

Orthopedics of childhood / by Willis C. Campbell.

Contributors

Campbell, Willis C. 1880-1941.

Publication/Creation

New York ; London : D. Appleton, 1927.

Persistent URL

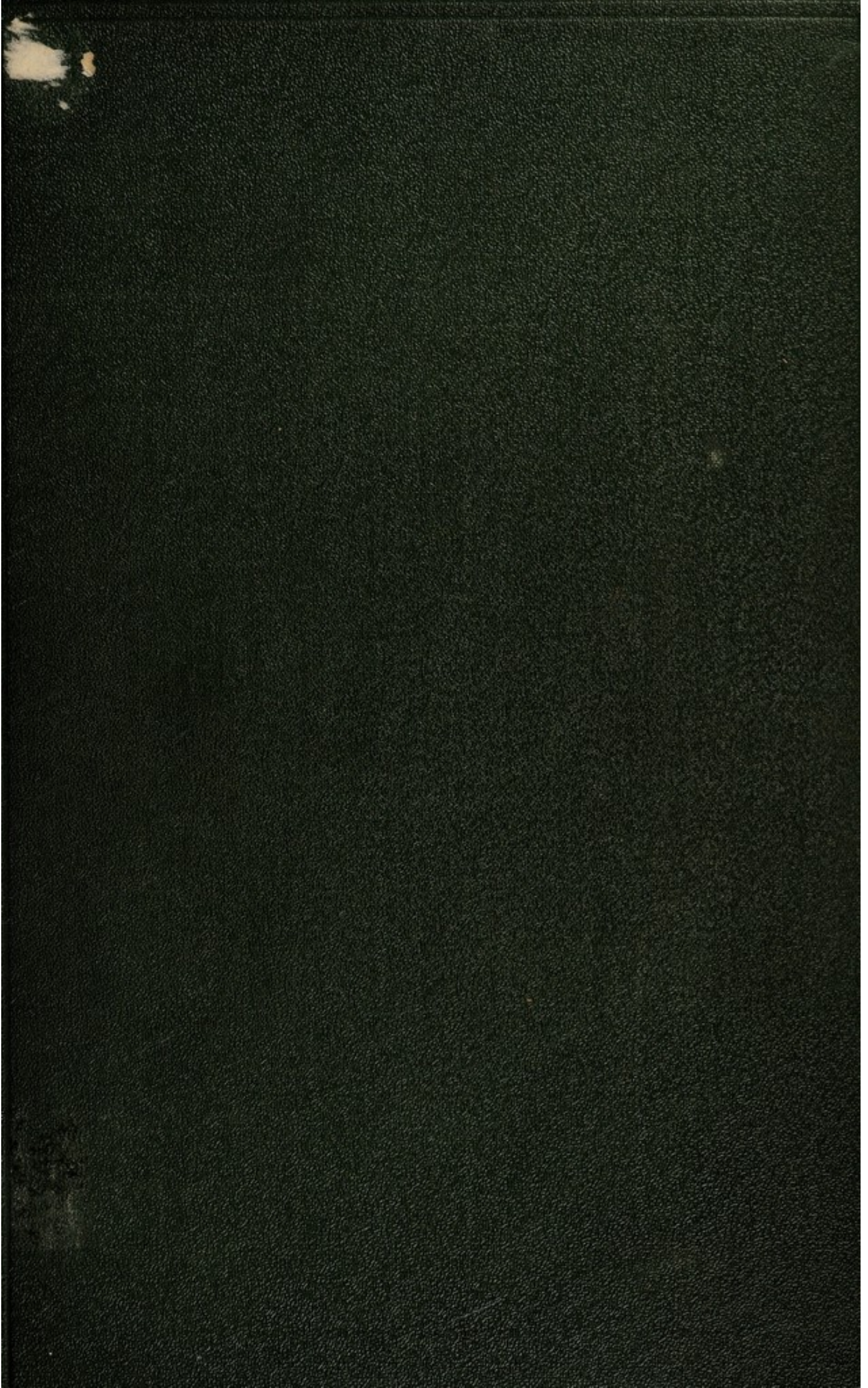
<https://wellcomecollection.org/works/vr5hxdmv>

License and attribution

Conditions of use: it is possible this item is protected by copyright and/or related rights. You are free to use this item in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s).



Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
<https://wellcomecollection.org>

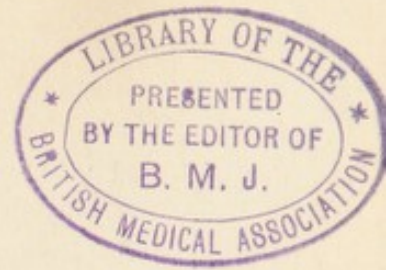


179^E

179




22101657998





ORTHOPEDICS OF CHILDHOOD



Digitized by the Internet Archive
in 2018 with funding from
Wellcome Library

<https://archive.org/details/b29929659>

14.6.27
16/-
✓ 189
CLINICAL PEDIATRICS

ORTHOPEDICS OF CHILDHOOD

BY

WILLIS C. CAMPBELL, M.D., F.A.C.S.

PROFESSOR OF ORTHOPEDIC SURGERY, UNIVERSITY OF TENNESSEE; ATTENDING ORTHOPEDIC SURGEON
TO ST. JOSEPH HOSPITAL, BAPTIST MEMORIAL HOSPITAL, METHODIST HOSPITAL, HOME FOR
INCURABLES, PORTER HOME AND LEATH ORPHANAGE; CONSULTING ORTHOPEDIC
SURGEON, MEMPHIS GENERAL HOSPITAL, MEMPHIS.

SUPERVISING EDITOR

ROYAL STORRS HAYNES, Ph.B., M.D.

CLINICAL PROFESSOR OF DISEASES OF CHILDREN
COLLEGE OF PHYSICIANS AND SURGEONS (COLUMBIA UNIV.) NEW YORK CITY



VOLUME VI

211 ILLUSTRATIONS

D. APPLETON AND COMPANY
NEW YORK LONDON

1927



2658 134

COPYRIGHT, 1927, BY
D. APPLETON AND COMPANY

WELLCOME INSTITUTE LIBRARY	
Coll.	welMOmec
Call	
No.	WS 270
	1927
	C 19.

PRINTED IN THE UNITED STATES OF AMERICA



PREFACE

The purpose of this volume is to place before the general practitioner in simple language the principles and practice involved in the management of those conditions which may impair function or cause deformities in childhood. Technicalities are avoided and no attempt is made to correlate the literature of this vast subject, nor to burden the reader with the evolution of this branch to the present time; therefore, pardon is requested if due credit is not given to various authors. Only the essential principles of the pathology are discussed, to impart a more comprehensive knowledge of the subject. The object of operative method alone is considered, consequently many standard procedures are barely mentioned or omitted.

Especial attention is given to the methods of examination with reference to normal function, so that abnormal variations may be recognized. The manner of reaching the correct diagnosis is also emphasized. In the treatment, stress is laid on the prevention of deformity and the retention of the spine and extremities in the most useful positions for future function. For this purpose, simple mechanical principles and apparatuses are described as may be applied by the average physician, for a vast majority of deformities are seen *in incipency* by the general practitioner. When the services of an expert are desired, a better coöperation is sought between the specialist, the family physician and the family for the benefit of the patient, which is often essential to a successful termination, as orthopedic affections are often of long duration.

WILLIS C. CAMPBELL.



PUBLISHERS' ANNOUNCEMENT

The publishers take pleasure in presenting to the medical profession the series of monographs of which this volume forms a unit.

The many inquiries which reached them proved, in advance of publication, that the work should be in monographic form and clinical in its presentation.

The series when completed will, they believe, be the most useful for the audience for whom it is written, the general practitioner of medicine, that has been presented in its particular field.

The authors are all men of wide experience and, in the main, teachers. The combination makes the work authoritative and of the utmost service in a field which has been often termed a "therapeutic specialty."

CONTENTS

	PAGE
INTRODUCTION	I
CHAPTER	
I. ORTHOPEDIC EXAMINATION	5
The Foot and Ankle	12
Inspection	12
X-Ray	12
The Knee	12
Inspection	12
X-Ray	14
The Hip	15
Inspection	15
Palpation	16
Passive Motion	16
Mensuration	18
X-Ray	18
The Sacro-iliac Joint	20
Inspection	20
Palpation	20
Passive Motion	21
Active Motion	21
The Spine	22
Inspection	23
Palpation	23
Passive Motion	23
Active Motion	24
X-Ray	25
Upper Extremity	25
The Shoulder	25
Examination of Bones	25
II. APPARATUS	26
General Considerations	26
Regional Application	27
The Ankle	27
The Knee	29
The Hip-Joint	34
The Sacro-iliac Joint	37
The Spine	37
The Shoulder	43

CHAPTER	PAGE
The Elbow	44
The Wrist	44
Symptoms of Constriction	44
Measurement of Braces	46
III. CLASSIFICATION OF ORTHOPEDIC AFFECTIONS	47
I. Affections of Joints	47
Acute Infectious Processes	47
Low-Grade Affections	48
Traumatic Affections	48
Blood Dyscrasias	48
Neoplasms	48
II. Affections of Bones	48
Acute Affections or Infections	48
Low-Grade Affections	48
Traumatic Affections	48
Epiphyseal Affections	48
Nutritional Disorders	48
Disorders of Internal Secretion	48
Neoplasms	49
Congenital Deficiencies	49
III. Affections of Epiphyses	49
IV. Affections of the Soft Tissues	49
V. Affections of the Nervous System	49
VI. Static or Postural Affections	49
VII. Congenital Anomalies	49
IV. ACUTE JOINT AFFECTIONS	50
Acute Infectious Arthritis	50
Symptoms	51
Laboratory and X-Ray Observations	52
Diagnosis	52
Prognosis	54
Treatment	54
The Ankle and Foot	58
The Knee	59
The Hip-Joint	60
Acute Infectious Spondylitis	62
Symptoms	62
Roentgenogram	64
Diagnosis	64
Prognosis	64
Treatment	66
The Shoulder Joint	66
The Elbow	67
The Wrist and Hand	67

CHAPTER	PAGE
V. LOW-GRADE JOINT AFFECTIONS	68
Tuberculosis	68
Etiology	68
Pathology	69
Symptoms	70
Diagnosis	70
X-Ray Examination	70
Tuberculin Test	71
Differential Diagnosis	71
Prognosis	71
Treatment	72
Tuberculous Abscess	76
Tuberculosis of the Foot and Ankle	76
Diagnosis	78
Treatment	78
Tuberculosis of the Knee	78
Prognosis	79
Treatment	80
Tuberculosis of the Hip	81
Symptoms	82
Diagnosis	82
Prognosis	83
Treatment	83
VI. LOW-GRADE JOINT AFFECTIONS (<i>Continued</i>)	85
Tuberculosis of the Spine	85
Symptoms	85
Complications	88
X-Ray Examination	90
Diagnosis	91
Prognosis	92
Treatment	92
Tuberculosis of the Upper Extremities	95
The Shoulder	95
Treatment	95
The Elbow	95
The Wrist	96
VII. LOW-GRADE JOINT AFFECTIONS (<i>Continued</i>)	98
Syphilis	98
Pathology	98
Symptoms and Joint Manifestations	99
X-Ray	100
Diagnosis	101
Prognosis	102
Treatment	102

Low-Grade or Chronic Infectious Arthritis	102
Pathology	103
Symptoms and Clinical Course	103
Diagnosis	104
Prognosis	105
Treatment	105
Arthritis deformans of Childhood	106
Treatment	107
Osteochondritis	107
Osteochondritis of Head of Second Metatarsal	107
Coxa plana	108
Symptoms	109
Diagnosis	110
Prognosis	110
Treatment	110
Coxa vara	111
Pathology and X-Ray	111
Symptoms	112
Diagnosis	113
Prognosis	113
Treatment	113
Coxa valga	114
Osteochondritis of the Spine	114
Etiology	115
Pathology	115
Symptoms and Clinical Course	115
Diagnosis	115
Prognosis	115
Treatment	115
VIII. TRAUMATIC JOINT AFFECTIONS	118
Traumatic Arthritis	118
Acute Traumatic Arthritis	118
Treatment	118
The Ankle	118
The Knee	119
The Hip	120
The Sacro-iliac Joint	120
X-Ray	120
Diagnosis	121
Treatment	121
Sciatic Scoliosis	122
Acute Traumatic Spondylitis	122
Treatment	122
The Elbow	122
Treatment	123

CONTENTS

xiii

CHAPTER

PAGE

Subacute Traumatic Arthritis	123
The Knee	123
Blood Dyscrasias	125
Neoplasms	125
Benign Tumors	126
Recurrent Tumors	126
Malignant Tumors	126
 IX. AFFECTIONS OF THE BONES	128
Acute Infections	128
Etiology	128
Pathology	128
Symptoms and Local Manifestations	129
Acute Stage	129
Subacute and Chronic Stage	130
Stage of Residual Impairment	130
X-Ray	130
Diagnosis	131
Prognosis	133
Treatment	135
Low-Grade Affections	136
Tuberculosis	136
Pathology	136
Symptoms	136
X-Ray	136
Prognosis and Treatment	136
Syphilis	136
Osteochondritis	137
Periosteal Stage or Periostitis	137
Osteomyelitis or Destructive Stage	138
Diagnosis	139
Prognosis and Treatment	139
Sclerosing Osteomyelitis of Garré	139
Pathology	139
Symptoms and Local Manifestations	139
X-Ray	141
Diagnosis	141
Prognosis	141
Treatment	141
Osteitis fibrosacystica	142
Pathology	143
Symptoms	143
Diagnosis	143
Prognosis	143
Treatment	143

Epiphysitis of Extra-articular Epiphyses	144
Epiphysitis of the Os calcis	144
Epiphysitis of Scaphoid	145
Köhler's Disease of the Scaphoid (Osteitis of Scaphoid)	145
Treatment	146
Epiphysitis of Tibial Tubercle	146
Treatment	146
Generalized Extra-articular Epiphysitis	146
 X. AFFECTIONS OF BONES (<i>Continued</i>)	147
Traumatic Affections	147
Fractures	147
X-Ray	147
The Shaft of the Femur	149
The Spine	151
The Forearm	151
The Elbow (Humerus)	156
The Shaft of the Humerus	158
The Clavicle	161
Symptoms	164
X-Ray Examination and Diagnosis	165
Prognosis	165
Treatment	165
Epiphyseal Separations	166
Malunited Fractures	169
The Shaft of the Femur	170
Upper Extremity of the Humerus	170
The Elbow	171
The External Condyle	172
Ununited Fractures in Children	174
Congenital Fractures	175
Treatment	176
Dislocations Recent and Ancient	177
The Elbow	178
The Hip	178
Traumatic Osteitis	181
Osteoporosis	181
X-Ray	181
Diagnosis	181
Prognosis and Treatment	181
 XI. AFFECTIONS OF BONES (<i>Continued</i>)	182
Disorders Due to Nutrition	182
Rickets	182
Pathology and X-Ray	182
Symptoms	182

CONTENTS

XV

CHAPTER

PAGE

Prognosis	182
Treatment	182
Bow-Leg (<i>Genu varum</i>)	183
Prognosis	185
Knock-Knee (<i>Genu valgum</i>)	185
Prognosis	185
Treatment	185
Late Rickets	187
Dyschondroplasia	187
Prognosis and Treatment	188
Scurvy	188
Congenital Deficiencies in Quality of Bone	189
<i>Fragilitas ossium</i>	189
Hereditary Type	190
Osteosclerosis	191
Dyschondroplasia	192
Chondrodysplasia <i>foetalis</i> (Fetal Rickets)	192
Endocrine Disturbances	192
Neoplasms or Bone Tumors	192
Benign Tumors	192
Osteochondromata	192
Chondromata	193
Giant-Cell Tumors	194
Pathology	195
Diagnosis	196
Prognosis and Treatment	196
Recurrent Tumors	196
Malignant Tumors	196
Periosteal Sarcoma	197
Pathology	198
Symptoms of Clinical Manifestations	198
X-Ray	198
Diagnosis	198
Prognosis	199
Treatment	199
Endothelioma	199
Myeloma	200
XII. AFFECTIONS OF THE SOFT TISSUES	201
Scar Contractures	201
Etiology	201
1. Burns	201
2. Lacerated Wounds	201
3. Infections	201
Location of Tissue Loss	201
Depth of Tissue Loss	202

