending forward, by which he is twisted to one side, so that one thigh is abducted and the other adducted. Of this mode of production Boisnot's[2] case is a good example: a bale of goods fell upon a powerful man, forty years old, striking him upon the left side of the head and neck, and bending him to the right, and caused a dorsal dislocation on the left side, and a suprapubic one on the right. In Barker's case, quoted in Chapter XXVI., both dislocations were obturator, and were caused by a fall from a height of about thirty feet upon a sand bank, the patient striking upon his feet, and having them widely separated. In Schinzinger's[3] case, dorsal on one side, and suprapubic on the other, it was thought the latter might have been caused by the efforts of the bystanders to drag the patient from under the bank of earth that had fallen upon him.

[1] Zinner: Zeitschrift für Heilkunde, vol. 8, p. 121; abstract in Centralblatt für Chir., 1888, p. 55.

[2] Boisnot: Am. Journ. Med. Sci., Oct. 1867, p. 396.

[3] Schinzinger: Wiener med Presse, 1880, quoted by Krönlein.

Simultaneous dislocations of the *left hip* backward and of the *right knee* forward and upward were reported by Brittain, in the *London Medical Gazette*, 1836, vol. xviii. p. 257; and of the *knee* and *hip of the same side* by Hulke, in the *British Medical Journal*, 1883, ii. p. 1.

Accidents caused by attempts to reduce.

Before the use of ether and chloroform to obtain anæsthesia, and the general substitution of milder methods in the place of forcible traction by pulleys, it was not rare for severe inflammatory reaction, and even suppuration, to follow reduction or the attempt to reduce, or for the patient to die in consequence of the shock and exhaustion produced by the efforts of the surgeon. Cooper (loc. cit., p. 33) says "there are plenty of cases on record of fatal abscesses from violent attempts at the reduction of dislocated hips." Such consequences are now extremely rare, but, even when forcible traction or other violent manipulations have not been employed, they must still be expected occasionally to occur as the result in part at least of the original traumatism.

Fracture of the neck or even of the shaft of the femur has been caused in a large number of cases by the surgeon in his efforts to reduce, either by forcible traction or by manipulation. Although in modern methods but little force, comparatively, is applied by the surgeon, yet it must be remembered that that force is habitually applied on the long arm of a lever of which the neck of the femur is the short arm, and the fracturing strain upon the latter is thereby greatly augmented. The fracture, apparently, takes place more frequently during rotation or abduction than during flexion of the limb. In most of the reported cases the account is limited to the circumstances attending the fracture, and no mention is made of the subsequent course of the case. Of the 14 cases collected by Wippermann (*vide supra*), including also the one in which the fracture occurred simultaneously with the dislocation and another in which it probably did, the final result is indicated in 9; of these consolidation of the fracture took place in 3 and failed in 6, and in two of the latter (Czerny, Bryck) in both of which the fracture was secondary and through the narrow part of the neck an abscess formed from which the necrotic head of the femur was subsequently removed. In consideration of the last two cases Wippermann advises that excision of the head of the femur should be immediately done in cases in which a fracture of the narrow part of the neck has been caused in an attempt to reduce an old dislocation; if the fracture is at the base of the neck, "extracapsular," he thinks union should be sought.

Fractures produced during moderate manipulation in recent cases should be treated in accordance with the considerations affecting the treatment of simultaneous fracture and dislocation.

In Stokes's fatal case of suprapubic dislocation, in which death was attributed to pulmonary embolus, it is impossible to say whether the fatal result was due to the traumatism or to the reduction. If it was due to pulmonary embolus the clot must have formed before reduction was attempted, and the latter could only have caused its detachment.

In a case of fresh dorsal dislocation that came under my care in Bellevue

Hospital in 1886, death occurred half an hour after reduction by manipulation without anæsthesia. The patient was a muscular young man, a worker in a brewery, and the dislocation was caused by a fall from a wagon. He was brought to the hospital within an hour after the accident, and presented marked symptoms of shock—restlessness, sighing, cool surface, small pulse. I placed him at once on his face on a table so that the injured limb hung down at the end, and immediately reduced the dislocation by making slight pressure with the fingers of one hand in the ham, while with the other hand the foot was held so as to flex the knee at a right angle and rotate the thigh. He was then placed in bed, and died quietly half an hour later. An autopsy was not permitted.

Prognosis and after-treatment.

The prognosis after reduction in uncomplicated cases is favorable, the patients usually regaining good use of the limb. The inflammatory reaction is usually slight, and other treatment than rest in bed for two or three weeks is rarely required. Occasionally there is a tendency to recurrence which needs to be combated either by slight permanent traction upon the limb or by keeping it in an attitude that is unfavorable to recurrence, extension, abduction, and outward rotation after a dorsal dislocation.

If reduction is not made the patient will be permanently crippled to a greater or less degree. Usually a new articular socket is formed by bony outgrowths about the head which permits some motion, and the principal disability is due to the attitude of the limb, to its lack of parallelism with the other, and to the necessity of tilting the pelvis and curving the spine in order to bring the foot to the ground; but in a few cases patients have also suffered from persistent pain aggravated by use, and even from numbness or paralysis due to pressure on a nerve.

In the dorsal dislocations the attitude of the limb, flexion and adduction, adds considerably to the actual shortening, and the patient may be unable to walk without crutches or a support attached to the sole of the shoe. In unreduced suprapubic, supracotyloid, and obturator dislocations the attitude is less faulty and in a number of cases the limb has been very serviceable.

Habitual dislocations.—A considerable number of cases have been reported in which the hip could be voluntarily dislocated by muscular contraction or by slight pressure upon the foot when the limb was placed in a certain attitude, or in which the dislocation recurred involuntarily during use of the limb. Perier[1] collected fifteen cases, more or less authentic, including one observed by himself and exhibited to the Société de Chirurgie, and Hamilton nine additional ones. In some the peculiarity clearly followed a primary traumatic dislocation, in others it was the consequence of congenital or acquired alterations in the constituent parts of the joint. Only the former will be here considered, the latter belonging more strictly in the class of spontaneous or pathological dislocations.

[1] Perier: Bull. de la Soc. de Chir., 1859 vol. 10, p. 12.

The two most satisfactory examples are one observed by Bigelow[1] and another quoted by him from a report furnished by Dr. E. M. Moore; both were dorsal. In Bigelow's case "the hip was dislocated while the legs were crossed, a wagon in which the man was riding having pitched into a hole. In a few hours the hip was reduced by flexion. Eight days after the accident, in attempting to walk upon the limb, it was again partially luxated, when the patient himself replaced it by pushing against it with one hand and pressing with the other against his knee. Since that time both luxation and reduction have been comparatively easy, and the patient now displaces the head of the bone backward upon the edge of the socket by muscular action, and reduces it by throwing the leg out sidewise. The luxation is sometimes attended with pain, and the prominence caused by the head of the luxated bone is sensitive to the touch. The displacement is rather a subluxation, and the limb exhibits slight flexion, shortening, and inversion."

Dr. Moore's patient was a soldier, who, while "skirmishing up a hill, sprang back suddenly to avoid the gun of a comrade in advance. His left foot became entangled, and his weight dislocated his hip. He felt the injury, and supposed it out of joint. Some comrades pulled it in. He immediately resumed his skirmishing, and marched seven miles, from 10 A.M. until 6 P.M. He lay down at night, and went on duty the next day, sharp-shooting, crawling all day. He continued this kind of duty five days, and returned to camp, when he was immediately put in intrenchments, and worked two days and two nights. Afterward he went on picket, and entered the hospital on the sixteenth day after the accident. At present he can luxate the hip-joint at any time, and does it by pressing the foot on the floor to fix it firmly, contracting the adductors, and throwing out the pelvis. The head suddenly leaves the acetabulum and goes on the dorsum ilii."

As no autopsy has been reported in any such case, the explanation of the peculiarity can only be inferred. It is probable that the rent in the capsule is insufficiently repaired, and the edge of the acetabulum lowered at the point where the head of the femur escapes. There is no record of any attempt made to correct the condition, unless a case reported by Bigelow (loc. cit., p. 55) may be included in this class: the patient was a woman twenty-seven years old, with a dorsal dislocation, which had been reduced by manipulation after it had existed for several months. When seen by Bigelow, sixteen days after reduction, the bone had again become displaced. "By forcible flexion, abduction, and eversion I brought the head of the bone into the socket with a snap, but when the limb was again extended a very slight inversion sufficed to reproduce the dislocation; in fact, the limb could not be trusted to itself. After the bone had thus repeatedly slipped out, the patient was placed in bed on her back, and the dislocation again reduced by flexion, abduction, and eversion, which brought the flexed thigh and knee down to the mattress on their outer side. The knee was then tied to the bedstead in this position by a towel, and the foot secured to the knee of the sound side until the socket

[1] Bigelow: The Hip, p. 112.

should be excavated by absorption. In two weeks she was allowed to sit up, and in two weeks more was discharged well."

Treatment of Old, Unreduced Dislocations.

There is the same uncertainty in old dislocations of the hip as in those of other joints, as to the length of time after which reduction should not be attempted. Cases have been reported in which reduction has been effected after the lapse of many weeks, or even months; Sir Astley Cooper (loc. cit., p. 81) reports a case in which reduction was said to have been produced by a fall after the lapse of five years, and Weller[1] one in which reduction took place accidentally after forty years. In Cooper's case, the only evidence of reduction is that a loud crack was heard at the time of the fall, and that the patient when met in the street a few weeks later, walked without limping. Weller's patient was a negro, fifty-five years old, whose hip had become gradually and spontaneously displaced backward at the age of fifteen. The shaft of the femur was broken in its upper third by a fall, and during treatment (double inclined plane) the patient felt something slip at the hip, and could no longer feel the head of the bone. It is stated that the patient was so muscular that the examination was very difficult.

Hamilton collected fifteen cases in which it was claimed that reduction had been successfully accomplished after the lapse of long periods, and shows that but few, if any, of them can be deemed trustworthy; in a number of them the dislocation was clearly not traumatic, and in the others the reports are brief and unsatisfactory. Sir Astley Cooper's statement that eight weeks was the period after which it would be imprudent to attempt reduction has been taken rather too literally, and the sounder judgment is that the question is to be determined by other facts than the simple length of time that has elapsed, such as the distance of the head from the acetabulum, its mobility, the degree of the inflammatory reaction, the usefulness of the limb, and the health or constitution of the patient. If the head has been displaced to a considerable distance, if the adhesions surrounding it are firm, if the patient's condition is such that suppuration is likely to be provoked, the attempt should not be made. The reasons which have been elsewhere given when considering the same question with reference to other joints are equally applicable to the hip, and justify, in my judgment, the preference of an open arthrotomy to forcible attempts by traction and manipulation.

The special measures that have been employed either to effect reduction or to improve the functional condition of the limb are subcutaneous division of the opposing bands, open arthrotomy, osteotomy or fracture of the neck or shaft, and excision of the head or of the head, neck, and trochanter.

The first two, subcutaneous division and open arthrotomy, are applicable to relatively recent cases which are thought to be not absolutely irreducible, to be supplemented in case of failure by excision. The others

[1] Weller: New Orleans Journ. of Med., 1870, vol. 23, p. 731.

are applicable to older cases, as palliative measures designed to improve the position of the limb and make it movable.

Subcutaneous division of opposing bands or muscles has been tried in one case, unsuccessfully, by Hamilton (loc. cit., p. 799). The dislocation was dorsal, of eight months' standing, in a man twenty-eight years old; after having failed to reduce by manipulation and continuous traction for a month, with a weight of twenty pounds, Hamilton introduced a long narrow knife "just above the trochanter major, carrying its point inward until it touched the neck at the base of the trochanter. From this point, the edge of the knife being directed toward the head of the bone, I swept the point of the knife slowly along until the head was distinctly felt, the point touching the neck apparently in its whole length." The limb was kept rotated outward and abducted during the cutting, and was felt to yield, so that both outward rotation and abduction became more complete. The attempts to reduce by manipulation and traction were then repeated, but without success.

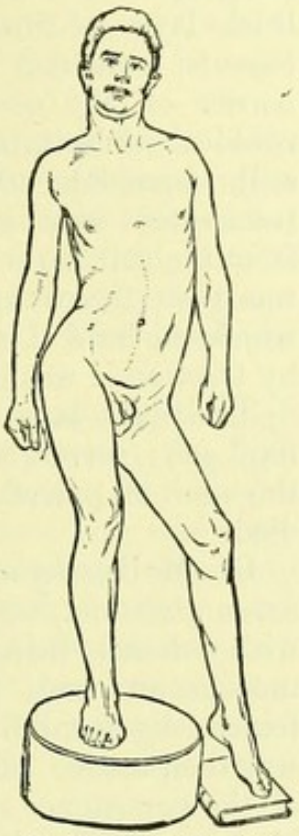
Open arthrotomy has been tried in six cases: Volkmann,[1] MacCormac,[2] Polaillon,[3] McBurney, Quénu,[4] and Severano.[5] Volkmann's, McBurney's, and Quénu's dislocations were dorsal at the time of operation; Polaillon's and MacCormac's, obturator. Volkmann, MacCormac, Quénu, and Severano failed in the attempt, and they resorted to excision of the head or below the trochanter; Polaillon succeeded, but his patient died of acute septicæmia; McBurney also succeeded, but a sinus persisted, and six months later he found the head carious and excised it.

Volkmann's patient was a man fifty-one years of age, who was admitted to the hospital six weeks after the accident which had caused the dislocation, obturator. An attempt to reduce by manipulation under anæsthesia, transformed the dislocation into a dorsal one, and a repetition only carried the bone back to its original position. This change was made several times, and the head was finally left upon the dorsum. Traction was then maintained for six weeks, but did no good. A longitudinal incision was made May 15, 1876, at the level of the great trochanter, with transverse section of the gluteus maximus for a distance of eight centimetres. This exposed the head and neck freely, but did not disclose the obstacle to reduction; successive division of the muscles attached to the great trochanter was then made, but still reduction was impossible. The head of the femur was then turned out through the wound, and a layer of muscle, at least one centimetre thick, was seen overlying the cotyloid cavity, and firmly adherent to its rim. Sub-trochanteric excision was done, and the limb brought into a suitable position. The wound healed without incident, and two months after the operation the patient, while lying in bed, was able to lift the limb. Nine months later he was able to go about without crutch or cane; he limped, and there was shortening of four centimetres; flexion was possible, and abduction to 25°; rotation and adduction were very limited.

[1] Volkmann: Reported by Rauke in Berlin. klin. Wochenschrift, 1877, p. 357.
[2] MacCormac: St. Thomas's Hosp. Reports, 1879, vol. 9, p. 103.
[3] Polaillon: Bull. de la Soc. de Chirurgie, 1883, p. 101.
[4] Quénu: Revue de Chirurgie, 1887, p. 310.
[5] Severano: Quoted by Trélat, Gaz. des Hôp., April 9, 1887.

MacCormac's patient was a man nineteen years old with an obturator dislocation that had existed for twenty-one months and had resisted several attempts to reduce; one of the earlier ones was followed by the formation of an abscess in the buttock. When he came under MacCormac's care the limb was abducted, rotated outward, and markedly flexed (Fig. 151). MacCormac made two unsuccessful attempts to reduce and the patient left the hospital, but returned a month later asking for an operation to relieve the constant pain and increasing disability. MacCormac rejected the suggestion to make a subcutaneous section of the femur because of the depth at which it was placed, the probable presence of the femoral vessels and crural nerve in front of it, and the possible necrosis of the detached head, and determined to try to replace the head in the socket after division of the capsule and opposing bands through a large incision.

Fig. 151.



MacCormac's case of old obturator dislocation.

June 5, 1878, a Y-shaped incision was made, the two branches of which were directed toward the anterior and posterior superior spines of the ilium, respectively, and the straight part ran down to the great trochanter; the soft parts were freely divided, and when the cotyloid cavity was reached it was found to be so reduced in depth that the head of the femur, even if it could have been replaced in it, would certainly not have remained there. He therefore divided the bone with a chisel just above the lesser trochanter, and, after a somewhat difficult dissection, removed the upper piece. Even after the excision the flexion of the limb could not be entirely corrected, but he abstained from section of the contracted muscles, immobilized the limb by a long side splint, and maintained continuous traction which ultimately overcame the remaining flexion.

The wound healed without incident, and seven weeks after the operation the patient was able to leave the bed. Passive motion; faradization. By the end of the following November the patient was able to walk without aid. The shortening was three inches; the thigh could be flexed 45° and completely extended.

Quénu and Severano resected the head alone, and their patients recovered; in Quénu's case the dislocation had existed for eighty days.

Polaillon's patient was a man forty-six years old, alcoholic, and of weak constitution. A dorsal dislocation had been caused by a fall the day before his admission. On the following day in an attempt to reduce by manipulation the dislocation was transformed into an obturator, and after being changed backward and forward several times the head was left in the latter position. Two other attempts were made during the next fortnight, and after the last one, November 20th, the thigh became swollen and tender, but these symptoms abated and there remained at the time of the following operation, December 16th, only some painless swelling of the hip and tumefaction of the glands in the groin.

Under "the most minute antiseptic precautions" an incision ten centimetres long was made, beginning at the anterior inferior spine of the ilium, and carried through the fascia and muscles to the same extent; the great trochanter was found fixed against the cotyloid cavity, and a thick layer of fibrous tissue, thought to be the anterior portion of the capsule, extended from the upper rim of the acetabulum to the upper border of the neck of the femur; this was divided, and the finger could then be introduced into the articular cavity. Reduction being still impossible, the muscles inserted upon the front of the great trochanter were in part detached, and the head and neck separated from the soft parts as freely as possible by a blunt elevator. The thigh was then flexed upon the abdomen, rotated inward, and extended, by which the head of the femur was carried behind the acetabulum, and then by traction it was brought into the socket.

Two days later the parts adjoining the wound were infiltrated with fetid gas; several sutures were removed; the tissues were gray and had the odor of putrefaction; on the fifth day, December 20th, the patient died.

Dr. McBurney's case has not yet been published; the patient, about seven years old, was admitted to St. Luke's hospital, New York, in 1886, with a dorsal dislocation of several months' standing. A longitudinal incision was made above and along the great trochanter, and the ilio-femoral ligament divided close by its attachment to the femur. Reduction was then made. The patient was kept in bed for several months because of the persistence of a sinus in the wound; as the probe disclosed the presence of bare bone the sinus was enlarged, and as the head of the femur was found to be carious it was excised. Sufficient time has not yet elapsed for the ultimate result to become known.

This showing is far from favorable; of six cases reduction was accomplished in only two; and of these two one died of the consequences of the operation, and in the other the head of the femur became carious. Still, it should be said that in MacCormac's case the length of time that had elapsed left no reasonable ground for the hope that the operation could be successful, and in Volkmann's case it does not appear that the adherent muscle which covered the cotyloid cavity could not have been detached. The fatal result in Polaillon's case may perhaps be fairly attributed to the repeated violence inflicted in the preceding attempts to reduce, from which the tissues had apparently not entirely recovered at the time of the operation. The caries of the head which spoiled the result in McBurney's case is, I fear, a consequence which may frequently follow and which may prove to be the most important objection to undertaking the operation.

Excision of the head, or of the head, neck, and great trochanter has been done in nine cases, in eight of which the dislocation was traumatic, and in three spontaneous, having occurred in the course of acute articular rheumatism or typhoid fever. The traumatic cases are those of Delagarde,[1] Volkmann, MacCormac, Quénu, and Severano, already quoted,

[1] Delagarde: St. Barth. Hosp. Rep., 1866, vol. 2, p. 183.

and Sydney Jones;[1] the spontaneous cases are those of Bruns,[2] Rawdon,[3] and William Adams.[4] In connection with these may be considered the cases of Bryck, Czerny, and Post, above mentioned, in which the head of the femur became necrosed after fracture of the neck accompanying or following dislocation and was removed; and it may further be added that, according to Krönlein, Roser excised the head of the femur in 1874 in a case of congenital dislocation.

Delagarde's patient was a man fifty-one years old, who, five months before the operation, had been crushed under a fallen wall, receiving a dorsal dislocation of the left hip and fracture of the femur in two places; the fractures had united. The slightest attempt to move the thigh made the head of the femur press on the sciatic nerve, producing throughout the limb a most peculiar and intolerable numbness. The head was deeply lodged in the upper part of the sciatic notch.

A deep incision was made from the trochanter to the sacrum through the gluteus, which laid bare the head and neck of the femur; the ligamentum teres had been strained, but not broken; the tendon of the pyriformis passed under the neck. By means of a trephine a hole was made in the neck of the femur at its junction with the shaft, and the remaining strip of bone on each side was sawn partly through with a narrow saw, the division completed with bone forceps, and the head and neck removed. The sciatic nerve was laid bare for an inch and a half, it was curiously flattened and moulded to the head of the femur. The relief was immediate. The wound healed in six weeks, and the patient was discharged four months after the operation with a serviceable limb.

Jones's patient was a boy eleven years old with a dorsal dislocation of six months' standing. "On Nov. 25, 1879, Mr. Sydney Jones excised the head of the femur, corrected the malposition of the limb, and drew down the upper end of the shaft to the acetabulum, which was filled up with condensed cellular tissue and inflammatory material. Now, five years after the excision, the boy has a straight limb an inch shorter than the opposite one. He can run, jump, play cricket, and ride a tricycle."

Volkmann's and MacCormac's cases have been given in detail above; both were obturator, but Volkmann's had been transformed into a dorsal dislocation before operation. Quénu's was dorsal.

Bruns's case was a "double spontaneous or pathological dislocation of the hip forward and downward (obturator and perineal)." The patient was a boy eight years old, who had suffered two years previously with acute articular rheumatism affecting all the joints in turn, but persisting after two months only in the hips and knees. The limbs gradually became abducted, and large abscesses formed and were opened below the groins; the suppuration persisted for many months.

Both thighs were abducted at a right angle with the trunk, so that the knees and toes looked directly outward. The head of the left femur could be distinctly felt resting at the junction of the rami of the pubis and ischium; that of the right femur lay upon the obturator foramen.

[1] Sydney Jones: Lancet, 1884, ii. p. 870.
[2] Bruns: Abstract by Tillmanns, Centralblatt für Chir., 1879, p. 697.
[3] Rawdon: Liverpool Med. Chir. Journ., 1882, p. 22.
[4] Adams: Lancet, 1884, ii. p. 775.

Both hips were immovable, and the knees could not be extended beyond a right angle. Locomotion was possible only upon all fours and sidewise.

Bruns treated the case by excising the head of the left femur, and making a subtrochanteric osteotomy on the right side.

The excision of the head was done through an incision through the adductor muscles in the long axis of the thigh, down upon the head of the bone. The detachment of the head from the soft parts could not be completely effected, and it had to be removed piecemeal after the neck had been sawn through. The position of the limb could not at the time be corrected, because of the tension of the contracted muscles, but after the wound had almost healed the limb was straightened under anæsthesia by the employment of moderate force, although with rupture of the tensor vaginæ femoris; the upper end of the femur remained in a position corresponding to that of an iliac dislocation. The knee also was straightened, and continuous traction applied. This forcible straightening was followed by suppuration at the place where the muscle had been torn, and the pus burrowed all along the back of the thigh down to the knee, greatly reducing the patient's strength.

Five months after the first operation, the abscess having completely healed, the second operation, subtrochanteric osteotomy, was done upon the right side; the bone was chiseled through three-fourths of its circumference, and the remainder broken; the limb was at once made straight, and the knee extended, and continuous traction applied to both limbs. The wound healed without incident, and in four weeks the fracture was consolidated.

Three months after the last operation the condition of the patient was very satisfactory; both hips and knees extended, the right hip ankylosed, the left quite movable, dislocated upon the ilium, rotated outward, and shortened five centimetres. The boy had already learned to stand upright and walk quite well with a thick sole on the left foot and a cane.

Rawdon's patient was a girl eight years old, whose right hip had become dislocated backward during an attack of typhoid fever, which ended about two months before she came under observation. Very free painless flexion was possible, extension to 135°, abduction and outward rotation almost entirely lost. An incision two and a half inches long was made, parallel with the shaft of the bone a little behind the trochanter; "reaching the neck, the muscular coverings were dissected off the head, cutting upon its rotundity with the thumb pressing back the tissues which embraced it, until the head could be turned out, and the neck divided with a blunt-pointed metacarpal saw." Antiseptic treatment discontinued after six days because of the abundance of the discharge and accidental wettings; no fever; wound healed in a month. Continuous extension by weight and pulley was begun on the third day, and maintained for four weeks; the limb was then found to be "capable of all the natural movements, freely and without pain." One inch shortening on measurement. Two months after the operation she could walk quite naturally without crutches.

Adams's patient was a boy eleven years old, with a dorsal dislocation that had taken place during a rheumatic fever. He made "a T-shaped incision with the long arm two and a half inches in length directly over

the head and neck of the bone, and the small arm one inch in length transversely over the head of the bone, which was at once exposed. . . . It was found that the capsular ligament had been ruptured, and the torn margins of the rent passed on either side of and closely embraced the neck of the bone. After dividing the margins of the capsular ligament the operator passed his small subcutaneous saw to the neck of the bone, and cut through it a little below the margin of the articular cartilage," and withdrew the head. There was not much suppuration, and the wound was completely healed two months after the operation. A fortnight later the patient walked with crutches, and four months later without them. "The limb was perfectly straight, and the movement at the hip-joint was free in all directions."

Subtrochanteric osteotomy has been done, in addition to Bruns's case above mentioned, by Van Wahl and Koch.[1] The latter's patient was a man forty-one years old, with a dorsal dislocation that had existed for twenty months, and in which the flexion was so great that the patient could not use the limb in walking. October 3, 1881, a wedge of bone was removed from the outer and posterior portion of the femur on a level with the lesser trochanter; the wound healed in two weeks, and the bone was then broken under anæsthesia, and the limb placed in a gypsum dressing in the position of extension, abduction, and outward rotation. The fracture united in three weeks, and it was then found that, owing to the intractability of the patient, the position had not been preserved, but that the limb was flexed 40°, and equally abducted. The functional result was nevertheless good.

He mentions a case of dislocation twenty-five days old treated by Van Wahl in like manner, except that the fracture was made at the time of the removal of the wedge, in which the result also was good.

Subcutaneous fracture of the neck has never, so far as I know, been intentionally done to correct a vicious position of the limb, but in a number of cases in which it has occurred during an attempt to reduce it has been utilized for this purpose and with good results, although, as above mentioned, necrosis of the head of the femur has twice ensued. The objection to it, and also to subtrochanteric osteotomy is that, unless the dislocated head is movable the limb is fixed in the position of extension, and while that position is advantageous in walking, it is very inconvenient when the patient is sitting. In this respect excision of the head is to be preferred.

Congenital Dislocations. (See Chapter IX.)

Spontaneous or Pathological Dislocations.

Almost all the different kinds of spontaneous dislocation have been observed at the hip, and many of them with a frequency that has not been observed at other joints. The weight of the body in walking is a factor of much importance and constantly at work, the effect of which is well

[1] Koch: Berlin. klin Wochenschrift, 1882, vol 19, p. 492.

shown in three cases reported by Lücke,[1] in which the dislocation followed rachitic changes in the shape of the femurs and the spinal column. The patients were children who, at birth and during infancy, showed no sign of dislocation; after a time rachitic changes occurred, the displacement appeared, and walking became difficult. Lücke found a marked lumbar lordosis and anterior curvature of the femurs; the trochanters were displaced far backward, and the dislocation was evident. He thought the curvature of the femurs was the primary change, and the lordosis compensatory of it, and that the dislocation was due to changes in the acetabulum following the consequent pressure at an unusual point.

Of similar character are those cases in which the dislocation has taken place in a healthy joint in consequence of the prolonged maintenance of some exceptional attitude, as in a case reported by Franks[2] of a child five years old, who had been confined to the bed for many months by an arthritis of the *left* hip, and had lain upon its left side with the knees and hips flexed, and the right hip adducted; a dorsal dislocation took place without pain in the *right* side. Here the contraction of the muscles takes the place of the weight of the body in producing the dislocation when the limb is long held in a favorable attitude, and many examples of this effect have been reported in cases in which the joint was the seat of an arthritis, as in acute articular rheumatism, or in continued fevers, typhoid, scarlatina, in which usually there are indications of inflammation of the joint, although in some cases attention was first called to the joint by the appearance of the deformity. As the individual usually lies with the thigh flexed and adducted, the dislocation almost always takes place backward and upward; but in a case observed by Stromeyer,[3] a man eighteen years old, affected with acute articular rheumatism, especially of the hip, during the entire course of which he had lain on his side, the dislocation was into the obturator foramen.