	PAGE
Prevention of Contractures	202
Treatment	204
Mechanical Treatment	204
Operative Treatment	204
Transplantation of Skin	204
Types of Grafts	205
Reverdin Grafts (Davis)	205
Ollier Thiersch Grafts	205
Whole Thickness Grafts (Wolfe-Krause)	205
Pedunculated Skin Flaps	205
Treatment of Special Deformities	206
Muscles	210
Rupture of Muscles	210
Pathology	211
Symptoms	211
Diagnosis	211
Treatment	211
Myositis	211
Ischemic Myositis (Volkmann's Paralysis)	211
Etiology	211
Pathology	212
Symptoms	212
Diagnosis	212
Prognosis	213
Treatment	213
Preventive Treatment	213
Corrective Treatment	213
Myositis ossificans	213
Etiology	213
Pathology	214
Symptoms	215
Diagnosis	215
Treatment	215
Tendons	215
Displacement of Peroneal Tendons	215
Tenosynovitis	215
Pathology	215
Symptoms	216
Diagnosis	216
Treatment	216
Ganglion	216
Bursæ	216
Calcaneobursitis	216
Achillobursitis	217
Prepatellar Bursitis (Housemaid's Knee)	217

CONTENTS

xvii

CHAPTER	PAGE
Subacromial Bursitis	217
Tennis Elbow	217
 XIII. AFFECTIONS OF THE NERVOUS SYSTEM	 218
Anterior Poliomyelitis	218
Etiology	218
Pathology	218
Symptoms and Clinical Course	218
The Foot	220
The Knee	223
The Hip	224
The Spine	225
The Shoulder	225
The Elbow	225
The Wrist	225
Prognosis	225
Treatment	226
Operations for the Correction of Deformity	228
Operations for the Restoration of Muscle Power	229
Operations for Stabilization	229
The Foot and Ankle	230
The Knee	232
The Hip	233
The Spine	233
The Upper Extremity	233
The Shoulder	233
The Elbow	233
The Wrist	234
 XIV. AFFECTIONS OF NERVOUS SYSTEM (<i>Continued</i>)	 237
Spastic Cerebral Paralysis (Little's Disease)	237
Etiology	237
1. Prenatal, When Damage Occurs before Birth	237
2. Natal or Birth Injuries	237
3. Postnatal Causes	238
Pathology	238
Symptoms	238
Differential Diagnosis	239
Treatment	240
Operations	240
Surgical Treatment	242
Muscle Training	243
Obstetrical Paralysis (Birth Paralysis)	243
Etiology	243
Pathology	243
Symptoms	244

X-Ray Examination	245
Diagnosis	245
Prognosis	245
Treatment	245
Progressive Muscular Atrophy	246
Etiology	246
Pathology	246
Symptoms and Clinical Course	246
Diagnosis	247
Differential Diagnosis	247
Treatment	247
Muscular Dystrophy	248
Etiology	248
Pathology	248
Clinical Forms	248
Symptoms and Clinical Course	248
Diagnosis	249
Differential Diagnosis	249
Prognosis	249
Treatment	249
Hereditary Ataxia (Friedreich's Ataxia)	250
Symptoms	250
Diagnosis	250
Treatment	250
Injuries to the Peripheral Nerves	250
1. Fractures	251
2. Injuries to the Soft Parts	251
3. Excessive Swelling or Constriction of an Extremity	251
4. Trauma or Excessive Stretching	251
Types of Nerve Injuries	251
Diagnosis	251
Symptoms	252
Treatment	253
1. Conservative	253
2. Operative	253
Complete Nerve Severance	253
Hysterical Paralysis	254
XV. STATIC DEFORMITIES	256
Deformities of the Feet	256
Structure and Function of the Normal Foot	256
The Weak Foot (Pes planus, Flat-Foot)	257
Deformity	257
Symptoms	257
Examination	257
Diagnosis	258

CONTENTS

xix

CHAPTER

PAGE

Treatment	258
1. Exercises and Physiotherapy	258
2. Supports	259
3. Operations	260
Scoliosis	260
Etiology	262
Deformity	263
Symptoms	265
Examination	265
X-Ray Examination	265
Diagnosis	267
Prognosis	267
Treatment	267
Gymnasium and Physiotherapy	267
Corrective Treatment	268
Retentive Appliances	268
Operative Treatment	269
Round Shoulders; Hollow-Back	269
Diagnosis	270
Prognosis and Treatment	270
Spondylolisthesis	270
Etiology	270
Symptoms	271
Examination	271
Treatment	272
Visceroptosis	272
XVI. CONGENITAL ANOMALIES	273
Deformities of the Feet	280
Congenital Club-Foot (Talipes)	280
Diagnosis	281
Prognosis	281
Treatment	282
Methods of Treatment	282
Varus	286
Congenital Valgus or Calcaneoalgus (Congenital Club-Foot)	286
Congenital Equinus	286
Deformities of the Knee	287
Genu recurvatum	287
Malformation and Rotary Displacements of Knee	288
Deformities of the Hip	288
Congenital Dislocation	288
Symptoms and Clinical Manifestations	289
Diagnosis	290
Prognosis	290

	PAGE
Treatment	291
Anomalies of the Spine	292
Torticollis	292
Diagnosis	293
Prognosis and Treatment	293
INDEX	295

ILLUSTRATIONS

FIGURE		PAGE
1.	X-ray of normal foot of child, age two years, showing that scaphoid and external cuneiform have not appeared	2
2.	X-ray of normal foot of adult	2
3.	X-ray of foot of Chinese woman, showing effect of early binding	3
4.	Burmese woman, showing elongation of neck by successive applications of brass rings	4
5.	Front and reverse sides of history card	7
6.	Drawing showing line of weight-bearing in normal posture	8
7.	Photograph showing method of auscultation of knee-joint	9
8.	Drawing showing method of aspiration of knee-joint	9
9.	X-ray showing atrophy of bone and extensive destruction of bones of wrist with atrophic changes in the bones of hand	10
10.	X-ray showing hypertrophy of bone	11
11.	Normal posture showing distribution of weight on foot and ankles	12
12.	Normal range of dorsal flexion of right foot and plantar flexion of left foot	13
13.	Normal range of abduction of foot	14
14.	Normal range of adduction of foot	14
15.	Normal range of flexion of knee	15
16.	Normal range of extension of knee	15
17.	Normal range of abduction of hip	16
18.	Normal range of adduction of hip	17
19.	Normal range of extension of hip	18
20.	Drawing showing hip ankylosed in flexed position, the spine held straight	19
21.	Drawing showing hip ankylosed in flexed position	19
22.	Drawing showing tilting of pelvis with apparent inequality in length of legs	19
23.	Normal range of extension of cervical spine	20
24.	Normal range of lateral motion in cervical spine	20
25.	Normal range of passive extension of spine	21
26.	Normal range of passive lateral motion of spine	22
27.	Normal range of flexion of spine	23
28.	Normal range of extension of spine	24
29.	Normal range of active side-bending	24
30.	Splint to retain foot at right angle to ankle, extending from toes to just below the knee-joint	28
31.	Ankle brace attached to shoe limiting plantar flexion	28
32.	Splint to hold knee in extension and foot at right angle to leg	29
33.	Small wooden block with rope and pulley fixed to end of board attached to foot of bed, used in Buck's extension	30
34.	Thomas knee splint	31
35.	Thomas knee splint with hinge at knee and adjustable foot plate	31
36.	Thomas caliper brace	32

FIGURE	PAGE
37. Simple knee brace attached to shoe, extending well up on thigh .	33
38. Illustrating undesirable condition of bed with consequent sagging of pelvis	34
39. Drawing showing body supported on firm surface for hip traction	34
40. Bradford frame with slip cover for use of bed-pan	35
41. Drawing showing traction in line of deformity of hip	35
42. Double spica cast	36
43. Thomas hip splint	37
44. Sayre head traction apparatus	38
45. Plaster-of-Paris body cast, including head	39
46. Sayre head traction apparatus for application of plaster-of-Paris body cast	40
47. Taylor spinal brace, with author's modification, extending from occiput to knees	42
48. Traction humerus splint	43
49. Splints used for support of elbow and wrist	44
50. Drawing of outline of body and leg with circumferences, to be used in manufacture of braces	46
51-A. X-ray showing acute infectious arthritis of knee, late stage, antero- posterior view	53
51-B. Same as Figure 51-A, lateral view	53
52-A. X-ray showing tuberculosis of knee, late stage, anteroposterior view	54
52-B. Same as Figure 52-A, lateral view	54
53. Photograph showing method of instituting passive motion in knee- joint by modified Thomas knee splint and overhead sling . .	57
54. Photograph showing swelling of knee and flexion deformity in acute arthritis	59
55. Campbell-Mitchner knee splint for correction of flexion deformity of knee	60
56. X-ray showing bilateral dislocation of hips resulting from acute infectious arthritis	61
57-A. X-ray showing subacute infectious spondylitis, with narrowing of intervertebral space between fourth and fifth lumbar vertebræ, anteroposterior view	63
57-B. Same as Figure 57-A, lateral view	65
58. Cross section of tuberculosis of knee, showing destruction of bone beneath articular cartilage of tibia and of articular surface of femur	69
59. Heliotherapy at Crippled Children's Hospital, Memphis, Tennessee	73
60. Heliotherapy on roof of private clinic showing how heliotherapy may be successfully administered in crowded city districts .	74
61-A. X-ray showing tuberculosis of ankle with destruction of bone and narrowing of joint space, anteroposterior view	77
61-B. Same as Figure 61-A, lateral view	77
62. Photograph of tuberculosis of knee, showing beginning subluxa- tion of tibia	79
63. X-ray series showing progressive destruction of tuberculosis of hip	81
64. Photograph of tuberculosis of cervical spine, showing forward luxation of head	86

FIGURE		PAGE
65.	Photograph of tuberculosis of dorsal spine, showing elevation of shoulders to relieve weight of spine	86
66.	Photograph of tuberculosis of dorsal region, showing extensive dorsal kyphosis with double psoas contraction from descending abscess	87
67.	Photograph of tuberculosis of lumbar spine with extreme deformity	88
68.	Photograph showing beginning sharp angle of deformity of tuberculosis of lower dorsal spine	89
69-A.	X-ray showing tuberculosis of spine with narrowing of intervertebral space, anteroposterior view	90
69-B.	X-ray showing tuberculosis of spine with narrowing of intervertebral space between third and fourth lumbar vertebræ and erosion of anterior margin of body of fourth lumbar vertebræ, lateral view	90
70.	X-ray showing tuberculosis of lower dorsal area with spindle-shaped mass of inflammatory exudate	91
71.	Schematic drawing of spine, showing method of Albee bone-graft operation	93
72-A.	X-ray showing tuberculosis of elbow joint with extensive destructive changes, anteroposterior view	96
72-B.	Same as Figure 72-A, lateral view	96
73.	Drawing from x-ray, showing syphilis of ankle with punched-out areas on the articular surfaces of tibia and astragalus	99
74.	Drawing from x-ray, showing multiple punched-out areas over both femoral condyles, end result of congenital syphilitic arthritis	99
75.	Drawing from x-ray, showing typical syphilitic dactylitis, one of the manifestations of polyarthritis	100
76.	Photograph of chronic polyarticular infectious arthritis, showing involvement of joints of hand	104
77.	Photograph of arthritis deformans (Still's disease) showing involvement with deformity of practically all joints	106
78.	Photograph of arthritis deformans after correction of deformities, showing ability to stand with braces	107
79.	X-ray of osteochondritis of head of second metatarsal, showing typical corpora libera in the joint	108
80.	X-ray series of coxa plana, showing progressive flattening and fragmentation of head and broadening of neck of femur	109
81-A.	X-ray showing coxa vara with downward displacement of head on neck of femur	112
81-B.	Same as Figure 81-A after correction by manipulation, showing normal relation of head and neck of femur	112
82.	X-ray showing coxa valga in anterior poliomyelitis	114
83.	X-ray showing osteochondritis of spine with wedge-shaped compression of vertebræ	116
84.	Drawing showing method of applying Gibney strapping for sprained ankle	119
85.	Drawing showing strapping of knee with adhesive plaster, basket-weave method	120
86.	X-ray showing enlarged transverse process of fifth lumbar vertebra	121

FIGURE		PAGE
87.	X-ray of osteochondritis dissecans, showing triangular area of rarefaction on medial condyle of femur surrounding small area of increased density; articular cartilage still intact	124
88.	Photographs of sequestrum removed at operation from chronic osteomyelitis of tibia	129
89.	X-ray of acute osteomyelitis of left femur, early state, showing very slight structural change	130
90.	Same as Figure 89, four weeks later, showing extensive proliferation and destruction	131
91-A.	X-ray of chronic osteomyelitis of tibia showing sequestrum, denoted by dark areas of condensed bone surrounded by proliferation and formation of involucrum, anteroposterior view	132
91-B.	Same as Figure 91-A, lateral view	132
92-A.	Same as Figure 91-A, eleven months after radical operation, showing dense new bone formation, anteroposterior view	134
92-B.	Same as Figure 92-A, lateral view	134
93-A.	X-ray of syphilitic periostitis of tibia, showing longitudinal deposition of new bone in layers, anteroposterior view	137
93-B.	Same as Figure 93-A, lateral view	137
94.	X-ray showing syphilitic osteomyelitis with pathological separation of upper femoral epiphysis	138
95-A.	X-ray showing sclerosing osteomyelitis of Garré of lower end of tibia, with increased density of bone, anteroposterior view	140
95-B.	Same as Figure 95-A, lateral view	140
96.	X-ray of osteitis fibrosa cystica of upper end of femur, showing multilocular cyst without expansion of bone cortex	142
97.	X-ray showing epiphysitis of os calcis with fragmentation	144
98-A.	X-ray showing osteitis of scaphoid, anteroposterior view	145
98-B.	Same as Figure 98-A, lateral view	145
99.	X-ray showing epiphysitis of tibial tubercle	146
100-A.	X-ray showing transverse fracture of shaft of femur, anteroposterior view	148
100-B.	Same as Figure 100-A, lateral view	148
101-A.	Same as Figure 100-A, after reduction	149
101-B.	Same as Figure 100-B, after reduction	149
102.	Drawing of plaster-of-Paris double spica cast, showing flexed position of hip and knee, used in treatment of fractured femur	150
103-A.	X-ray of fracture of bones of forearm, anteroposterior view	151
103-B.	Same as Figure 103-A, lateral view	151
104-A.	Same as Figure 103-A, after reduction	152
104-B.	Same as Figure 103-B, after reduction	152
105-A.	X-ray showing fracture of head of radius with vicious union, anteroposterior view	153
105-B.	Same as Figure 105-A, lateral view	153
106-A.	X-ray showing supracondylar fracture of humerus, anteroposterior view	154
106-B.	Same as Figure 106-A, lateral view	154
107-A.	Same as Figure 106-A, after reduction	155
107-B.	Same as Figure 106-B, after reduction	155

FIGURE	PAGE
108. Same as Figure 107-B, showing that acute flexion alone does not always reduce supracondylar fracture of humerus	155
109. Photograph showing method of fixing arm in acute flexion by adhesive strapping	156
110-A. X-ray showing fracture of external condyle of humerus with wide separation, anteroposterior view	157
110-B. Same as Figure 110-A, lateral view	157
111-A. Same as Figure 110-A after open reduction and fixation with wire nail	158
111-B. Same as Figure 110-B, after open reduction	158
112-A. X-ray showing fracture of middle third of humerus, anteroposterior view	159
112-B. Same as Figure 112-A, lateral view	159
113-A. Same as Figure 112-A, after reduction and osseous union	160
113-B. Same as Figure 112-B, after reduction and osseous union	160
114. Photograph of traction humerus splint with banjo attachment for traction of forearm	161
115. X-ray showing fracture of surgical neck of humerus	162
116. Same as Figure 115, after reduction	163
117-A. Photograph of traction humerus splint applied, anteroposterior view	164
117-B. Same as Figure 117-A, lateral view	164
118-A. X-ray of fracture of clavicle, junction of middle and outer thirds, showing upward displacement and overriding of medial fragment	165
118-B. Same as Figure 118-A, after reduction	165
119. Drawing showing method of applying Sayre adhesive dressing	166
120. Drawing of posterior splint for retention of fractured clavicle	166
121-A. X-ray showing separation of lower femoral epiphyses, anteroposterior view	167
121-B. Same as Figure 121-A, lateral view	167
122-A. Same as Figure 121-A, after open reduction	168
122-B. Same as Figure 121-B, after open reduction	168
123-A. X-ray showing malunited fracture of shaft of femur, anteroposterior view	169
123-B. Same as Figure 123-A, lateral view	169
124-A. Same as Figure 123-A, after reduction; perfect functional result	170
124-B. Same as Figure 123-B, after reduction	170
125-A. X-ray of malunited supracondylar fracture with impingement of lower end of shaft on coronoid process of ulna	171
125-B. Same as Figure 125-A, after surgical removal of mass of bone and restoration of function	171
126-A. X-ray showing fracture of external condyle of humerus with non-union, anteroposterior view	172
126-B. Same as Figure 126-A, lateral view	172
127-A. X-ray showing ununited fracture of upper end of radius, anteroposterior view	173
127-B. Same as Figure 127-A, lateral view	173
128-A. X-ray showing congenital fracture of tibia and fibula, anteroposterior view	174

FIGURE	PAGE
128-B. Same as Figure 128-A, lateral view	174
129-A. Same as Figure 128-A, after homogeneous bone-grafting from mother, showing callus formation and solid union	175
129-B. Same as Figure 128-B, after bone-grafting, showing callus formation and solid union	175
130. Photograph of child (Figures 128-A, 128-B, 129-A, 129-B) showing contour of right leg after operation	176
131-A. X-ray showing posterior dislocation of elbows, anteroposterior view	177
131-B. Same as Figure 131-A, lateral view	177
132. X-ray of traumatic dislocation of hip after reduction	179
133. X-ray of old traumatic dislocation of hip, showing epiphyseal disturbance	180
134-A. X-ray showing epiphyseal disturbance characteristic of rickets, anteroposterior view	183
134-B. Same as Figure 134-A, lateral view	183
135. X-ray of bow-leg following rickets	184
136. Same as Figure 135 after operation, showing osteotomies of both femurs, tibiae and fibulae	186
137-A. Photograph showing deformity following rickets; right genu valgum, left genu varum	187
137-B. Same as Figure 137-A, after operation	187
138. X-ray showing typical osteomalacia of femur with metaplasia; also involvement of tibia	188
139-A. Photograph of child showing dwarfism and typical deformities of chondrodysplasia foetalis, age ten years	189
139-B. Same as Figure 139-A, lateral view	189
140. X-ray of bones of legs, showing changes in chondrodysplasia foetalis	190
141. X-ray of bones of forearms, showing changes in chondrodysplasia foetalis	191
142. Photograph of twin boys, showing endocrine disturbance	193
143. X-ray of osteochondroma of lower end of femur, showing tumor with pedicle	194
144-A. X-ray showing giant-cell tumor of tibia with multilocular cyst, with expansion of bone cortex	195
144-B. Same as Figure 144-A, lateral view	195
145. X-ray of osteogenetic sarcoma of humerus, showing complete osteolysis of shaft of bone	197
146. Case of osteogenetic sarcoma of humerus of which x-ray is shown in Figure 145	198
147-A. X-ray of periosteal sarcoma of lower end of femur, anteroposterior view	199
147-B. Same as Figure 147-A, lateral view	199
148-A. Photograph of child with extension scar in left axilla	206
148-B. Same as Figure 148-A	206
149. Photograph showing operation for scar contracture of axilla	207
150-A. Photograph showing scar contracture on dorsum of foot, following extensive burn, with talipes calcaneus deformity	208
150-B. Same as Figure 150-A, after operation by pedicled skin flap	208

FIGURE		PAGE
151.	Photograph of fingers extended by banjo traction splint to prevent scar contracture	209
152.	Series of photographs showing technic and result of plastic procedure (J. S. Speed) for ulcer of leg following osteomyelitis	210
153.	X-ray showing myositis ossificans in lumbar muscles following contusions	214
154-A.	Photograph showing equinus deformity of foot with lordosis of spine	220
154-B.	Same as Figure 154-A, after operation	220
155-A.	Photograph showing paralytic varus of left foot and paralytic valgus of right	221
155-B.	Same as Figure 155-A, after operation	221
156-A.	Photograph showing calcaneovalgus of left foot	222
156-B.	Same as Figure 156-A, after reconstruction	222
157-A.	Photograph showing flexion deformity of knee	223
157-B.	Same as Figure 157-A, showing correction of flexion deformity of knee	223
158-A.	Photograph showing bilateral genu recurvatum	224
158-B.	Same as Figure 158-A, showing correction of bilateral genu recurvatum after author's operation of transplantation of patella to tibia	224
159.	X-ray showing fusion of patella to tibia in author's operation for genu recurvatum	225
160.	Photograph showing flexion contractures of hips and knees with quadruped locomotion	225
161.	Same as Figure 160, showing correction of deformity	226
162.	Method of progression in severe case of paralysis, resulting from anterior poliomyelitis with paralysis and deformity of both lower extremities	227
163.	Drawing showing Z-shaped incision for lengthening tendo achillis	228
164.	Schematic drawing showing technic of drop-foot operation, illustrating the tendo achillis lengthened by Z-shaped incision and mass of bone chips transplanted to upper surface of os calcis	229
165.	X-ray of foot following arthrodesis of astragaloscaphoid and calcaneocuboid joints and drop-foot operation	230
166-A.	Photograph showing talipes equinovarus of right foot	231
166-B.	Same as Figure 166-A, after drop-foot operation	231
167.	X-ray of foot five years after astragalectomy	232
168.	Photograph showing method of progression with weakened quadriceps	233
169.	Photograph showing flexion deformity of hip, causing typical quadruped	234
170.	Same as Figure 169, after correction of flexion deformity of hip by author's transference of crest of ilium	234
171.	Similar to Figure 169	234
172.	Similar to Figure 170	235
173.	Photograph showing amount of abduction of arm following arthrodesis of shoulder in anterior poliomyelitis, with paralysis of deltoid muscle	235
174-A.	Detail of joint at knee, showing catch to lock knee in extension	236

FIGURE	PAGE
174-B. Detail of joint at knee, showing stop-joint to prevent hyperextension	236
174-C. Detail of joint at knee, showing control dial to regulate amount of motion by set screw	236
175-A. Photograph showing spastic paralysis with adduction of thighs, flexion of knees and contracture of tendo achillis	239
175-B. Same as Figure 175-A, after Stoffel operation and correction of deformities	239
176. Drawing showing the branches of tibial nerve which resected in Stoffel operation to relieve spastic contracture of foot	241
177. Drawing showing branches of median nerve which are resected in Stoffel operation to relieve spastic contractures of hand	242
178. Photograph of obstetrical paralysis, upper-arm type, showing limited abduction and external rotation of arm	244
179. Photograph of muscular dystrophy, showing patient sliding through shoulders	244
180. Photograph of hysterical paralysis	254
181. Photograph of weak or flat-foot	257
182. Drawing showing method of strapping for pes planus	259
183. Congenital anomaly of spine with absence of part of seventh and eighth dorsal vertebræ and the seventh and eighth ribs on left side	261
184. Photograph showing paralytic scoliosis	262
185. Photograph showing scoliosis of static type, right dorsal, left lumbar	263
186. X-ray of scoliosis, right dorsal, left lumbar, showing rotation of bodies of vertebræ	264
187. Same as Figure 185, after correction by turnbuckle cast	266
188. Photograph of scoliosis being corrected by turnbuckle cast	267
189. Photograph of plaster-of-Paris cast model of body, cut and corrected to desired degree, to be used in manufacture of leather corset	268
190. Photograph of leather corset reinforced with steel to be used after maximum correction has been obtained in treatment of scoliosis	269
191. Drawing from an x-ray of spondylolisthesis	271
192. Same as Figure 191, showing method of fixation with Albee bone-graft	271
193. Photograph of congenital equinovarus associated with constricting bands about leg and hypertrophy of great toes	273
194. Photograph showing intra-uterine amputation of forearm on right and congenital absence of ulna on left	273
195. X-ray showing congenital anomaly of fifth finger, left hand, with atrophy of terminal two phalanges	274
196-A and B. Congenital hypertrophy of leg before and after excision of redundant tissue and stabilization of foot	274
197-A. Photograph of hands, showing sixth finger on each hand	275
197-B. Same as 197-A, after removal of supernumerary fingers	275
198-A. Photograph of feet, showing additional great toe on each foot	275

FIGURE	PAGE
198-B. Same as Figure 198-A, after removal of supernumerary toes . . .	275
199. X-ray of hand, showing sixth finger articulating by rudimentary sixth metacarpal to fifth metacarpal	276
200. X-ray of foot, showing rudimentary metatarsal bone attached to first metatarsal bone and complete duplication of great toes .	277
201. Photograph of child with bilateral congenital absence of fibula with extreme talipes valgus	278
202-A. X-ray of Figure 201, showing bilateral congenital absence of fibula, with extreme talipes valgus and compensatory hypertrophy of tibia, anteroposterior view	279
202-B. Same as Figure 202-A, lateral view	279
203-A. Photograph showing bilateral congenital club-foot in infancy . .	280
203-B. Photograph showing correction of bilateral congenital club-foot by plaster-of-Paris cast	280
204. Photograph of retention splint used for club-foot after correction by successive casts	283
205-A. Photograph showing bilateral congenital club-foot in child, age eighteen months	284
205-B. Same as Figure 205-A, after correction by manipulation . . .	284
206-A. Photograph showing bilateral congenital club-foot in twins, age ten years	285
206-B. Same as Figure 206-A, after surgical correction	285
207-A. X-ray showing congenital dislocation of knee, lateral view . . .	287
207-B. Same as Figure 207-A, anteroposterior view	287
208. Drawing of congenital dislocation of hip, illustrating lengthening of ligamentum teres and hour-glass contraction of joint capsule	289
209-A. X-ray of congenital dislocation of left hip, showing deficiency of rim of acetabulum and formation of false acetabulum	290
209-B. Same as Figure 209-A, after reduction and fixation in full abduction	290
210. Photograph of bilateral congenital dislocation of hips after reduction, showing plaster-of-Paris cast from pelvis to below knees, Lorenz position	291
211. Photograph of congenital torticollis, showing deviation of head toward affected side and chin toward opposite side	293

INTRODUCTION

Orthopedic surgery is the branch of general surgery which deals with diseases and trauma of the bones, joints, muscles, fasciæ and nervous system that may impair function or cause deformity at any age. This subject has become gradually broader, having long since outgrown the original definition of the two Greek words, *ὀρθός* straight + *παῖς* child, to "straighten a child." However, the term orthopedic will continue to be employed until one more descriptive of the specialty of to-day has been advanced.

This volume is confined to the subject as related to children. It is therefore essential that the characteristics of the tissues during the period of growth be carefully considered in contradistinction to those of the matured adult. As might be expected, there is an inherent structural difference in the adult and in the organism in process of development, which is more apparent in the skeletal system. The younger the organism, the greater the contrast in quality, which materially influences the manner and methods of surgical procedure in each period of development.

The future length and breadth of the organism depends largely upon areas of growth, or epiphyses, in the bones. The integrity of these must not be violated by the slightest injury, otherwise there may be either an arrest or an irregularity in development. In consequence, no surgical procedure should invade the epiphyseal cartilage for the purpose of correcting deformity, except for the arrest of a progressive pathological process or as a life-saving measure. After the correction of a deformity in the child, retentive apparatus is required for a much longer period than in the adult, for the epiphyses in the area involved may proliferate in an irregular manner, thus inducing recurrence. In the adult, future growth is not a factor; therefore, excision of pathological tissue and many valuable reconstructive measures may be carried out with impunity.

The osseous structure also differs materially. In the child, bone is less compact and contains a larger per cent of cartilage and is, therefore, more resilient and pliable. At birth and during early childhood, the extremities of many long bones and some of the tarsal and carpal bones are composed entirely of cartilage. In fact, until the age of twelve or fourteen years this is a factor to be seriously considered in employing any surgical operation. Cartilage does not unite by cartilage, but by fibrous tissue, thus preventing stability and permanent fixation. Therefore, arthrodeses, or surgical procedures to induce osseous fusion, are rarely indicated in very young children, but when essential, retentive apparatus to avoid recurrence of

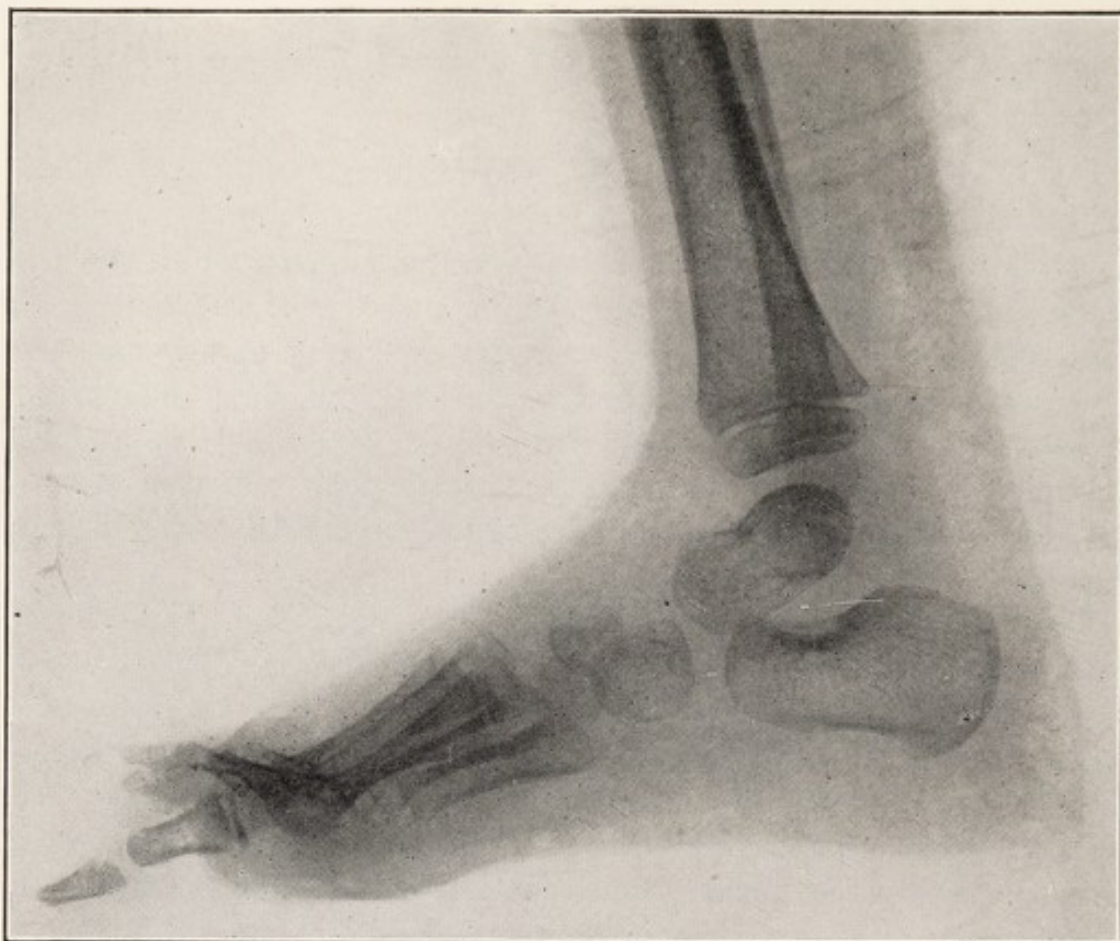


FIG. 1.—X-RAY OF NORMAL FOOT OF CHILD, AGE TWO YEARS, SHOWING THAT SCAPHOID AND EXTERNAL CUNEIFORM HAVE NOT APPEARED.

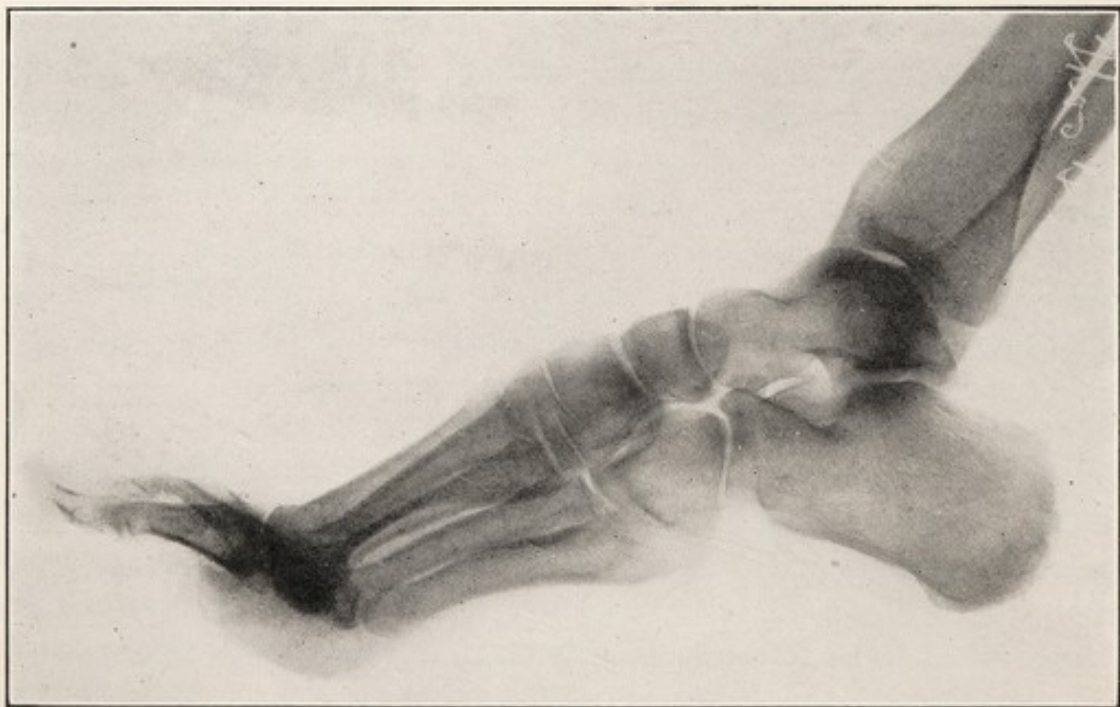


FIG. 2.—X-RAY OF NORMAL FOOT OF ADULT.

deformity is required for a long period of time. In the adult, old bone is found beneath the encrusting articular cartilage, which may be remodeled and reconstructed with the assurance of stability and permanency of position just so soon as bony union occurs, which is often effected in a few weeks.