It is believed that in these cases, at least in those in which there is any inflammation of the joint, the quantity of synovial liquid is increased, the ligaments and the capsule are softened and, perhaps, lengthened, and thus the dislocation is favored. The immediate cause of the dislocation is the persistent contraction of the muscles which connect the femur with the trunk, a contraction which is stimulated by the pain in the joint.

"Paralytic" or "myopathic" dislocations of the hip, those in which the displacement is effected by the unopposed contraction of certain muscles or groups of muscles, whose antagonists are paralyzed, have been most frequently seen as a consequence of infantile paralysis. As has been shown in Chapter X. they were formerly confounded with congenital dislocations, and were first clearly separated from them by Verneuil,[4] and afterward studied in detail by some of his pupils, especially Reclus.[5] When the paralysis involves all the muscles of the hip the joint becomes loose, and the femur may be displaced and replaced at will, but when

[1] Lücke: Quoted by Forgue and Maubrac, Luxations pathologiques, Paris, 1886, p. 15.
[2] Franks: Lancet, 1883, ii. p. 15.
[3] Stromeyer: Handbuch der Chir., 1844, vol. i., quoted by Forgue and Maubrac.
[4] Verneuil: Bull. de la Société de Chirurgie, 1866.
[5] Reclus: Revue de Méd. et Chir., 1878, p. 176.

only a part of the muscles are paralyzed the contraction of the others leads to a permanent displacement. If the posterior muscles are paralyzed, and the adductors remain in good condition, the dislocation is dorsal; if the adductors are paralyzed and the glutei remain sound, the dislocation is forward upon the pubis. One of the cases observed by Reclus may be taken as a good example of one form; a child, which had previously been healthy and well-formed, was attacked at the age of seven years with high fever and a paralysis which, at first general, became localized in the glutei and the other pelvi-trochanteric muscles; the other groups, especially the adductors of the thigh, recovered their activity; a well-marked dorsal dislocation followed.

In a case reported by Bradford,[1] a girl, eighteen months old, the right thigh was flexed and abducted at a right angle, the adductors were paralyzed, the glutei and tensor vaginæ femoris sound. The head of the femur could be felt in the groin upon the superior ramus of the pubis midway between the symphysis and the anterior superior spine of the ilium. Reduction was effected, but the limb remained almost powerless.

The cases should be treated by prompt reduction, if possible, and the maintenance of the limb in an attitude that opposes recurrence.

In three cases reported by Roser[2] in 1885, at the Congress held at Strassburg, the paralysis was due to spinal disease; in one of them the patient produced the dislocation by swinging his legs forward while walking with crutches; in the other two the dislocation took place in bed without appreciable cause.

The limitation of the paralysis to one group of muscles is to be explained by the fact that the adductors are supplied by the obturator nerve, a branch of the lumbar plexus, and the posterior muscles by branches of the sacral plexus, and that the medullary centres of these nerves are at different points in the cord, that of the former being at a higher point than the other, probably at the upper part of the lumbar enlargement.

Dislocations due to destruction of the bony parts of the joint by tubercular disease are comparatively common; their consideration belongs rather to the subject of disease of the hip-joint.

In like manner the consideration of those dislocations which follow changes in the bones produced by chronic rheumatism or dry arthritis or in ataxia belongs to works upon those subjects. The alterations in the shape of the bones, either by atrophy, or by hypertrophy, are so marked that reduction or maintenance of reduction is impossible. In dry, or deforming, arthritis not only are all the constituent parts of the joint involved in the changes, but the muscles also become degenerated; the bones are usually hypertrophied by outgrowths at the borders of the articular surfaces, they lose their articular cartilage, and become eroded at points of contact. The changes in locomotor ataxia are characterized by early and rapid atrophy of the head and neck of the femur with destruction to a greater or less extent of the rim of the acetabulum. Sometimes dislocation takes place abruptly with well-marked and characteristic symptoms; in other cases the symptoms are more like those of

[1] Bradford: Boston Med. and Surg. Journ., 1883, vol. 108, p. 73.
[2] Roser: Quoted by Forgue and Maubrac, loc. cit., p. 43.

fracture of the neck of the femur, the foot is everted and the trochanter raised, but the movements are exceptionally free and may be painless.

A case of remarkable laxity of the hip-joint, apparently due to syphilis, but somewhat resembling that of ataxia, was reported by Defontaine:[1] when the limb was dependent the deformity was not great, but when the patient bore his weight upon it the trochanter projected immediately above and to the outer side of its normal position, so that there was a deep depression between it and the ilium; on flexion of the thigh the head of the femur projected at the outer and posterior part of the buttock.

[1] Defontaine: De la syphilis articulaire, 1882, quoted by Forgue and Mœubrac

CHAPTER XXVIII.

DISLOCATIONS OF THE KNEE.

Anatomy.—The knee-joint may be regarded as composed of two joints, of which one is formed by the patella and femur, the other by the femur and tibia; and the latter is composed of two parts, differing somewhat from each other, each of which is formed by one of the condyles of the femur and the corresponding portion of the upper surface of the tibia. The condyles of the femur are separated from each other by the intercondylar notch, and between the condylar surfaces of the tibia is a depression which is interrupted in the centre by the spine.

The ligaments which bind the femur to the tibia and fibula are the external and internal lateral, the posterior, and the crucial. The internal lateral ligament, long and flat, extends from the internal tuberosity of the femur to the inner side of the shaft of the tibia; the external lateral, more rounded and cord-like, extends from the external tuberosity of the femur to the head of the fibula, overlying the tendon of the popliteus above and being embraced by the tendon of the biceps below. The short external lateral ligament, lying somewhat more deeply and posterior to the other, is attached above to the side of the condyle and below to the styloid process of the fibula. The posterior ligament is formed in great part by an expansion from the tendon of the semi-membranosus and is attached above to the upper part of the intercondylar fossa of the femur and below to the posterior margin of the head of the tibia. The crucial ligaments extend from either side of the intercondylar notch, that from the outer side passing forward and downward to the depression in front of the spine of the tibia, that from the inner side passing more directly backward to the posterior margin of the upper surface of the tibia behind the spine. In full extension of the knee these ligaments are made tense, but in flexion at a right angle the lateral ones, especially the external lateral, are relaxed.

The semilunar fibro-cartilages are interarticular structures attached to the head of the tibia at their outer margins and ends and having free smooth surfaces above and below; they are triangular on vertical section, the peripheral border being thick, the central thin; as they are rings, not disks, each leaves the corresponding condylar surface of the tibia uncovered at the centre. The internal one is semicircular, and its ends are attached in front of and behind the spine of the tibia respectively; the external one is nearly a complete circle, and its ends are attached to the spine of the tibia between those of the internal one, its posterior end is also attached to the inner condyle of the femur in connection with the posterior crucial ligament. The external cartilage is movable upon the tibia, this freedom of motion being utilized in the outward rotation of the leg which occurs

at the end of extension, while the internal one is more fixed and serves mainly to make a more concave surface for articulation with the internal condyle of the femur. The anterior borders of the two cartilages are connected together by a slight transverse band, the transverse ligament; it is sometimes lacking.

The capsular membrane fills the gaps between the ligaments; and those portions which extend from either side of the patella to the femur and tibia in connection with the vasti muscles and the fascia lata are called the lateral patellar ligaments.

The synovial membrane extends well up on the front of the thigh, frequently communicating with a bursa under the quadriceps, is reflected over both the surfaces of the semilunar cartilages to the margin of the tibia, and invests the crucial ligaments by a reflection from the posterior wall. Between the tibia and patella it rests upon a mass of fat, forming two lateral folds, the alar ligaments, and sending backward from its middle another fold, the ligamentum mucosum, which is attached to the front of the intercondylar notch. By these folds and the crucial ligaments the joint is divided into three communicating compartments; in some animals and sometimes in man they are completely distinct or communicate with one another only by small openings.

Functionally, the femoro-tibial joint is a ginglymo-arthrodial, its movements being effected by a combination of gliding, rolling, and rotation of the bones upon each other. In complete extension no rotation is possible, but as the knee is flexed rotation appears and increases. According to Meyer,[1] whose researches form the basis of much of the later formal descriptions of this joint, the amount of possible outward rotation varies with the angle of extension, as follows:

Angle of extension.	Extent of outward rotation.
150°	11°
120	12
90	21
60	31

The extreme range of flexion and extension in a preparation from which the muscles has been removed is 160°, but the range of voluntary motion is only 130°. In complete extension the patella rests upon the upper part of the trochlear surface of the femur, and as flexion is made it moves downward and is gradually turned outward by the increasing prominence of the internal condyle, so that at the last it rests by its upper and outer facet on the front of the external condyle and by its inner facet against the narrow surface of the outer margin of the internal condyle. As the movement of extension approaches its limit the tibia undergoes slight outward rotation in which the external semilunar cartilage does not participate, that is, the outer condylar surface of the tibia moves backward under the fibro-cartilage; correspondingly, when flexion is begun from the position of complete extension it is accompanied by inward rotation of the tibia. The limitation of extension is effected by the posterior and lateral ligaments, that of flexion by the contact of the

[1] Mayer: Anatomie, 2d ed., p. 138.

soft parts of the calf and thigh and of the posterior margin of the semilunar cartilages with the back of the condyles of the femur. Lateral motion and rotation are entirely prevented in full extension by the lateral ligaments; when the knee is flexed at a right angle the rotation of the leg is increased by division of the lateral ligaments; division of the crucial ligaments does not effect rotation.[1] Displacement of the tibia forward, backward, or to either side is opposed by the lateral and crucial ligaments.

Statistics.—Dislocations of the knee, of the femora-tibial joint, are rare, constituting about one per cent. of all cases. They are divided according to the direction in which the tibia is displaced into *forward*, *backward*, *outward*, and *inward* dislocations, and dislocations by *rotation*. Malgaigne made additional groups of intermediate forms. The dislocation may be complete or incomplete, simple or compound. A tabulation which I made by the aid of the references to periodical literature in the Index-Catalogue of the Surgeon General's Library showed that of 114 traumatic cases the dislocation was forward in 52, backward in 34, outward in 21, inward in 4, "lateral" in 1, and by rotation in 3. In 21 of them the dislocation was compound; 11 forward, 4 backward, 6 outward.

The injury is very rare in childhood, the two youngest patients in my list being aged ten and eleven respectively; it is of exceptional gravity because of the size of the joint, the fact that it is usually caused by great violence, and because of the frequency with which it is compound and with which the popliteal vessels are injured. Amputation has been resorted to in a large proportion of cases. Simultaneous dislocation of both knees has been observed in a few cases.

Dislocations Forward.

These may be complete or incomplete, simple or compound. The complete seem to be very much rarer than the incomplete; the compound occur in an exceptionally large proportion, over 21 per cent. in the tabulation just given, and the wound is habitually made by rupture of the soft parts posteriorly where they are stretched across the projecting condyles of the femur in hyperextension of the leg.

The cause may be either hyperextension of the leg, or violence received upon the front of the thigh or the back of the leg near the knee. The former appears to be much the more common; in it the tibia turns upon its anterior margin as a centre, putting the posterior, lateral, and crucial ligaments upon the stretch, and after their rupture it glides forward along the condyles, or the condyles slide backward along it. The hyperextension may be produced by a force applied to the back of the leg or foot, or, more commonly, by the propulsion of the trunk and thigh while the leg is held stationary and upright; thus, a man running down a hill steps into a hole, the leg entering as far as to its upper third, and falls forward. The other cause, direct violence, may act while the leg is either extended or partly flexed; a man standing upright was

[1] Horoch: quoted by Albert, Chirurgie, vol. 4, p. 389.

struck upon the front of the knee by the arm of a windlass, receiving, beside a dislocation of the tibia backward, a fracture of the patella; a very heavy weight fell upon the front of the thigh of a man who was standing, or squatting, with the knee bent (Lowe, Madelung). In another set of cases, of which I have met with the records of four examples, the mode of production is not clear; the patients were caught in rapidly revolving wheels or shafts and whirled around many times, the body passing at some part of its course through a narrow space; in three of these cases both knees were dislocated, in two of them one dislocation being forward, the other backward, and in the third one dislocation was forward and the other inward. In a unique case reported to Hamilton the patient was sitting on the platform of a freight car with his legs extended and his feet resting on the platform of the next one; as the train slowed the cars came together and pushed the head of the tibia upward on the femur.

In a case reported by Cotton[1] the ligaments of the joint had gradually grown so weak that the knees bent backward; as the patient got out of bed one morning a compound dislocation, with rupture of the popliteal artery, was produced.

Pathology.—In the incomplete form, that in which the upper articular surface of the tibia is still in contact by its posterior portion with the inferior surface of the condyles, the injury to the ligaments and other soft parts appears to be slight; in the only autopsy, one reported by Desormeaux,[2] the anterior crucial ligament alone was torn, and that only in part. In the complete form, on the other hand, the injuries are very extensive; one or both lateral ligaments, one or both crucial, the posterior, and the lateral ligaments of the patella are completely ruptured or widely torn. The posterior muscles, the biceps, gastrocnemius, popliteus, even the soleus and vastus internus are lacerated or divided; the internal and external popliteal nerves may be torn or bruised, the popliteal artery and vein ruptured, the skin of the popliteal space torn through. Sometimes the ligaments are ruptured, sometimes they are torn from the femur, perhaps bringing with them portions of the bone; the protruding condyles appear sometimes as if they had been cleaned with a knife. The overriding of the tibia and femur may amount to two or even three inches; in Mayo's case (quoted by Cooper, loc. cit., p. 187) it was said to be fully four inches.

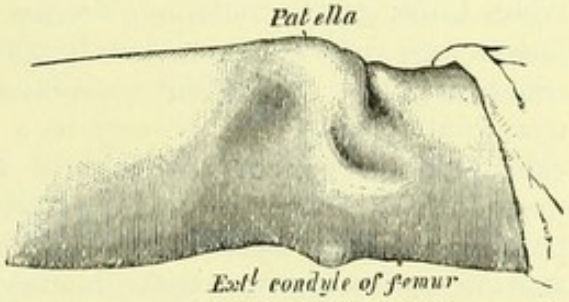
The injuries to the popliteal artery are of exceptional interest and importance. Its inner and middle coats may be torn completely across (Annandale. Cotton, Knichynicki,[3] Lowe,[4] two cases, Vevers,[5] and Stewart and Turner, quoted by Spillmann; in most of them the dislocation was compound); or, as in a case examined by Malgaigne, there may be several small rents at atheromatous, calcareous points. The artery may be simply compressed and remain competent to perform its functions

[1] Cotton: Proc. Connecticut Med. Soc., 1880, vol. 2, p. 54.
[2] Desormeaux: Bull. de la Soc. de Chirurgie, 1853, vol. 3, p. 367.
[3] Knichynicki: Allg. Wiener med. Zeitung, 1873, vol. 18, p. 255.
[4] Lowe: St. Barthol. Hosp. Reports, 1869, vol. 5, p. 80.
[5] Vevers: Lancet, 1869, ii. p. 542.

when the pressure is removed (Davis,[1] Hixon[2]), or it may be so bruised that a thrombus will subsequently form (Brittain) The popliteal vein appears from the reports to have been less frequently torn, but when bruised it also may become occupied by a thrombus. It seems probable that in the cases in which gangrene followed the vein as well as the artery was injured. The opportunities for direct examination after death or amputation have been numerous; among the reports may be mentioned those by Malgaigne, Volkmann,[3] Albert,[4] Birkett,[5] Annandale,[6] Brittain,[7] Madelung,[8] Spillmann,[9] and Lowe, above quoted.

Symptoms.—The leg is usually in almost complete extension, and when viewed from the side it is seen to lie in a plane more or less anterior to that of the thigh, according as the dislocation is complete or incomplete; it may be hyperextended, or partly flexed, and may be rotated in either direction. The outlines of the projecting condyles can be seen and felt in the popliteal space, and above the tibia in front lies the patella, more or less horizontal and freely movable, and the skin above it shows marked transverse folds; the flat articular surface of the tibia can be felt on each side of the ligamentum patellæ. In the incomplete form the deformity is less marked, and the diagnosis may be difficult if the region is swollen.

FIG. 152.



Dislocation of the knee forward. (BRYANT)

The shortening, which is produced by the overriding of the tibia in front of the femur, appears to be at the expense of the latter when viewed from in front, and the appearance suggests a fracture above the condyles. Posteriorly, the leg appears shortened, and the skin is tightly stretched over the condyles.

The limb may be fixed in its position, or it may be movable in any direction, hyperextension, flexion to a right angle, or laterally.

If the skin is broken the rent is transverse and posterior, and through it one or both condyles may project, or the finger can be readily passed into the joint. The main vessels and the internal popliteal nerve commonly lie in the intercondylar notch, and may sometimes be plainly visible.

Injury to, or compression of, the artery is shown by the loss of pulsation in the arteries of the foot and ankle; injury to the nerve by loss of sensation or numbness, and, later, by changes due to defective nutrition of the limb and by pain.

The course after injury to the artery is well shown in the report of

[1] Davis: Phil. Med. Times, 1876–7, vol. 7, p. 270.
[2] Hixon: North Am. Med. Chir. Rev., 1858, vol. 2, p. 76.
[3] Volkmann: Beiträge zür Chir., p. 119.
[4] Albert: Wiener med. Presse, 1872. [5] Birkett: Lancet, 1850, ii. p. 703.
[6] Annandale: Lancet, 1881, ii. p. 903.
[7] Brittain: Lond. Med. Gaz., 1836, vol. 18, p. 257.
[8] Madelung: Berlin. klin. Wochenschrift, 1873.
[9] Spillmann: Dict. encyclop. des Sc. Méd., art. Genou, p. 600.

Annandale's case, that after injury to the nerve in Le Dentu's.[1] Annandale's patient complained that the foot felt cold, but sensation in the toes was normal; the dislocation was easily reduced, and the patient did well for a week; then it was noticed that the foot was livid and cold. Two days later blebs had appeared upon it, and the discoloration had advanced upon the leg; three days later the signs of gangrene were marked, and the limb was then amputated above the knee. The inner and middle coats of the popliteal artery, which were atheromatous, were torn about an inch above its bifurcation, and curled inward; the vessel was plugged by a firm clot.

Le Dentu's patient, a man twenty-seven years old, was caught in the belt of machinery and whirled around rapidly, his legs striking each time against the ceiling; he received a complete dislocation forward of the right knee, and a complete backward dislocation of the left one; the latter was reduced immediately, the former on the next day. On the nineteenth day the patient complained of sharp pain in both legs, and on examination an eschar as large as a fifty cent piece was found on the left calf, and another over the right tendo Achillis; the former healed promptly, the latter increased, and part of the tendon sloughed. The pain became very severe in the right leg, it was neuralgic in character, a sensation of numbness with darting pain in the foot and sometimes in the leg, recurring especially at night. It persisted until the thirty-fifth day, and returned a week later. On the forty-fifth day another eschar appeared on the sole of the right foot opposite to the head of the first metatarsal bone. Sensation, which had previously been dulled in front, was now entirely lost throughout the right leg, except in the region supplied by the long saphenous nerve. Four days later the pain ceased, and the eschars began to heal. Seven months after the accident the patient returned to the hospital; there was considerable atrophy of the right leg, loss of power in the muscles that move the foot and toes, and some stiffness at the ankle. The movements of both knees were normal, and the ligaments appeared to have reunited solidly. The patient limped in walking, but the limp was due solely to the atrophy of the muscles and to the persistence on the outer side of the sole of the right foot of one of the three ulcerations that had appeared upon the foot and heel. The trophic troubles were attributed to a neuritis of the popliteal nerves occasioned by their laceration or bruising at the time of the accident.

Paralysis of the muscles of the outer side of the leg has been observed in three other cases, Brand, Unruh, and Poinsot,[2] in one of which, however (Brand), the fibula had been broken at its upper end.

Of the compound cases, several recovered with good use of the limb; in others, amputation or excision of the joint was done.

The prognosis is grave in the compound cases and in those in which the artery has been injured, and it is not very favorable even in the simpler ones. It must be remembered that gangrene may delay its appearance until the second or even the third week, and that even in some simple cases which have done well for a week or two suppuration of the

[1] Le Dentu: Bull. de la Soc. de Chirurgie, 1880, p. 591.
[2] Poinsot: Trans. of Hamilton, p. 1142.

joint has ultimately occurred. Even after simple dislocations that have done well there is ordinarily some limitation of the movements of the joint.

Treatment.—Reduction is easy by traction and coaptation of the ends of the bones; ordinarily, no more force is required in the traction than an assistant can make with his hands. Flexion of the knee to an acute angle has proved successful. The suggestion that the leg should be hyperextended, and the head of the tibia then pressed directly downward, is a dangerous one, because of the chance of injury to the popliteal vessels.

The rule of conduct in the presence of compound dislocations, and of those in which there is evidence of injury to the popliteal artery, has been the subject of recent discussion. Several compound dislocations in which the artery was intact have recovered, and even with full subsequent use of the joint, and I believe that the conservation of the limb under such circumstances should be attempted. Of course, the utmost care is required in the dressing; the joint should be washed and drained, the dislocation reduced, and the limb immobilized.

Whether or not arrest of pulsation in the arteries of the ankle and foot, and its failure to return after reduction, is a positive indication for amputation, I cannot say. There is, I think, no case on record, in which the limb has been preserved under such circumstances, although the attempt has been made a number of times. Velpeau thought it was an indication for amputation; Nélaton thought the attempt to save the limb might properly be made. Certainly the simple occlusion of the artery by rupture or the formation of a clot ought not, in itself, to be sufficient to cause gangrene, as the very large number of successful cases of ligation of the femoral artery have shown; and it therefore seems probable that some additional cause intervenes, such as obliteration or rupture of the vein, or injury to the main nerves. Where such associated injuries can be shown to exist, as by paralysis and loss of sensation and by œdema and venous congestion of the leg and foot, the limb may properly be deemed lost. In a considerable number of cases tardy amputation, even after the patient's condition had become very low, has been successful in saving life, so that I think conservation of the limb, in selected cases, may properly be attempted, with the understanding that amputation must be promptly done as soon as the early signs of gangrene of the limb appear.

Dislocations Backward.

They may be complete or incomplete; in the former the head of the tibia is displaced backward and upward behind the condyles; in the latter it still remains partly in contact by its upper surface with the condyles.

The common cause is direct violence received upon the upper end of the tibia in front, or upon the lower end of the femur behind, but in some cases the application of the force is more indirect, as when the body and thigh are forced forward while the leg is held; thus, a woman hastening to escape from a press of wagons in the street, caught her foot deeply under a bar which held the leg upright while the thigh was pressed forward. In four cases the patients were caught in machinery and whirled around; and in one case a boy, eleven years old, suffered a com-

pound dislocation by having his leg caught between the spokes of a wagon wheel.

Pathology.—The posterior ligament is torn, and usually one or both of the lateral ligaments; in a case of complete dislocation with rupture of the popliteal artery (quoted by Malgaigne loc. cit., p. 945) in which Robert resorted to amputation, all the ligaments were intact except for two rents, each three centimetres long, in the posterior portion of the capsule through which the tibia protruded. It seems likely that the crucial ligaments, or at least the posterior one, must also be ruptured. The muscles which bound the popliteal space have been reported untorn, but widely infiltrated with blood; and in other cases one or both heads of the gastrocnemius and the popliteus have been torn. The semilunar cartilages may be in part detached or otherwise injured. In a case reported by Vast[1] a portion of the tuberosity of the tibia had been torn off by the strain upon the ligamentum patellæ. The popliteal vessels, both artery and vein, are sometimes completely torn across, and sometimes only the inner and middle coats of the artery are torn, an injury the consequences of which may easily be as serious as those of complete rupture. This injury is produced by the forcible stretching of the vessels across the sharp posterior margin of the head of the tibia.

The patella may be drawn directly downward so as to lie below its normal position, or it may be displaced outward to the side of the condyle. In a case reported by Fitzgerald[2] the patella was broken into several pieces, and the joint was opened at the end of a fortnight by the sloughing of the overlying skin. The injury was caused by the fall of a heavy case upon the front of the knee. The joint suppurated, but the patient recovered without entire loss of mobility.

As complications, fracture of the femur above the condyles, Testut,[3] and fracture of the tibia just below the knee, Adams,[4] have been reported; also rupture of the tendon of the quadriceps femoris, Walshman,[5] Lossen.[6]

Symptoms.—The leg is usually hyperextended upon the thigh, the antero-posterior diameter of the knee notably increased, the head of the tibia placed behind its usual position and, in the complete dislocations, also above the level of the lower surface of the condyles of the femur. The leg may also be deviated somewhat to either side, and exceptionally it may be flexed. The head of the tibia can be felt in the popliteal space, and a marked depression exists below the condyles of the femur in front. The patella may lie against the front part of the under surface of the condyles, or may be displaced to the outer side, or rotated upon its axis, Callender.[7] The amount of shortening is slight in the incomplete form; in the complete form it may be one or two inches.

Pressure upon or rupture of the popliteal artery is manifested by absence of pulsation in the posterior tibial and dorsalis pedis arteries, and may result in gangrene of the limb.

[1] Vast: Bull. de la Soc. de Chirurgie, 1877, p. 688.
[2] Fitzgerald: Australian Med. Journ., 1882, p. 554.
[3] Testut: Bordeaux Médical, 1874.
[4] Adams: Lancet, 1881, ii. p. 1108. [5] Quoted by Cooper, loc. cit., p. 190.
[6] Lossen: Deutsche Chirurgie, Lief. 65, p. 131.
[7] Callender: Med. Times and Gazette, 1863, i. p. 161.

The diagnosis is not difficult; and as reduction is usually easy the prognosis in simple, uncomplicated cases is good; but attention should always be paid to the presence or absence of pulsation in the distal branches of the artery, both before and after reduction.

In some reported cases in which the dislocation has remained unreduced, the patient has had good use of the limb. Two such are the cases of Bagnall-Oakeley[1] and Karewski.[2] The former's patient was a man, seventy years old, who had dislocated his left knee at the age of nine months; he had always made full use of the limb, and had earned his living as a brickmaker. A false joint had formed between the femur and tibia, which permitted 15° of flexion. The foot and leg were normally developed; the thigh had an abnormal anterior curvature. The patella could not be recognized, and was thought to have become united with the femur. The different prominences of the lower end of the femur were absolutely subcutaneous and seemed ready to perforate the skin, but there was no trace of previous ulceration.

Karewski's patient was a servant girl, thirty-two years old, whose dislocation had existed for more than sixteen years. The right limb presented a typical dislocation backward, and when viewed from behind looked like a genu recurvatum, while when seen from in front and the side the thigh overhung the leg to a certain extent. The muscles of the calf were somewhat atrophied; the nerves and vessels stretched above the tibia like tense cords. The growth of the bones had been materially affected, the tibia being three centimetres shorter than the other, and also thinner; while the femur was lengthened by three or four centimetres. The overriding of the tibia and femur was four centimetres. Flexion and extension were normal, both actively and passively, and although there was much lateral mobility the functions of the limb were admirably performed. Pain was felt only after exceptional use.

In Lossen's case, in which reduction was attempted at the end of six weeks and failed, the patient finally walked well; extension was complete; flexion to a right angle. The rupture of the external lateral ligament resulted in the production of a genu varum.

Treatment.—Reduction, which is usually easy, has been effected by traction with coaptative pressure upon the adjoining ends of the femur and tibia and flexion of the knee and hip. In some cases flexion alone has been sufficient. In Testut's case, in which the femur was broken just above the condyles, reduction was made by traction under anæsthesia.

Spence[3] successfully treated an irreducible dislocation by open arthrotomy. The patient was a man, sixty years old, who had received the dislocation March 15, 1876, two days before admission to the hospital. After a failure to reduce under anæsthesia, continuous traction with a weight of sixteen pounds was made for three days, and then a second unsuccessful attempt was made. March 22d, traction with pulleys having also failed, the joint was opened by a curved incision below the patella; it was found filled with clots, the internal lateral ligament broken, and the posterior part of the internal semilunar cartilage displaced. After

[1] Bagnall-Oakeley: Lancet, 1882, i. p. 53.
[2] Karewski: Arch. für klin. Chir., 1886, vol. 33, p. 525.
[3] Spence: Lancet, 1876, ii. p. 534.

division of the external lateral ligament and the tendons of the hamstring muscles, the dislocation was easily reduced. The wound was drained and dressed antiseptically, the limb placed on a long posterior splint, and continuous traction made with a weight of eight pounds. As the lower end of the femur tended to project anteriorly, pressure was made upon it in front. The traction was maintained until June 15th, and when the patient was last seen, September 13th, the limb promised to be very useful.