The soft tissues are always more pliable in children than in adults, but the difference in quality is not of such importance as in the bone. Muscles



FIG. 3.—X-RAY OF FOOT OF CHINESE WOMAN, SHOWING EFFECT OF EARLY BINDING.
(Courtesy of Edgar Torrington Gilcreest, San Francisco, California.)

and tendons may be retarded in growth, or contractures may arise by loss of muscle balance, injury, disease or excessive growth of bone, thus inducing distortions. However, as the principles of treatment of the soft parts in children are the same as in adults, no further discussion is necessary.

The child is more susceptible to all infections, for the same degree of immunity has not been acquired as in the adult. Also, the quality of the tissues renders children less resistant to the invasion of many organisms. As the parts in the child are smaller, destructive changes may produce relatively more damage. For example, the same pathological process in the spinal column may destroy several vertebrae in the child and cause

extensive deformity, which in the adult may involve only a part of one segment, with slight, if any, distortion.

As growth follows the line of least resistance, and the tissues of the child respond to pressure, the contour of any part can be controlled by external force applied in the desired direction. This is graphically illustrated by the binding of the feet of Chinese females at birth, the molding of the head in flat-head Indians, and the elongation of the cervical spine by the successive applications of brass rings to the neck of the female baby,



FIG. 4.—BURMESE WOMAN, SHOWING ELONGATION OF NECK BY SUCCESSIVE APPLICATIONS OF BRASS RINGS. (*National Geographic Magazine*, March, 1922.)

as practiced by the Karen Hill tribes of Burma.¹ The same principles are utilized by the surgeon in the correction of congenital and other abnormalities. Tissue is thus conserved, and restoration to normal is often possible without loss of structure, as may be required by surgical operations.

In the treatment of all children, the psychology of the parents or guardian must be duly considered, as well as that of the patient. This is possibly more important in orthopedic affections on account of the usual indefinite duration. When coöperation is impossible from ignorance, mental lack of conception, or economical reasons, radical measures are often indicated where conservatism would give a better functional result. The greatest and most common error is to overindulge the cripple child. This tends to induce hysteria, self-pity and unhappiness, which is often a far

greater handicap than the actual physical impairment. Children in whom permanent disability is to be expected should be taught from the beginning that compensation for their defects is possible through vocational training. This can now be secured by the civilian cripple in a majority of the states, so that they may be able to assume their part in life as the average normal person, though possibly more individual effort may be required. They must never be led to believe that the world owes them anything, for precious little will be received after maturity. It is only by a close coöperation of the specialist, the family physician and the family that the proper mental attitude can be successfully developed, which will be their greatest asset in after life.

¹ Sir George Scott: *National Geographic Magazine*, March, 1922.

ORTHOPEDICS OF CHILDHOOD

CHAPTER I

ORTHOPEDIC EXAMINATIONS

The acquisition of a comprehensive knowledge of any scientific subject is facilitated by first demonstrating a systematic method of investigation and classification, which should be as simple as possible.

In orthopedic surgery, as in all other branches of medicine and surgery, this investigation should logically begin with a complete physical examination of the patient, including routine laboratory tests of blood and urine, and such special tests as may be indicated by the detailed history of the case in question. After this, the differentiation of the type of case is suggested by the chief complaint, or that which brings the patient to the physician. An accurate, painstaking, and chronological account must then be recorded, eliciting all evidence of significance from an orthopedic point of view. The manner of onset is most important. If sudden, with high fever, the indications are that an acute infection was the causative agent, and if slow or insidious, a low-grade degenerative process. If trauma be suspected, the time, place, and every detail of the accident must be ascertained, not only as a matter of scientific interest, but because a compensation or legal problem may later arise. The exact relation of trauma to the lesion must be determined, as there is a tendency to ascribe any disability, especially in children, to remote injuries. This may be brought out by ascertaining if the symptoms were coincident with the injury; if not, the period of time which elapsed before such symptoms arose. It is of practical value in eliciting this point to determine whether the patient was carried away or required assistance at the time of the injury. If the condition is a deformity, it must be ascertained whether congenital or acquired; if the latter, a careful investigation is indicated to determine the causative agent.

Voluminous records are unnecessary and only the essential facts are of material value. For practical purposes, a 5-inch by 7-inch history card, with blanks arranged with special reference to orthopedic affections, has for many years met all requirements in private practice, and at The Crippled Children's Hospital and The Hospital for Crippled Adults, of Memphis, Tennessee. Both sides of the cards are used, and conform to the regulations of the American College of Surgeons. This, of course,

does not obviate the necessity of regular hospital records during the post operative period or acute illness, but supplies a simple method by which data regarding any case can be secured immediately, or a large group of cases reviewed and correlated for scientific purposes.

After a complete record has been made, the patient is next prepared for examination by removal of the clothing. No compromise should be made except in obviously local conditions, as an injured toe or finger. Material advantage is thus gained by observing the body in the nude, as valuable information is often acquired which has either been forgotten, purposely omitted, or considered of no importance by the patient. In females, a simple T strap is placed over the genitals, and bibs over the mammary glands, which permits free access to the entire body. The examination may be divided into two parts: (1) the body as a whole from the standpoint of posture; (2) the mechanism and characteristics of each individual member.

1. The body as a whole from the standpoint of posture: Posture is determined solely by inspection, from which is demonstrated the attitude of the patient in standing and in walking. Beginning below, the distribution of body weight on the soles of the feet and the relation of the feet to the legs are noted; next, the contour of the legs and the relation to the knees. The relation of the hips to the pelvis, the shoulders to the chest, and the contour of the spine, chest and abdomen must also be observed. A knowledge of normal posture is presumed, and, therefore, only a brief description will be given. As the child stands with the feet parallel and the weight evenly distributed, the line of weight-bearing should correspond to a line passing through the second toe on each foot. Prolonged upward, the lines pass through the center of the patellæ and then converge to unite at the lumbosacral joint. The line of weight-bearing in the sagittal plane should correspond to the midline of the trunk, neck and head. Viewed from the side, the line of weight-bearing, if projected upward from the mediotarsal joint, should cross the center of the hip-joint and ear. Posteriorly, the tips of the spinous processes should form a straight line which is continuous with the gluteal cleft. The gluteal folds should be at the same level. The physiological curves of the spine are developed after birth and are: cervical lordosis, dorsal kyphosis, lumbar lordosis and sacral kyphosis (see Spine, p. 20). Normally, a plumb-line just clearing the sacrum barely touches the dorsal kyphosis.

2. The mechanism and characteristics of the individual members: The mechanism and characteristics of each member require, chiefly, a consideration of the joints with all the component parts, which includes the bones or levers of the body, with attached and surrounding structures that control function. Special emphasis will be made of the manner of determining the mechanism and qualities of normal joints, which will facilitate the compre-

2. Palpation elicits the texture of the tissues, as induration and also fluctuation, vibration, local temperature, and irregularities, as tumors, etc. Local temperature is more accurately determined by the successive comparing of both knees with one hand. In this way, a finer differentiation of the degree of heat can be made than when both hands are used, placing one hand on each knee.

3. Passive motion is the movement of a joint by the surgeon without voluntary assistance of the patient, to determine range and quality of motion, and often requires much tact to elicit, especially in a child, if pain is incurred. The quality of motion may be free, obstructed, rough, or crepitant from friction. The degree of motion can be accurately measured by instruments of precision, but for all practical purposes may be recorded in terms of plus signs; + + + + indicating normal range in any given direction, + + + about 75 per cent, + + 50 per cent, and + 25 per cent; less than 25 per cent may be approximately estimated in degrees. Passive motion may be limited by reflex muscle spasm, mechanical obstruction, or adhesions of articular surfaces. Excess or false motion may be demonstrated by increase of normal range or movement in a direction in which no motion normally exists, and usually indicates ligamentous impairment.

4. Active motion is voluntary movement in a joint by the patient at the request of the physician, from which may be determined: first, muscular power; second, limitation of motion from fear or reflex muscular spasm; third, limitation of motion by mechanical obstruction or fusion of joint surfaces. Active motion and muscle power are also recorded in terms of the plus sign.

5. Mensuration is the measurement of a part to determine the dimension as compared with normal, and may demonstrate hypertrophy, atrophy, or loss of structure. A tapeline is quite sufficient.

6. Auscultation with the stethoscope is at times of value to locate certain clicks or snaps in large joints, or to discover the source of certain transmitted sounds.

7. Neurological. The eliciting of sensation and certain reflexes is most important in differentiating lesions of the nervous system.

8. Aspiration is the withdrawal of fluid by the use of the needle and syringe, which should not be smaller than 10 c.c. In order to avoid subsequent infection or



FIG. 6.—DRAWING SHOWING LINE OF WEIGHT-BEARING IN NORMAL POSTURE.

leakage of the joint, the needle should be inserted obliquely to traverse the subcutaneous tissue for a short distance, when a direct plunge is made into the joint. The needle should be of sufficient length and caliber; 2 inches long and No. 18 gauge is usually satisfactory, but if no result, No. 16 may be used. Under no circumstances are a trocar and cannula indicated for diagnostic purposes. Aspiration demonstrates the type of fluid, if any, that may exist within the joint. This fluid, after withdrawal, is submitted to various laboratory tests, from which material information may be obtained.

9. The x-ray. The value of this agent in early diagnosis of bone and joint lesions, with the exception of fractures, is over-rated, which is due to the fact that the cardinal symptoms of many affections of bones and joints may be apparent for a long period of time, or even death ensue, before pathological changes are demonstrated by the roentgenogram. The x-ray is accurate, but interpretation by the inexperienced is frequently the means of incurring actual damage through error in diagnosis. The tendency is to find changes which, to one of mature



FIG. 7.—PHOTOGRAPH SHOWING METHOD OF AUSCULTATION OF KNEE-JOINT.

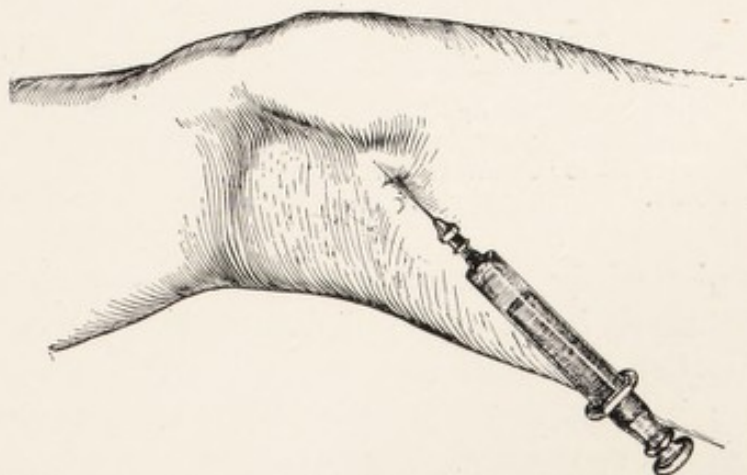


FIG. 8.—DRAWING SHOWING METHOD OF ASPIRATION OF KNEE-JOINT.

judgment, acquired by years of experience, do not in reality exist. An interpretation of the roentgenogram should not be made from one view alone when it is possible to secure both dimensions. When the relation of parts is desired in regions where a side view cannot be obtained, the stereoscopic roentgenogram is indicated.

There is no intention of underestimating the importance of the x-ray in bone and joint affections, for it has completely revolutionized this field of surgery in recent years, and to-day is preëminently the greatest asset in

demonstrating pathological processes and the effect of treatment. It is also invaluable in ascertaining the condition and relation of bones during many operative procedures.

Abnormalities of ligaments and cartilages cannot be demonstrated by the roentgenogram, except as the relation of bones may be thereby affected, as illustrated by the diminution of joint space from destruction of the encrusting articular cartilage. Bone, on account of its density, is more clearly defined than any other tissue; consequently, abnormalities are more apparent. Pathological changes which may be demonstrated in bone are limited to four: atrophy, hypertrophy, destruction and metaplasia. Atrophy is demonstrated by a loss of contrast in definition as compared to normal. Hypertrophy shows bone production as indicated by increase in size or density, or increase in size and density, and irregular proliferation. Destruction may be complete, or observed as a super-



FIG. 9.—X-RAY SHOWING ATROPHY OF BONE AND EXTENSIVE DESTRUCTION OF BONES OF WRIST WITH ATROPHIC CHANGES IN THE BONES OF HAND.

ficial or deep erosion of the surface, or the loss of small or large areas in the interior. Metaplasia is the substitution from within of a different type of tissue, and is often associated with destructive changes; therefore it is doubtful whether it deserves special consideration. Furthermore, metaplasia is of infrequent occurrence. The peculiar appearance of one, or any combination of atrophy, hypertrophy, destruction and metaplasia produces

the characteristic x-ray visualization of a pathological process. However, as bone often reacts in a similar manner to different agents, a diagnosis should not be concluded by the roentgenogram alone.

A working knowledge of the anatomy and function of the joints is



FIG. 10.—X-RAY SHOWING HYPERTROPHY OF BONE.

essential to a thorough comprehension of the subject. This can be acquired from standard textbooks on that subject. The order of description of the method of examination in special joints will be from below upward, beginning with the foot and ankle, as their function is so closely related as to make differentiation difficult.

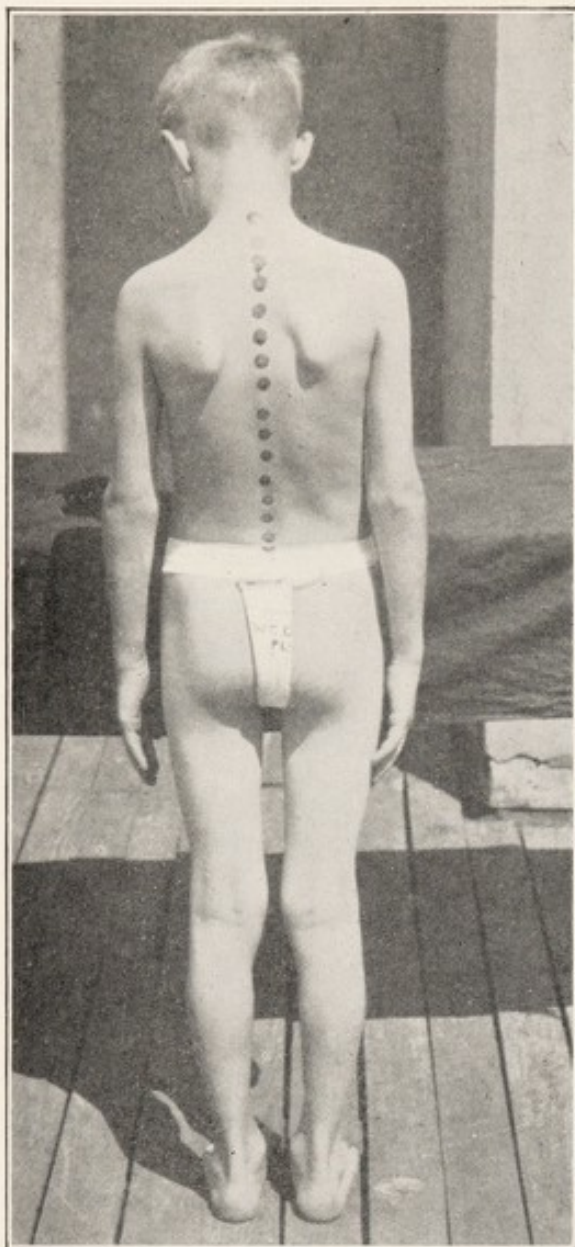


FIG. 11.—NORMAL POSTURE SHOWING DISTRIBUTION OF WEIGHT ON FEET AND ANKLES.