In compound dislocations, and in those complicated by injury to the main vessels and nerves, the principles of treatment are the same as in dislocations forward.

Lateral Dislocations.

Lateral dislocation, more rare than either of the preceding varieties, may be outward or inward, complete or incomplete, simple or compound. The outward form is more common than the inward. The term *sub-luxation* has been applied to those cases in which the displacement is slight.

A. *Outward dislocations.*

Of the complete form of this dislocation Malgaigne could find only one recorded case, and that a doubtful one; but, since the publication of his work, von Pitha[1] has reported two cases in which the dislocation was nearly, perhaps quite, complete; and Hughes[2] has since published a third. Von Pitha's first patient was a young woman who, while carrying a heavy basket on her back, suddenly doubled up under it. The right tibia was so completely dislocated outward that its entire upper articular surface stood out free, so that von Pitha could easily lay four fingers upon it. The skin was tightly and smoothly stretched over the articular surface, and was continuous at a sharp angle with that of the side of the thigh; the edge of the tibia threatened to cut through the tense, thin skin, and in like manner the internal condyle of the femur projected abruptly over the leg. The patella was displaced outward, and was placed obliquely, almost transversely. Reduction was extraordinarily easy. The reaction was so slight that the patient left the hospital on the next day.

His second patient was a robust young man who received his injury by springing to the sidewalk from an overturning wagon. The appearance of the limb, when seen immediately after the accident, was the same as in the other case, except that, if possible, the edge of the tibia had more nearly cut through the tense, white skin. The flat upper surface of the tibia stood out so free beside the femur that an ordinary goblet could have rested on it. Reduction was easily made, and the intense pain at once ceased. The patient refused to remain in hospital, saying that he felt able to walk, if necessary.

In Hughes's case the injury was not compound, but the skin was much

[1] Pitha and Billroth: Chirurgie, vol. 4, part 2, B., p. 258.
[2] Hughes: Lancet, 1880, ii. p. 974.

stretched. Reduction was easy. The patient had fallen thirty feet and died within twenty-four hours.

In the incomplete form only a part of the head of the tibia, usually all the outer half, projects beyond the side of the external condyle of the femur.

The commonest cause is outward flexion of the knee, abduction, produced by a fall upon the foot or by the pressure of a heavy weight upon the posterior, or by a blow upon the outer, side of the knee; in the latter case the blow is probably received upon the lower end of the femur and not upon the tibia. A rarer cause is direct violence acting transversely upon the outer side of the lower end of the femur or the inner side of the head of the tibia without causing lateral inflection (Annandale). The mode of production appears to be rupture of the internal lateral and perhaps of the crucial ligaments by abduction of the leg, followed by the lateral gliding of the articular surfaces.

The only reports of direct examination of the injured joint are furnished by Hargrave[1] and Bonn, quoted by Malgaigne, and by Wells.[2] Hargrave's patient died on the fifty-third day, after suppuration of the joint; the internal lateral ligament was completely ruptured, the external partly torn; the anterior crucial torn across, the posterior crucial and the ligaments of the patella intact. Bonn's was an old unreduced dislocation; he says all the ligaments were intact and that the external condyle of the femur rested upon the crest of the tibia. In Wells's case a large scale of bone was torn from the inner side of the internal condyle, the patient died on the fourth day in consequence of gangrene of the limb.

Instead of being directly outward the displacement may also be somewhat backward or forward. When compound, the wound has always been on the inside. In one compound case, Notta,[3] the popliteal artery was ruptured and the patient died after amputation.

The symptoms are more or less marked in accordance with the degree of the displacement; the internal condyle of the femur projects more or less markedly on the inner side, and the outer part of the head of the tibia on the outer side; and the greater the displacement the more likely, according to Malgaigne, is it that the outer part of the tibia will be rotated backward. The displacement outward of the patella shows corresponding variations in degree; it may be simply inclined, so that its vertical axis is directed downward and outward, or it may be carried to the outer side of the external condyle.

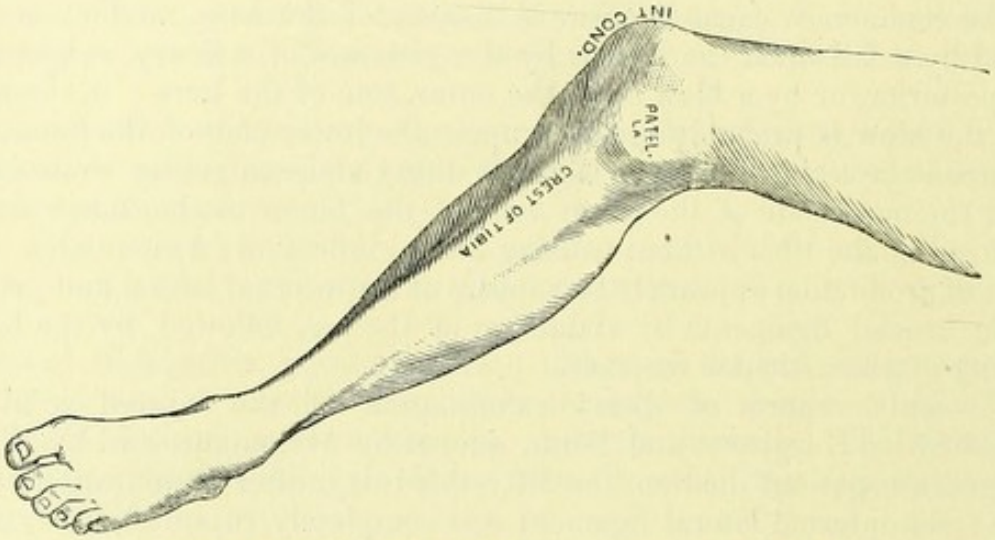
The leg may be flexed or extended, and is usually adducted, but may be widely abducted (Fig. 153); voluntary movements are generally impossible.

The prognosis does not differ materially from that in the two preceding forms; but it is worthy of note that in a case seen six years after the accident by Desormeaux (quoted by Spillmann) the leg was permanently abducted 45°, presumably the consequence of failure of repair of the internal lateral ligament. In another, reported by Morgan,[4] in which the

[1] Hargrave: Dublin Quart. Journ. Med. Sci., 1850, vol. 9, p. 473.
[2] Wells: Am. Journ. Med. Sc., 1832, vol. 10, p. 25.
[3] Notta: Annales Méd. des Calvados, 1876, quoted by Poinsot.
[4] Morgan: Lancet, 1825–26, vol. 9, p. 843.

dislocation had remained unreduced for three and a half years, the limb could be flexed to a right angle but could not be voluntarily extended, so that the patient fell whenever the leg became at all bent while he was standing upon it.

FIG. 153.



Robert's case of dislocation of the knee outward, with abduction.

In one reported by Dr. W. T. Bull (*N. Y. Med. Journal*, Jan. 1885), and shown to the N. Y. Surgical Society three years later (Jan. 1888), the recovery was absolutely complete.

Treatment.—Reduction, generally very easy, is effected by traction and direct coaptative pressure upon the ends of the bones. It is very important that the limb should be immobilized for a long time after reduction in order that the torn ligaments may solidly reunite. Probably it would be well to keep the limb for three or four months in a firm dressing which would keep it extended and prevent lateral bending. Passive flexion and extension might be systematically employed during much of this time if loss of normal mobility were feared.

In a case reported by Braun[1] of incomplete outward dislocation which proved irreducible arthrotomy was done. The patient was a man forty-four years old; the leg was rotated inward and abducted at an angle of 145°; the internal condyle of the femur was prominent, and a small movable piece of bone could be felt below its inner side. "A curved incision eight centimetres long was made parallel to the internal condyle." The small piece of bone proved to be the detached internal tuberosity. The internal condyle filled the rent in the capsule so closely that only after a long search could a small opening be found below it through which the tip of the finger could be passed into the joint; it was slightly enlarged with the knife, and then reduction was easily made. The patient made a slow recovery, and the joint remained stiff.

The treatment of compound dislocations and of those in which the artery has been torn is the same as in forward dislocations (q. v.).

[1] Braun: Deutsche med. Wochenschrift, 1882, p. 291.

B. *Inward dislocations.*

These also may be complete or incomplete, simple or compound. Of the complete form there are only two cases on record, Miller and Hoffmann,[1] and Galli, both quoted by Malgaigne. The first was a man twenty-eight years old who while getting into a carriage caught his leg between the spokes of the wheel and could not free it before the horses started. The femur was completely separated from the tibia and projected outward and downward, the external condyle presenting through a wound in the skin three inches long. Through this wound the joint and the uninjured popliteal artery could be seen. Reduction was made at once without difficulty; four months later the wound had closed and the patient walked with crutches. A month later he could walk well without aid.

Galli's patient, a very muscular young man, was thrown from a horse, striking upon the right foot with the limb abducted, the knee bent and carried at the same time forward and inward. The lower end of the femur had almost entirely passed through the soft parts on the outer side; the ligamentum patellæ was ruptured. Reduction was made and the patient recovered. Two years later he could ride on horseback, but the knee was subject to become inflamed and also to frequent displacements which had to be guarded against by wearing a brace.

The causes of the incomplete form are similar to those of the outward dislocations: lateral flexion of the knee or a blow upon the outer side of the tibia or on the inner side of the condyle of the femur.

In a case quoted from Cooper by Malgaigne (loc. cit., p. 960) in which there was also rotation inward of the tibia, the soft parts covering the external condyle of the femur behind and externally had been ruptured. The limb was amputated, and dissection showed a large rent in the vastus externus immediately above its insertion upon the patella; posteriorly the capsule and gastrocnemius were torn; the lateral and crucial ligaments were intact.

The symptoms of the incomplete form are the projection of the head of the tibia on the inner side and of the external condyle of the femur on the outer side. The leg may be inclined outward or inward, rotated inward, and more or less flexed.

Reduction appears always to have been effected without much difficulty by traction and coaptative pressure; and the only special feature in the prognosis arises from the rupture of the internal lateral ligament, for if its repair is not thorough, or if the limb is prematurely used, the leg tends to deviate outward (knock-knee) under the weight of the body. It would, therefore, be advisable to support the joint for a long time by means of a brace.

ANTERO-LATERAL dislocations constituted in Malgaigne's classification a separate class of very rare occurrence, the tibia being displaced forward and outward. Of the latter form he found only one recorded example and that a doubtful one. In the very rare examples of dislocation forward and inward no special features appear; and the same may be said

[1] Miller and Hoffman: London Medical Repository, 1825, p. 346.

of the equally rare dislocations *backward and outward.* They may, therefore, be treated as belonging to the forward and backward dislocations respectively.

Dislocations by Rotation.

In this form the dislocation is characterized by a rotation of the leg about its longitudinal axis or about a parallel axis passing through the centre of one of the condylar surfaces of the tibia; in the former case both condylar surfaces are displaced from their corresponding condyles, and the dislocation is said to be complete; in the latter only one of them is thus displaced, and the dislocation is said to be incomplete. The descriptive terms *outward* and *inward* are used, as in normal rotation of the leg, according to the direction in which the toes are turned.

Outward rotation.—The first recorded case is one reported by Dubreuil and Martellière,[1] at the time internes in Malgaigne's service. The patient was a woman, who while walking in the street was struck upon the back of the leg by the end of a ladder carried upon a cart which was violently turned around and dragged a short distance in collision with a runaway horse. The woman was knocked down by the blow, her foot caught between the rounds of the ladder, and she was dragged a few feet. When brought to the hospital, the leg was completely extended and rotated outward, so that the internal tuberosity was in front, below the trochlea of the femur, the external tuberosity and the head of the fibula behind in the intercondylar notch. The patella lay upon the outer side of the external condyle. There was also a compound fracture of both bones of the leg in the middle third. Reduction was easily made two hours after the accident by slight traction upon the upper portion of the leg followed by inward rotation. Recovery took place, but the joint was not firm, and nineteen months after the accident the patient could not take a step without crutches.

By experiment upon the cadaver the reporters found they could reproduce the dislocation by forcible outward rotation of the leg continued until the ligaments were felt to yield. The lateral ligaments were then found to be ruptured or torn from one or the other insertion; the capsule, the fascia on the outer side, and some muscular bundles were torn, the semilunar cartilages loosened or displaced. The crucial ligaments were not torn, but lay parallel with each other in the transverse vertical plane passing through their upper insertions. In one experiment the tendon of the biceps was torn away from the head of the fibula. The tendon of the semi-membranosus was wrapped under the internal condyle and prevented full extension of the leg.

Sulzenbacher[2] reported another case and repeated and confirmed these experiments. His patient was a young Italian laborer, and the dislocation was caused by forcible outward rotation of the leg followed by hyperextension of the knee. The leg was extended, neither abducted nor adducted, and so far rotated outward that as the patient lay on his

[1] Dubreuil and Martellière: Arch. gén. de Méd., 1852, vol. 30, pp. 150 and 288.
[2] Sulzenbacher: Wiener medicin. Presse, 1880, vol. 21, p. 272.

back the outer border of the foot rested on the bed. Besides the rotation there was displacement backward and outward of the upper end of the tibia. Notwithstanding the swelling there was a distinct projection of the condyles, and the soft parts below them were deeply depressible. Below the internal condyle was a movable piece of bone as large as a bean. The upper end of the tibia could be felt in the hollow of the knee projecting backward and outward and so rotated that the outer surface and the head of the fibula lay furthest back and the outer articular surface could be felt through the soft parts. The inner articular surface lay in the depths of the popliteal fossa. The anterior tuberosity of the tibia looked outward and had drawn the patella laterally so that it rested snugly on the outer surface of the external condyle, its anterior surface being directed outward. There was one inch shortening, and the antero-posterior diameter of the joint was notably increased.

Reduction was easily effected by flexing the leg a little, then rotating it inward and pressing the head forward, and finally extending.

There was a tendency during the first fortnight to subluxation backward and outward; a gypsum dressing was worn during the second fortnight, and on its removal the tendency had ceased. At the end of six weeks the patient could walk with a cane.

The case differs from the preceding one in the additional backward and outward displacement of the rotated leg.

Experimenting on the cadaver, Sulzenbacher found that by rotating the leg outward 45° he got an incomplete dislocation, accompanied by the appearance of a small fragment of bone under the internal condyle similar to that observed in his case, and that then by hyperextension he could make the dislocation complete and exactly like that of his patient. The lesions found on dissection differed from those noted by Dubreuil and Martellière in this, that the crucial ligaments were ruptured and the external lateral ligament untorn. The small movable piece of bone proved to be the part of the internal condyle to which the internal lateral ligament was attached.

In a case reported by Boursier[1] still another variety is shown, the rotation taking place about the internal condyle as a centre. The patient, while standing with the outer side of his right leg resting against the cross-bar of a pair of skids by which he was unloading a large cask, was overthrown by the rapid descent of the cask which struck against the inner side of the right knee. The pain was very severe, and when raised by his companions he was unable to stand. The knee appeared a little enlarged transversely; the external condyle overlapped the corresponding articular surface of the tibia, forming a rather large, hard, rounded prominence. The patella, firmly fixed upon this condyle, was placed obliquely, its external border tending to turn forward. The relations of the internal condyle and inner surface of the tibia were normal. Palpation was painful along the interarticular line, especially at the outer side. Voluntary movement was impossible. Passively, flexion could be made nearly to a right angle, but was very painful; the limb could not

[1] Boursier: Journ. de Méd. de Bordeaux, 1882–3, vol. 12, p. 225, quoted by Poinsot.

be completely extended, and there was no rotation. No sign of fracture. Reduction was easily made under anæsthesia by slight traction and inward rotation of the leg. The patient recovered completely.

Another case has been reported by Mazel,[1] and Malgaigne quotes the accounts of two speciments of old unreduced dislocations given by Godman and Pétrequin. Of the former it is only said that "the leg has undergone complete outward rotation, so that the foot points directly outward, the heel corresponding to the hollow of the other foot, and the articulation of the knee crossing its natural position at right angles."

Still another variety, displacement forward of the inner side of the head, the outer remaining in place, has been recently reported by Hénaff.[2] "A sailor, thirty-three years old, while squatting with his heels together and knees abducted and flexed, was struck upon the inner side of the head of the left tibia by an iron ring through which a hawser had begun to run rapidly. When brought to hospital the leg was partly flexed and not deviated to either side; flexion and extension were limited, abnormal lateral movements very free. The relations of the external condyle and tibia were unchanged; the inner side of the head of the tibia was displaced forward, and the internal condyle was prominent posteriorly. The patella was inclined so that its anterior face looked forward and inward, its inner border rested on the inner condylar surface of the tibia, and its outer border and point raised the skin, the point being nearly in the median line. Reduction was easily effected by traction and internal rotation, and the patient made a complete recovery.

Inward rotation.—Of this the only recorded instance is one reported by Pâris, and quoted by Malgaigne. "The internal condyle of the tibia had slipped behind the corresponding condyle of the femur. The limb was shortened five or six centimetres, and the leg and thigh formed an arc of a circle." Malgaigne supposes this to have been an incomplete dislocation by rotation inward, and explains the alleged shortening as an error of observation. He mentions in connection with it a singular displacement which he had himself seen, and which he thought belonged to this class more than to any other. When seen by him it had existed five years. Although the patient limped, he flexed and extended the leg quite freely. In extension the internal condyle projected very slightly forward and inward, and the relations of the external condyle were normal. In marked flexion the internal condyle projected considerably forward and inward, the inward projection being more than two centimetres, and the external condyle projected slightly forward.

Dislocation of the Semilunar Cartilages.

("*Subluxation of the knee.*" *Hey's* "*Internal derangement of the knee.*")

A certain group of symptoms at the knee, occasioned usually by slight violence, such as the twisting of the leg or marked flexion of the joint, and having a decided tendency to recur, to which attention was first per-

[1] Mazel: Montpellier Médical, 1863, vol. 10, p. 76.
[2] Hénaff: Thèse de Paris, 1883, No. 277.

manently called by Hey[1] nearly a hundred years ago, is still far from being thoroughly understood. In many cases the symptoms are identical with those caused by a floating cartilage in the joint, and many of the reported cases, especially the earlier ones, were probably of this character. Hey said "The complaint may be brought on, I apprehend, by any such alteration in the state of the joint as will prevent the condyles of the os femoris from moving truly in the hollow formed by the semilunar cartilages and articular depressions of the tibia. An unequal tension of the lateral or cross ligaments, or some slight derangement of the semilunar cartilages may probably be sufficient to bring on the complaint." He reported five cases, and said he had seen many others; the difficulty always occurred suddenly, sometimes without recognizable cause during ordinary use of the limb, the joint becoming "locked" in the position of slight flexion, with more or less pain, the patient being unable to bring his heel to the ground and walking on the toes, but the joint could always be freely moved passively. It was always relieved by gradual passive extension of the limb followed by sudden full flexion. His first case is very like one of loose cartilage, and Malgaigne thinks the last two were chronic arthritis.

In 1731 Bassius (quoted by Malgaigne) reported the first case, but it differs notably from all that has since been reported, for the external semilunar cartilage had become much hypertrophied in consequence of an arthritis, and formed a projection on the outer side as large as the thumb; it could be pressed into place with crepitation, and became displaced when the pressure was removed.

In some cases a distinct projection has been noticed in front, formed by one or the other cartilage, which could be made to disappear by pressure or by flexing and extending the joint, and with the disappearance of the projection the symptoms ceased; but in Malgaigne's case it is noted that there was a similar, though smaller, projection at the other knee without symptoms. It is upon these few cases of recognizable projection and upon the sensation sometimes felt of a distinct slipping or jar in the joint while it is moved, that the theory of displacement of the cartilage rests, it being supposed that it slips forward upon the head of the tibia so that its thicker posterior margin lies between the condyle and tibia at or in front of the point where they come most nearly into contact or actually touch. No post-mortem examination has been made in any case, and the only experiments are those of Bonnet. He was able by hyperextension of the knee to rupture the posterior attachments of the cartilages, but this mode of production is entirely unlike that observed clinically; in one case, in a loose-jointed cadaver, he was able by forced outward rotation to engage the internal cartilage in front of the condyle without rupture, and, as Malgaigne says, this resembles what is observed in the living, except that the leg remained rotated, and the head of the tibia projected in front of the condyle. The same effect was obtained in the same manner by Dubreuil and Martellière in their experiments upon dislocations by rotation mentioned above. In a case seen by Hamilton this subluxation of the inner part of the joint with outward rotation

[1] Hey: Observations in Surgery, Am. ed., 1805, p. 208.

appears to have occurred and to have been followed after a few weeks by a liability to the occurrence of the symptoms under consideration accompanied by the presence of a small, hard movable lump on the inner side of the ligamentum patellæ. As the primary accident was followed by a sharp arthritis, this lump may have been of inflammatory origin.

In the chance examination of two knee-joints without history, the external semilunar cartilage has been found detached and displaced into the centre of the joint; they proved the possibility of this displacement, but there was then no reasonable ground for connecting them with the clinical cases. The specimens were described by Reid[1] and Godlee;[2] in each the rupture of the attachments had taken place along the periphery of the cartilage, and it had lodged vertically in the intercondylar notch alongside the spine of the tibia and the posterior crucial ligament. In each, the opposing articular cartilage on the condyle and tibia showed some roughening. Reid's patient died in hospital, and during his stay there had made no complaint of the knee, and had not been observed to limp.

In a case reported by Nicoladoni,[3] a lump was felt in the interarticular line in front, and was thought to be a floating cartilage; on cutting down upon it, without having opened the capsule, it proved to be the semilunar cartilage, and was drawn back into the interior of the joint during flexion, reappearing on extension.

In another, Fergusson (quoted by Marsh) found in a dissecting-room subject "that one of the semilunar cartilages had been torn from the tibia throughout its whole length, except at its ends, so that in flexion and extension it sometimes slipped behind the articular surfaces. The cartilage was flattened in its outer margin, and when it passed behind the condyle of the femur, seemed to fit to the articular surfaces as accurately as the internal cavity does in the natural condition of the parts."

Marsh[4] gives a fourth case: "In a subject lately in the dissecting-room of St. Bartholomew's Hospital, a considerable piece had become partially detached from the rim of the internal cartilage, and was found standing up like a tongue, so that it would have had the effect, when it was nipped between the bones (as it was in certain positions of the joint), of locking the knee. A deep groove on the cartilaginous edge of the femur had been formed by long pressure, for its accommodation."

In four cases recently reported by Annandale,[5] which he treated by arthrotomy, the semilunar cartilage (in three the internal, in one the external) was found torn away from its anterior attachment and folded back into the cavity of the joint; he drew it forward into place, and made it fast by catgut sutures; the patients all recovered without accident, and were relieved of their disability. The cases were characterized clinically by the recognizable absence of the cartilage from the edge of the tibia in front.

In most of the cases the symptoms are like those occasioned by a float-

[1] Reid: Edinb. Med. and Surg. Journ., 1834, vol. 42, p. 377.
[2] Godlee: Trans. of Path. Soc., London, 1879–80, vol. 31, p. 240.
[3] Nicoladoni: Arch. für klin. Chir., 1881–2, vol. 27, p. 667.
[4] Marsh: Dis. of Joints, p. 199.
[5] Annandale: Brit. Med. Journal, 1885, i. p. 779, and 1887, i. p. 319.

ing cartilage, and, as has been said, probably some of the reported cases are such; the patient feels that the knee has suddenly become locked, with more or less pain and loss of power over the limb, which he can neither flex nor extend. Then, after a time, and as the result of manipulation of the joint or of the limb, he feels that all is right again, and walks as well as before. In others the joint has remained stiff and slightly flexed for weeks, or even years (Smith's[1]), and has then been cured by pressure with the thumb upon the projecting semilunar cartilage, while the limb was repeatedly flexed and extended. In some cases the cartilage, usually the internal, can be distinctly felt to project in front; in others there was no such recognizable change. In a case described by Lucas,[2] it is said that when the knee became about half flexed the leg and foot jerked inward with a sudden shock, and at the same time a projection appeared at the outer side of the patella, and the patient said, "now my knee is locked." Flexion could then be completed without any great discomfort, and in extension the leg and foot jerked outward when the same point was reached, and the cartilage went back into place.

In a case presented by Lannelongue[3] to the Société de Chirurgie, a girl eleven years old, the external semilunar cartilage was displaced forward with a distinct sound, so as to be plainly visible under the skin whenever the knee was flexed 20° from full extension, and returned to its place with a similar sound when, in extending the limb, it had passed about 20° beyond a right angle. This condition had come on suddenly about a year previously, and the knee had at last become so painful that the child could not walk.

Le Fort,[4] himself the subject of the affection, felt that something became displaced forward in the knee whenever the limb was markedly flexed, and returned to its place with a distinct snap and with pain when the limb was straightened. On one occasion the displacement appeared to be backward; the pain in straightening the limb was very severe and lasted for a week.

In a case seen by Agnew,[5] a lady while playing with a kitten on the floor, suddenly found both knees had become locked, so that she was unable to rise.

As in these last instances, flexion of the knee beyond a certain point is, in some cases, sure to produce the condition, and this is then relieved by extension; but in most the occurrence is not so uniform in its mode of production, and the commonest cause appears to be a rotation of the leg.

Treatment has almost always yielded good results, both in relieving the condition and in preventing recurrence. The manipulations which have proved most efficient in the common form, those due to a twist or turn of the leg, have been the ones recommended by Hey, extension as far as is possible without much pain, and then sudden forcible flexion. When the cartilage can be felt to project pressure upon it should be conjointly

[1] Smith: Trans. Clinical Soc. London, 1884, vol 17, p. 123.
[2] Lucas: Brit. Med. Journal, 1879, ii. p. 774.
[3] Lannelongue: Bull. de la Soc. de Chirurgie, 1879, p. 573.
[4] Le Fort: Bull. de la Soc. de Chirurgie, 1879, p. 578.
[5] Agnew: Surgery, vol. 2, p. 114.

employed. In such cases as those of Lannelongue and Le Fort, simple complete extension was sufficient.

The after-treatment may require permanent pressure by a pad at the point at which the cartilage tends to protrude, or the wearing of a brace that will limit the movements of the joint. Marsh,[1] who has treated many cases, recommends a clamp (Fig. 154) "which consists of a steel band passing across the back of the joint, and ending laterally in two plates, which clasp the joint and skirt the edges of the patella, a pad being

FIG. 154.

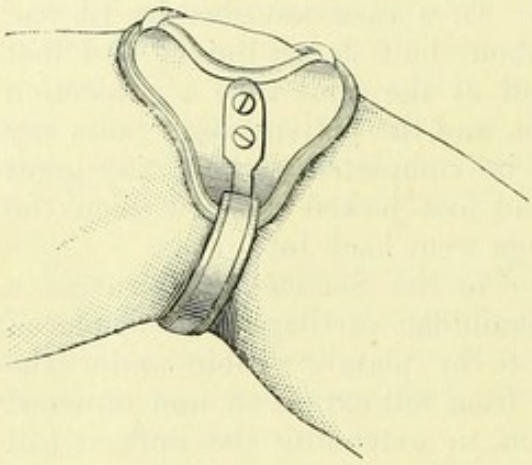
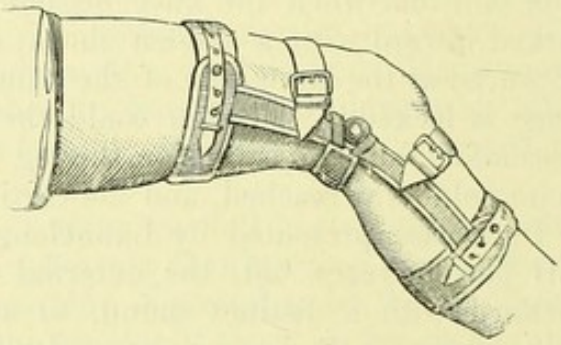


FIG. 155.



placed beneath the plate, should either of the semilunar cartilages be felt to project." For the less amenable cases he recommends the more bulky apparatus shown in Fig. 155. Prolonged immobilization of the limb in a fixed dressing, has been used in a number of cases and seemed to aid in overcoming the tendency to recurrence. Nicoladoni sought to prevent the forward movement of the cartilage by drawing together the tissues from above and below by buried sutures, to form a sort of pad in front of it, but no benefit followed. Annandale operated through a free transverse incision along the anterior edge of the head of the tibia, opened the capsule, and drew the cartilage forward with a hook.

CONGENITAL DISLOCATIONS.

Excluding a few cases in which various malformations of the knee have been found in fœtal monstrosities showing many other abnormalities, and one or two doubtful cases, the reported cases of congenital dislocation are seventeen in number.[2] In one, Mason, the displacement was backward;

[1] Marsh: Dis. of Joints, p. 211.