THE FOOT AND ANKLE

Inspection.—The distribution of weight-bearing on the feet, or any abnormality in contour, is noticed. The patient then walks, when any limp or peculiarity in gait becomes apparent. Passive motion of the foot and ankle is elicited by grasping the forefoot and moving the ankle and foot as far as possible in dorsiflexion, extension or plantar flexion, abduction, and adduction. If the normal range is known, any restriction is apparent. Passive motion of the foot alone is carried out by grasping the heel and forefoot, thereby demonstrating movements in the midtarsal and subastragalar joints. Motion in the toes and smaller joints is obviously too simple to warrant description. As deformity is more frequent in the feet than elsewhere from the loss of muscle balance, active motion is most important to ascertain muscle power. The range of active motion can be ascertained by observing the movements of any normal child.

X-Ray.—The x-ray of the foot and ankle requires two views of the ankle and two of the foot.

THE KNEE

Inspection.—As the knee is superficial, slight abnormalities are apparent by obliteration of bony landmarks from effusion within, periarticular swelling, or changes in position and contour. A comparison with the opposite knee facilitates differentiation. There are only two movements to be considered in the examination of the knee: flexion and extension. Flexion is possible until the calf of the leg approximates the posterior aspect of the thigh. Extension begins when the leg is fully flexed, and is completed when the leg forms a straight line with the thigh. A line drawn from the anterior superior spinous process to the great toe should pass through the

center of the patella when the knee is in extension. A limp or any abnormality in mechanism is noted.

Passive motion is combined with palpation to demonstrate the more significant signs. Crepitation and friction fremitus are elicited, when present, by placing one hand over the joint while the other grasps the leg just above the ankle and makes rapid motion. The integrity of the lateral ligaments is tested with the knees in full extension; the thigh is fixed by one hand while the leg above the ankle is grasped by the other, when a rocking movement of the leg is attempted from side to side. In a normal knee, there should be slight, if any, motion from side to side. In those frequently observed, with congenital laxity but otherwise normal, motion will be detected in both knees. If the internal ligament is impaired, there will be increased motion to the lateral aspect; if the external, to the medial aspect. Rotary motion may be detected by rotating the leg internally and externally, and, if increased, is of significance. The integrity of the anterior crucial ligament is determined by flexing the knee to right angles, grasping the leg firmly with both hands and attempting to glide the articular surface of the tibia backward over the condyles of the femur. If the anterior ligament is intact, there will be slight, if any motion; if defective or torn, the tibia will glide backward. The integrity of the posterior ligament is determined with the knee in full extension; if defective, the tibia will glide forward. Hyperextension within certain limits is not abnormal but, when in excess from laxity of the posterior structures, may be a serious disability. Loose or pedunculated bodies may be discovered by simple palpation, but may require passive or active motion to bring them to the surface. To elicit active motion, the patient alternately flexes and extends, when the range and character is noted. The muscle power is demonstrated by resisted movements. Active motion in individual muscles, as the biceps, can be determined by palpation while the patient voluntarily flexes the knee. Fluctuation is elicited with ease, and the presence of fluid determined. Aspiration is harmless and frequently employed.

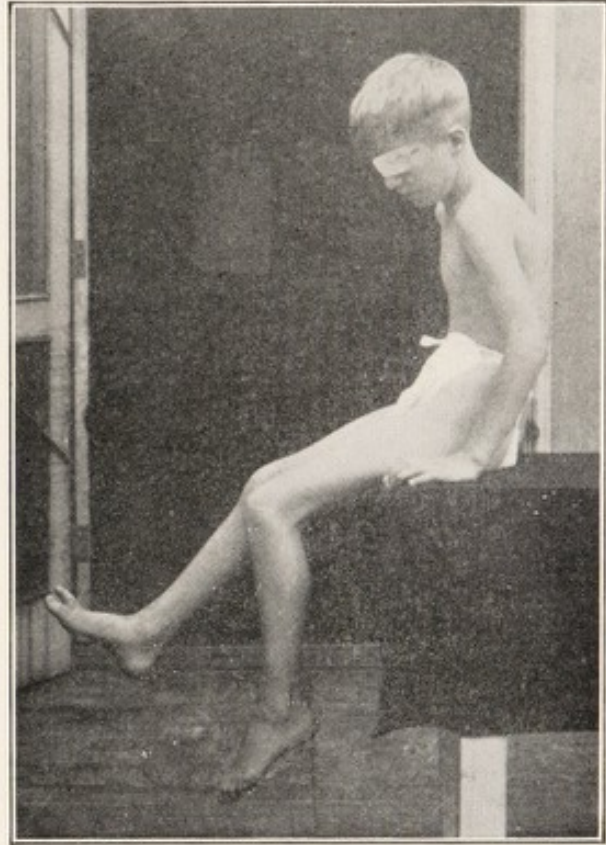


FIG. 12.—NORMAL RANGE OF DORSAL FLEXION OF RIGHT FOOT AND PLANTAR FLEXION OF LEFT FOOT.

Local temperature is not only a valuable diagnostic sign, but an aid in determining the subsidence of an active process. Auscultation is occasionally

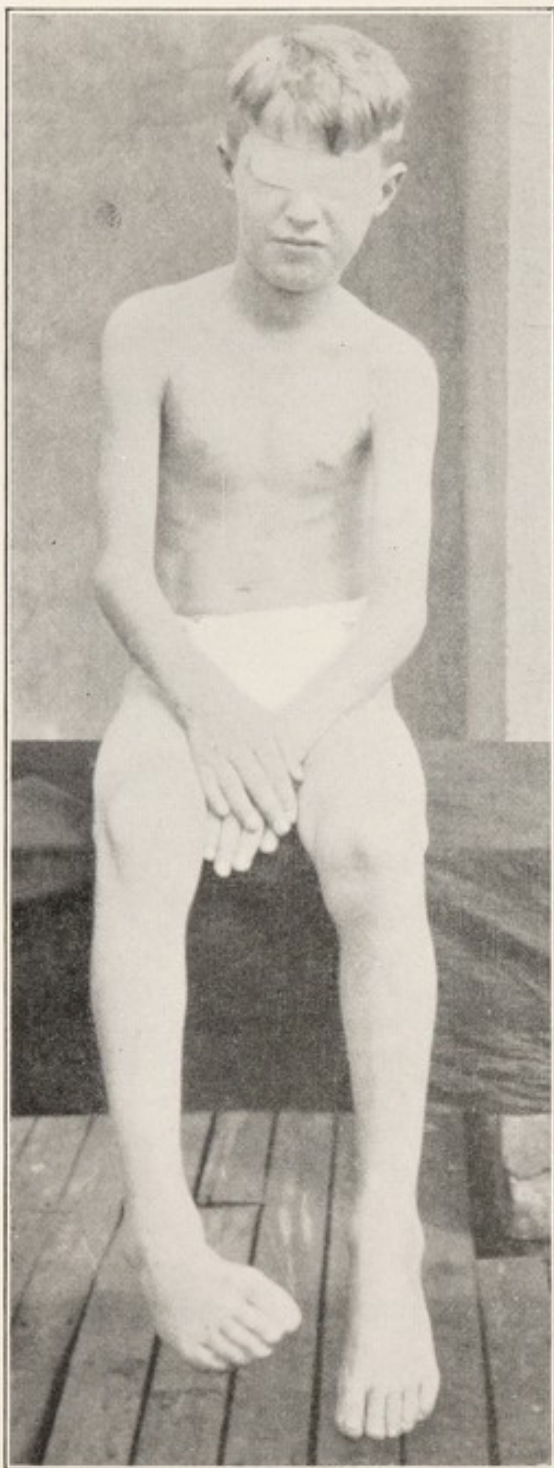


FIG. 13.—NORMAL RANGE OF ABDUCTION OF FOOT.

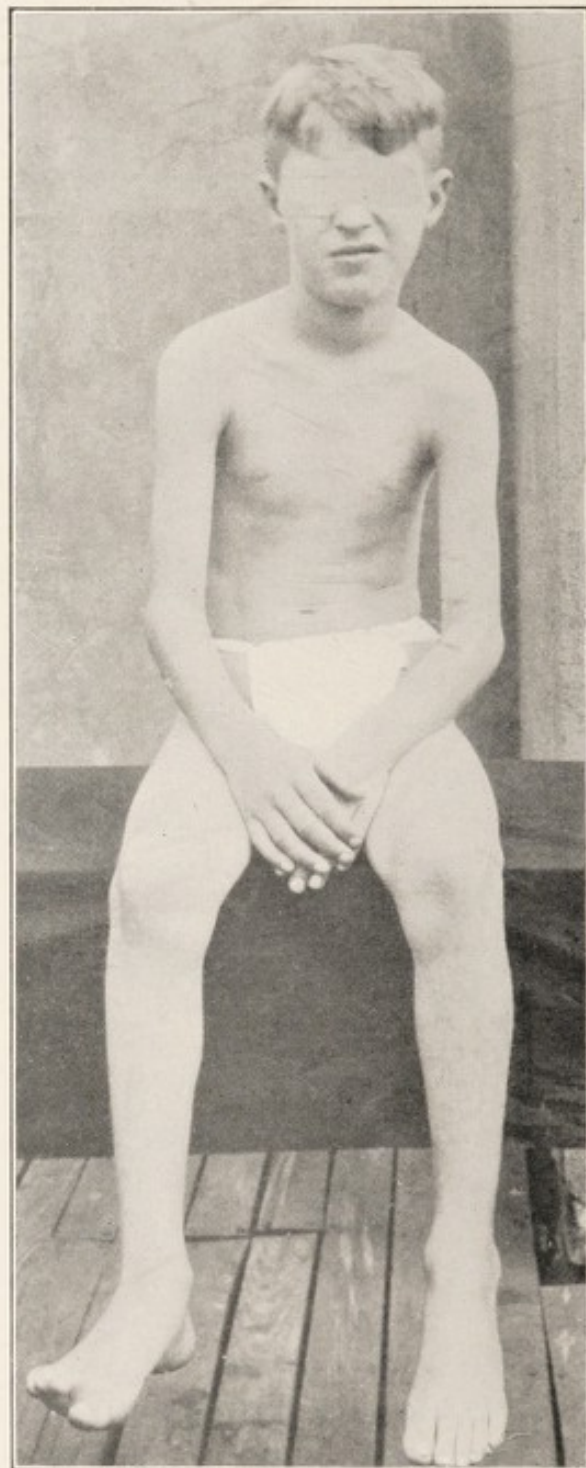


FIG. 14.—NORMAL RANGE OF ADDUCTION OF FOOT.

of value in locating certain obscure sounds, crepitation and friction fremitus. The latter is identical with that heard in dry pleurisy.

X-Ray.—Two views should always be made: the anteroposterior, with the knee extended, and the lateral, with the knee flexed about 30 degrees.

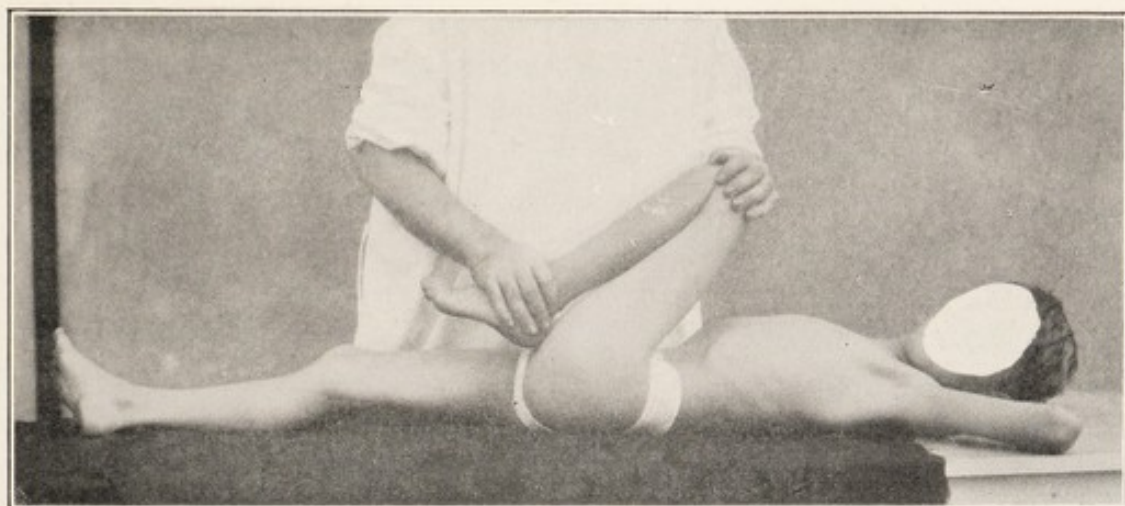


FIG. 15.—NORMAL RANGE OF FLEXION OF KNEE.

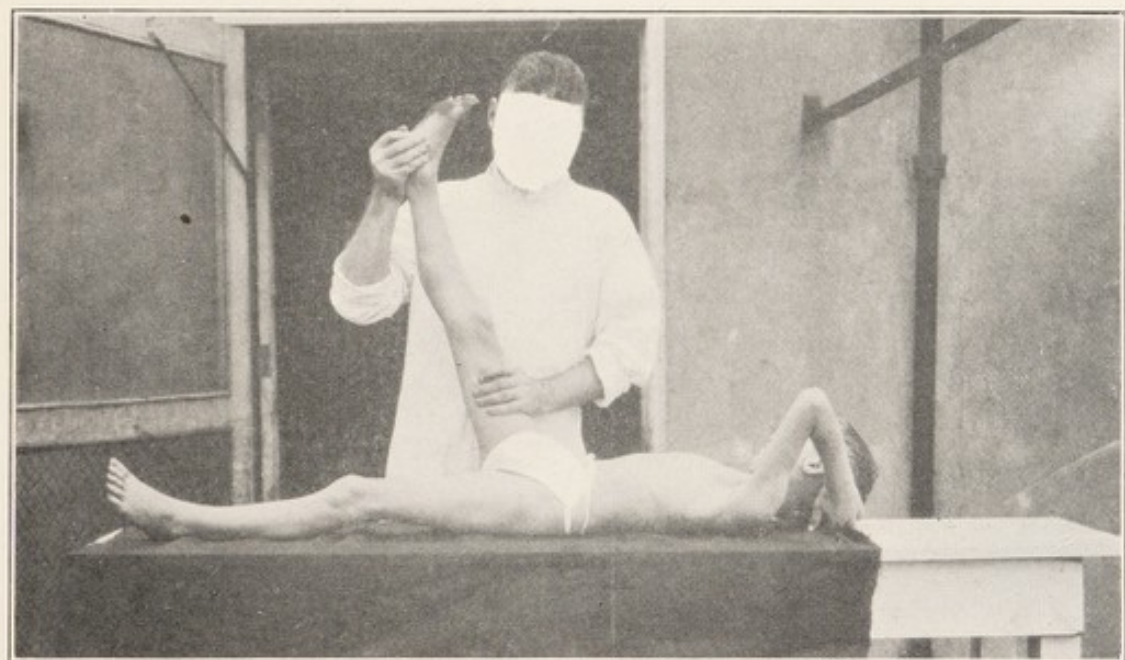


FIG. 16.—NORMAL RANGE OF EXTENSION OF KNEE.

If the position of flexion is fixed, as often occurs, the anteroposterior view will be distorted and misleading, if taken in the usual manner, but this can be largely obviated by placing the film about a cylinder and fitting close into the popliteal space before making the exposure.

THE HIP

The hip-joint is placed deeply beneath heavy muscles, fat and fascia, which protect the joint and often obscure physical signs. The routine examination is as follows:

Inspection.—Position and contour are noted. By walking, the character of movements and impairment of gait, as limp, are elicited. The relation of the gluteal folds is observed. The stamina of the muscles which

pass from the pelvis to the thigh is demonstrated by the so-called Trendelenburg's sign: the patient stands on the foot of the suspected side, with the opposite knee and hip flexed. If there is muscular impairment or mechanical instability of the hip-joint, there will be a deflection of the pelvis on the opposite side, the buttocks and the gluteal fold assuming a lower level. If normal, the buttocks and gluteal fold will be on the same level with no change in relation.

Palpation.—On account of the depth of the joint, very little information can be obtained by palpation. Local elevation of temperature, induration, fluctuation, or any change in contour are usually late manifestations.