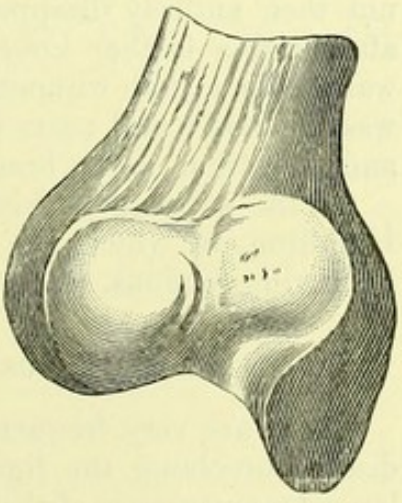
[2] They are those of Kleeberg and Chatelain, quoted by Malgaigne; Bard, Youmans, and Hamilton, 2 cases (Hamilton, loc. cit., p. 895); Friedleben, Schmidt's Jahrbuch, vol. 112, p. 307; Motle, quoted by Hibon, Thèse de Paris, 1881, No. 10, p. 34; Gueniot, 2 cases, Bull. de la Soc. de Chirurgie, 1880, p. 442; Perier, idem, p. 683; Bertin, Union Médicale, 1880, vol. 30, p. 616; Richardson and Porter, 2 cases, Boston Med. and Surg. Journ., 1875, vol. 93, p. 321; Mason, N. Y. Med. Record, 1877, vol. 12, p. 42; Maas, Arch. für klin. Chirurgie, 1874, vol. 17, p. 492; Albert, Chirurgie, vol. 4, p. 435. In addition, Albert names four others which I have not found: Wutzer, Dubrisay, Godlee, and Barwell. In one reported by Cruveilhier, it was claimed that there was hyperextension without displacement.

in one of Hamilton's it was backward at both knees; in the remaining fifteen it was forward, with marked hyperextension of the leg upon the thigh, frequently so extreme that the foot lay at the groin. In a few cases there is mention of a blow or fall received by the mother while carrying the child, but it cannot be maintained that the cause is in any case clear. The facility with which the displacement could always be reduced, the normal shape of the bones, and the prompt establishment of the functions of the limb point toward an accidental mechanical cause; probably, in the movements of the fœtus the leg is extended and becomes engaged in such a position that it cannot be flexed, and then by the pressure of the wall of the uterus hyperextension is effected. Hyperextension in consequence of unopposed contraction of the quadriceps can hardly be supposed, for the flexors have not been found paralyzed. In the single case of double backward dislocation, Hamilton, the flexors were contracted, and their tendons had to be divided before the legs could be straightened.

Of the 13 cases in which the sex was noted, 10 were females, 3 males; in 4 the right knee was dislocated, in 7 the left, and in 4 both; in 2 of the latter 4, Hamilton, Friedleben, both hips also were dislocated. In Maas's the patella was lacking. Friedleben's died during delivery, Mason's at the age of one month. The only detail given in Mason's case is that the reduction was easy, so that Friedleben's and Albert's are the only ones available for the study of the changes; in Friedleben's the articular surface of the tibia rested against the front of the lower end of the femur; the condyles of the femur and the head of the tibia were normally developed, the patella normally attached, the capsule loose and large.

In Albert's, a newborn child, both legs were in dorsal flexion at a right angle. The articular surface of the femur had the shape shown in Fig. 156. The upper part of the synovial sac and the ligamentum alare were lacking. The inner semilunar cartilage was only a narrow strip, the outer one was well developed; the crucial ligaments were very broad and long, the inner one being inserted further inward on the tibia than normal; on slight outward rotation of the leg the two crucial ligaments became parallel to each other. The popliteal vessels and nerves lay behind the external condyle.

FIG. 156.



Congenital dislocation of the knee. (ALBERT.)

Of Maas's patient it is said there was no difference in the length of the limbs or in the development of the muscles, and the same absence of inequality is noted in Gueniot's, Motte's, and Bertin's. In Kleeberg's the limb is said to have been three-fourths of an inch shorter than the other in straight extension, but the inequality disappeared on traction.

The attitude of the limb at birth, in the forward dislocations, was hyperextension to or beyond a right angle, sometimes so extreme that

the front of the leg was actually in contact with the front of the thigh; usually there was no deviation of the leg to either side. It was always freely movable, could be brought down to the position of straight extension by moderate force, and in most cases could even be flexed nearly or quite as far as usual; on removal of the pressure the limb resumed the position of hyperextension. While the joint was dislocated the condyles of the femur projected at the back of the popliteal space, the head of the tibia lying against their anterior surface, and the patella situated well up on the thigh. In several cases the skin on the front of the knee was thrown into transverse folds, in the grooves between which sebaceous matter had sometimes collected. Nothing in any case indicated that the dislocation was recent and traumatic, and the experiments made by Hibon upon the bodies of newborn and stillborn children show that in a similar forcible dislocation, even by a force acting continuously for several hours, detachment of one or both epiphyses always occurred, with, however, but slight separation and not always with rupture of the periosteum. In the forcible straightening of the leg the quadriceps became tense, and in a few cases this tension prevented further flexion of the straightened limb.

The results of treatment were almost always very good, the limb showing a complete restoration of form and function after a few weeks; but in two cases the result was not entirely satisfactory. Six weeks after birth the leg in Perier's case showed exaggerated extension and outward rotation; the quadriceps was manifestly retracted, and showed as a tense cord whenever the attempt was made even slightly to flex the leg. In the hope of an ultimate return to the normal condition, Gueniot, who then had charge of the case, limited treatment to the maintenance of the extended position and to slight passive flexion and traction repeated two or three times daily. In the other case, Maas, the limb when first seen was in dorsal flexion at a right angle; reduction was easily made, and the limb could then be normally flexed. It was placed in a plaster-of-Paris dressing for six weeks, and as the tendency to recurrence had not then entirely disappeared the dressing was renewed for a time, and afterward a leather knee-cap was worn. In its second year the child walked for a time without support, but at the time of the report, when it was two and a half years old, there was still a tendency to anterior flexion and abduction, and a brace was constantly worn.

Of the subsequent history of the only case of backward dislocation, Hamilton, in which the dislocation was reduced after division of the hamstring tendons, there is no mention.

Spontaneous or Pathological Dislocations.

These are very frequent at the knee, mainly as the result of chronic disease involving the ligaments and the bones of the joint, and of prolonged maintenance of the partly flexed position. There are also instances on record of sudden dislocation due to muscular contraction during an acute arthritis, and quite a number of the class to which Volkmann gave the name *deformations-luxationen*, or dislocations by deformity, those in which the shape of the articular ends of the bones has been greatly

changed without suppuration, as in arthritis deformans and Charcot's disease.

The principal displacements are backward and backward and outward, usually combined with outward rotation of the leg. As a great exception dislocation forward has occasionally been observed.

An example of a sudden dislocation backward and upward occurring in the course of a rheumatic attack has been quoted in Chapter X., page 113, from Verneuil.

Examples of dislocation due to the prolonged action of the flexor muscles, the knee being long held partly flexed because of disease at some point in the thigh, are not very uncommon, and in young people its effect is intensified by the exaggerated growth of the femoral condyles downward by which the lateral ligaments become too short to permit the tibia to return to its place. This last mentioned change was first pointed out by Volkmann in 1874, and deserves to be constantly borne in mind, for if the attempt is made forcibly to straighten such a limb the tibia may turn upon its anterior edge as a centre, so that when straightened it is found to lie well behind its proper position, "dislocation by leverage," as it has been termed. One such instance I saw in a lad of twelve years who had long suffered from caries of the lower portion of the shaft of the femur, the knee-joint not being involved in the disease.

The dislocations that occur in the course of chronic tubercular or other destructive disease must here be passed with simple mention.

CHAPTER XXIX.

DISLOCATIONS OF THE PATELLA.

DISLOCATIONS of the patella are rare, about one per cent. of all dislocations, according to the tables in Chapter I., and the infrequency with which they have come under the observation of individual surgeons and the incompleteness or the obscurity of the reports of many cases have combined to make the systematic descriptions rather artificial and unsatisfactory. The physical conditions and relations of the patella, which is really a sesamoid bone developed in the tendon of the quadriceps extensor and not an integral part of a joint, are entirely different from those of other bones, and the changes in position and relations which it undergoes in displacement are very varied. The anterior articular surface, or trochlea, of the femur extends higher upon the outer than the inner side and presents a central groove bounded laterally by a sharp margin from which the internal and external surfaces of the inner and outer condyles, respectively, run abruptly backward, and the outer condyle projects more sharply forward than the inner one does. The articular or posterior surface of the patella presents a longitudinal ridge nearer its inner than its outer margin from which the surface slopes forward to the edge. From each lateral border of the bone passes a strong aponeurotic expansion, the so-called lateral ligaments of the patella, portions of the fascia lata which receive expansions from the vasti muscles and are attached to the tibia; of the outer one, the "ilio-tibial ligament" is the strongest part and tends to displace the patella outward when the knee is flexed. A superficial layer, given off from the fascia lata on the sides, crosses the front of the patella and is separated from it by a bursa. In full extension of the knee the patella lies upon the upper part of the trochlea of the femur, but it can be drawn almost completely above it by the forcible contraction of the quadriceps. This muscle is inserted upon the upper border and somewhat on each side of the patella, and the long axis of the muscle is inclined to that of the patella and its ligament as the shaft of the femur is to that of the tibia—that is, they meet at an obtuse angle whose apex is directed inward. As a consequence of this inclination the traction of the muscle tends to displace the bone toward the outer side, and this tendency is resisted by the projection of the anterior surface of the outer condyle and by the internal lateral ligament of the patella.

The first collation of recorded cases was made by Malgaigne[1] in 1836; the 25 cases which he then collected were increased to 46 in 1855, when he published his work on dislocations. Streubel[2] in 1866 collected 120 cases and made a number of experiments upon the cadaver. Elaborate

[1] Malgaigne: Gazette Médicale, 1836, p. 433.
[2] Streubel: Schmidt's Jahrbuch, 1866, vol. 129, p. 311, and vol. 130, p. 54.

articles were furnished by Panas[1] in 1872, and Berger[2] in 1877, but the most original and at the same time the most recent one is the paper by Von Meyer,[3] Professor of Anatomy at Zurich.

The patella may be displaced to different distances on the outer or the inner side while the knee is extended or partly flexed, and with such displacement may be combined varying degrees of rotation about its own longitudinal axis. These combinations are so numerous and varied that if a classification should be made according to them it would confuse rather than simplify their study and description. Malgaigne in his first paper, based on only 25 cases, described nine forms of dislocation, including an upward and after rupture of the ligamentum patellæ, but in his later work he made only two principal forms, dislocation outward and inward, with subvarieties corresponding to the degree of displacement and the addition to it of more or less rotation of the patella upon its axis. As some of the most striking differences depend upon this last element it will perhaps simplify the subject first to consider the conditions which determine the fixation of the displaced bone, and in doing this I shall speak only of displacements to the outer side, which are much the more common.

The bone may be displaced to the outer side by muscular action or by a force acting upon its inner lateral border; as it passes sideways along the projecting surface of the condyle its outer border is raised and its inner border depressed into the bottom of the trochlear groove; if the force continues to act the patella is carried past the edge of the trochlea to the outer side of the external condyle, and when its longitudinal ridge passes this edge the outer border of the patella may be turned backward by the traction of its outer lateral attachments and the bone comes to rest with its articular surface against the outer side of the condyle, and its anterior surface looking outward; or it may undergo no rotation, and may come to rest with its inner border against the outer surface of the condyle, its anterior surface looking more or less directly forward, and its outer border projecting markedly outward; or, again, it may undergo rotation in the opposite direction and come to rest with its inner border directed backward, its anterior surface looking inward against the outer surface of the condyle, and its outer border directed forward. These three forms constitute the "complete outward dislocations."

If the force is not sufficient to carry the patella entirely past the outer edge of the trochlea, the bone may come to rest with its inner border in the bottom of the trochlear groove, its posterior surface resting partly against the outer surface of the trochlea and partly projecting beyond it, its outer border directed forward and outward, and its anterior surface looking forward and inward—the "incomplete outward;" or the rotation may be somewhat greater, and while the inner border still rests in the groove of the trochlea the outer border looks directly forward, and the anterior surface directly inward—"vertical" or "edgewise" dislocation; or the rotation may be still greater, the anterior surface being turned so as to look directly backward and lie upon the front of the trochlea, and the posterior surface looking directly forward under the skin—"complete reversal."

[1] Panas: Dict. de Méd. et Chir. pratiques, vol. 16, p. 40, art. Genou.
[2] Berger: Dict. Encyclop. des Sc. Méd., 3d series, vol. 5, p. 334, art. Rotule.
[3] Von Meyer: Arch. für klin. Chirurgie, 1882–3, vol. 28, p. 256.

It appears, then, that the bone frequently becomes fixed, and firmly fixed, in positions of apparently great instability—that is, resting upon the front or side of the femur only by its narrow lateral edge, and the fixation which is given to it in these positions is given by the tension of the soft parts attached to it and by the overlying fascia. It may be compared to a stick on end under a tightly stretched sheet, which will stand not only upright, but also when inclined, so long as its lower end does not slip along the ground, or its upper along the sheet.

Fig. 157.

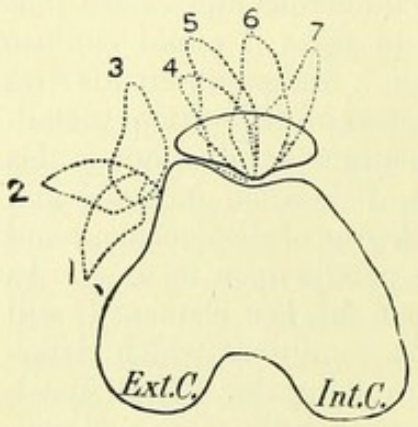


Diagram of the various dislocations of the patella.

It also appears, in consequence, that the bone may take many intermediate positions between the extremes, and that consequently the grouping of the different positions must be somewhat arbitrary. The terms in general use are *complete* and *incomplete outward* and *inward* dislocations, *edgewise* or *vertical* (outward and inward) dislocations, and *complete reversal* in either of the two directions. Dislocations upward and downward should not, I think, have a place in the classification, since they are the secondary results of other lesions, rupture of the ligamentum patellæ, or of the tendon of the quadriceps, which are to be deemed the principal and controlling ones. Among the incomplete outward and inward dislocations those in which one edge of the patella is turned sharply forward differ from the corresponding edgewise ones only in the degree of rotation, and the distinction between them is not only difficult to make in practice, but also does not seem worth preserving. I shall, therefore, group them all as edgewise dislocations, and limit the term incomplete to others in which the rotation is absent or slight.

The outward dislocations are much the more common; it is doubtful if any really complete inward dislocation has been recorded, and of Malgaigne's 46 cases only 6 were incomplete inward. Of the vertical or edgewise dislocations the outward appear to be somewhat more frequent than the inward.

Cause.—The cause and mode of production of the different forms are, in many respects, the same. The dislocation may be produced either by muscular action, contraction of the quadriceps, or by external violence acting directly upon the patella. Of the former there are many unquestionable examples; a man dislocates the patella while fencing, a woman by jumping backward and to one side, a boy by jumping upward and turning partly around to strike a ball. Of the latter, external violence acting directly upon the patella, the common examples are falls and blows upon the knee; in several instances a man riding a horse has struck his knee violently against another moving in the opposite direction. In a number of cases it has been noted that the knee was previously affected with hydrarthrosis, and in a few genu valgum existed. In the cases of frequent, or habitual, dislocation some such predisposing cause is supposed always to exist.

Outward Dislocations.

1. *Complete.*

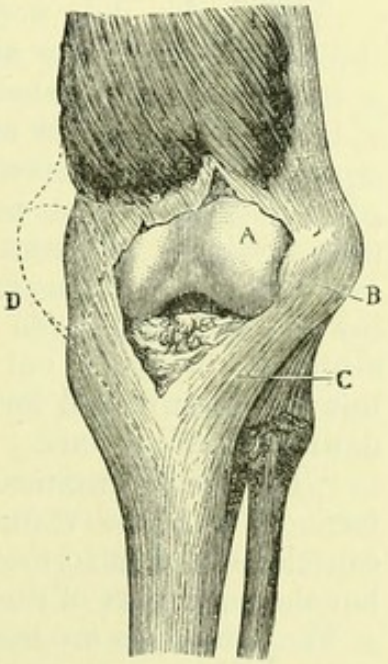
In complete outward dislocations the patella is displaced entirely to the outer side of the external condyle, against which it rests either by its posterior, cartilaginous surface, or, more rarely, by its inner border, its anterior surface being still directed forward, or by the inner part of its anterior surface, the outer border projecting forward and the anterior surface looking inward.

According to von Meyer, and his opinion is based upon clinical observations, as well as upon anatomical and experimental data, the patella can reach this position either by passing outward at or above the upper part of the trochlea in complete extension or hyperextension of the knee, or by passing outward and upward over the lower border of the condyle while the knee is flexed nearly to a right angle. In the former case the dislocation may be produced by muscular action, the contraction of the quadriceps extensor, by which the patella is raised so high that its passage is no longer resisted by the outer border of the trochlea, and the displacement is further favored by the outward rotation of the leg which takes place at the end of extension, and which makes more acute the obtuse angle formed by the junction of the quadriceps and the ligamentum patellæ. Hyperextension of the knee favors the displacement by carrying the patella still higher above the trochlea. Other conditions that favor the displacement are exaggerated outward rotation of the leg and bending inward of the knee. As illustrative examples Meyer quotes cases reported by Foucart and Robert. A muscular young man jumping down from a stool (apparently backward) felt a sharp pain, and found he could no longer stand on the right foot; examination showed an outward dislocation of the patella. A woman, carrying a heavy burden upstairs, felt sharp pain and a cracking in the right knee, and was unable to walk; the patella was dislocated outward.

External violence can produce the dislocation at the same, upper, point.

In either case the further displacement of the patella downward upon the outer surface of the condyle and its fixation there are aided by the subsequent flexion of the knee which involuntarily follows upon the sensation of an injury received there.

Fig. 158.



Complete dislocation of the patella outward. (Anger.)

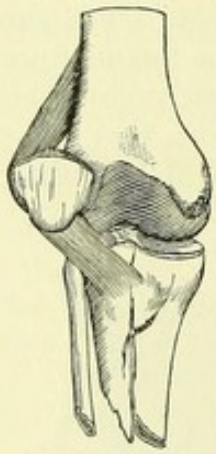
In studying the manner in which displacement took place, by external violence, while the knee was partly flexed, von Meyer found that the resistance of the ligamentum patellæ compelled the bone to move in a curve downward and outward, so that it lodged over the lower part of the condyle, or even in the groove between it and the tibia, and the

tendon of the quadriceps slipped sidewise over the edge of the trochlea, and lay upon the outer surface of the condyle.

The pathology of the commoner form has been studied only in experiments upon the cadaver and in specimens of old unreduced dislocations, of which seven cases have been reported. In four of these seven cases the internal lateral ligament of the patella was torn, and in one the rent extended upward in the vastus internus more than three inches above the patella. Experiments upon the cadaver confirm these facts. Fig. 158 represents a specimen obtained experimentally. It may be added that in three cases of long standing the bones had undergone various changes; in some the patella was hypertrophied, in others atrophied; in some it had lost part or all of its articular cartilage; in some the leg was distinctly rotated outward, presumably the result of the traction exerted upon it through the ligamentum patellæ.

The only examination of an uncomplicated recent case of which I have knowledge is one reported by Andrews;[1] the specimen was obtained by amputation, which was rendered necessary by a compound fracture of the leg. The displacement was of the rare form in which the patella has undergone no deviation about its longitudinal axis and rests against the external condyle only by its inner border (Fig. 159). The patient had been run over by a freight car. "The patella was found shoved nearly straight outward with its inner edge resting firmly against the outer condyle, and with its front and back surfaces presenting in a nearly normal direction. . . . . At the place where the inner border of the patella rested against the femur the shell and spongy tissue of the condyle were crushed in, making an oval or spoon-shaped hollow about one inch long and five-eighths inch wide. The sharp inner edge of the patella rested firmly in this hollow and was thus effectually prevented from slipping. The rest of the patella was stoutly held in position, like a tent-pole or derrick, by tight bands drawing in three different directions, as follows: 1. By a portion of the vastus externus muscle drawing the outer angle upward, inward, and backward. 2. By a part of the rectus femoris, not represented in the figure, but drawing in the direction of the dotted line *R*, upward, inward, and forward. 3. By the ligamentum patellæ, drawing downward and inward.

Fig. 159.



Andrews's case of dislocation of the patella outward.

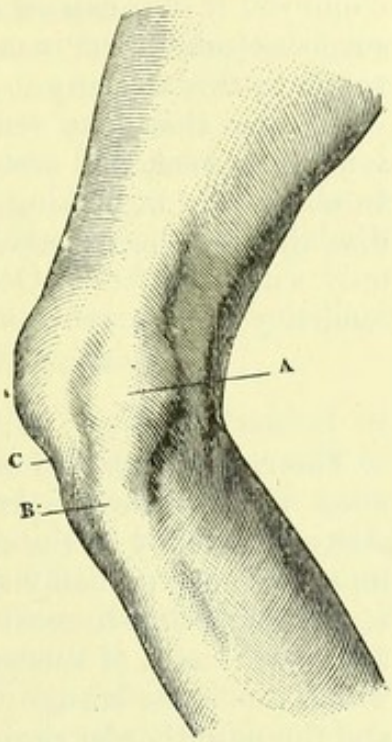
"The vastus internus was torn off. The inner half of the rectus was torn off with the vastus internus, and the lateral attachments of the capsular ligament to the sides of the patella were effectually ripped away, but the outer part of the rectus was still attached."

The symptoms are loss of power to stand upon the limb or actively to move the knee, pain, and deformity. The knee is usually partly flexed, but occasionally has been found fully extended. Passive motion is painful, complete extension usually possible, further flexion rarely possible.

[1] Andrews: Annals of Anat. and Surgery, 1883, vol. 7, p. 199.

The knee appears broadened and flattened anteriorly; the normal prominence of the patella is lost, and in its place is a depression through which the anterior articular surface of the condyles can be distinctly traced unless the swelling is too great. The patella can be readily felt upon the outer side of the condyle, and the tendon of the quadriceps and the ligamentum patellæ show as tense bands under the skin. Usually the patella rests with its articular surface against the outer surface of the condyle and its inner border directed forward, but, as has been already said, it may stand directly out from the condyle, resting against it by its inner border only, or it may be rotated in the opposite direction so that its outer border is directly in front. Of this last form a case was reported by Parkes,[1] which may be quoted in illustration. The patient made a misstep and fell to the ground, striking his bent knee against a large piece of coal; the leg was slightly flexed and immovable. "The inner edge of the patella was thrown entirely external (to the condyle), clearing the femoral articular surface absolutely, and rested against the outer tuberosity of the external condyle of the femur, so that the inner border of the displaced bone was fully half an inch behind the highest point of the outer rim of the trochlear facet of the femur." "Its subcutaneous surface was turned inward, and its articular surface outward." "The ligamentum patellæ was very tense, and so also in a remarkable degree was the ilio-tibial band of the fascia lata." Flexion of the knee turned the outer border backward, and Parkes took advantage of this fact to reduce; he flexed the knee as far as possible, and then with the end of his pocket-knife pushed the inner edge of the patella forward over the edge of the trochlea; then the knee was extended, and the bone returned to its place. Similar cases have been reported by Mayo,[2] Grasnick,[3] and Faucon.[4]

FIG. 160.



Dislocation of the patella outward. (DUPLAY.)

Treatment.—The method of treatment that has proved the most successful is one proposed more than a hundred years ago by Valentin, which consists in full extension of the knee and flexion of the hip to relax the quadriceps, followed by direct pressure with the hands upon the patella; it may be necessary to increase the laxity of the tendon of the quadriceps by pressing the lower part of the muscle downward toward the knee. Possibly a device which Duplay employed successfully in a

[1] Parkes: Chicago Med. Journ. and Ex., 1883, vol. 46, p. 387.

[2] Mayo: Lond. Med. Gaz., 1828; quoted by Malgaigne, loc. cit., p. 911. Malgaigne doubts the correctness of the diagnosis.

[3] Grasnick: Preuss. mil. ärztl. Zeitung, 1862, 1; quoted by Berger, loc. cit., p. 347.

[4] Faucon: Bull. de la Soc. de Chirurgie, 1887, p. 388.

vertical dislocation might be used, if pressure with the hands failed; he inserted the points of a strong double hook through the skin, engaged them under the edge or in the anterior surface of the patella, and drew the bone forward. Moreau did an arthrotomy, but the joint suppurated and the patient barely escaped with his life. Albert and König speak rather lightly of the risk involved in such an operation, and the latter employed it in a case of three months' standing, but whatever confidence surgeons may have in antiseptic methods they will, I think, be slow to resort to this measure.

In cases that have remained unreduced the usefulness of the limb has sometimes been well restored, the patients being able to walk freely and troubled only in making complete extension. In other cases, again, the disability has been great, the knee being stiff and the patient able to walk only with crutches. Occasionally the accident is followed by a marked tendency to recurrence on flexion of the knee.

2. *Incomplete.*

The cases to which I limit this group are those in which the dislocation takes place while the knee is extended, and in which the patella rests above and partly to the outside of the outer part of the femoral trochlea, its apex being probably still on the median side of the crest. It is to be remembered that in most systematic descriptions the group is made also to include cases of moderate edgewise or vertical displacement, those in which the inner border of the patella rests in the hollow of the trochlea and the outer border projects outward and forward; but still the majority of the reported cases are of the kind to which I have restricted the use of the term. There are, however, cases of habitual dislocation in which the patella moves outward during flexion of the knee and the outer border turns backward, which might properly be termed incomplete. Malgaigne (loc. cit., p. 912) reports one such in which the condition followed a primary traumatic dislocation, and a number have been reported in which the condition developed gradually or was thought to have existed at birth.

The causes are essentially the same as those which produce the complete outward dislocations in which the patella escapes at or above the upper part of the trochlea, that is, muscular action and external violence received while the knee is fully extended or even hyperextended.

Von Meyer finds the explanation of the incompleteness of the dislocation in the supposition that the lateral movement of the patella takes place while it is still at a lower point upon the femur than it is when it undergoes displacement outward; the outer margin of the trochlea engages in the sulcus at the junction of the patella and ligamentum patellæ, and thus the bone is prevented from being drawn further outward by the traction of the ilio-tibial band.

Direct examination has been reported in only one case, and that an old one, Diday;[1] the specimen came from a man thirty-four years old; the deformed patella rested on the external condyle and was prevented from moving inward by a bony ridge which occupied the trochlea; the

[1] Diday: Bull. de la Société Anatomique, 1836, p. 297.

articular surface extended an inch higher upon the outer than upon the inner condyle. The patient walked without difficulty.

The limb is in extension, and any attempt to flex is painful. The inner half of the trochlea can be distinctly traced with the finger, and the patella can be recognized above and to the outer side of its normal position, with its anterior surface looking almost directly forward, and if inclined at all it appears to be usually inclined outward.

The treatment is the same as that of the complete form: flexion of the hip and extension of the knee to relax the quadriceps, followed by direct pressure inward upon the patella. Reduction is easy and sometimes spontaneous; in a case reported by Cooper the reduction followed immediately and spontaneously upon the displacement, the only proof of the dislocation being a demonstrable rupture of the inner anterior part of the capsule and swelling of the joint.

3. *Outward edgewise or vertical dislocations.*

According to Malgaigne this form of dislocation was first reported in 1777 by Nannoni, an Italian surgeon, who communicated two cases to the Académie royale de Chirurgie. His account appears not to have been credited, and the subject was not again mentioned until Malgaigne, in 1836, gave a description of it. Since that time a considerable number of cases have been reported; without making a very thorough search I have found about thirty, five of which were reported in the *New York Medical Record* between the years 1873 and 1879, and in this enumeration I have not included cases reported as incomplete outward dislocations, although I include such in the classification.

The dislocation is characterized by a displacement outward of the patella and its rotation upon its longitudinal axis, by which its inner border is brought to rest at or near the bottom of the groove of the trochlea, while the outer border projects more or less directly forward and its anterior surface looks inward; it is said by Panas that its apex is also directed slightly backward.