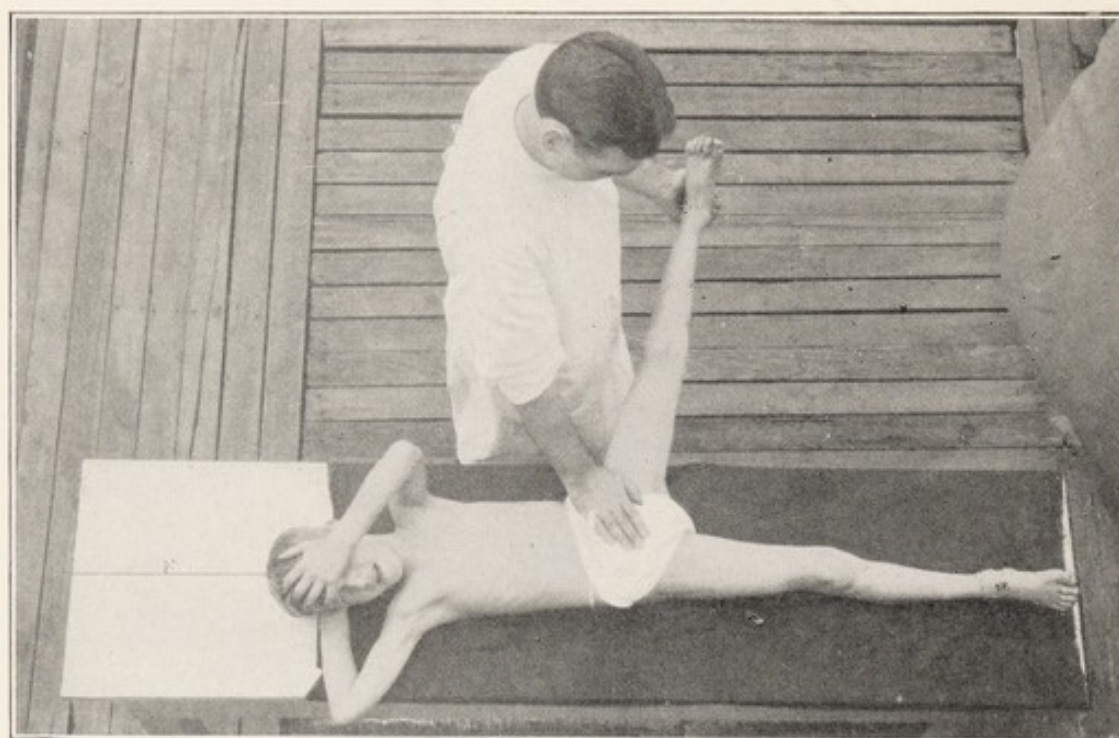


FIG. 17.—NORMAL RANGE OF ABDUCTION OF HIP.

Passive Motion.—The movements are flexion, extension, abduction, adduction, internal and external rotation. The patient reclines on a hard, narrow table. Flexion is elicited by grasping the ankle with one hand while the other is placed over the anterior superior spinous process, fixing the pelvis and spine. The knee is flexed upon the thigh and the hip upon the pelvis. In normal children, the anterior aspect of the thigh will touch the chest (Fig. 14). Normal abduction in children will be from 50 to 60 degrees and is elicited by grasping the ankle and moving the limb outward as far as possible, with the knee extended and the posterior surface of the lower extremity upon the examining table. Adduction is demonstrated by carrying the limb across the opposite thigh, and in the normal child is about 40 degrees. Rotation is accomplished by twisting or rotating the hip in the extended position, and also in flexion; external rotation is from 30 to 40 degrees, internal from 20 to 30 degrees. If the child is in the reclining

position, the forefoot will make about a half circle from extreme internal to extreme external rotation. Extension or hyperextension is elicited by placing the patient in the prone position (face downward), whereupon the knee is flexed to 90 degrees. The ankle is grasped with one hand while the other is placed over the sacrum, holding the pelvis firm against the table. The leg is then lifted upward, removing the anterior aspect of the thigh from the table. The normal range is from 30 to 40 degrees in a child. Limitation of hyperextension is not only of significance in affections of the hip-joint, but when contracture of the psoas muscle is present from lesions in or near the spine. Due consideration must be given to compensatory motion in the lumbar spine and lumbosacral region when motion of the hip is limited or fixed. If the hip-joint is ankylosed in the anatomical position,

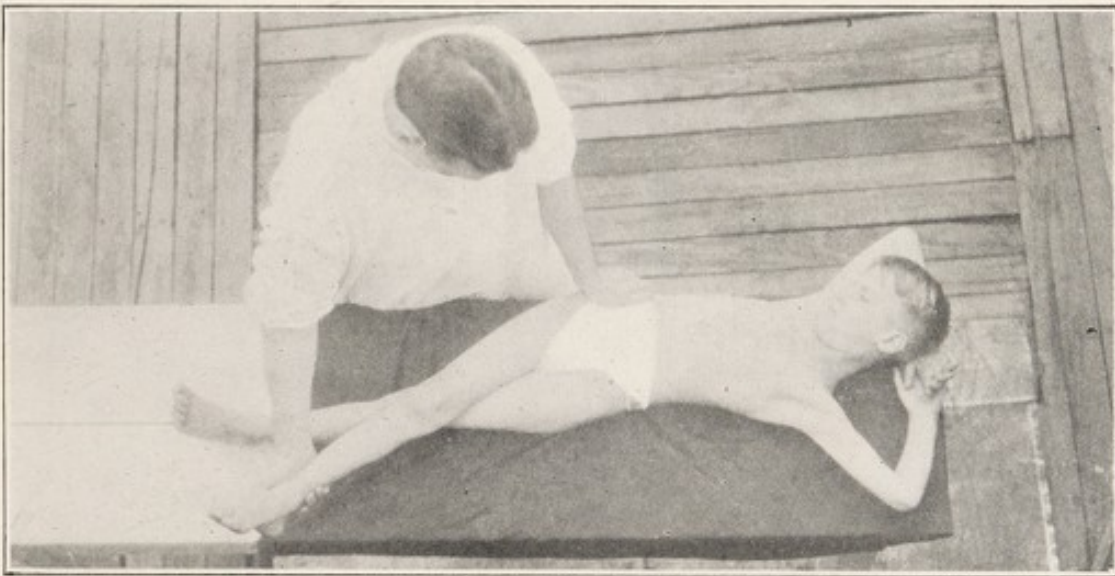


FIG. 18.—NORMAL RANGE OF ADDUCTION OF HIP.

which is about a straight line with the nipple, walking is accomplished by motion of the lumbar spine. In the young, it is surprising the extent to which such motion may be developed. If the hip is fixed in flexion, there must be compensatory lordosis of the spine to enable the individual to touch the ball of the foot to the floor in walking. A hip fixed in flexion is well illustrated by the old test described in many textbooks, as follows: The patient is placed in the reclining position on a firm table; the popliteal space is forced against the surface of the table, which causes the lumbar spine to rise, so that a space exists between the surface of the table and the spine. This obviously is compensatory lumbar lordosis. If the hip is fixed in abduction, approximation with the normal limb can be accomplished by lateral movements of the lumbar spine and the lumbosacral region, the pelvis becoming elevated on the normal side and depressed on the abducted side, which appears longer. On account of this compensation of the spine and deviation of the pelvis when the hip is fixed, it is frequently impossible

to convince the layman that there is no actual difference in length. This also renders many an easy prey to the ignorance and artifices of irregular practitioners, who often claim the existence of dislocations and reductions of same when no dislocation exists.

Mensuration.—Mensuration gives more valuable information in lesions of the hip than in other joints, as malpositions and loss of continuity from destructive changes occur earlier in pathological processes of this region than elsewhere. Actual or true length of the lower extremity is determined by measurement, with an ordinary tapeline, from the anterior superior iliac spine to the tip of the internal malleolus, which are two fixed bony parts. Apparent or practical shortening or lengthening is caused by malposition, or tilting of the pelvis, as above described, and is determined by measurement

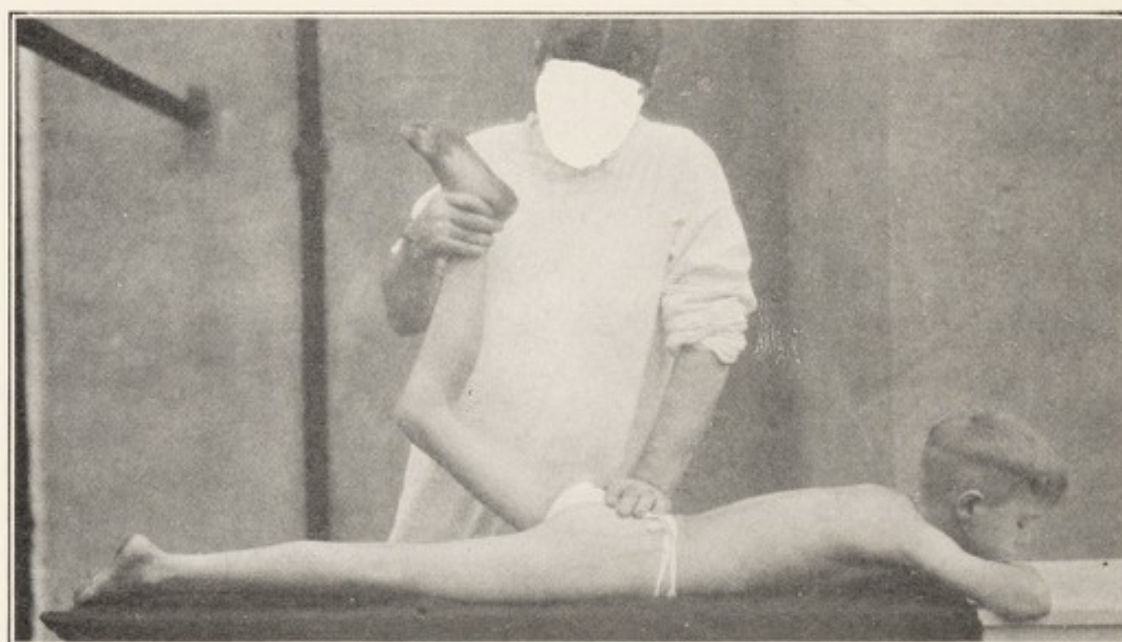


FIG. 19.—NORMAL RANGE OF EXTENSION OF HIP.

from a central point above the pelvis. As there is no central fixed bony process, the umbilicus is selected above, the internal malleolus below.

In taking these measurements, the patient should be placed as near the anatomical position as possible; otherwise, one may be deluded by postural deviation of the lumbar spine or lumbosacral region. In fact, it is possible for any normal individual to apparently lengthen and shorten each limb at will by voluntarily tilting the pelvis.

Before completing the measurements, the relation of the trochanters must be observed. The greater trochanter normally lies below a line drawn from the anterior superior spinous process of the ilium to the center of the tuberosity of the ischium, the so-called Nélaton's line; if above this point, structural abnormality is apparent.

X-Ray.—In making the roentgenogram, both hips should be taken in the same position, if possible; otherwise, a satisfactory comparison cannot be

made and the observations may be misleading. A simple anteroposterior view is usually sufficient in demonstrating pathology; however, a stereoscopic series is necessary, if displacements or exact relations are to be determined.



FIG. 20.—DRAWING SHOWING HIP ANKYLOSED IN FLEXED POSITION, THE SPINE HELD STRAIGHT.



FIG. 21.—DRAWING SHOWING HIP ANKYLOSED IN FLEXED POSITION.

Note compensatory lordosis of spine to place legs parallel.

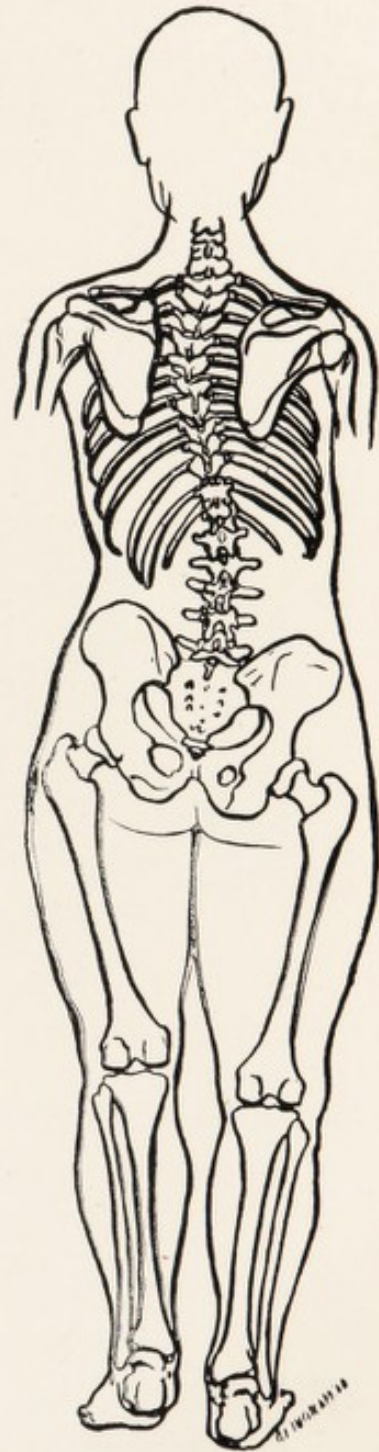


FIG. 22.—DRAWING SHOWING TILTING OF PELVIS WITH APPARENT INEQUALITY IN LENGTH OF LEGS; HOWEVER, THERE IS NO ACTUAL DIFFERENCE.

THE SACRO-ILIAC JOINT

Motion of the normal sacro-iliac joint is not appreciable, and is detected infrequently, even in very rare affections. The routine examination is as follows:

Inspection.—Any change in relation of the iliac crest must be observed, also swelling in the region of the joint, and especially lateral deviation of the lumbosacral spine, so-called sciatic scoliosis.

Palpation.—With the patient standing, each joint is deeply palpated for swelling and tenderness. The patient is then placed on an examination table or other firm surface and turned on the normal side. If a pathological condition exists, pain will frequently be elicited when pressure is made over the iliac crest. By rectal examinations, tenderness may be demonstrated by pressure over the anterior aspect of the joint, or swelling and tumors elicited. In children, however, this causes so much discomfort as to render

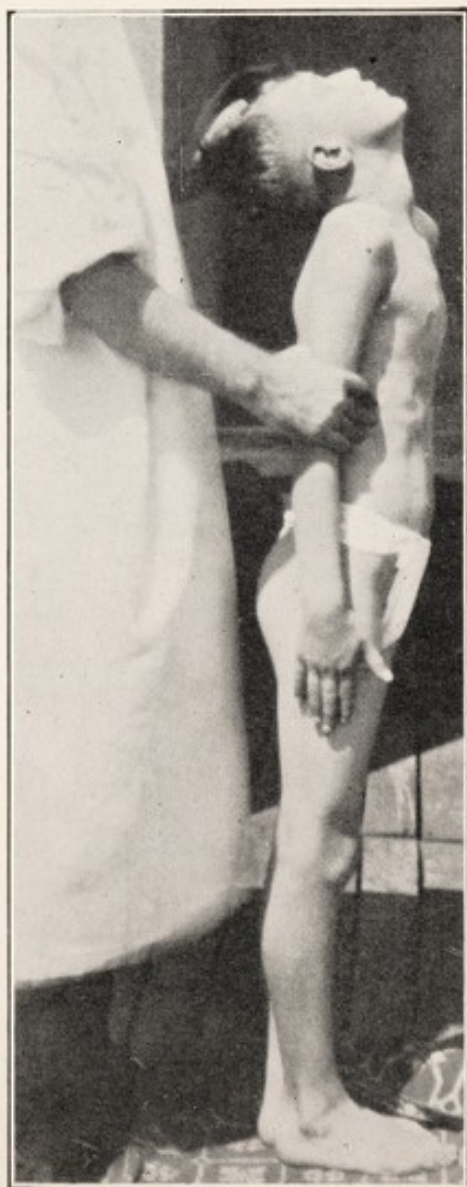


FIG. 23.—NORMAL RANGE OF EXTENSION OF CERVICAL SPINE.

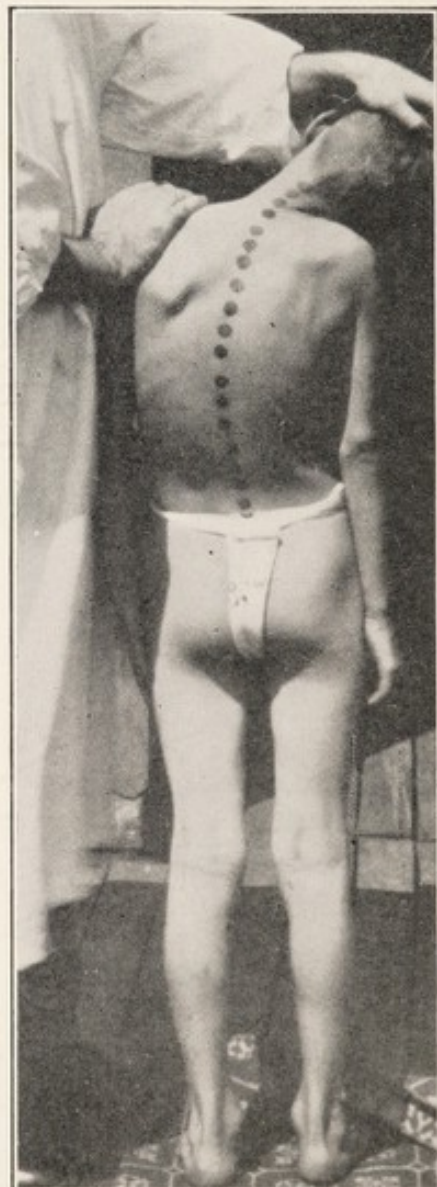


FIG. 24.—NORMAL RANGE OF LATERAL MOTION IN CERVICAL SPINE.

rectal examinations impractical as a routine measure. As the sacral plexus which forms the sciatic nerve is over the anterior aspect of the joint, there may be pain on pressure over the point of exit of the nerve at the great sacro-sciatic notch and along the course of the nerve, down the posterior aspect of the thigh.

Passive Motion.—No motion can be detected except in rare instances, but undoubtedly slight motion occurs and, if forced, will often give rise to pain when pathology exists as first observed by Goldthwaite. This is elicited by extending the knee and forcibly flexing the hip, thus instigating a definite pull on the ilium by the tense hamstring muscles, which are



FIG. 25.—NORMAL RANGE OF PASSIVE EXTENSION OF SPINE.

attached below to the bones of the leg and above to the tuberosity of the ischium. Passive motion may also be rarely elicited by grasping both iliac crests. If inflammation or traumatic irritation is present, pain will be felt in the sacro-iliac joint and, at times, down the nerve. Normally, the hip with the knee extended may be flexed from 90 to 120 degrees. This valuable test was first described by Goldthwaite, though Kernig had previously observed the same reaction in acute meningitis. The Goldthwaite sign may also be positive in affections of the lumbar spine, but, together with other symptoms, is of undisputed value in the diagnosis of lesions of the sacro-iliac joints.

Active Motion.—Active motion is rarely apparent in the sacro-iliac joint, but when the sacro-iliac joint is irritated, motion in the lumbar spine may be restricted by muscle spasm in flexion and side bending. In flexing the spine, there may be free movement for a short distance, and then a sudden twist to one side, usually toward the joint involved. Side bending is, as a rule, more limited toward the unaffected side. There are so many variations in signs that no arbitrary statements can be made in lesions of this region.

THE SPINE

In the examination of the spine, due consideration must be given to the evolution of normal growth and development. At birth and during the first year, the spine is a straight line in the recumbent position, and more or less a rounded curve from the skull to the tip of the coccyx in the sitting posture. When sitting alone and walking begin, the contour of the spine follows the law of functional adaptation by force of gravity from superincumbent weight and other internal and external forces: "As a twig is bent so shall it grow." In consequence, the physiological curves are formed, which are purely compensatory: that is, when there is a forward convexity in one region, there will be a convexity backward in the region below. A convexity forward is known as lordosis, a convexity backward, as kyphosis. The physiological curves of the spine are entirely in the antero-posterior direction; any lateral deviation or rotation is known as scoliosis, and is distinctly abnormal. In the normal spine, there is lordosis of the cervical region, kyphosis of the dorsal, lordosis of the lumbar, and kyphosis of the sacrum and coccyx. Any exaggeration of the physiological curve is abnormal and not only affects the spine, but also the entire trunk, which forms an integral connection through the skeletal system with the pelvis, shoulder-girdle and ribs. The definition of the terms "kyphosis," "lordosis" and "scoliosis" must be clearly understood for an intelligent interpretation of affections of the spine.

The physical examination of every patient should include the spinal column, as the nerves to all parts of the body pass from the spinal cord through the intervertebral foramina, and pain simulating various affections is often referred to the periphery when pathology is present in the vertebræ.

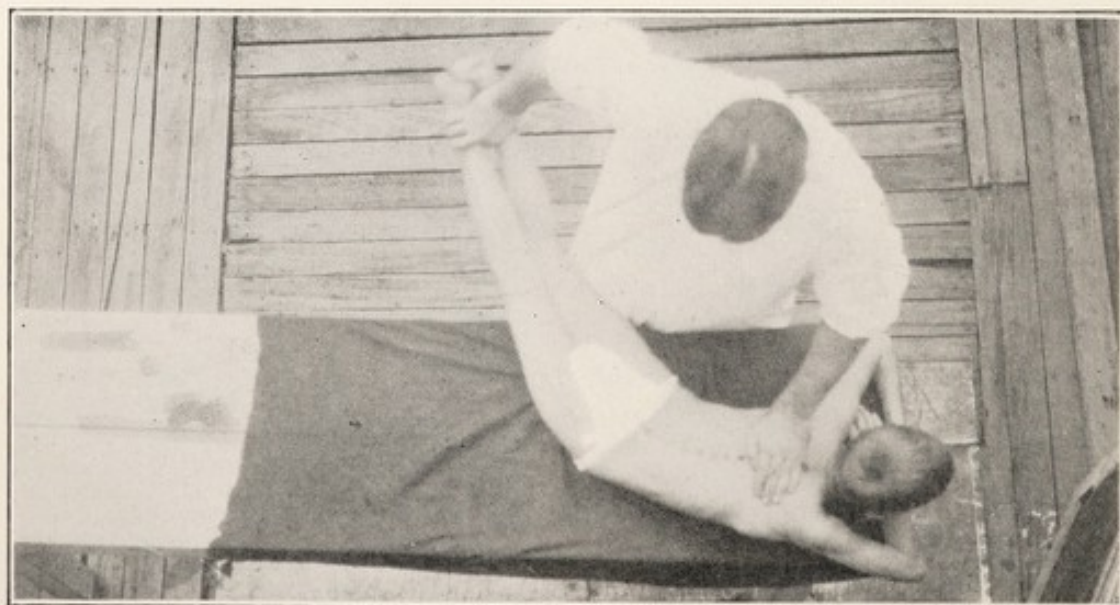


FIG. 26.—NORMAL RANGE OF PASSIVE LATERAL MOTION OF SPINE.

The routine examination of the spine is as follows:

Inspection.—The child stands with feet approximated and the light from a window distributed over the entire spine. The spinous processes may be marked with a skin pencil to indicate the position of each vertebra, though as a rule this is unnecessary. Any abnormalities in contour of the spine or trunk, referable to the spine, are easily detected. The child next walks, disclosing any peculiarities in gait.

Palpation.—The spinous processes and lateral aspects are palpated for any irregularities or points of tenderness.

Passive Motion.—In the sitting posture, the extent of motion in the cervical spine is first elicited. In normal flexion, the chin touches the superior extremity of the sternum. In extension, the occiput will approximate the spinous process of the upper dorsal vertebrae. In extreme lateral motion, the ear touches the shoulder. Rotation is free and describes about half a circle. Motion in the dorsal spine is limited in the anteroposterior direction by the vertical articular process and laterally by the attachment of the ribs; therefore, only by experience can restricted motion be detected. However, passive motion in the dorsal spine is accomplished with the patient in the sitting position, by first flexing the cervical spine until the chin touches the chest, when further pressure is made upon the occiput. Extension in the dorsal spine is determined by fully extending the cervical spine until motion occurs in the dorsal region, and lateral motion by extreme side bending of the cervical spine in the same manner. Motion in the lumbar spine, as in the cervical, is free in all directions and may be ascertained by placing the child on its side and fully flexing the cervical spine with one hand while the other fixes the buttocks. Compression of the head and buttocks will fully flex the entire spine. The child is next placed in the prone position, when one hand grasps both ankles while the other is placed over the posterior aspect of the thorax to hold this region firmly upon the table; extension and hyperextension is next carried out by an upward lift through the ankles. Lateral motion is also elicited by side bending. The comprehension of motion in all directions can be acquired by the observation of a normal child. In young children, more information is obtained by

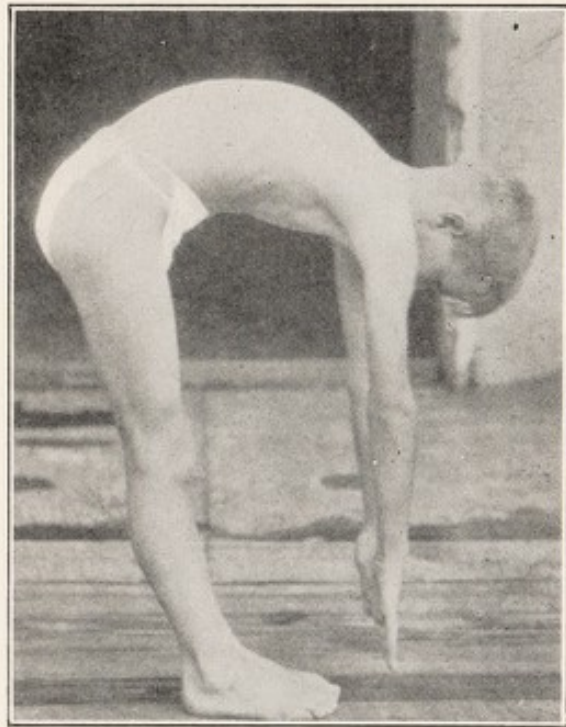


FIG. 27.—NORMAL RANGE OF FLEXION OF SPINE.

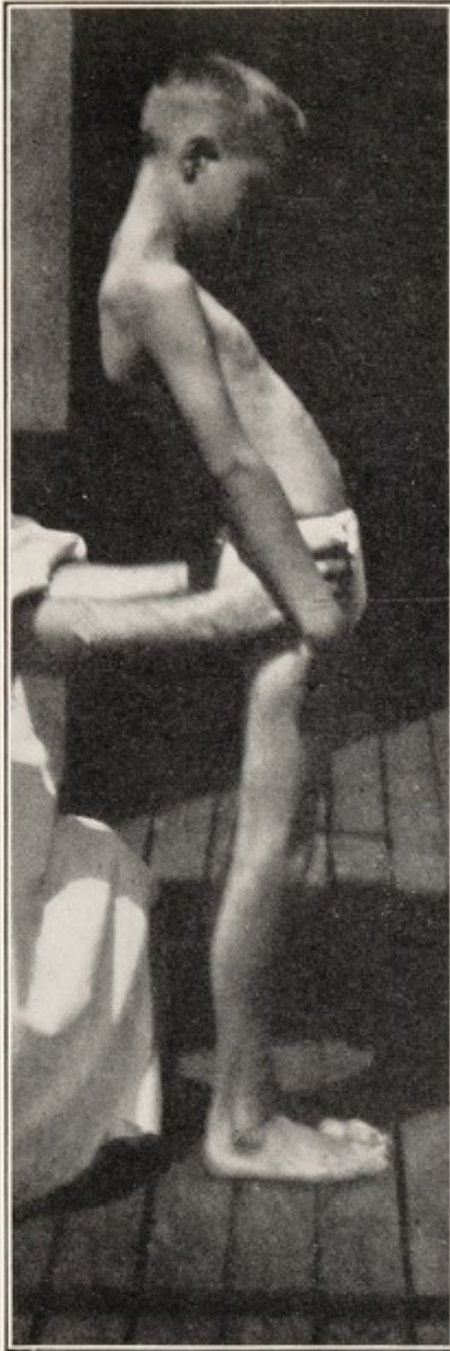


FIG. 28.—NORMAL RANGE OF EXTENSION OF SPINE.

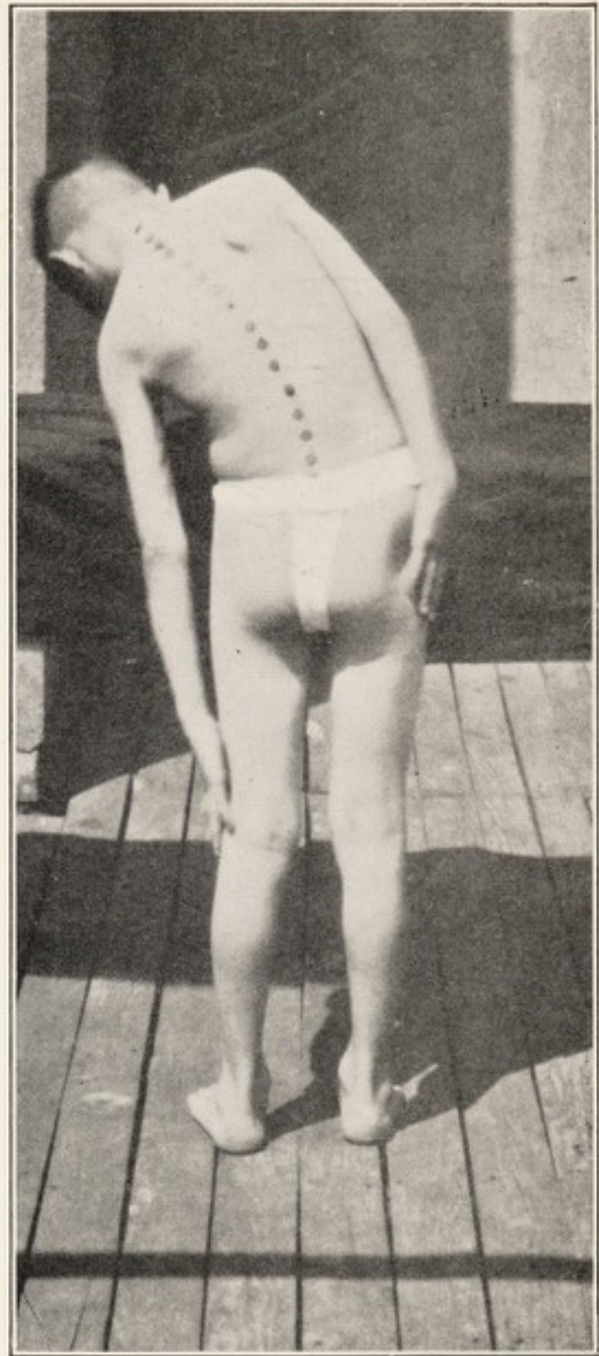


FIG. 29.—NORMAL RANGE OF ACTIVE SIDE-BENDING.

passive motion than by the other methods of examination, as coöperation by voluntary motion cannot usually be obtained. Often, through fright, a child may contract all the muscles of the spine, becoming rigid, but with continued slight pressure, there will invariably be relaxation and normal motion unless restricted by abnormal processes.

Active Motion.—In older children, except in the cervical region, the desired information may be obtained by active motion; therefore, passive motion is omitted. Active motion is elicited as follows: The patient stands erect and upon request moves the cervical spine in all directions, the range of which is the same as described in passive motion. Active motion of the

dorsal spine is observed in connection with the lumbar spine; with the knees extended, the patient is requested to bend forward, when flexion is possible until the tips of the fingers either touch or come close to the floor. Hyperextension is elicited by requesting the patient to bend backward while the hips are fixed by the physician. Side bending is possible until the finger tips touch the head of the fibula or below. The knees must be continuously extended, otherwise the extent of motion cannot be determined with accuracy. Rotation of the spine is difficult to elicit and is associated with side bending.

X-Ray.—In affections of the spine, there should be a routine roentgenogram from the tip of the coccyx to the base of the neck, and if symptoms are referable to the cervical spine, this region should also be x-rayed. There should be two views, as the side view will often show defects or pathology which are not apparent in the anteroposterior. A stereoscopic series should be made of the lumbosacral region when that location is involved.

UPPER EXTREMITY

In the upper extremity, the same methods of examination meet all requirements, the shoulder being the only joint requiring special mention.

The Shoulder.—Inspection and palpation define position, contour, irregularities and points of tenderness. Active and passive movements are affected in the same directions as in the hip: flexion, extension, abduction and adduction, internal and external rotation. It should be remembered that from 30 to 40 per cent of shoulder motion is accomplished by the scapula. In fact, a fair degree of function may be present when there is a complete bony ankylosis of the shoulder joint proper. Scapula motion cannot be classed as compensatory, as the mechanism combined with the scapulohumeral motion is a uniform synergetic action, culminating in normal function of the shoulder. As in the hip, an anteroposterior roentgenogram is usually sufficient, but to determine the exact location of pathology and bony relations, the stereoscope must be employed.

EXAMINATION OF BONES

The method of examination of the bones is similar in all respects to that of the joints. Swelling, contour, etc., may be determined by inspection and palpation. The test for increased intra-osseous pressure is very important, and is carried out in the following manner: The affected bone is palpated for points of tenderness, and the point where tenderness is greatest is selected. Over this point the index finger is placed and continuous pressure made. If intra-osseous tension is increased, marked pain will be induced, and the patient will scream out in agony.