Muscular action is the most frequent cause, and in some cases the contraction of the muscle appears not to have been forcible, as in Martin's[1] patient, a young girl, who caused the dislocation by moving in bed; in others more force has been exerted, as a boy in throwing a snowball, a man in wrestling, another in stumbling, another in jumping. External violence is a less frequent cause; a blow upon the inner edge of the patella by which the bone is pushed outward, its inner border depressed into the hollow of the trochlea, and its outer border raised by the passage of the bone along the slope of the external condyle. The mode of production by muscular action has not been made clear.

The patella may rest partly against the projecting outer portion of the trochlea, or it may touch the femur only by its inner edge even when its outer border still lies somewhat to the outer side of a sagittal plane passing through the inner one, and in one case, Payen, quoted by Malgaigne, the patella had turned more than 90°, so that its outer border lay

[1] Martin: Arch. gén. de Méd., 1831, vol. 26, p. 259.

a little to the inner side of the inner border. Its fixation in this position without lateral support must be attributed to the tension of the overlying soft parts and the untorn parts of the capsule, for in one case in which both the tendon of the quadriceps and the ligamentum patellæ were cut subcutaneously by the surgeon in the effort to reduce the bone remained as firmly fixed as before.

The knee is generally extended, but in some cases it was flexed half way to a right angle, and is usually immovable because of pain. The deformity is characterized by the sharp projection of the outer border of the patella in front, on each side of which the skin is depressed so that the anterior and articular surfaces of the patella can be felt, but sometimes the skin is stretched tightly toward each side.

The most successful treatment has been that recommended for the preceding forms: flexion of the hip, extension of the knee, and pressure upon the patella, the latter being so directed as to force the projecting outer border outward and backward, but this has failed in several cases in which reduction was afterward obtained by forced flexion of the leg or, in one case, by getting the patient forcibly to contract the quadriceps and then pressing upon the patella after it had been thus drawn upward. Possibly Duplay's device, above mentioned, of drawing the patella forward with a strong sharp hook, would be of use by diminishing the friction between it and the femur. Eben Watson, and others following his example, succeeded by slightly flexing the leg upon the thigh during anæsthesia, pressing the patella moderately outward, and then suddenly extending the leg. Three surgeons have resorted to section of the ligamentum patellæ, and one of them also to that of the tendon of the quadriceps, but without success, and in the last one the joint suppurated and the patient died.

4. *Complete reversal.*

Complete reversal, the outer border passing in front to the inner side, so that the anterior surface rests against the trochlea and the articular surface is directed forward, has been reported in only two cases which are briefly quoted by Malgaigne as follows; "In 1752 J. Sue saw a dislocation produced by muscular action in which he clearly recognized a two-thirds reversal of the patella from without inward without any evidence of rupture of the ligaments. Subsequently Hévin said that he had heard Bruyères read before the Académie royale de Chirurgie the details of a total reversal of the patella upside down, also without rupture of the ligaments; in the latter case the cause was a blow received upon the inner part of the knee."

Inward Dislocations.

These are so similar to the outward dislocations in their nature, causes, symptoms, and treatment that a detailed description is unnecessary.

Complete Inward.—This dislocation is denied by several authors, the only alleged cases being those of Putégnat and Walther, both quoted by Malgaigne. The former was traumatic in origin, but when the patient

came under observation the condition was that of habitual dislocation: the patient, a girl thirteen and a half years old, had fallen upon her knees five years before, and since that time both patellæ had been so freely movable that she sometimes amused herself by dislocating and reducing them more than a hundred times in an hour. The right patella could be more easily dislocated outward, the left one inward; but both could be dislocated so completely inward that their anterior aurfaces were exactly in contact when the knees were brought together. The ligaments were so relaxed that the legs could not be completely extended by the contraction of the quadriceps.

Of Walther's case, nothing is known but a brief description in Latin of a specimen in a museum at Berlin. Malgaigne thought it might be a complete inward dislocation, but admits that its character is uncertain.

Of *incomplete inward* dislocation only one case has been reported, by Key;[1] it also was quoted by Malgaigne. The patient, a girl twenty years old, slipped and fell; she felt great pain in the left knee, and was unable to walk. "The patella was found resting on the inner condyle, the outer part of its articulating surface being supported obliquely by the projecting edge of the trochlea of the femur. Gentle pressure on the inner edge of the patella, as the limb lay on the bed, reduced it to its natural position." The joint suppurated, and apparently the patient died or the limb was amputated. The tendon of the vastus externus was partly torn through.

Inward edgewise or vertical dislocation.—This seems to be nearly as frequent as the corresponding outward form. Possibly its relative frequency and the rarity or absence of the complete and incomplete inward forms are to be explained by the greater projection inward of the internal condyle, and the relative shortness of the ligamentum patellæ, which prevents the patella from reaching that side of the condyle.

Complete reversal, the inner border passing in front to the outer side, has been reported in three cases, Castara, quoted by Malgaigne, Wragg,[2] and Gaulke.[3]

Castara's patient, a girl seventeen years old, bent forward to lift a book from a table, resting her weight upon the extended right leg, and pressing the outer border of the patella against the edge of a chair; she suddenly cried out, and Castara, summoned immediately, found the leg partly flexed, and could extend it but very little. The patella rested by its outer border upon the outer and upper part of the trochlea of the femur, which it covered only over a breadth of a quarter of an inch; its inner border inclined outward and projected in this direction two and a half centimetres, its articular surface looking forward and inward. The tendon of the quadriceps and the ligamentum patellæ each formed a quite thick and hard rounded cord above and below. The surgeon grasped the bone with his thumbs and forefingers, and by a simple movement of rotation from behind forward, and from without inward, restored it easily to its place.

Wragg's patient was a negro, who had been struck upon the outer side

[1] Key: Guy's Hosp. Reports, 1836, vol. i. p. 260.

[2] Wragg: Charleston Med. Journ., May, 1856, abstract in Schmidt's Jahrbuch, 1856, vol., 91, p. 362.

[3] Gaulke: Deutsche klinik, 1863, p. 108.

of the right patella. The limb was extended and immovable. The inner border of the patella had turned forward and outward, and lay about half an inch to the outside of the normal position of the outer border; the outer border could be felt deep in the trochlea about half an inch from its inner edge. The tendon of the quadriceps and the ligamentum patellæ showed under the skin as hard twisted cords; very little passive motion at the knee. The dislocation was reduced quite easily by pressing with the thumbs against the projecting inner border, and with the index and middle fingers against the outer border in the opposite direction. The reaction was slight, and the patient made a good recovery.

Gaulke's patient, a girl seventeen years old, injured her knee in a fall from a horse, and was not seen by him until ten days after the accident. "The patella lay entirely upon the outer condyle of the femur, and had been so turned about its longitudinal axis that its posterior surface looked forward and inward, and the anterior surface backward and outward." After several failures he reduced by making pressure against the projecting inner border with one jaw of a vise, such as is used by carpenters to hold pieces of wood that have been freshly glued together, the counter-pressure being made with the other jaw against the internal condyle. The force of the screw was so applied as to press the inner border of the patella forward and inward, while its outer border was expected to move along the outer slope of the trochlea. After many efforts, the patella suddenly moved with a snap, turned about its long axis, and fell back into place. The patient recovered in a fortnight.

Congenital Dislocations.

In a number of reported cases the term *congenital* has been used although the writers knew that the dislocation had first appeared long after birth; in most of the others it has not been possible to ascertain with certainty the date of the appearance of the condition, and in many the probability is very great that it had been gradually developed long after birth. The reported cases in which it is reasonably certain that the condition existed at birth are not numerous, perhaps fifteen or twenty, but if to these are added the other cases which several of the patients have said existed in other members of their families, the number becomes considerably increased. The principal paper upon the subject is one by Zielewicz;[1] Bessel-Hagen[2] recently read one before the Berlin Medical Society, and presented two cases, but the published abstract is very short. Zielewicz's paper gives the details of 13 cases, in 3 of which the patella was dislocated upward with elongation of its ligament; in the remaining 10 the dislocation was outward. The congenital character of the first 3 is uncertain. Of the outward ones in which the sex is noted, 6 were males, 3 females; in 5 both patellæ were dislocated, and in all the patients were able to make good use of the limb.

Bessel-Hagen points out that the cases may be grouped in three classes: 1. The *incomplete*, in which the patella lies upon the outer condyle when the knee is extended, and returns to its normal place when the knee is

[1] Zielewicz: Berlin. klin. Wochenschrift, 1869, vol. 6, p. 25.
[2] Bessel-Hagen: Deutsche med. Wochenschrift, 1881, p. 45.

flexed; 2, *complete intermittent*, in which the displacement occurs during flexion; 3, *complete permanent*, in which the displacement is increased during flexion, and is not overcome during extension.

A case reported by Lannelongue[1] is less open to criticism than most, for the displacement was recognized at birth. The patient was a girl, seven years old at the time of the report. The right patella lay on the side of the outer condyle and was very movable, but could not be brought back to its normal place; the groove of the trochlea was almost effaced. There was no lateral mobility of the knee; the normal movements were free. When the child was told to raise the limb she first flexed the knee a little and then extended it rapidly. The right limb was smaller than the other, both in length and fulness, the femur being two centimetres, the tibia one centimetre, shorter than its fellow.

Caswell[2] reported a case of congenital dislocation of both patellæ in a man, forty-three years old, who said that five members of his family, in three generations, had the same deformity—his father, sister, son, and nephew. Dr. Caswell examined the son and confirmed the statement to that extent.

Shapleigh[3] saw a man, thirty-nine years old, both of whose patellæ "were dislocated outward, resting on the upper and outer surface of the external condyle of the femur." They were of normal size. The patient said the condition had existed from birth, and that his grandfather, father, and one of his own children, four generations, had the same deformity. The man walked without difficulty and had served as a soldier during the war.

An anonymous writer[4] reported a case of congenital dislocation of both patellæ in a girl whose father, aunt, and aunt's daughter were in the same condition.

Bessel-Hagen's two patients were brothers; in one the dislocation was intermittent; in the other permanent, with much disability, strong rotation inward of the femur, and slight contracture in the direction of flexion at the hip and knee.

Spontaneous or Pathological Dislocations.

A number of varying conditions in the bones or ligaments of the knee may have for consequence the frequent, even habitual, dislocation of the patella in certain positions or movements. Almost without exception, these dislocations are to the outer side and complete. Many cases reported as congenital are probably of this character; Isemeyer,[5] indeed, published an elaborate paper on the subject in which he claimed that all reported cases of congenital dislocation were really pathological ones.

Among the alleged causes are chronic hydrarthrosis, relaxation of the ligaments, chronic arthritis of different kinds, and malformation of the knee, especially genu valgum.

[1] Lannelongue: Bull. de la Soc. de Chirurgie, 1880, p. 238.
[2] Caswell: Am. Journ. Med. Sc., July, 1865.
[3] Shapleigh: Boston Med and Surg. Journ., 1881, vol. 105, p. 252.
[4] N. Y. Med. Journal, 1885, vol. 42, p. 27.
[5] Isemeyer: Arch. für klin. Chirurgie, 1866, vol. 8, p. 1.

Chronic hydrarthrosis has been claimed by several writers to be a frequent cause, and many illustrative cases have been published; but I think it must be conceded that something more than the simple presence of an effusion in the joint is needed to produce the condition, for all are familiar with cases in which an effusion, and even a very large one, has existed for years without creating any recognizable tendency to dislocation of the patella. This additional cause may be a softening and relaxation of the ligaments, itself due also to the cause of which the effusion is an effect.

In genu valgum the increased abduction of the leg upon the thigh produces a corresponding exaggeration of the angle between the quadriceps and the ligamentum patellæ in consequence of which the contraction of the muscle constantly tends to draw the patella outward, and if the patella passes to the outer side of the outer condyle the muscle then aids still further to abduct the leg and increase its deviation. Indeed, in some of the reported cases it has remained in doubt whether the abduction of the leg preceded or was itself the consequence of the dislocation of the patella.

The patella is habitually very movable, and the dislocation takes place or is increased during flexion of the knee and is reduced or diminished during extension. The functions of the limb are more or less interfered with, complete voluntary extension being difficult or impossible. The femur tends to rotate inward, and the leg outward and to become abducted.

A case which resembles Putégnat's of complete inward dislocation in the facility with which the patient could rapidly reduce the dislocation by muscular action is reported by Albert;[1] the patient was a boy, sixteen years old, with genu valgum on the affected side. When the knee was held at an angle of 160° he could repeat the production and reduction with great rapidity and ease. Flexion at 150° was the limit at which voluntary reduction could be made; voluntary dislocation was possible even when flexion was carried to 90°.

The treatment consists in the wearing of a knee-cap designed to oppose the displacement during flexion or to restrict the flexion to the range beyond which the displacement took place.

In a case reported by Golding Bird[2] it was believed that "the cause of the displacement was due to structural shortening of the quadriceps extensor following paralysis of the muscle — probably infantile," and tenotomy of the ligamentum patellæ was done, but without benefit.

[1] Albert: Chirurgie, vol. 4, p. 396.
[2] Bird: Lancet, 1884, ii. p. 778.

CHAPTER XXX.

DISLOCATIONS OF THE FIBULA.

THE fibula may be dislocated at its upper or at its lower end, and as the result of external violence, or of muscular action, or of unequal growth of the tibia and fibula.

A. *Dislocations of the upper end.*

These are among the rarest dislocations; Malgaigne, excluding cases complicated by fracture of the tibia or of the fibula, collected only 5 reported instances, and I have been able to increase the list only to 18, of which 6 were forward, 5 backward, 3 upward, 1 outward, and in 3, briefly mentioned by Bryant, the direction is not stated. It is to be remembered that as the head of the fibula is situated behind the most external part of the tibia a dislocation forward must also be outward. The cases are those of Dubreuil, Jobard, Savournin, Thomson and Boyer, quoted by Malgaigne, Stoll,[1] Richardson,[2] Sorbets,[3] Melzer,[4] Robert,[5] Oldright,[6] Read,[7] Parkinson,[8] Bryant,[9] and Erichsen.[10]

Of cases complicated by fracture of either the tibia or fibula, or of both bones, quite a number have been reported; several associated with fracture of the upper end of the fibula have been quoted in Fractures, page 586, and one of an exceptional form on page 580. Of those in which the dislocation is a complication of fracture of the tibia, and is produced by the overriding of the fragments by which the head of the fibula is forced upward, it is only necessary to say that, although the reported displacement has been very great in some cases, it does not appear seriously to have affected the treatment of the fracture, and in most cases reduction was easy. In some, in which the fracture united with shortening, there remained a permanent displacement of the head of the fibula upward. In a specimen presented by Shaw,[11] in which the tibia had been broken in its lower third and had united with much shortening, and in which the fibula also had been broken in two places, "the articulating surface of the head of the fibula was elevated to the same level as that of the tibia

[1] Stoll: Med. Corresp. Blatt., 1881, p. 300.
[2] Richardson: Am. Journ. Med. Sci., 1863, vol. 45, p. 385.
[3] Sorbets: Med. Corresp. Blatt., 1868, p. 279.
[4] Melzer: Allgem. mil. ärzt. Zeitung, 1871, vol. 12, p. 140.
[5] Robert: Rec. de mém. de med. chir. et pharm. mil., 1879, vol. 35, p. 279.
[6] Oldright: Canada Journ. Med. Sci., 1881, vol. 6, p. 79.
[7] Read: Phil. Med. News, 1883, vol. 42, p. 241.
[8] Parkinson, N. Y. Med. Record, 1886, vol. 29, p. 442.
[9] Bryant: Surgery, 3d Am. ed., pp. 807 and 934.
[10] Erichsen: Surgery, Am. ed., p. 440.
[11] Shaw: Patholog. Soc. London, 1848–50, p. 125.

and had become ankylosed in its displaced position." The dislocation is not always upward, but is sometimes forward, and sometimes the head has been freely movable backward and forward.

1. *Forward.*—The reported cases are those of Jobard, Savournin, Thomson, Melzer, Robert, and Read. Jobard's patient, a man thirty years old, stumbled and fell while going upstairs, and felt a sort of snap before he had fallen to the ground; Savournin's patient, a woman, thirty-five years old, while descending a staircase, caught her heel on a step; the front of the foot was sharply depressed and turned inward, and she fell in a squatting posture. Thomson's patient fell into a ditch, striking upon the injured leg; Melzer's slipped sidewise, and Robert's while jumping over a bench fell with the foot flexed and inverted, and suffered much pain all along the outer side of the leg, especially at the lower part. Read's patient, while shoeing a horse, was thrown down with his leg doubled under him. The mode and mechanism of production are not clear, although they seem to be directly associated with forcible depression and inversion of the front part of the foot. Jobard was inclined to attribute the displacement to the contraction of the muscles of the foot that arise from the front of the fibula, and Malgaigne regarded the explanation with favor, but it is open to serious objection.

Jobard's patient could flex and extend the leg, but could not rest his weight upon it; Melzer's could flex the knee and foot to a right angle, but the movements were painful; in Robert's the leg was slightly flexed and the foot everted, and extension of the knee and adduction of the foot were painful. In Read's the leg was extended, and the patient was in much pain. In Robert's there was much tenderness on pressure at the external malleolus, but no lesion was recognizable there.

The head of the fibula can be felt as a marked prominence in front of its normal position, forward and outward in Read's, three centimetres nearer the anterior tuberosity of the tibia in Robert's, and in Jobard's and Robert's it is noted that the tendon of the biceps could be plainly felt curving forward to the fibula.

Reduction was effected by Thomson, Jobard, and Robert by direct pressure upon the head of the fibula, while the knee was partly flexed; Savournin reduced while the knee was extended and the foot held in such a position that the anterior muscles of the leg were relaxed; in Read's case reduction took place spontaneously during the struggles of the patient while being anæsthetized. All recovered full use of the limb.

2. *Backward.*—The reported cases are those of Dubreuil, Richardson, Erichsen, Oldright, and Parkinson. Dubreuil's patient, a man thirty-two years old, in jumping to save himself from a fall, contracted his muscles forcibly and abducted his right leg; he felt sharp pain at the head of the fibula, and it was found to have been displaced an inch backward. Richardson's patient, a boy nine years old, fell from a fence and was thought to have struck the head of the fibula in the fall; Oldright's, a boy two years old, fell from a chair; Erichsen's, a man twenty-three years old, fell while walking, with the leg bent under him, so that he came down in a sitting posture; Parkinson's, a man of twenty-four years, fell on the injured side while walking. In Dubreuil's, Erichsen's, and Parkinson's cases it seems reasonable to attribute the displacement to the

forcible contraction of the biceps, but in Oldright's and Richardson's the patients were so young that the intervention of direct external violence is probable. In a case observed by myself (Fractures, p. 586) complicated by fracture along the epiphyseal line, direct violence was the cause.

In Dubreuil's and Richardson's cases the foot was slightly everted, and in the former there was a sensation of cold and numbness along the peroneal region of the leg. In Parkinson's the external lateral ligament could be distinctly felt; in Erichsen's the tendon of the biceps was tense, and in Richardson's it could be distinctly felt still attached to the fibula. The displacement is described as backward in all, and its extent as one inch in Dubreuil's.

Reduction was effected without much difficulty by Dubreuil, Richardson, and Parkinson by direct pressure upon the head of the fibula while the knee was flexed. In Dubreuil's the displacement recurred on the following day, and was then less easily reduced; a knee-cap of leather was then worn for twelve days, and the patient was then able to walk with a cane, but for some time the leg had a tendency to bend outward; ultimately recovery was complete, as it was also in the other two cases.

Erichsen and Oldright did not see their patients until some time after the accident; in the former's the displacement was permanent and "the limb was somewhat weakened, so that the patient could not jump, but otherwise he suffered no inconvenience." In Oldright's the displacement could be easily reduced, but it immediately recurred; local pressure and immobilization of the knee failed to cure. Judging from my experience with dislocations of the outer end of the clavicle, I should think that retention by a strip of adhesive plaster placed around the upper part of the leg would be effective.

3. *Upward.*—Of this form there are only three reported cases, Boyer, Stoll, and Sorbets, and the account of the latter is too incomplete to be of any use or even to establish the accuracy of the diagnosis.

Boyer's patient appears to have received a dislocation outward of the foot or a Pott's fracture of the ankle in which the fibula, instead of breaking, had been pushed bodily upward; the extent of the displacement is not stated; the restoration of the foot to its place corrected the upper dislocation also, and the patient recovered. A somewhat similar case in which there was fracture of the lower end of the tibia is quoted in Fractures, p. 580.

In Stoll's case the head of the fibula is described as standing "notably higher than normal on the outer surface of the tibia, and forming there an immovable, firm, sharply projecting tumor, very painful on pressure." He quotes Dubreuil's case as identical, and attributes the displacement to the forcible contraction of the biceps, and, therefore, it seems possible that the dislocation may belong among the backward ones. The patient was a circus-rider and received the injury in jumping from his horse, alighting upon his toes. The sole was everted, the toes abducted; the inner side of the ankle swollen and tender; passive motion of the knee and ankle very painful; numbness of the outer side of the leg. No fracture could be found. Reduction was made by forcible traction on the foot, the knee being flexed at a right angle, and was accompanied by a snapping sound.

4. *Outward.*—The only case in which the displacement is described as outward is one briefly referred to by Bryant, in which the displacement was due to arrest of the growth of the tibia following injury to its epiphyseal cartilage.

B. *Dislocations of the lower end.*

Of this the only two recorded cases, excluding, of course, the numerous ones in which diastasis of this joint has formed one of the lesions of Pott's fracture at the ankle and the few cases in which the same diastasis has been part of inward or outward dislocation of the foot, are one observed by Nélaton in the service of Gerdy and one in the service of Tillaux reported by Dunand.[1] Gerdy's patient came to the hospital thirty-nine days after the accident. The wheel of a wagon had passed across the lower end of his leg and had forced the external malleolus so far backward that it was almost in contact with the outer border of the tendo-Achillis; the outer surface of the astragalus could be felt through almost its entire extent. The patient walked fairly well, and Gerdy thought no attempt to reduce should be made.

Tillaux's case resembles Pott's fracture at the ankle. The patient in stepping from an omnibus caught his foot and fell forward. The foot was everted, there was a large ecchymosis on the inner side of the leg and foot, and another on the outer side; the ankle was swollen and tender, especially on the inner side; no fracture could be found. The lower end of the fibula was freely movable forward and backward with cartilaginous crepitus, and could be drawn outward so far that the end of the finger could be inserted between it and the astragalus. The patient made a good recovery. It seems probable that this was produced by *inversion* of the foot, by which the upper outer border of the astragalus was turned outward, forcing the fibula away from the tibia.

Spontaneous or Pathological Dislocations.

These have been reported as occurring at the upper end in consequence of inflammation of the joint, of rachitic changes in the bones, and of exaggerated growth of the tibia following necrosis. In the same group may be classed the dislocation outward reported by Bryant, and quoted above, which was due to arrest of the growth of the tibia.

Malgaigne, after quoting a general description given by Cooper, according to which chronic hydrarthrosis leads to the easy displacement of the head of the fibula and to much weakness and fatigue in walking, describes a case under his own care in which this laxity of the joint existed; in certain movements of the knee the fibula was displaced backward, returning almost at once to its place with a cracking sound; the condition followed an arthritis which had produced a similar relaxation of the knee.

In a case of rachitic curvature of the leg in an infant Malgaigne thought he could recognize the head of the fibula displaced upward almost to the level of the articular surface of the tibia, and on examining the rachitic

[1] Dunand: Thèse de Paris, 1878, No. 217.

skeletons preserved in the Musée Dupuytren he found several examples; the displacement was upward and outward at the upper end, the lower end preserving its normal relations.

Dislocation downward of the upper end due to elongation of the tibia following necrosis was described by Parise (quoted by Malgaigne), who reported three cases. In one of them the elongation was three centimetres on the inner side of the tibia and one and a half centimetres on the outer. Malgaigne subsequently saw and reported a fourth case. The condition did not affect the functions of the limb.

CHAPTER XXXI.

DISLOCATIONS AT OR NEAR THE ANKLE.

1. DISLOCATIONS OF THE FOOT. 2. SUBASTRAGALOID DISLOCATIONS. 3. DISLOCATIONS OF THE ASTRAGALUS. 4. MEDIO-TARSAL DISLOCATIONS.

Anatomy.—The principal movements of the foot are those of flexion and extension, or dorsal and plantar flexion, which take place in the joint formed by the astragalus and the tibia and fibula, and that of adduction and abduction combined, respectively, with inversion and eversion of the sole, which takes place in the joints between the astragalus on one side, and the calcaneum and scaphoid on the other, and is aided by slight motion between the calcaneum and cuboid. The axis of the first joint, the ankle, is horizontal and nearly transverse, its inner end inclining forward; that of the other runs obliquely from a point near the inner tuberosity of the calcaneum upward and forward to a point on the upper surface of the neck of the astragalus.

The astragalus articulates above with the under surface of the tibia, and on the sides with the malleoli, between which it is so snugly placed that no lateral motion is possible. On each side the lateral ligament passes to the astragalus and calcaneum from the malleolus, and the lower ends of the tibia and fibula are bound together by ligaments in front and behind. The capsule, which is attached close to the edge of the articular cartilage on each bone, is loose in front and behind. The range of dorsal and plantar flexion is nearly 90°, and as the articular surface of the astragalus is somewhat narrower behind than in front some lateral motion of the joint is possible in full plantar flexion.

The rounded head of the astragalus articulates with the posterior concave surface of the scaphoid, the inferior calcaneo-scaphoid ligament, and slightly with the anterior end of the calcaneum. On the under surface of the astragalus are two articular facets corresponding to two on the upper surface of the calcaneum, and between them is the strong interosseous ligament which fills the canal formed by grooves separating the two articular surfaces on each bone, and binds the bones firmly together. The maximum range of motion in these joints is about 40°, and is limited partly by bony contact and partly by the ligaments.

In this chapter I shall describe four different dislocations: those of the foot, those of the astragalus, the subastragaloid, and the medio-tarsal dislocations; under the first term are included those in which the astragalus, while maintaining its relations with the other bones of the foot, is displaced from the bones of the leg; under the second, those in which it is also displaced from the calcaneum and scaphoid; under the third, those n which the astragalus remains in the tibio-fibular mortise, and is sepa-

rated from the calcaneum and scaphoid; and in the fourth, those in which the scaphoid and cuboid are together dislocated from the astragulus and calcaneum.

1. Dislocations of the Foot. Tibio-tarsal Dislocations.

The displacements of the astragalus and the foot are so complex that the nomenclature of the various dislocations presents serious difficulties, and the confusion has been increased by the varying practices of different writers, some of whom treat the tibia as the dislocated bone and apply the terms indicative of direction to it, while others consider the foot as the dislocated portion. I shall here follow the latter practice, and shall use in the classification only four main terms, dislocations *forward*, *backward*, *outward*, and *inward*, disregarding for the moment the many deviations in the direction of the toes and of the sole which are seen in conjunction with the principal dislocations. Of these four the first two are pure dislocations; in the latter two are frequently placed cases in which the displacement is associated with fracture of one or both bones of the leg, and of which the more common forms have been elsewhere described among fractures at the ankle. It must be freely conceded that the classification, especially in respect of the last two groups, is arbitrary and open to serious criticism, but so are all others that have been proposed, and it is believed that this one has a sound clinical basis in so far that the terms outward and inward correspond to displacement outward or eversion, or to displacement inward, or inversion of the foot, symptoms which would at once attract the attention of the surgeon, and that its divisions coincide also with those of the modes of production.

Two striking varieties, in which the toes are turned directly inward or outward, will be mentioned under inward and outward dislocations respectively. The latter has been classified by some as a separate form, under the title of dislocations of the foot by rotation outward.

The mechanism of the joint and the mode of production of the dislocations have been experimentally studied by many surgeons and anatomists, of whom I shall here name only one of the more recent, Hönigschmied,[1] whose experiments were exceptionally numerous, and whose article is very full.

A. *Dislocations backward.*

(Syn. Dislocations of the lower end of the tibia forward.)

In these dislocations the astragalus, and with it the foot, is displaced backward to a variable distance, with rupture of the lateral ligaments and sometimes of other parts of the capsule, and sometimes with fracture of one or both malleoli or of the posterior edge of the lower articular surface of the tibia.

The cause is usually extreme plantar flexion of the foot, in which the posterior border of the end of the tibia comes into contact with the posterior lip of the astragalus (Henke[2]), by which a new centre of motion is

[1] Hönigschmied: Deutsche Zeitschrift für Chir., 1877, vol. 8, p. 239.
[2] Henke: Zeitschrift für rat. Med. 1858, 3d ser., vol. 2, p. 177.

established behind the line of the malleoli; the continuation of the movement ruptures the lateral and the anterior ligaments, and the bones being thus freed the tibia is pushed forward over the astragalus, or the foot is pushed backward under the tibia, according as the causative violence acts upon the leg or upon the foot. The rupture of the ligaments is the first step, and the fixation of the astragalus behind the tibia takes place by correction of the plantar flexion. Commonly the injury is produced by a fall backward while the foot is fixed. In an incomplete dislocation reported by Sanson (quoted by Albert) the patient's leg was bent under him in a fall in such a way that the dorsum of the foot and the front of the leg rested on the ground, and the buttocks rested on the heel; in this case the mechanism appears to have been pure exaggerated plantar flexion. Examples of pure primary dislocation are rare, Malgaigne could find only 18 reported cases; but partial, and perhaps complete, dislocations occurring as a secondary result of rupture of the lateral ligaments or fracture of the fibula and internal malleolus, as in Pott's fracture at the ankle, are frequent, and always need to be guarded against in the treatment of this last-named injury; they are produced either by the falling backward of the insufficiently supported foot, as the patient lies upon his back, or by contraction of the flexor muscles, and occasionally subcutaneous division of the tendo-Achillis has been resorted to to overcome or prevent it.

Hönigschmied produced the dislocation 20 times and found the results quite constant; in 14 the internal lateral and the anterior branch of the external lateral ligament were the first to yield, being torn away from their insertions, then the middle and posterior branches of the external lateral ligament yielded, and the foot was thus completely freed. The ligaments were torn away, and occasionally small scales of bone came away with them. In 5 experiments on the bodies of elderly people, both malleoli were broken off in 3, and the external malleolus in 2. The internal malleolus broke at its base, and the line of fracture ran downward and backward; that of the external malleolus ran upward and backward, beginning just above the insertion of the anterior branch of the lateral ligament.

Clinically and post-mortem the same lesions have been found; fracture of the external malleolus is common, that of the internal malleolus and of the posterior articular border of the tibia is occasionally seen. In a case reported by Malgaigne of this fracture of the tibia the posterior fragment comprised the posterior half of the articular surface and extended an inch upward on the back of the bone.

The foot appears shortened in front, and the heel lengthened, to an extent that varies with the degree of the displacement, the maximum being about an inch; the lower end of the tibia projects more or less markedly in front and sometimes is exposed by rupture of the skin; the extensor tendons may be felt as tense cords crossing to the dorsum of the foot, and the tendo-Achillis curves backward to the heel leaving on each side a well-marked depression between itself and the malleolus. The toes may be a little depressed, and perhaps abducted or adducted. If the fibula is broken its malleolus accompanies the foot in its displacement backward.

Reduction, with the exception of Cooper's first case, in which he appears not to have made the diagnosis at the time, has always been easily obtained by pressing the foot forward and the lower end of the leg backward. Malgaigne recommends that the foot should be held in dorsal flexion while the pressure is made, but others, and, I think, more justly, prefer plantar flexion because the foot is in that position when dislocation takes place. Prevention of recurrence appears to have been difficult; Malgaigne quotes several cases in which the treatment failed and the patients remained crippled. In his own last case he was successful by immobilizing the limb in a mould of plaster, and there seems to be no reason to doubt that a firm dressing of gypsum or silicate bandages would fully meet the indication. I have always found it satisfactory in cases of Pott's fracture in which the foot tended to sink backward.

If the dislocation is compound it must be treated antiseptically in the most rigorous manner, and with drainage behind as well as in front of the joint.

The disability in cases that remain unreduced is very great and may call for excision or amputation. It is worthy of note that Hueter successfully reduced by plantar flexion and direct pressure a dislocation that had existed for six months.

B. *Dislocations forward.*

(Syn. Dislocations of the lower end of the tibia backward.)

In this dislocation, which is much rarer than the preceding, the astragalus, and with it the foot, is displaced forward from beneath the tibia. Malgaigne collected only 5 cases, Delamotte, Colles, Nélaton, Pierre, and R. W. Smith, and I am able to add only 5 more, Huguier,[1] Sarazin,[2] Augarde,[3] Willemin,[4] and Hornby,[5] making 10 in all.

The mode of production may be by dorsal flexion of the foot followed by impulsion of the tibia downward and backward by a force acting in the direction of its long axis, or by direct pressure of the foot forward and of the leg backward while they are at right angles to each other. Among the recorded cases are clear examples of each, such as R. W. Smith's and Nélaton's of the former, and Huguier's of the latter. R. W. Smith's[6] patient, while standing with the hip and knee flexed and with the foot resting on a stone in such a manner that the toes were higher than the heel, was struck upon the knee by a falling cask which forced it downward and increased the flexion at the knee and ankle. In Nélaton's[7] case, a woman, who fell from the fourth floor, the anterior lip of the articular surface of the tibia was broken off, and the upper surface of the astragalus was scratched antero-posteriorly, showing that the tibia had been inclined forward so that the edge of the fracture was in contact with

[1] Huguier: Gaz. des Hôpitaux, 1855, p. 469, and Arch. gén. de Méd., 1868, i. p. 513.
[2] Sarazin: Recueil de mém. de méd, chir. et pharm. mil., 1860, vol. 4, p. 66.
[3] Augarde: Idem., 1880, vol. 36, p. 168.
[4] Willemin: L'Union méd., 1866, vol. 29, pp. 50 and 73.
[5] Hornby: Med. Times and Gazette, 1871, ii. p. 10.
[6] R. W. Smith: Dublin Quart. Journ. of Med., 1852, i. p. 465.
[7] Nélaton: Pathol. Externe, vol. ii. p. 477.

the astragalus and had been pressed firmly against it as the tibia slipped backward.

The experiments of Henke and Hönigschmied indicate that dorsal hyperflexion alone is not competent to produce the dislocation or even to rupture both lateral ligaments. They both found it necessary to divide the tendo-Achillis before the flexion could be carried far enough to rupture any of the parts of the joint, and even then the injury was usually limited to fracture of the internal malleolus and rupture of the posterior branch of the external lateral ligament. It is probable, therefore, that the real mechanism in cases like the two just quoted is the violent driving of the tibia downward and backward while the knee is bent forward over the foot.

The second method of production differs, therefore, from the first only in the direction in which the force and counter-force are applied, both acting, in the second, at right angles to the long axis of the limb, the one upon the front of the lower end of the tibia, the other in the opposite direction upon the back of the heel. Huguier's case is an example: a man, while engaged in turning a railway turntable, fell and caught his foot in such a manner that the knee was fixed and a projecting rail on the moving turntable pressed against the front of the tibia six inches above the ankle and produced a well-marked dislocation of the foot forward. In the case reported by Willemin the mechanism was probably the same; a woman slipped with her left foot and fell, and in the fall struck the heel of the right foot upon the floor, dislocating it forward; she had previously suffered dislocation of several other joints by comparatively slight violence, and probably her ligaments were relaxed or weak. In Hornby's it was also probably the same; the patient had his foot and leg caught under a falling horse; and in Augarde's the dislocation was caused by a violent movement of the patient in an effort to rise from the floor while his foot was caught between two iron bars; apparently the knee was thrust forward while the foot was fixed and the front of the lower part of the leg rested against one of the bars, and thus the extreme lower end of the bone was carried behind the astragalus. In Sarazin's the cause appeared to have been a fall upon the feet, but the patient was not seen until three months after the accident, the displacement forward was only one centimetre, the external malleolus had been broken, and the intermalleolar space was widened; the articular surface of the astragalus could not be felt in front of the tibia.

The symptoms are lengthening of the front of the foot and shortening of the heel, with effacement of the depressions on each side of the tendo-Achillis. The foot is in the position of more or less plantar flexion, and in one or two cases the hollow of the instep was exaggerated. The upper articular surface of the astragalus can be felt in front of the end of the tibia, and the malleoli are nearer to the heel and to the sole than normal.

In Huguier's, Willemin's, Hornby's, and Augarde's cases reduction was easily made by traction and direct pressure; in Smith's it could not be made, but there is reason to think the efforts were not guided by a correct appreciation of the nature of the injury; Nélaton's patient was killed by the fall; in the remaining cases the details of treatment are

lacking. In Smith's, Colles's, Pirrie's, and Sarazin's cases the dislocation was not reduced, and the patients were much crippled.

C. *Dislocations inward.*

In this division are placed those cases in which, usually by adduction and inversion (supination), the foot is moved downward and to the inner side, so that the astragalus leaves the tibio-fibular mortise more or less completely. Two distinct forms are observed: in one the foot is markedly inverted and the upper surface of the astragalus can be seen and felt raising the skin under the external malleolus; in the other the inversion of the foot is less or is absent and there is marked adduction, so that sometimes the ends of the toes point directly inward; in the latter form it is thought that the displacement is secondary to a backward dislocation.

Malgaigne includes in the group (which he terms tibio-tarsal dislocations outward) many cases complicated by fracture of the astragalus or of one or both bones of the leg; but of his total of 22 cases, 8 were not thus complicated, and to these I can add 4, Busch,[1] Nunnely,[2] Eames,[3] and Carmichael.[4] I have described under "fractures by inversion and adduction of the foot," Fractures, p. 578, the lesions and symptoms in cases in which fracture is present and the displacement is absent or slight.

Excluding for the moment those cases in which the displacement is secondary to a backward dislocation, it seems probable that the cause is violent supination, or inversion, of the foot, but the histories of the cases do not positively establish this opinion. In most the cause has been a fall, usually from a height; Carmichael's patient, a woman, turned her foot while walking down hill, Nunnely's ran at night into an excavation the bottom of which was covered with loose stones and bricks, Eames's fell with a falling platform, and Busch's was injured in the overturning of a wagon.

The astragalus fits so snugly and squarely into the tibio-fibular mortise that in a considerable proportion of cases it cannot be turned in it about its own antero-posterior axis without breaking the external malleolus or forcing it away from the tibia by the pressure of the upper outer edge of the astragalus. In the experiments which Hönigschmied made by fixing the foot in a vise and bending the leg directly toward the inner side—tibial flexion—the external malleolus was broken 5 times, the external lateral ligament torn from its insertion 12 times, and in 3 cases the joint remained unopened and separation took place between the astragalus and the calcaneum. These results coincide in the main with those obtained in a similar manner by Bonnet, and Hönigschmied accepts the latter's opinion that the fracture of the malleolus is effected by the direct pressure upon it of the outer upper border of the astragalus and not by traction exerted through the external lateral ligament. Bonnet frequently found the internal malleolus also broken, Hönigschmied never.

[1] Busch: Lehrbuch der Chir., vol. 2, part 3, p. 327; quoted by Lossen.
[2] Nunnely: Brit. Med. Journ., 1868, ii. p. 362.
[3] Eames: Idem, 1871, i. p. 503.
[4] Carmichael: Idem, 1871, ii. p. 35.

In one case, Busch, in which there was no fracture, the dislocation was compound and the bones of the leg protruded through the wound in front, the astragalus lay entirely to the inner side of the internal malleolus, and the foot was greatly adducted; Busch thought the dislocation had been primarily backward. In Bardy's fracture of the fibula was noted, and in Ravaton's (both quoted by Malgaigne) there was diastasis of the lower tibio-fibular joint, which gave him much trouble in the treatment.

In some cases, in which the displacement inward may be assumed to have been secondary to a backward dislocation, the adduction of the foot has been very great, 90°, so that the toes pointed directly toward the other ankle; in the others the adduction is less, but the inversion is great; in Carmichael's "the plantar aspect pointed to the middle line of the body," in Eames's "the plantar aspect of the foot was completely inverted." In some the external malleolus was very prominent; in Nunnely's "there was a large and well-marked projection below the outer malleolus" over which the skin was very tense, and "there was a deep, narrow depression at the inner malleolus where the skin was also very tight."

Reduction has always been easily effected by traction and eversion of the foot, and in the uncomplicated cases the recovery has been complete.

D. *Dislocations outward.*

The injuries which have been described under this head are, almost without exception, those which are now commonly known as Pott's fracture at the ankle, and which have been described in Fractures, page 581, as fractures by eversion and abduction of the foot. A few more or less doubtful cases have been reported which differ more or less from those of Pott's fracture in their mode of production and lesions, and which might be termed partial dislocations of the foot outward. One such, Boyer, has been quoted in Chapter XXX., page 505, as an example of upward dislocation of the head of the fibula; another is that of Desault, quoted by Malgaigne (loc. cit., pp. 996 and 998), in which the cause appears to have been abduction of the foot without eversion.

In three cases, Huguier,[1] Thomas,[2] and Soubie,[3] the foot has been so far abducted that the toes pointed directly outward. This form was first observed by Huguier and described by him as "*dislocation of the foot by rotation outward.*" His patient was overthrown by a cask, which rolled upon his legs; Thomas's by a falling mass of straw; and Soubie's fell from a height of six feet, alighting upon his left foot, which was then engaged between a large stone and the trunk of a vine, while the body was twisted to the right, and the patient fell on his right side. In Huguier's case the external malleolus was separated from the tibia, pressed backward, and rotated outward, and the shaft of the fibula was broken in the upper third. In the other two cases no fracture was found. In Thomas's "the anterior border of the lower end of the tibia formed a

[1] Huguier: L'Union Médicale, 1848, p. 128.
[2] Thomas: Revue de Chirurgie, 1887, p. 821.
[3] Soubie, quoted by Thomas.

marked prominence in front over which the skin was tightly stretched, and below which was a transverse depression that would admit the finger." Reduction was easily effected under anæsthesia in all three cases.

Nélaton made a separate class of those rare cases of Pott's fracture in which the astragalus is forced upward between the tibia and fibula, and termed them *dislocations upward*. I do not see that any advantage is to be gained by separating them from the group of which they are only an extreme form.

The principles of treatment are the same as in Pott's fracture.

E. *Compound and complicated dislocations of the foot.*

Dislocations of the foot may be compound, primarily or secondarily, with protrusion of the bones of the leg or of the astragalus through the wound, and they may be complicated by rupture of bloodvessels and by other fractures than those of the malleoli already referred to.

In dislocations that are primarily compound the wound of the skin may be made from within outward by the projecting bone or by contact with the ground. In those that become secondarily compound the sloughing of the soft parts may be due to the pressure of the unreduced bones or to bruising of the soft parts inflicted at the time of dislocation.

The statistics that have been collected come almost entirely from the period anterior to the introduction of antiseptic methods and therefore cannot be trusted to show the necessity or desirability of amputation or excision. So far as can be judged from recent experience in these dislocations and in compound dislocations of other joints, conservative treatment under antiseptic rules may properly be tried in primary compound dislocations not seriously complicated by fracture, and if suppuration is avoided a useful, movable joint may be hoped for. Particular attention must be given to drainage, and as the astragalus completely fills the space between the malleoli separate drainage must be provided for the back and front of the joint. The limb must be carefully immobilized with the foot at a right angle to the leg and without inversion or eversion, in order that if the joint should become stiff the disability will not be increased by a faulty position of the foot.

In cases in which suppuration has ensued, either before or after reduction, the treatment should still be conservative with the object of obtaining ankylosis in a good position or perhaps a slightly movable joint; but if the astragalus is broken I think it would be better to remove it. It has frequently happened that suppuration of the joint has been followed by necrosis of the astragalus, presumably because of the interruption of its blood-supply consequent upon the laceration of its ligaments, and this result would of course be still more probable after its fracture. Langenbeck[1] even in 1874 recommended conservative treatment in compound injuries of the ankle, both in civil and military practice, although Billroth and Socin estimated the mortality after such injuries under all kinds of treatment at 34 and 38 per cent. respectively. I have had no experience with compound dislocations of the ankle, but all the compound fractures

[1] Langenbeck: Arch. für klin. Chir., 1874, vol. 16, p. 484.

involving the joint that have come under my care, nine or ten in number, have, with one exception, recovered without suppuration, and although the laceration of the soft parts is less in such injuries than it is in the complete dislocations I believe that primary amputation or excision should not be resorted to in the absence of exceptional conditions, such as extreme laceration or fracture, that specially indicate one or the other.

2. Subastragaloid Dislocations. Dislocation of the Astragalo-calcaneoid and the Astragalo-scaphoid Joints.

For the establishment of this group in the classification of dislocations of the tarsal bones we are indebted to Broca,[1] who, in a remarkable paper read before the Société de Chirurgie in 1852, carefully analyzed the scattered cases that had been reported under various titles and gave a detailed and systematic description of the various forms of the injury to which little has since been added except in amplification of the statistics. His plan of subdivision recognized dislocations backward, inward, and outward of the calcaneum and scaphoid from the astragalus. Malgaigne added a fourth variety, dislocations forward, of which Broca himself subsequently saw a possible example, and changed the nomenclature by treating the astragalus as the dislocated bone and applying the terms indicative of the direction of the displacement according to its position with relation to the others. I shall here follow Broca's use of the terms, which is in harmony with that used in the other dislocations.

The dislocation, then, presents four varieties: that in which the calcaneum and scaphoid are displaced inward (and somewhat backward), the head of the astragalus projecting on the outer part of the dorsum of the foot; that in which they are displaced outward; and those in which they are displaced directly forward or backward and downward. The first two are about equal in frequency and together comprise most of the reported cases; of each of the last two only one or two examples have been reported. The most notable addition to the collected statistics has been made by Poinsot.[2]

A. *Dislocations inward, or inward and backward.*

The cause is forcible inversion and adduction of the foot, usually combined with violence acting in the direction of the long axis of the leg, as in a fall from a height. The displacement is rarely, if ever, directly inward, but is also somewhat backward, so that the head of the astragalus rests partly upon the cuboid. The only autopsy is one made in an old case by Quénu;[3] there was shortening of the dorsum of the foot, and elongation of the heel, and the foot was in the position of varus. The head of the astragalus lay upon the interarticular lines between the

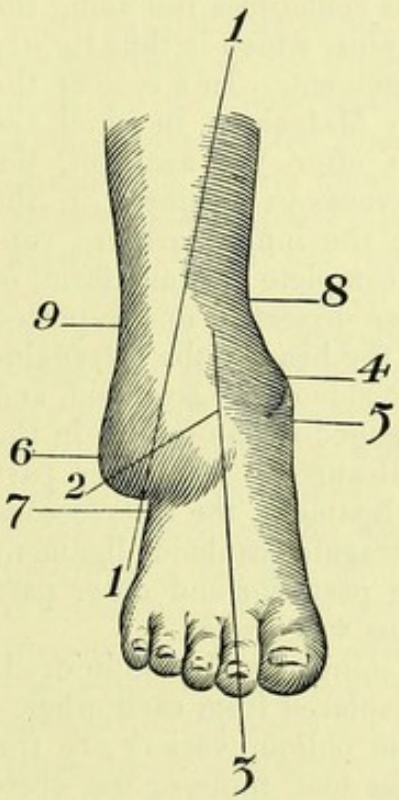
[1] Broca: Mém. de la Soc. de Chirurgie, 1852, vol. 3, p. 566, and abstract in Bull. de la Soc. de Chirurgie, 1853, vol. 3, p. 241.

[2] Poinsot: L'intervention chirurgicale dans les luxations compliqués du cou-de-pied, Paris, 1877, and his translation of Hamilton's Fractures and Dislocations, p 1196.

[3] Quénu: Progrès Méd., 1883, p. 187.

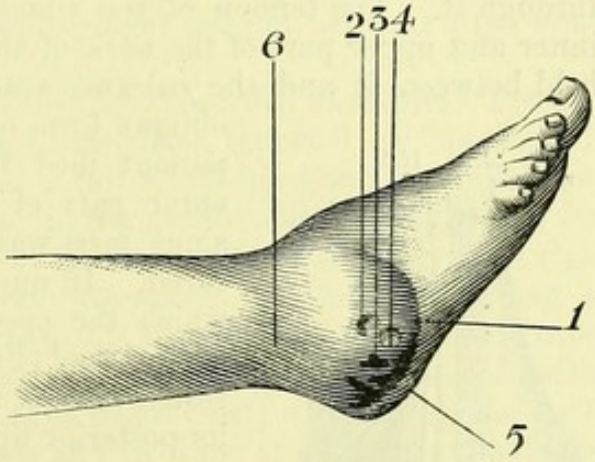
calcaneum and cuboid and the cuboid and scaphoid, overlapping the former half an inch and thus resting on the cuboid. The posterior border of the astragalus lay in the groove between the anterior and posterior superior articular surfaces of the calcaneum, and its posterior lip had been broken off and remained in its normal relations with the calcaneum. There was no fracture of either malleolus. The dorsalis pedis artery and the extensor tendons lay to the inner side of the head of the astragalus; the peroneal tendons had been displaced from their groove and separated half an inch from the fibula. In other cases the displacement has been greater and the skin has been broken on the outer side of the foot; in one of Malgaigne's the head of the astragalus was almost in contact with the fifth metatarsal bone; in one of Letenneur's it corresponded to the outer border of the foot and projected entirely through a wound in the skin, and the calcaneum had been completely displaced from its inferior articular surface. The form and degree of the displacement vary with the different combinations of displacement inward, back-

FIG. 161.



Subastragaloid dislocation inward; 5, sustentaculum tali; 4, inner malleolus. (DU BOURG.)

FIG. 162.



The same; 1, head of astragalus; 3, 4, old cicatrices; 5, a fistula; 6, fracture of the fibula. (DU BOURG.)

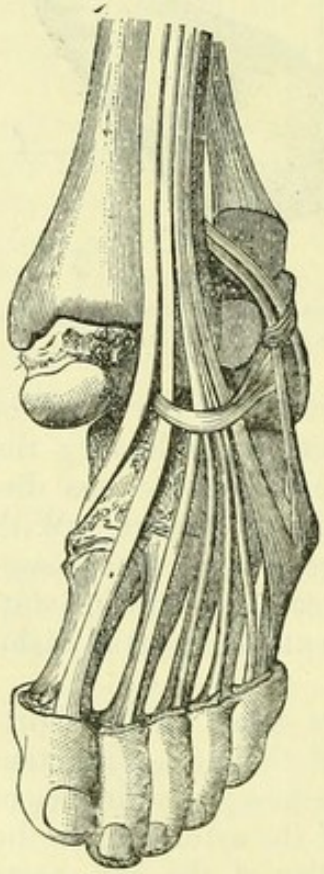
ward, and by adduction of the front of the foot, the latter sometimes leaving the posterior part of the calcaneum less displaced inward than its front part. With the dislocation there is sometimes associated injury to the calcaneo-cuboid joint, rupture of its ligaments and partial dislocation of the bones.

The symptoms are more or less shortening of the dorsum of the foot and lengthening of the heel, adduction of the toes, and elevation of the inner border of the foot; prominence of the tip of the external malleolus and of the head of the astragalus on the outer side of the dorsum, with marked depressibility of the soft parts below each; the internal malleolus is deeply placed under the skin, and below and behind it can be felt the projecting sustentaculum tali, and in front of it the inner surface of the scaphoid.

B. *Dislocations outward.*

Of this Malgaigne makes two varieties, distinguished clinically by the existence of marked abduction of the toes in one, and its absence in the other. In the former (his *luxation oblique en dedans*, or *obliquely outward*, according to the nomenclature here used) the posterior articular surface of the astragalus is not separated from the calcaneum, but the foot has turned upon the posterior calcaneo-astragaloid joint, or upon the outer part of the interosseous ligament as a centre, and the scaphoid has been carried to the outer side of the head of the astragalus, and also sometimes either upward or downward. In the second form, that without abduction of the toes, the foot is displaced bodily outward from beneath and in front of the astragalus. The cause in the former is the forcible abduction of the foot; in the latter it appears to be either abduction and eversion of the foot, or great violence exerted directly against the inner side of the foot, or the outer side of the lower part of the leg. The dislocation may be primarily or secondarily compound, the wound in the skin corresponding to the head of the astragalus, which may project entirely through it. The tendon of the tibialis anticus sometimes lies along the inner and upper part of the neck of the astragalus, which is thus tightly held between it and the calcaneo-scaphoid ligament. In a case of the oblique form quoted by Malgaigne, in which the patient died four days after the accident, the outer part of the interosseous ligament in the sinus tarsi was entire; the inner part was ruptured. In one of the complete outward form, of which the specimen was dissected, and reported by Nélaton[1] (Fig. 163), the head of the astragalus rested against the inner side of the scaphoid, and its posterior lip was engaged in the groove in the upper surface of the calcaneum; the lower part of the internal lateral ligament, the interosseous ligament, and the astragalo-scaphoid ligament were ruptured, and the posterior and outer part of the external malleolus was broken.

Fig. 163.



Subastragaloid dislocation outward. (Malgaigne.)

The calcaneo-cuboid joint may also be injured, and the bones partly displaced from each other.

The symptoms in the oblique variety are the marked abduction of the foot, more or less eversion, and marked prominence of the head of the astragalus on the inner side. In a case reported by Boyer the displacement was slight, and was at first overlooked; when recognized, it was irreducible, but the patient regained good use of the limb.

The symptoms in the variety in which the displacement is directly outward are the marked displacement of the foot, with but little, if any, eversion or abduction, the axis of the leg falling to the inner side, and

[1] Nélaton: Bull. de la Soc. Anatomique, 1835, p. 38.

somewhat in front of the part of the foot to which it normally corresponds. Above the outer surface of the calcaneum and cuboid is a notable depression in the place of the usual prominences formed by the external malleolus and the head of the astragalus. The internal malleolus is very prominent and nearer to the level of the sole, and below and in front of it is the projecting head of the astragalus. On the dorsum of the foot the scaphoid is recognizable with a depression behind it.

C. *Dislocation backward.*

In this the calcaneum and scaphoid are displaced directly backward, the scaphoid descending to a lower level so as to lie under the head or neck of the astragalus. Deviation of the foot to either side would create forms intermediate between this and the two preceding ones. A number of reported cases, which were claimed to be subluxations of this kind, the relations between the scaphoid and astragalus being changed, while those between the calcaneum and astragalus remained unchanged, were rejected by Broca as errors of diagnosis, but are accepted by Malgaigne as probably correct. In some of them reduction was easy; in others it failed, but the persistence of the displacement did not permanently impair the functions of the limb.

Of the complete form there are only two recorded examples: the first is the much quoted case of Prof. Carmichael, reported by Macdonald.[1] Carmichael, in his effort to avoid a fall when his horse stumbled and came upon his knees, leaned back in the saddle and thrust his feet forward; his weight was received upon the inner side of the ball of the right foot, and the dislocation was thereby produced, the deformity being so great that it was recognizable through his boot. The toes were abducted about 30°, the foot slightly everted; the concavity of the tendo-Achillis was manifestly increased, and the heel lengthened; the astragalus could not be felt behind the tibia. Below and in front of the inner malleolus was a hard prominence, over which the skin was tense, formed by the inner surface of the astragalus. The most striking deformity was a prominence on the dorsum of the foot; "immediately in front of the tibia it presented a flat surface broad enough to receive the finger, from which there was an abrupt descent upon the anterior part of the tarsus. Over the projection caused by the head of the astragalus thrown on the upper surface of the scaphoid and cuneiform bones, the integuments were so tense that it was very evident a small additional force would have driven it through the skin." The distance from the internal malleolus to the end of the great toe was one inch less than on the other foot. No fracture could be found. Flexion and extension were very painful. The dislocation was reduced by traction with the pulleys, and direct pressure on the heel and leg.

The second case was observed by Thierry, and communicated to Malgaigne by Broca; the dislocation was caused by a fall upon the toes; the head of the astragalus was prominent under the skin, the front of the foot appeared shortened, the heel lengthened; the foot was extended, and not deviated to either side. Good recovery.

[1] Macdonald: Dublin Quart. Journ. Med. Sci., 1838, vol. 14, p. 235.

D. *Dislocations forward.*

Of this only two examples have been reported, one by Parise, quoted by Malgaigne, the other by Broca.[1] Parise's patient was injured by being crushed under a heavy weight, the thigh being flexed on the trunk, the leg on the thigh, and the foot on the leg (dorsal flexion). Nine months afterward the condition was as follows: the foot was at a right angle with the leg, a little adducted, and very slightly everted; it was displaced forward, so that it appeared lengthened in front, and the external malleolus almost touched the tendo-Achillis. The extensor tendons on the instep were tense, and no prominence could be felt beneath them, but on the outer side a bony prominence could be felt, which was thought to be the head of the astragalus, and immediately in front was a depression which admitted the finger. The hollow between the astragalus and calcaneum seemed to be filled. Behind, the prominence of the heel was completely lost, the leg flattened, and its surface interrupted at the level of and a little below the malleoli by a bony prominence which raised the tendo Achillis and overlapped the heel nearly half an inch; above it was another, less prominent, formed by the posterior articular edge of the tibia. There was no trace of fracture, no separation of the malleoli. There was slight motion in the tibio-tarsal joint; motion in the joints of the tarsus was entirely lost. The patient could hardly walk without crutches.

In Broca's case the displacement was much less marked, and the only symptoms were an increase of one centimetre in the distance from the internal malleolus to the great toe, and a corresponding shortening of the heel, and the absence of abnormal prominence of the astragalus in front of the tibia. By traction and pressure under chloroform the inequality in the measurements was overcome and the patient, at the time of the report, was in a fair way to recover. So far as can be judged from the report, Broca did not consider the diagnosis entirely clear, and the symptoms as given are identical with those of Sarazin's case of incomplete tibio-tarsal dislocation forward. The differential diagnosis between these two injuries would have to be made on the existence of a gap between the astragalus and scaphoid in the subastragaloid dislocation, and the absence of such a gap and possibly the abnormal prominence of the upper articular surface of the astragalus in front of the tibia in the incomplete tibio-tarsal dislocation forward. The recognition of either symptom might be made difficult or impossible by swelling.

Diagnosis of subastragaloid dislocations.—If the date of the injury is so recent that swelling has not yet supervened, or so remote that it has disappeared, the diagnosis may usually be made with considerable ease and certainty, but if swelling is present it may be very difficult. The important functional features are the preservation of the normal movements in the tibio-tarsal joint, and the loss or the exaggeration in one or the other direction of the lateral and rotatory movements of the foot which take place in the subastragaloid and medio-tarsal joints. As no lateral motion takes place in the tibio-tarsal joint, except in the position

[1] Broca: Report by Petit of a clinical lecture, Gaz. hebdom., 1874, p. 316.

of full plantar flexion, the exaggeration of the normal movement to either side must be due, when the ankle is sound, to injury of the last two named joints. The physical signs are the preservation of the relations between the astragalus and the bones of the leg, as shown by the normal relations of the malleoli to the head of the astragalus and by the absence of abnormal projection of the body of the astragalus in front or behind the tibia, the changes in length of the front part of the foot and heel, and the change in the relations of the calcaneum and scaphoid with the astragalus and the malleoli.

Treatment of subastragaloid dislocations.—The statistics collected by Broca and Poinsot give 23 simple cases in which reduction was attempted; to these may be added Pick's[1] case. Of these 24 reduction was successfully made in 14 and the ultimate result was good; in 2 the reduction was incomplete, and 1 of these died of septicæmia. The 8 failures (excluding the 2 incomplete reductions) gave 4 secondary amputations with 3 deaths, 3 secondary removals of the astragalus with 1 death, and 1 good functional result notwithstanding the persistence of the deformity.

In 7 additional cases in which the reduction was not attempted, 4 of the patients (Du Bourg, Dubreuil, Sée, quoted by Poinsot, and Quénu) had apparently good use of the limb, although in 1 of them sloughing and a violent arthritis followed the accident; in 1, Brown,[2] reduction was made after six months; in 2 (Sinnigen, quoted by Poinsot, Raffa[3]) the disability was such that the patient sought relief; Sinnigen removed the astragalus and external malleolus, and at the time of the report death by septicæmia was expected; Raffa chiselled away the head and the neck of the astragalus and was then able to straighten the foot; recovery without suppuration; good result.

In 2 cases (Verneuil,[4] Oré quoted by Poinsot), primary excision of the astragalus was done, in each with a good result. In Verneuil's there was fracture of the astragalus and rupture of the peroneal artery; in Oré's an attempt to reduce had failed and gangrene of the tense skin was imminent.

Of compound dislocations 17 cases were collected by Broca and 6 additional by Poinsot in 1884, and to these 1 reported by Jackson[5] is to be added; of these reduction was made in 10, with 2 deaths, with persistent suppuration apparently maintained by necrosis in 2, and with secondary removal of the astragalus in 1. In 14 reduction was not made; in 3 of these primary amputation was done, in 10 removal of the astragalus, with 2 deaths, and in 1 the head of the astragalus became necrosed and was spontaneously cast out, the patient recovering. The results of primary removal of the astragalus, according to these statistics, are rather better than those of reduction, but, as has been said before, the value of these statistics as a basis for the choice of a method of treatment has been greatly diminished by the improvement in the methods of treatment of open wounds that has taken place in the last few years, and there is good

[1] Pick: Lancet, 1880, i. p. 170.
[2] Brown: Lancet, 1876, i. p. 314.
[3] Raffa: Centralblatt für Chir., 1885, p. 211.
[4] Verneuil: Bull. de la Soc. Anatomique, 1872, p. 493.
[5] Jackson: Lancet, 1881, ii. p. 590.

reason to hope that suppuration and its attendant dangers will be less frequent in future.

Reduction, which has sometimes been made by traction with the hands alone, more frequently has needed the aid of the pulleys, even when anæsthesia has been employed. The knee should be flexed to relax the muscles of the calf, and the traction in the lateral cases should be downward and usually also forward, and coaptative pressure should be made upon the foot and leg. The cause of the irreducibility in some cases is not entirely clear; it has been attributed to the engagement of the posterior lip of the astragalus in the groove on the upper surface of the calcaneum, and in the outward cases to the constriction of the astragalus under the tendon of the tibialis anticus.

3. Total Dislocations of the Astragalus.

("Double dislocations of the astragalus.")

This dislocation is a combination of the two preceding ones, the tibio-tarsal and the subastragaloid, the astragalus being simultaneously displaced from its normal relations with the bones of the leg, the calcaneum, and the scaphoid. It is much more frequent than either of the other two and is often compound. The astragalus may be displaced forward, backward, or to either side, or to any intermediate position, and may at the same time be rotated about any of its axes, or it may be rotated while remaining in the tibio-fibular mortise. The varieties of dislocation are, consequently, very numerous, but they may be grouped as dislocations *forward*, *backward*, *outward and forward*, and *inward and forward*, these terms indicating the direction in which the astragalus is displaced, and *dislocations by rotation*, including in the latter only those in which the bone remains more or less completely within the mortise.

The causes are varied, the most common being falls from a height upon the feet and violent twisting of the foot, as when it has been caught between the spokes of a wheel. It is seldom possible to determine the exact mode of production in any given case, and experiment upon the cadaver has not done much to elucidate the subject; but it seems probable that dorsal or plantar flexion and abduction or adduction are requisite to rupture the ligaments that bind the astragalus to the other bones, and that then it is forced from its place by pressure exerted through the bones of the leg.

A. *Dislocation forward.*

In this form, which is very rare, the astragalus is displaced directly forward. To the briefly described and somewhat doubtful cases collected by Malgaigne, Delorme[1] added only two, in one of which (Morel-Lavallée) the astragalus had been rotated 180° about its vertical axis and both malleoli were broken; the foot was very movable on the astragalus, and the astragalus on the tibia. The sides of the bone could be distinctly felt, and its posterior surface, which looked directly forward. Reduction was easily made. In the other case, Barral, the dislocation was com-

[1] Delorme: Dict. de Méd. et Chir. pratiques, 1879, vol. 27, p. 640.

pound, the head of the astragalus projecting through the wound and resting on the dorsal surface of the scaphoid. Both it and the foot were freely movable. The extensor tendons and that of the tibialis anticus were ruptured, the malleoli and calcaneum were broken.

B. *Dislocation outward and forward.*

In this, the most common form, the head of the astragalus rests on the outer cuneiform and the cuboid bones or even on the fifth metatarsal, its posterior part lying just within the mortise, and is freely movable; the foot is adducted and inverted and usually displaced bodily inward, so that the external malleolus is prominent and the internal hidden, and sometimes the adduction of the front of the foot is very marked and combined with abduction of the heel. If the dislocation is compound the astragalus presents in the wound, which commonly extends backward to or beyond the external malleolus. The lower end of the fibula may be torn away from the tibia, and either or both malleoli broken. With the displacement may be combined various kinds and degrees of rotation of the astragalus, and sometimes the astragalus is broken.

An exceptional form was observed by Küster;[1] a man in falling had his foot so twisted inward that its inner side was almost in contact with the leg; the astragalus projected outward below the external malleolus without change in the direction of its axis and with fracture of its neck, and as the skin covering it was dangerously stretched Küster excised the posterior part of the bone, leaving the head, which had preserved its relations with the scaphoid. Antiseptic dressing; rapid recovery; good functional result.

C. *Dislocation inward and forward.*

In this, the second in order of frequency, the foot is everted and abducted, but sometimes is bodily displaced to the outer side without deviation. The astragalus projects in front of or below the internal malleolus, and its head appears always to be depressed, sometimes so far that the bone must have undergone rotation of 90° about its transverse axis. In a case reported by Hunt[2] it was so far rotated about its vertical axis that the head was directed toward the middle of the other foot. If the injury is compound the wound lies on the inner side and extends backward below the malleolus. It may be accompanied by fracture of the malleolus.

D. *Dislocation backward.*

In this form, which also is rare, the astragalus may be displaced backward or backward and to either side, and in some of the reported cases the bone has been broken at the neck and only the posterior fragment has been displaced. Malgaigne (loc. cit., p. 1058) collected 8 cases, including one reported by Denonvilliers, which he places (loc. cit., p. 1060) among "dislocations by rotation in place," but which, I think, belongs

[1] Küster: Berlin. klin. Wochenschrift, 1877, p. 16.
[2] Hunt: Phila. Med. Times, 1872, vol. 3, p. 50.

here; the cases are Phillips, 2, Lizars, Liston, Turner, Nélaton, *Denonvilliers*, and one anonymously reported in the *Lancet*, 1838–39, vol. 2, p. 559. To these Delorme adds 5, Blatin, *Lejeune*, *MacCormac*, *Pichorel*, and *Cheever;* he also quotes Foucher as having reported two cases, but, I think, erroneously, one of them being Denonvilliers's case, the other Thierry's, a dislocation by rotation. Another case was reported by Munro,[1] and one by *myself*,[2] and another, *Legros Clark*, is reported in MacCormac's paper, making 16 in all. In the 7 printed in italics the bone was broken at the neck, and only the posterior fragment was dislocated.[3]

Of the 9 not complicated by fracture of the astragalus, the dislocation was backward in 6, backward and outward in 1, Turner, and backward and inward in 2, Lancet, Munro. Reduction was made in 3 (Lancet, Blatin, Munro), and failed in 4, the functional result being good in 3 of the latter; Turner, and apparently Nélaton, removed the astragalus.

Of the 7 complicated by fracture, the displacement in Lejeune's is described as backward, in the others as backward and inward; the difference is slight, for in the latter the most prominent part of the astragalus projects but little beyond the level of the side of the internal malleolus. The tendons of the flexor longus digitorum and tibialis posticus are displaced upon the inner side of the malleolus, and that of the flexor longus pollicis sometimes lies to the outer side of the astragalus and sometimes is pushed directly backward by it. The fragment is also rotated, so that its trochlear surface looks inward, and its fractured surface is directed forward and downward. The line of fracture runs from the anterior border of the trochlea into the groove occupied by the interosseous ligament. In 3, Lejeune, MacCormac, Denonvilliers, the injury was compound; in Cheever's the skin over the astragalus sloughed, but the ulcer soon healed without having exposed the bone.

Reduction was made in none, although Pichorel divided the tendo-Achillis, and Cheever successively divided the tendo-Achillis, the tibialis anticus and posticus, the flexor longus digitorum, and the flexor longus pollicis at the toe. In three, MacCormac, Clark, Cheever, the patients recovered with good use of the limb; in 1, Pichorel, suppuration followed and the limb was amputated; in 2, Denonvilliers, Stimson, the posterior fragment was removed and both patients died, mine of pneumonia on the ninth day. The result in Lejeune's is not stated. (Compare also Küster's case above quoted.)

The foot may appear somewhat shortened in front, and is not deviated; the astragalus can be felt behind the ankle, either pressing the tendo-Achillis backward or lying on one side of it. If the entire bone is displaced the absence of the head from its normal position is shown by the depressibility of the soft parts behind the scaphoid. Marked, incorrigible flexion of the terminal phalanx of the great toe is noted in three of

[1] Munro: Lancet, 1859, ii. p. 364.

[2] Stimson: N. Y. Med. Journal, May 28, 1887, p. 594.

[3] The following are two of the references: MacCormac (and Clark's case): Trans. Path. Soc. London, 1875, vol. 26, p. 174, with plate of specimen obtained two years later. Cheever: Boston Med. and Surg. Journ., 1875, vol. 93, p. 237.

the cases. In mine the tendons of the peroneus longus and brevis were displaced upon the outer side of the external malleolus.

In the three cases in which reduction was made the means employed were traction followed by extension of the foot, traction, direct pressure, and inversion of the foot, and traction and direct pressure; in Munro's case several months elapsed before the patient regained good use of the limb.

E. *Dislocation by rotation.*

In this class are not included those numerous cases in which the bone has undergone rotation in connection with displacement from the tibia and fibula, but only those in which it still lies mainly within the mortise.

Two distinct varieties of this class may be made; those in which the bone has been rotated upon its vertical or transverse axis, and also, perhaps, upon the antero-posterior axis, but still remains in great part within the mortise; and those in which the bone still lies almost exactly in its normal position between the malleoli and has undergone only rotation about its antero-posterior axis.

The division between the first variety and that of dislocations forward and inward is rather arbitrary and is perhaps not always to be made clinically, and the three cases collected by Malgaigne differ notably from one another. Barwell,[1] in a valuable paper containing a well observed and well reported case of his own and abstracts of all the other alleged cases except Chevallez's, proposes to term the injury dislocation of the foot with version, or with torsion, of the astragalus, applying the term *version* to the cases of rotation about the vertical axis, and *torsion* to those of rotation about the antero-posterior axis. I see no sufficient reason for using the term dislocation of the foot, which has already been employed for another form of injury; and *version* and *torsion* do not in themselves indicate the sense in which they are used, but must be accompanied by a definition.

Malgaigne gives four cases of rotation about the vertical axis, Barwell's "version," but I have placed one of them, Denonvilliers, among the dislocations backward To the remaining three Barwell adds two reported by Verebely;[2] in three of them the head of the astragalus lay below the internal malleolus, in one just behind it, and in one just in front of the external malleolus. As they cannot well be grouped I give a summary of each.

Laumonier. The head of the astragalus protruded under the inner malleolus between the tendons of the tibialis posticus and flexor longus digitorum, the trochlea lying transversely in the mortise and forcing apart the tibia and fibula.

Foucher.[3] The specimen was taken from a subject found in the dissecting-room. The astragalus had been rotated 90° about its vertical axis, the trochlea being still upright in the mortise, and the head below the internal malleolus. The tendon of the tibialis posticus and the posterior tibial artery lay in front of the internal malleolus. The posterior

[1] Barwell: Med. Chirur. Trans., 1883, vol. 66, p. 39.
[2] Verebely: Wiener med. Wochenschrift, 1869, vol. 19, pp. 279 and 296.
[3] Foucher: Bull. de la Société Anatomique, 1854, vol. 29, p. 388.

half of the astragalus lay on the calcaneum, the latter bone lying under the external malleolus and displaced forward and outward, and its axis directed forward and inward. The cuboid was partly dislocated downward from the calcaneum. There was no cicatrix; the foot was flattened, the heel shortened.

Thierry. The head of the astragalus projected midway between the internal malleolus and the tendo-Achillis, the outer border of the foot was much raised, and it was then seen that the bone was also so turned that its upper surface looked forward and inward, the tibia resting on the internal lateral face of the body of the bone, and the internal border of the trochlea exactly occupied the angle between the internal malleolus and the under surface of the tibia. Amputation; recovery.

Verebely: Male, twenty-nine. Fibula fractured above the malleolus. Under the internal malleolus the skin was very tense; about an inch lower there was a hard bony prominence about half an inch in diameter. Reduction failed. At the end of the third week an abscess was opened, and it was seen that the prominence under the malleolus was the head of the astragalus. After four months' treatment the man could with difficulty put the foot to the ground.

Verebely, second case. Male, forty-five. The foot was at right angles with the leg, the sole looking somewhat inward and upward. "Under the easily distinguishable outer malleolus and in front of it a long projection half an inch in diameter may be plainly felt; this can be moved without much pain backward and forward independently of the other bones. Behind the scaphoid is a considerable hollow." Reduction failed.

Of the second variety, *rotation about the antero-posterior axis*, Malgaigne gives seven cases, most of which Barwell rejects because of the incompleteness of the description or because the astragalus was more or less displaced from the mortise. Rejecting Boyer's, Smith's, Liston's, and two of Dupuytren's, there still remain Malgaigne's own and one of Dupuytren's: to these are to be added Barwell's and Chevallez's.[1] In all four cases the condition was shown by direct examination: Malgaigne describes a specimen from an old case, Chevallez's patient was killed by the fall that caused the dislocation, and Dupuytren and Barwell excised the astragalus. In Malgaigne's, Chevallez's, and Barwell's the rotation was outward, that is, the upper surface of the trochlea had become external and rested against the inner face of the external malleolus, although in Malgaigne's the rotation was somewhat less than 90°; in Dupuytren's the bone was turned completely upside down, rotation of 180°.

Of Malgaigne's specimen, which is represented in his *Atlas*, plate xxx., Fig. 5, it is said that the head of the astragalus rested on the scaphoid and cuboid; its trochlea, turned outward, corresponded almost entirely to the inner facet of the fibula, and its inner side lay under the tibia. The rotation, however, was not a complete quarter of a circle, for a portion of the outer side of the body of the astragalus could still be seen partly in contact with the point of the external malleolus and looking downward and outward. There was bony ankylosis between the astragalus

[1] Chevallez: Bull. de la Soc. Anatomique, 1870, vol. 45, p. 406.

and calcaneum, and it was evident that the man had walked only on the outer border of his foot.

In Chevallez's specimen there was subluxation of the head of the astragalus on the scaphoid, the upper surface of the trochlea was turned outward, the calcaneum was broken transversely and its posterior fragment driven up behind the astragalus; the lateral ligaments of the ankle were detached, and the anterior border of the lower end of the tibia was broken.

Dupuytren's patient was a man fifty years old, who had jumped from a ladder, alighting on his heel. There was a large, hard, irregular, and irreducible prominence in front of the tibia and extending to the instep. An incision was made parallel to the axis of the foot, and the head and neck of the astragalus were immediately brought into view. Efforts to remove the bone failed, for the posterior part was grasped and held fast between the tibia and calcaneum. On seeking for the cause of this fixation it was found that the astragalus was turned around in such a way that its upper surface was directed downward, its lower upward, and that the hook-like process at its inferior and posterior part was fixed beneath the tibia so as completely to frustate our efforts to extract it. The patient did well.

Barwell's patient, a man twenty-eight years old, was injured by the overturning of his wagon. When seen an hour and a half after the accident the foot was greatly inverted, its front somewhat turned in, the heel raised. The inner malleolus was much hidden; beneath it the skin was thrown into two ridges by three deep folds drawn in segments of concentric circles from a centre a little above the malleolus. The outer malleolus projected abnormally, the skin over it was rather tightly drawn. About an inch in front of it and a little below its level was a rounded projection, which also somewhat stretched the skin. An inch and a half up the leg and in front of the fibula was a small but deep wound. The foot was immovable and painful. Below and in front of the inner malleolus deep pressure revealed absence of the usual bony substratum, the finger sank into a hollow bounded in front by the tuberosity of the scaphoid, which lay abnormally near the malleolus. The rounded projection in front of the malleolus could readily be recognized as the head of the astragalus. A little way behind this was a ridge of bone, also evidently a part of the astragalus; it led from the head backward and a little upward, disappearing under the upper part of the malleolus, at the angle between it and the anterior edge of the tibia. This ridge was markedly convex *outward*. The extensor tendons, pressed together, ran in a bundle a little distance inside the rounded projection. The wound communicated with the injury. No fracture could be detected.

It was seen that the relations of the astragalus to the other bones were altered, although it was still within the mortise, but the exact nature of the injury was not recognized. Various attempts were made to reduce, and even the tendo-Achillis was divided, but in vain; a moulded splint was applied, and the wound dressed with carbolic acid.

Two days later a semilunar incision was made from the middle of the lower end of the tibia across the head of the astragalus to the tip of the outer malleolus, the flap turned up, and the bone fully exposed. It was a little turned on its vertical axis, the head having moved outward, and

90° on its antero-posterior axis, the trochlea being in contact with the cartilaginous surface of the external malleolus. The inner upper angle of the trochlea fitted closely into the reëntrant angle formed by the external malleolus and the tibia. The bone was not at all displaced forward—that is, it did not protrude abnormally from its socket. The interosseous ligament had been ruptured; the few remaining fibres were divided, and the bone removed. Examination of the cavity failed to show any fracture or detachment of cartilage. The patient made a good recovery, and was discharged nine and a half weeks after the operation.

Treatment of total dislocations of the astragalus.

The statistics, collected by Broca, Dubreuil, and Poinsot, show that of 121 cases of dislocations not compound, 43 were successfully reduced, and it is worthy of note that Poinsot's list, composed of cases reported between 1864 and 1883, shows 19 reductions in 31 cases, about 60 per cent., and as many of Broca's cases were treated without the aid of anæsthesia it may reasonably be hoped that Poinsot's percentage is an indication of the success that will be obtained in future. Primary extirpation of the astragalus was done in 9 of the 121 cases, with 6 successes, 1 death, and 2 deaths after secondary amputation. Consecutive extirpation was done in 41 cases, with 39 successes, and 2 deaths. Of 15 cases in which the dislocation remained unreduced, and in which the result is known (excluding those of secondary extirpation) the functional result in 8 was good.

Of 63 compound dislocations, collected by Broca, reduction was made in 9, and of these 9, 6 recovered, secondary removal of the astragalus was done in 2, and 1 died. Poinsot adds 2 cases in which reduction was made; 1 was successful, in the other extirpation became necessary.

In 58 compound cases primary removal of the astragalus was done, with 42 successes, 14 deaths, and 2 consecutive amputations followed by death.

For reasons that have been already given, we have the right to expect better results in the future in compound cases, and may feel encouraged to make reduction whenever it is possible. Expectation in irreducible compound dislocations has almost always ended in removal of the astragalus, or amputation, or death, and the cases will probably be very few in which primary removal of the astragalus will not give the patient the most speedy recovery, the least risk, and the most useful limb.

Of 56 simple irreducible dislocations contained in these statistics, suppuration of the joint and sloughing of the skin followed in at least 41, and there is not much reason to suppose that the frequency of this result will be much, if at all, diminished in the future, for the exciting cause—bruising, pressure, and destruction of the blood-supply of the astragalus—will be repeated. It is important, therefore, to determine the proper course to be pursued under such circumstances. In 1884 Dr. McBurney, of New York, successfully reduced a dislocation forward and inward by exposing the head of the astragalus through an incision, and lifting the tendon of the tibialis anticus which tightly embraced the neck of the bone and had prevented reduction; probably other equally good results will be obtained by the same means. Primary removal of the astragalus is

recommended by Barwell in all cases in which "certain and sufficient, but not too persevering, attempts at reduction" have failed, and the facts that four-fifths of the cases left to themselves have ended in suppuration and secondary removal of the astragalus, and that the functional result after removal is good, will be generally accepted as a justification of the advice, but it needs, I think, to be conditioned upon the failure of reduction by arthrotomy.

In a case of dislocation forward and outward Anger[1] reduced by making continuous traction by means of India-rubber for ten or fifteen minutes, and then pressing directly upon the bone. The rubber was attached to the foot by means of long strips of adhesive plaster passed in figure-of-8 around the heel and dorsum to form a loop beneath the sole to which the rubber cords were fastened.

In short, the plan to be pursued in simple cases is to attempt reduction by traction upon the foot with the hands or pulleys, under anæsthesia, and with the knee flexed, and by direct pressure so applied as first to correct such rotation of the bone as may exist, and then to force it back into place. This failing, expose the bone by incision, and seek to remove the obstacle to reduction and then to reduce; this also failing, remove the astragalus. In cases in which the astragalus is not only dislocated but also broken, I think primary removal is the safest plan, even in cases of backward dislocation of the posterior fragment, although in three such treated without removal the patients recovered with useful limbs.

In compound dislocations reduction is to be sought unless the astragalus is entirely detached or the lacerations are so extensive that suppuration is unavoidable; otherwise, primary removal of the astragalus, or amputation if clearly indicated.

4. Medio-tarsal Dislocations.

In this the dislocation takes place in the medio-tarsal joint, the scaphoid and cuboid being together displaced from the astragalus and calcaneum which preserve their relations to each other and to the bones of the leg. Broca, in the paper above quoted, pointed out that most dislocations previously reported under this title were actually sub-astragaloid. Partial dislocation of the cuboid from the calcaneum appears to be frequently associated with sub-astragaloid dislocations, but the cases in which the medio-tarsal joint alone is involved are few. Cases, too briefly described to be positively accepted, were reported by J. L. Petit, Liston, and Cooper, but more recently three cases have been placed on record in two of which the diagnosis was confirmed at the autopsy. Thomas[2] reported a case in the service of Denonvilliers; the patient's foot had been crushed by the wheel of a cart. The plantar surface was convex, the dorsum so swollen that the bones could not be felt; the foot was shortened, and its anterior portion could be moved laterally, but the movements were painful and accompanied by crepitation. The diagnosis of fracture of the head

[1] Th. Anger: Bull. de la Soc. de Chirurgie, 1875, vol. i. p. 219.

[2] Thomas: Mém. de la Soc. Méd. d'Indre et Loire, 1887, quoted by Duplay and Delorme.

or neck of the astragalus and rupture of the calcaneo-cuboid ligaments was made. The patient died of erysipelas, and at the autopsy the tibio-tarsal and calcaneo-astragaloid joints were found intact; the head of the astragalus and the cuboid surface of the calcaneum formed a very marked abnormal prominence above the second row of the tarsus; the scaphoid was fractured antero-posteriorly, and its outer fragment projected on the plantar surface; the cuboid was still in contact with the inferior half of the anterior end of the calcaneum; the superior medio-tarsal ligaments were ruptured, and the inferior calcaneo-scaphoid partly detached; the inferior calcaneo-cuboid was unbroken.

Anger's[1] patient was injured by a fall from a height. There was slight flattening of the arch of the foot, without deviation, and with considerable ecchymotic and inflammatory swelling. He died of erysipelas. At the autopsy the head of the astragalus was found above and in front of the scaphoid, and the cuboid facet of the calcaneum upon the upper surface of the cuboid. The superior calcaneo-scaphoid and internal calcaneo-cuboid ligaments were ruptured and torn from their anterior insertions. It was difficult to reduce the dislocation even after dissection. The only fracture was of the anterior part of the scaphoid, the tubercle of which was almost entirely torn away.

In the third case, Ward,[2] the dislocation was old. "The foot presented a remarkably twisted appearance, the anterior part being directed considerably inward, and the inner edge somewhat elevated." The dorsum was shortened one inch. The anterior ends of the calcaneum and astragalus projected distinctly on the dorsum. The external malleolus had been fractured.

Congenital Dislocations of the Ankle-joint.

Kraske[3] exhibited at the Ninth Congress of the German Surgical Society two patients, father and son, with congenital dislocation of both ankles, and also the two legs of another child of the same father which had died in infancy and had been similarly affected. The abnormality was a subluxation outward accompanied by, and probably due to, defective development of the fibula. In all three cases the middle and upper part of the fibula was lacking, but in the specimen a small upper epiphysis existed. In the father the lower end of the fibula was only four centimetres long and was obliquely placed, the apex directed outward. The articular surface of the tibia was also oblique, looking downward and outward; the foot was flattened, markedly abducted, and moderately pronated. The legs, compared with the thighs, were abnormally short and slight.

Resection of both ankles had been done upon the son to correct the faulty position of the foot: on the right side the internal malleolus and a comparatively large part of the astragalus had been removed; on the left, the entire lower end of the tibia and a small piece of the astragalus.

Other forms of congenital subluxation belong to the subject of clubfoot.

[1] B. Anger: Traité iconographique, p. 334.
[2] Ward: Trans. Path. Soc. of London, 1849–50, p. 254.
[3] Kraske: Beilage zum Centralblatt für Chir., 1882, No. 29, p. 85.

CHAPTER XXXII.

DISLOCATIONS OF THE TARSAL AND METATARSAL BONES AND OF THE TOES.

In addition to the dislocations described in the preceding chapter, the bones of the tarsus may be dislocated separately and in various combinations. None of the different kinds has occurred with sufficient frequency to permit systematic grouping and description, and in most of them the exact nature of the injury cannot be said to have been positively established, for the difficulties of the diagnosis upon the living are usually very great and the surgeon is limited to the recognition of the more prominent features. I shall confine the account of them mainly to the enumeration of the different varieties that have been observed, with bibliographical references for the convenience of those who may desire to examine the reports in detail.

Calcaneum.—Malgaigne quotes a case in which the calcaneum was bodily displaced to the outer side, but apparently was not entirely separated from the astragalus and scaphoid. Reduction was easy. Also a second (Canton, *Lancet*, 1847, i. p. 505) found upon the cadaver, in which the calcaneum was displaced to the outer side together with the external malleolus; its anterior end lay between the cuboid and scaphoid, almost in contact with the third cuneiform; and the astragalus was rotated inward about 45°.

Scaphoid.—The scaphoid has been dislocated forward and outward in connection with the astragalus, the dislocation being compound (Burnett), forward and inward (Rizzoli, quoted by Poinsot), upward and backward in conjunction with the first and second cuneiforms and the first two metatarsals and with dislocation of the third metatarsal and fracture of the cuboid (Chassaignac, *Bull. de la Soc. de Chir.*, 1861, vol. i. p. 307), upward and inward in conjunction with the first cuneiform (Lonsdale, *Lancet*, 1857, ii. p. 192) or with the middle cuneiform (Clarke, *London Med. Times*, 1851, vol. 3, p. 233), or outward, upward, or inward alone (Piédagnel, Walker, R. W. Smith, quoted by Malgaigne, Bryant, *Surg.*, 3d Am. ed., 1881, p. 813), or from the cuneiforms only, as seen by Garland (*Lancet*, 1857, ii. p. 270) in a case that was compound. In a case reported by Enos (*N. Y. Journ. of Med.*, 1857, II. p. 98) the cuneiform bones and the cuboid were displaced outward from the scaphoid and calcaneum.

Cuboid.—The only case of dislocation of the cuboid of which I have knowledge, except in connection with other dislocations as above described, is one reported by Bell (*N. Y. Journ. of Med.*, 1859, vol. 7, p. 329) in which it was displaced upward in connection with the fifth metatarsal by inversion and adduction of the foot. Reduction was made.

Cuneiform bones.—All three cuneiform bones and the second and third have been displaced together, and the first and second have been displaced separately. Isolated dislocations of the first are the most frequent. Lemoine[1] collected eleven such cases, to which may be added two observed by Bryant (loc. cit., p. 813); the displacement is usually upward and inward, in only one case downward and inward (Fitzgibbon, *Dublin Journ. Med. Sci.*, 1877, ii. p. 271); sometimes the bone is displaced from all the three with which it is normally in contact, sometimes the first metatarsal is displaced with it. The symptoms are flattening of the arch of the foot, prominence of the displaced bone, and a depression at its normal site. In some cases reduction has been easily made; in others the attempt has failed.

The second cuneiform has been separately dislocated upon the dorsum in three cases, Foulker (*Lancet*, 1856, ii. p. 283), Laugier, and Lagarde (quoted by Delorme, *Dict. de Méd. et Chir. prat.*, vol. 27, art. Pied), the displacement being slight in one and nearly complete in the others, and accompanied in one by other serious injuries of the foot, and followed in another (Foulker) by sloughing of the skin, grave symptoms, and ultimate recovery. In a case of multiple injuries of the foot reported by Lagrange (*Bull. de la Soc. Anatomique*, 1871, p. 180) the second cuneiform was displaced upward from all its connections except that with the scaphoid.

The second and third cuneiforms were displaced together upon the dorsum in a case reported by Key (quoted by Malgaigne); the dislocation, which was incomplete, was caused by direct violence and accompanied by extensive laceration of the skin. The patient died.

All three cuneiforms have been reported displaced together upon the dorsum in several cases, but it does not appear in the histories whether or not they were separated only from the scaphoid or also from the cuboid and metatarsals; in one of them (Bertherand, *Bull. de la Soc. de Chir.*, 1856–57, vol. 7, p. 361) they were accompanied by the metatarsals and the dislocation could not be reduced.

Dislocation of the Metatarsal Bones from the Tarsus and from one another.

Malgaigne collected twenty-one cases of the various dislocations, and Hitzig[2] collected twenty-nine.

The first metatarsal is much more frequently dislocated than the others, and the displacement appears always to have been upward except in one case (Demarquay, *Bull. de la Soc. de Chir.*, 1870, vol. 10, p. 35) in which the base lay under that of the second metatarsal; in this latter the first metatarso-phalangeal joint was also dislocated, compound, and Demarquay removed the bone. A frequent cause has been a fall while on a horse, the pressure of the stirrup against the inner and under surface of the bone apparently causing the injury. The symptoms frequently indicate the coexistence of a sprain of neighboring joints. Reduction has always been easy by traction and direct pressure.

[1] Lemoine: Revue de Chirurgie, 1883, vol. 3, p. 118.
[2] Hitzig: Berl. klin. Wochenschrift, 1865, p. 393.

Isolated dislocation of the second metatarsal upon the dorsum has been reported in one case, Brault and Belin, quoted by Hitzig; that of the third downward and backward in one, Tufnell (*Dublin Quart. Journ. Med. Sci.*, 1855, p. 302); that of the fourth upon the dorsum in three, Malgaigne, Surmay (*Bull. de la Soc. de Chir.*, 1876, ii. p. 579), Gosselin (*Gaz. des Hôpitaux*, 1876, p. 755).

The fourth and fifth metatarsals have been together dislocated upward and inward, Monteggia, and upward and backward, South; both quoted by Malgaigne. The third and fourth, Hartmann, and the first and second, Marit, have been together displaced; both quoted by Delorme.[1] The first, second, and third were dislocated together upon the dorsum in two cases, Laugier, quoted by Malgaigne, and Wilms, quoted by Hitzig, and downward into the sole in a case reported by Tufnell (*Dublin Quart. Journ. Med. Sci.*, 1854, vol. 17, p. 65); in the latter case the injury was caused by the fall of a horse and was irreducible, but the patient recovered good use of the limb; the later history is recorded in the same journal, 1855, vol. 20, p. 302.

Dislocation of the second, third, and fourth together upon the dorsum was seen by Malgaigne once; the same diagnosis was made by him in another case, but at the autopsy it was found that the fifth was also partly dislocated from the cuboid and that the first together with the internal cuneiform was displaced inward.

Dislocation of the first four metatarsals has been reported in three cases, Malgaigne, Hitzig, Demarquay (*Gaz. des Hôpitaux*, 1865, p. 534); in Malgaigne's the first three were displaced downward, the fourth upward; in the other two the displacement was upward. Malgaigne was able to reduce the fourth, Demarquay the first, and Hitzig all; notwithstanding the persistence of part of the dislocation the two patients had good use of the limb.

All the metatarsal bones may be displaced together upward, inward, downward, or outward; of the latter two forms only one example of each has been reported. Smyly (*Dublin Quart. Journ. Med. Sci.*, 1854, vol. 17, p. 317) saw all five bones dislocated downward by the fall of a wagon which pressed the heel forward while the toes were fixed; reduction was made. The case of dislocation inward is Kirk's, quoted by Malgaigne, who distrusts the diagnosis.

Of dislocation *outward* five cases have been reported, Laugier and Lacombe, quoted by Malgaigne, Tutschek, quoted by Hitzig, Mignot-Danton (*Arch. gén. de Méd.*, 1866, ii. p. 405), and Desprès (*Bull. de la Soc. Anatomique*, 1878). The interlocking of the base of the second metatarsal between the first and third cuneiform bones must make a lateral dislocation impossible except as secondary to one upward or downward or unless accompanied by fracture; in Laugier's and Dsprès's the second metatarsal was broken at its upper end, and in Mignot-Danton's and Lacombe's the third was broken. In four cases reduction was made.

Dislocation *upward* may be complete or incomplete, and sometimes the whole or a part of the first cuneiform remains attached to the first metatarsal and is displaced with it. Hitzig collected eleven cases. The most

[1] Delorme: Dict. de Méd. et Chir. prat., vol. 27, art. Pied.

frequent cause is direct violence, but in two cases it was muscular action, the efforts of the patients to avoid falling after having slipped while carrying heavy bundles. The autopsies and the compound cases have shown rupture of the dorsal and of some of the palmar ligaments, rupture and laceration of some of the interosseous ligaments and muscles, fracture of some of the metatarsal bones and occasionally of the cuboid and first cuneiform, and sometimes separation of the first or fifth metatarsal laterally from the others. The metatarsus may remain in line with the rest of the foot or be deviated to either side, and the bases of its bones form a transverse ridge either corresponding exactly to the line of the joints or at a somewhat higher point upon the tarsus. Reduction was made more or less completely in some of the cases; in others it failed, but the patients gradually recovered the use of the limb; in one compound case, Mazot, primary amputation was done.

Dislocations of the Toes.

A. *Metatarso-phalangeal dislocations.*

1. *Dislocations of the great toe.*—Of this injury Malgaigne collected 19 cases, to which Delorme added 12. The most common cause is a fall upon the toes; among the less frequent are the act of kicking, receiving the weight of the body upon the toe alone in going upstairs, and violence received upon the metatarsus. The injury is frequently compound. The dislocation has been upward, backward, and to one side, the most frequent appearing to be those to the outer side and backward, and secondly those directly backward; the former of these two is almost always compound with projection of the head of the metatarsal bone through the wound on the inner and lower aspect of the joint. Coexistent sprain or subluxation of the first tarso-metatarsal joint has been occasionally noted.

Of 14 simple cases collated by Delorme reduction was easily made in 8 and failed in 4; of the compound cases the head of the metatarsal bone was excised in 5, and the entire bone removed in 3; of 14 compound cases in which the attempt to reduce was made it was successful in 9. The means employed to reduce have been traction and direct pressure upon the base of the phalanx. Probably in the difficult cases the special procedures employed in the corresponding dislocations of the thumb would be advantageous.

2. *Dislocations of the other toes.*—Dislocation of the four outer, the four inner, or of all five toes together has been reported in several cases, the direction of the displacement being upward and backward or directly outward; in the latter the head of the metatarsal projected through a wound and had to be excised before reduction could be made.

B. *Dislocations of the phalanges.*

With one exception, the second phalanx of the third toe, in all the cases that have been reported the dislocation was of the terminal phalanx of the great toe. In one case reduction could not be made; in another, which was compound, a portion of the bone was subsequently cast off.

INDEX.

ACCIDENTS during reduction, 74
Acetabulum, fracture of edge, 32
floor, 413
Acromion, fracture of, 31, 257
After-treatment, 72
Ambi, 61
Anæsthesia, dangers of, 63
Ankle, anatomy of, 508
congenital dislocations of, 530
dislocations at or near, 508
Anterior dislocations of shoulder, 207
Anterior oblique dislocation of hip, 421
Arteries, injured in dislocation, 33
in reduction, 79
Astragalus (see Foot), 509
dislocation by rotation, 525
"double" or "total" dislocation of, 522
Atlas, dislocation of, 145
Avulsion of forearm, 48, 78
Axillary artery, injured in dislocation, 34
in reduction 80

BIGELOW on reduction of hip, 425
Bloodvessels injured during reduction, 79
in dislocation, 35
at elbow, 35, 80
at hip, 35, 449
at shoulder, 80, 259
Bone, overgrowth after dislocation, 45, 344, 352
Brachial artery, injured in dislocation, 35, 288
in reduction, 80
Brachial plexus, torn in reduction, 89

CALCANEUM, dislocation of, 531
Capsule, interposition of, 47
Carpal bones, dislocation of, 367
Carpo-metacarpal dislocations, 374
Causes, determining, 24
predisposing, 25
Circumflex artery, injured in dislocation, 34
in reduction, 81
nerve, injured in dislocation, 36, 258
Clavicle, dislocations of, 173
acromial end, 184
subacromial, 191,
subcoracoid, 193
supra-acromial, 185
both ends, 195
statistics, 173
sternal end, 174
backward, 179
forward, 175
upward, 182
Coccyx, dislocations of, 395
Complications (see also Special dislocations), 30
of bloodvessels, 33
of bones, 31
of nerves, 35
of soft parts and skin, 39
of viscera, 38
Congenital dislocations (see also Special dislocations), 97
etiology, 98
pathology at elbow, 106
at hip, 103
at shoulder, 106
statistics, 97
symptoms, 106
treatment, 108
Coracoid process, fracture of, 257
Coronoid process of ulna, fracture of, 290
Costal cartilages, dislocation of, 170
Course, 56
Crural nerve, pressed on in dislocation, 437
Cuboid, dislocation of, 531
Cuneiform bones, dislocation of, 532

DEFINITIONS, 17
Desprès, method of, 68, 424
Distention, dislocation by, 112
Divergent dislocation of radius and ulna, 315
Dorsal dislocations of the hip, 409
Double dislocations of the astragalus, 522

ELBOW, anatomy of, 280
dislocations of (see also Radius and Ulna), 280

Elbow, backward dislocations, 285
after-treatment, 298
diagnosis, 292
pathology, 287
prognosis, 293
symptoms, 291
theories of production, 285
treatment, 294
classification, 283
congenital and pathological, 349
divergent dislocation of radius and ulna, 315
forward dislocations, 310
fracture during reduction, 92
frequency, 282
injury of nerves in, 37
injury of vessels in, 35, 80
isolated, of radius and ulna, 317
lateral dislocations, 298
incomplete, 299
inward, 301
outward, 302
complete outward, 306
subepicondylar, 308
supraepicondylar, 309
old unreduced dislocations, treatment, 343
relations to dislocation of shoulder and fracture of clavicle, 201
Emphysema during reduction of shoulder, 76
Ensiform process, dislocation of, 165
Epitrochlea, fracture of, 288, 290, 303, 313
Etiology, 24
Everted dorsal dislocation of hip, 418

FAT embolism, 95
Femoral artery, injured in dislocations, 35, 449
Femoral vein, injured in dislocations, 40, 430, 449
Femur, fracture of head, 31, 413, 450
of neck, 413, 438, 450
of shaft, 452
Fibula, dislocations of, 503
lower end, 506
spontaneous and pathological, 506
upper end, 503
backward, 504
forward, 504
outward, 506
upward, 505
Fingers, dislocations of, 380, 389
distal phalanges, 392
metacarpo-phalangeal, 389
Fingers, dislocations of middle phalanges, 391
Foot, dislocations of, 509
"by rotation outward," 514
"upward," 515
congenital dislocations, 530
Foramen ovale, dislocation into, 428
perforated, 429
Forearm, avulsion of, 48, 78
Fracture, as a complication, 31
during reduction, 91
of acetabulum, 453
of epitrochlea, 288, 303, 313
of femur, 31, 92, 413, 450
of pelvis, 437, 453
of tuberosities of humerus, 41

GLENOID fossa, fracture of, 257

HABITUAL dislocations, 27
of hip, 455
of shoulder. 262
treatment, 73
Hip, anatomy, 396
dislocations of, 396–466
accidents in reduction, 454
after-treatment, 455
backward dislocations, 408
anterior oblique, 421
dorsal, 409
diagnosis, 417
pathology, 410
symptoms, 414
everted dorsal, 418
pathology, 420
symptoms, 422
treatment, 423
classification, 404
complications, 449
compound, 39, 402
congenital, 103
directly upward, 441
downward and inward, 428
obturator, 428
cause, 428
pathology, 429
symptoms, 431
treatment, 433
perineal, 435
downward on tuberosity of ischium, 446
fracture during reduction, 92, 450
of acetabulum, 453
of femur, 31, 413, 438, 450, 452
of pelvis, 437
habitual dislocations, 455
ilio pectineal, 435
injury of nerves in, 38, 91, 437, 450, 461
of vessels in, 35, 40, 430, 449

Hip, dislocations of, infracotyloid, 446
intra-pelvic, 410, 436
labrum cartilagineum, detachment of, 453
old dislocations, treatment of, 457
arthrotomy, 458
excision, 460
osteotomy, 463
subcutaneous section, 458
paralysis of quadriceps extensor, 440
paralytic dislocations, 464
pathological dislocations, 463
præglenoid dislocations, 436
prognosis, 455
simultaneous of both hips, 18, 402, 448, 453
spontaneous dislocations, 463
statistics, 401
suspinous, 441
suppuration after, 439
supracotyloidea, 441
suprapubic, 435
suscotyloidienne, 441
upward and forward (suprapubic), 435
pathology, 436
symptoms, 438
treatment, 410
Humerus, fracture of anatomical neck, 32, 254
of shaft, 257
of surgical neck, 254
of tuberosities, 254
Hyperextension in reduction at elbow, 296

ILEO-PECTINEAL dislocation of hip, 435
India-rubber, traction by, 69
Infracotyloid dislocation of hip, 446
Internal derangement of knee, 482
Intracoracoid dislocation of shoulder, 217
Intrapelvic dislocation of hip, 436
Ischium, dislocation on tuberosity, 446

JAW, dislocations of lower, 117
backward, with fracture, 117
congenital, 127
forward, 119
pathological, 126

KNEE, anatomy, 466
dislocations of, 466
backward, 469
by rotation, 480
congenital, 486
forward, 469
injuries of nerves in, 472
injuries of vessels in, 34, 470
lateral, 476
inward, 479
outward, 476
spontaneous and pathological, 488
statistics, 469
internal derangement, 482
semilunar cartilages, 482
Kocher, on reduction of hip, 426, 434
of shoulder, 228

LABRUM cartilagineum, detachment of, 453
Luxatio erecta, 237

MANIPULATION, reduction by, 65
at hip, 424
at shoulder, 227
Median nerve, injury of, 36, 37
Medio-carpal dislocations, 368
Medio-tarsal dislocations, 529
Metacarpo-phalangeal dislocations of fingers, 389
of thumb, 380
Metatarsal bones, dislocations of, 531
Metatarso-phalangeal dislocations, 534
Muscles torn during reduction, 77
Muscular action, a cause of dislocation, 77
Musculo-spiral nerve, injury of, 291
Myopathic dislocation of shoulder, 279

NERVES injured in dislocation, 35
injured in reduction, 89
injured at elbow, 37, 291, 307, 312
at hip, 38, 91, 437, 450, 461
at knee, 472
at shoulder, 258

OBTURATOR dislocation, 428
Occiput, dislocation of, 143
Œdema, persistent, 49, 94
Olecranon, fracture of, 31, 290, 311
Os magnum, dislocation of, 372, 374

PARALYSIS after dislocation of hip, 440
of shoulder, 258
Paralytic dislocations, 112
of hip, 464
of shoulder, 278
Patella, dislocations of, 490
complete reversal, 498, 499
congenital, 500
edgewise or vertical, 497, 499
inward, 498

Patella, dislocations of, outward, 493
spontaneous or pathological, 501
Pathological dislocations, 111
Pathology of old dislocations, 43
of recent dislocations, 29
Pelvis, dislocations of, 394
fracture of, 437, 453
Pendel-methode, at shoulder, 223
Perineal dislocations, 435
Phalanges of hand, dislocations of, 380
distal, 392
middle, 391
proximal, 380, 389
of foot, dislocations of, 534
Pisiform, dislocations of, 372
Popliteal artery, injury of, 34, 470, 474
Pouteau, on reduction by manipulation, 67
Præglenoid dislocations of hip, 436
Prognosis, 56

RADIO-CARPAL dislocations, 356
backward, 357
forward, 361
outward, 362
congenital, 362
pathological, 363
Radius, fracture of, 290
isolated dislocations of, 323
backward, 324
forward, 331
outward, 328
by elongation, 335
with fracture of ulna, 340
pathological and congenital, 349
Recurrent dislocations, 27
Reduction, 59
accidents during, 74, 268, 454
after long periods, 60, 457
by manipulation, 65
consecutive, 60
obstacles to, 61
spontaneous, 59
Reid, on reduction of hip, 424
Repair, 40
Rheumatism, dislocation in, 112
Ribs, dislocations of, 167

SCAPHOID, dislocations of carpal, 369
tarsal, 531
Schinzinger, on reduction of shoulder, 231
Sciatic nerve, pressure upon, 414, 461
Semilunar bone, dislocation of, 370
cartilages, dislocation of, 482
Shoulder, anatomy, 197
dislocations of, 197 to 279
Shoulder, dislocations of, after-treatment, 261
anterior, 207
after-treatment, 232, 261
intra-coracoid, 217
subcoracoid, 207
pathology, 211
symptoms, 214
treatment, 219
by manipulation, 227
Kocher, 228
Schinzinger, 231
direct reposition, 222
heel in axilla, 226
traction downward, 222
upward, 224
with leverage, 225
with pulleys, 227
classification, 202
complications, 253
fracture of acromion, 257
of coracoid, 257
of glenoid fossa, 257
of neck, 254
of shaft, 257
of tuberosity, 254
injury of nerves, 258
of vessels, 259
compound dislocations, 259
congenital dislocations, 271
downward dislocations, 234
luxatio erecta, 237
subglenoid, 234
symptoms, 237
treatment, 237
subtricipital, 238
fracture, 32, 254
during reduction, 92
habitual dislocations, 262
injury of nerves in, 35, 258
of vessels in, 34, 80
old dislocations, treatment, 266
arthrotomy, 268
excision, 269
fracture, 270
osteotomy, 271
subcutaneous section, 267
paralytic dislocations, 278
pathological, 276
posterior dislocations, 240
symptoms, 245
treatment, 247
prognosis, 261
relation to other injuries, 201
simultaneous of both shoulders, 260
statistics, 200
upward (supracoracoid), 248
Skin, torn during reduction, 75
Smith, Nathan, on manipulation, 68, 424

Spinal column (see Vertebræ), 128
Spontaneous dislocations, 111
reduction, 59
Statistics, general, 20
Sternum, dislocations of, 161
Subacromial dislocation of clavicle, 191
of shoulder, 240
Subastragaloid dislocations, 516
diagnosis, 520
treatment, 521
Subepicondylar dislocation, 307
Subclavicular dislocation, 217
Subcoracoid dislocation of clavicle, 193
of shoulder, 207
Subcotyloid dislocation of hip, 446
Subglenoid dislocation, 234
Subscapular artery torn, 81
Subspinous dislocation of hip, 441
of shoulder, 240
Subtricipital dislocation, 239
Suppuration, 40, 93, 439
Supra-acromial dislocation of clavicle, 165
Supracoracoid dislocation of shoulder, 240
Supracotyloid dislocation of hip, 441
Supraepicondylar dislocation, 307
Suprapectineal dislocation, 410, 436
Suprapubic dislocation, 435
Sus-cotyloidienne dislocation, 441
Symptoms, 50
Syncope, 95

TARSAL bones, dislocation of, 531
Thumb, dislocations of, 380
distal phalanx, 392
proximal phalanx, 380
Thyroid dislocation, 428
Tibio-tarsal dislocation, 509
Toes, dislocation of, 534
Trapezium, dislocation of, 373
Trapezoid, dislocation of, 373, 374
Treatment, 59
Typhoid fever, dislocation in, 112

ULNA, fracture with dislocation of radius, 340
isolated dislocation of, 319
Ulnar nerve, injured, 36, 307, 312
Unciform, dislocation of, 372

VERTEBRÆ, dislocations of, 128
atlas, 145
cervical vertebræ, 149
classification, 131
dorsal vertebræ, 157
etiology, 137
lumbar vertebræ, 159
occiput, 143
pathology, 131
prognosis, 140
statistics, 128
symptoms, 137
treatment, 141
Viscera, injury to, 38
Voluntary dislocations, 27

WRIST, dislocations of, 352, 356
of fibro-cartilage of, 337
pathological, 363

Y-LIGAMENT, 398
ossified, 431

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INDEX.

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Adams (W.) on Clubfoot, 11
———— on Contraction of the Fingers, 11
———— on Curvature of the Spine, 11
Alexander's Displacements of the Uterus, 6
Allan's Outlines of Infectious Diseases, 7
Allingham on Diseases of the Rectum, 14
Anatomical Remembrancer, 3
Balfour's Diseases of the Heart and Aorta, 9
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Barnes (R.) on Obstetric Operations, 5
———— on Diseases of Women, 5
Basil's Commoner Diseases and Accidents, 10
Beale's Microscope in Medicine, 8
—— Slight Ailments, 8
—— Urinary and Renal Derangements, 14
Bellamy's Surgical Anatomy, 3
Bennet (J. H.) on the Mediterranean, 10
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Bentley and Trimen's Medicinal Plants, 7
Bentley's Manual of Botany, 7
———— Structural Botany, 7
———— Systematic Botany, 7
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———— Pay Hospitals, 4
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—— Operative Surgery of Malignant Disease, 13
—— Sarcoma and Carcinoma, 13
Buzzard's Diseases of the Nervous System 9
———— Peripheral Neuritis, 9
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Charteris on Health Resorts, 10
———— Practice of Medicine, 8
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Churchill's Face and Foot Deformities, 11
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Cobbold on Parasites, 13
Coles' Dental Mechanics. 13
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Coulson on Diseases of the Bladder, 14
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———— Short Manual for Monthly Nurses, 6
Curling's Diseases of the Testis, 14
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———— Short Contributions, 12
Day on Diseases of Children, 6
—— on Headaches, 10
Dobell's Lectures on Winter Cough, 8
—— Loss of Weight, &c., 8
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Duncan on Diseases of Women, 5
—— on Sterility in Woman, 5
Dunglison's Medical Dictionary, 14
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Fenwick's (S.) Chronic Atrophy of the Stomach, 8
———— Medical Diagnosis, 8
———— Outlines of Medical Treatment, 8
———— The Saliva as a Test, 8
Flint's Principles and Practice of Medicine, 7
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———— Diseases of the Spinal Cord, 9
———— Manual of Diseases of Nervous System, 9
———— Medical Ophthalmoscopy, 9
———— Pseudo-Hypertrophic Muscular Paralysis, 9
Granville on Gout, 9
———— on Nerve Vibration and Excitation, 9
Guy's Hospital Formulæ, 2
———— Reports, 2
Habershon's Diseases of the Abdomen, 9
———— Liver, 9
———— Stomach, 9
———— Pneumogastric Nerve, 9
Hardwicke's Medical Education, 14
Harley on Diseases of the Liver, 9
———— Inflammations of the Liver, 9
Harris's Dentistry, 13
Harrison's Surgical Disorders of the Urinary Organs, 13
Hartridge's Refraction of the Eye, 12
Harvey's Manuscript Lectures, 3
Heath's Certain Diseases of the Jaws, 10
—— Injuries and Diseases of the Jaws, 10
—— Minor Surgery and Bandaging, 10
—— Operative Surgery, 10
—— Practical Anatomy, 3
—— Surgical Diagnosis, 10
Helm on Short and Long Sight, &c., 11
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Jones (C. H.) and Sieveking's Pathological Anatomy, 4
Jones' (H. McN.) Diseases of the Ear and Pharynx, 12
———— Atlas of Diseases of Membrana Tympani, 12
———— Spinal Curvatures, 11
Journal of British Dental Association, 2
———— Mental Science, 2
King's Manual of Obstetrics, 5
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Lewis (Bevan) on the Human Brain, 4
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Mackenzie on Diphtheria, 12
———— on Diseases of the Throat and Nose, 12
McLeod's Operative Surgery, 10
MacMunn's Spectroscope in Medicine, 8
Macnamara's Diseases of the Eye, 12
———— Bones and Joints, 11
Martin's Ambulance Lectures, 10
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Middlesex Hospital Reports, 2
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———— Manual of the Diseases of India, 7
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Mouat and Snell on Hospitals, 4
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Ophthalmological Society's Transactions, 2
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—— on Hydrocele, 13
Owen's Materia Medica, 7
Page's Injuries of the Spine, 11
Parkes' Practical Hygiene, 5
Pavy on Diabetes, 10

[*Continued on the next page.*

Pavy on Food and Dietetics, 10
Pharmaceutical Journal, 2
Pharmacopœia of the London Hospital, 7
Phillips' Materia Medica and Therapeutics, 7
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——————— on Syphilis, 14
Robinson (W.) on Endemic Goitre or Thyreocele, 12
Ross's Aphasia, 9
——— Diseases of the Nervous System, 9
——— Handbook of ditto, 9
Routh's Infant Feeding, 7
Royal College of Surgeons Museum Catalogues, 2
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——————— Wasting Diseases of Infants and Children, 6
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——————— Diseases of the Prostate, 14
——————— Diseases of the Urinary Organs, 14
——————— Lithotomy and Lithotrity, 14
——————— Stricture of the Urethra, 14
——————— Suprapubic Operation, 14
——————— Surgery of the Urinary Organs, 14
——————— Tumours of the Bladder, 14
Thorowgood on Asthma, 8
——————— on Materia Medica and Therapeutics, 7
Thudichum's Pathology of the Urine, 14
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