CHAPTER II

APPARATUS

GENERAL CONSIDERATIONS

The mechanical principles in the treatment of orthopedic affections in general are practically the same; therefore, one description of the various routine measures will enable the student to possess a more comprehensive knowledge and avoid constant repetition. Only simple and uncomplicated apparatus, such as can be adjusted by the average busy practitioner, with special reference to the prevention of deformity and means of fixation, will be considered in detail.

Various materials are used in the construction of splints and braces, but the plaster-of-Paris cast is probably more commonly employed than any other, and therefore will receive first consideration. Unfortunately, no manufacturer has been able to place on the market a satisfactory plaster bandage, which is probably due to chemical instability, the selection of improper material and too tight rolling of the bandage, so that water does not permeate. Bandages, to be uniformly stable and constant, must be correctly made. There are two constituents, plaster-of-Paris and crinoline, which must possess certain qualities. The crinoline should be about No. 12 mesh and stiffened with starch and not glue, as the latter may retard or actually prevent setting of the plaster. The material for stiffness in the crinoline can be determined by a very simple test, which consists in placing ten drops of tincture of iodine in a glass of water and then inserting a strip of crinoline, which will turn blue if starch is present. If the reaction is negative, the crinoline is not suitable as a base for the plaster-of-Paris bandage. Common commercial plaster as sold by the average drug store is unsatisfactory. Only refined dental plaster of the best quality, which requires from five to seven minutes for setting, should be used. Salt, or any chemical to reduce the setting time should not be added, as the finished product is rendered more brittle and the purpose of the splint often defeated by early breakage. Bandages should be 5 yards in length and can be torn in any width desired, but for ordinary purposes, 2, 3 and 5 inches are sufficient. To prepare the bandage, the plaster is rubbed into the crinoline on a wooden table, by hand or common school blackboard eraser. These must be rolled by hand rather loosely, so that water may soak into

all parts. All bandages must be placed in an air-tight metal container and kept in a dry place.

The part to which the cast is applied is prepared by applying bandages of sheet wadding, cotton flannel, silence or outing cloth. The contour of the part must be preserved, which requires close conformation of padding. Bony prominences must be carefully protected, and there should be no binding, as a slight wrinkle may cause serious injury. On application of a plaster bandage, there must be sufficient water in large, deep pans or buckets; otherwise, the loose plaster in the water will consolidate *en masse*, requiring the pans to be emptied and refilled with water. This delay may allow the cast to become dry in layers, which obviously renders the finished product friable. Two or three bandages are immersed in tepid water at one time, and so soon as completely soaked, one bandage is grasped with both hands, the palms covering the ends to prevent escape of loose plaster. Excess water is squeezed out and the bandage is then applied snugly but without compression, each layer being rubbed firmly to induce cohesion and a uniform solid cast. As "setting" occurs, the cast may be molded with the hands to conform closely to contour, but under no circumstances compressed, as a hard ridge may be formed. The cast must be supported by hand or a soft surface, as a pillow or mattress, until hard, as indentation can easily occur by irregular pressures on a hard table, the corner of a table or instrument, which may cause decubitus. Unless the physician will master the technic of preparing plaster-of-Paris bandages, he must use the ready prepared bandage, which, however, is not practicable when extensive casts are required and only fairly satisfactory in the extremities. In acute trauma or infection that may remotely induce swelling, the cast must be bivalved to the skin, but retained snugly in place by a gauze or muslin roller bandage or adhesive plaster completely encircling.

Splints and braces will be discussed in connection with the special joints and members.

In the treatment of affections of joints, and often affections of bones, each joint must be held in that position which will render the greatest service, should ankylosis or restricted motion occur. This position will be called the most useful or serviceable position. One of the most important objects of mechanical appliances is to maintain a part in the most serviceable position. Each joint must be considered separately, and for convenience in description, the same order will prevail, from below upward, beginning with the ankle.

REGIONAL APPLICATION

The Ankle.—The most useful position for an ankle is at right angle to the leg, which may be maintained by a plaster-of-Paris bandage or simple splint. Care must be taken, by fenestra or padding, to prevent pres-

sure on the heel; and the malleoli should also be protected. The cast or splint should extend from the tip of the great toe to that point just

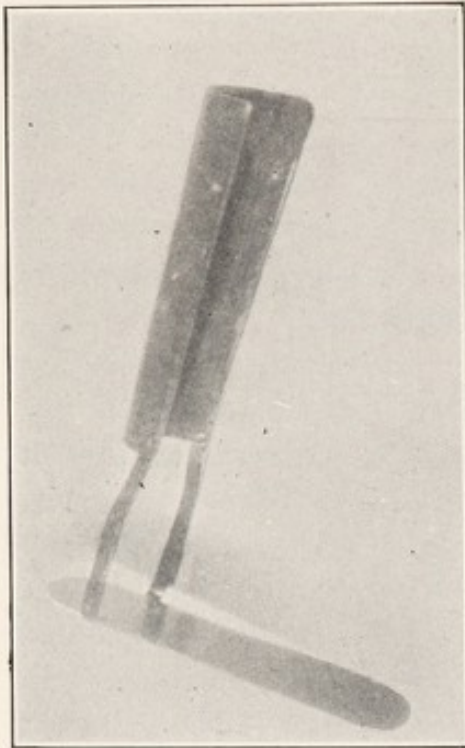


FIG. 30.—SPLINT TO RETAIN FOOT AT RIGHT ANGLE TO ANKLE, EXTENDING FROM TOES TO JUST BELOW THE KNEE-JOINT.

below the knee which will permit flexion without obstruction; if below this point, fixation is inefficient. The toes must at all times be visible. In applying a plaster cast, the unconscious tendency is to permit plantar flexion through the force of gravity, with fixation in the equinus position. This common error can be avoided only by constant attention of the physician or an intelligent assistant. Windows for the dressing of wounds may be required, or the entire cast may be bivalved. The posterior half makes a very satisfactory and comfortable splint. Wood, tin, aluminum, sheet iron, etc., are available materials for splints, which must conform to the normal relation of the foot to the leg, an outward deviation of about 25 degrees. The sole of the foot must be supported from toes to heel by one solid piece, which is attached to leg piece. The leg piece should conform to contour of calf or be of

sufficient width to prevent lateral slipping. After sufficient padding, the splint is held in place by adhesive plaster and bandage. Specially prepared meshed wire splints are commonly employed, but permit too much equinus and too little fixation, and are only of value as temporary measures, as for transportation.

Braces are in reality more durable splints and are usually applied as a supplementary support to permit weight-bearing or to retain a desired position until so maintained by nature. An ankle brace consists of one or two upright steel bars, attached above to a metal calf band just below the knee, and below to a sole plate or the shoe. Depending on conditions present, the ankle may be held rigid, or a joint so constructed as to permit any degree of motion desired in an antero-posterior direction. No lateral motion is ever possible, nor is it desirable, in an ankle brace of this type.

Walking is often permitted by the aid of crutches. The proper length of crutches can be obtained by measurement from axilla to sole of foot,



FIG. 31.—ANKLE BRACE ATTACHED TO SHOE LIMITING PLANTAR FLEXION.

The Knee.—The position of choice in affections of the knee is complete extension, for should a fair degree of motion, as much as 30 degrees, remain after the cessation of any pathological process, a useful member is secured; whereas, should the same degree of motion result with the knee at 90 degrees' flexion, walking would only be possible with a severe limp, a peg leg or crutches. The most useful position for a stiff knee is not in extension, but about 30 degrees' flexion, which permits walking with only a slight limp and sitting with comfort. However, as the tendency in affections of the knee-joint is toward flexion with external rotation of the tibia on the femur, there is great danger of deformity if any degree of flexion is permitted, and hence the position of choice is complete extension.

The plaster cast is a convenient means of immobilizing the knee. If complete fixation is desired, the cast must extend from the crest of the ilium to the toes, but for ordinary purposes a cast from the toes to the groin, or even from the malleoli to the groin is sufficient. If the latter is applied, the cast tends to slip downward on the leg. This may be prevented by attaching long strips of adhesive plaster to the skin of the thigh and leg, with loose ends extending below the ankle, to be turned up and incorporated into the plaster. A very common error is to apply a cast which is too short both above and below, and not only fails to immobilize, but also does not prevent deformity. A window over the patella may be advisable, but rarely is it necessary to bivalve the entire cast. A knee may be temporarily held in extension by a padded posterior splint of simple wood, but a metal gutter splint which conforms to the contour is more efficient. All knee splints must extend from the gluteal fold to just above the heel, and often the foot should be included as in an ankle splint, if more complete fixation is required.

Traction by means of weight and pulley, the well-known Buck's extension, is a most valuable measure, but is so frequently employed inefficiently as to be almost a universal farce. Therefore, it is deemed worthy of detailed description.

The limb is prepared by shaving. Strips of adhesive plaster about 2 inches in width are applied to the inner and outer aspects of the leg below

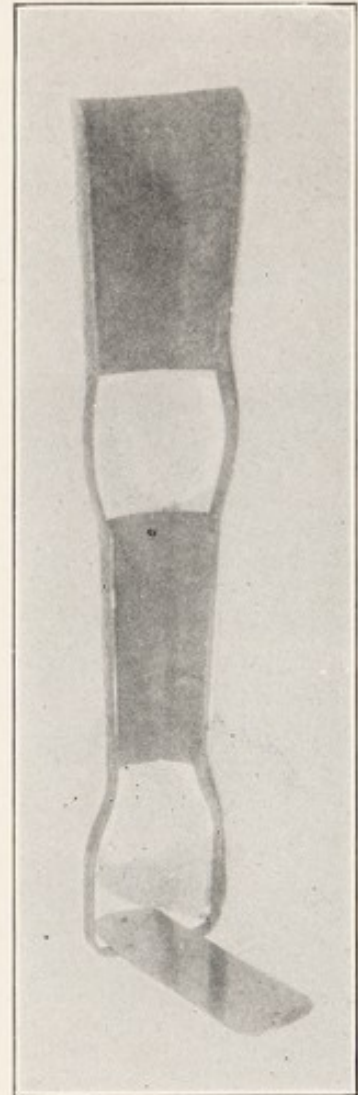


FIG. 32.—SPLINT TO HOLD KNEE IN EXTENSION AND FOOT AT RIGHT ANGLE TO LEG.

Note the lateral deviation of foot-piece to conform to normal relation of foot and ankle.

the knee and extend loosely for about 6 inches below the sole of the foot. Circular strips of adhesive maintain in place the longitudinal ones, over which a gauze or muslin bandage is applied. To each end of a wooden block, about 3 by 4 inches, a strip of heavy canvas, the same width as the block and almost 6 inches in length, is securely fastened with tacks. A hole is made through the center of the block, through which a rope is drawn and knotted, and the free ends of the canvas are attached to the free ends of the lateral adhesive strips on the leg by heavy safety pins, holding

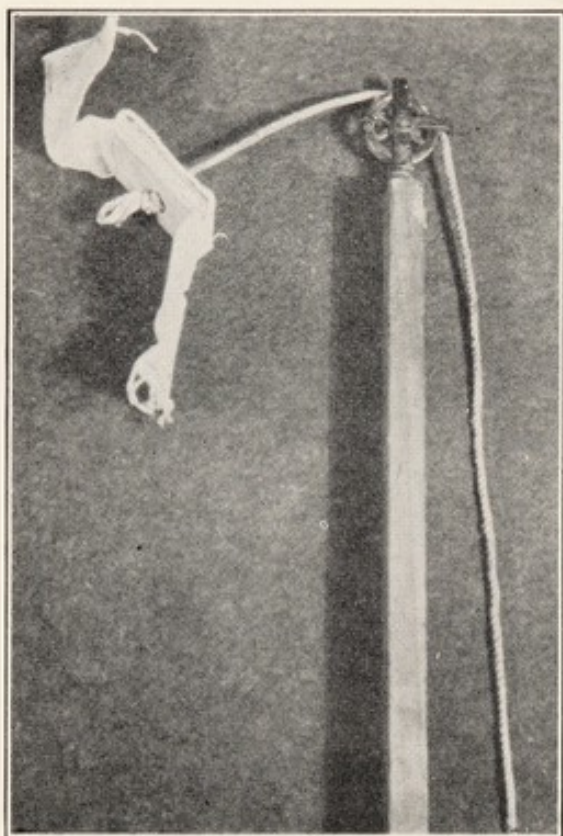


FIG. 33.—SMALL WOODEN BLOCK WITH ROPE AND PULLEY FIXED TO END OF BOARD ATTACHED TO FOOT OF BED, USED IN BUCK'S EXTENSION.

the block within 2 inches of the sole of the foot. A pulley is attached to the foot of the bed in direct line with the affected limb. The free end of the rope is passed through the pulley, and weights attached; beginning, as a rule, with about 4 pounds and gradually increasing the weight as indicated. The limb must be supported on a firm even surface, which can be secured by boards under the mattress, and the pull must be in a direct line with the limb. If the knee is in a flexed position, the calf of the leg is supported by a box or pillows, and the pulleys elevated so as to be in direct line with the leg. As flexion is overcome and extension acquired, the height of the box and pulley is decreased until the limb is on a firm bed. The weights must be free and unhampered, otherwise they may be caught in the ledge of the bed, a near-by chair, or, if the rope is too

long, may rest on the floor. The patient must not slide toward the foot of the bed, as the block will come in contact with the pulley, thus releasing all traction. This can be avoided by elevating the foot of the bed. Constant attention is required to keep the adhesive intact and the entire apparatus in working order, and also to prevent meddlesome visitors or relatives from lifting the weights. The object of weight and pulley traction is to relax muscular spasm which tends to approximate articular surfaces, to prevent flexion contractures, to correct flexion contractures when present, to hold the joint in the position of choice (complete extension), and to allay pain by decreasing intra-articular pressure.

The Thomas knee splint, devised by H. O. Thomas, is the most practical splint for the treatment of injuries and affections of the lower extremities;

this is largely due to simplicity in construction and application. This splint is employed to accomplish so many objectives that it might well be called "the universal splint." In recumbency, fixed traction and fixation are obtained, and as an ambulatory splint without weight-bearing, stilting, fixation and traction are secured. In addition to traction, constant pressure

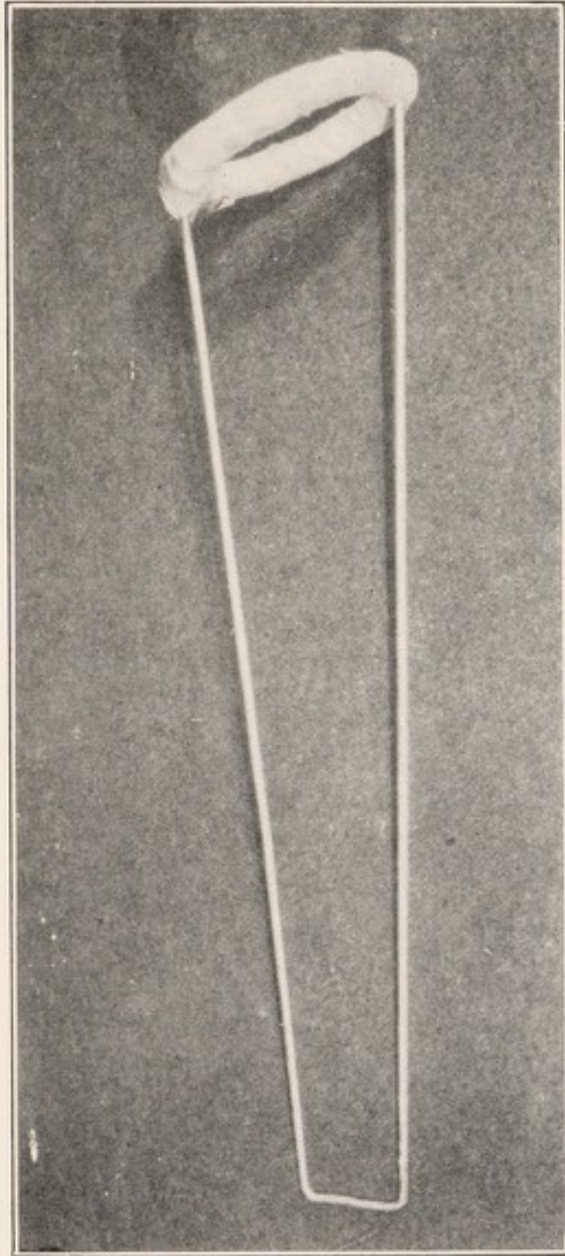


FIG. 34.—THOMAS KNEE SPLINT.

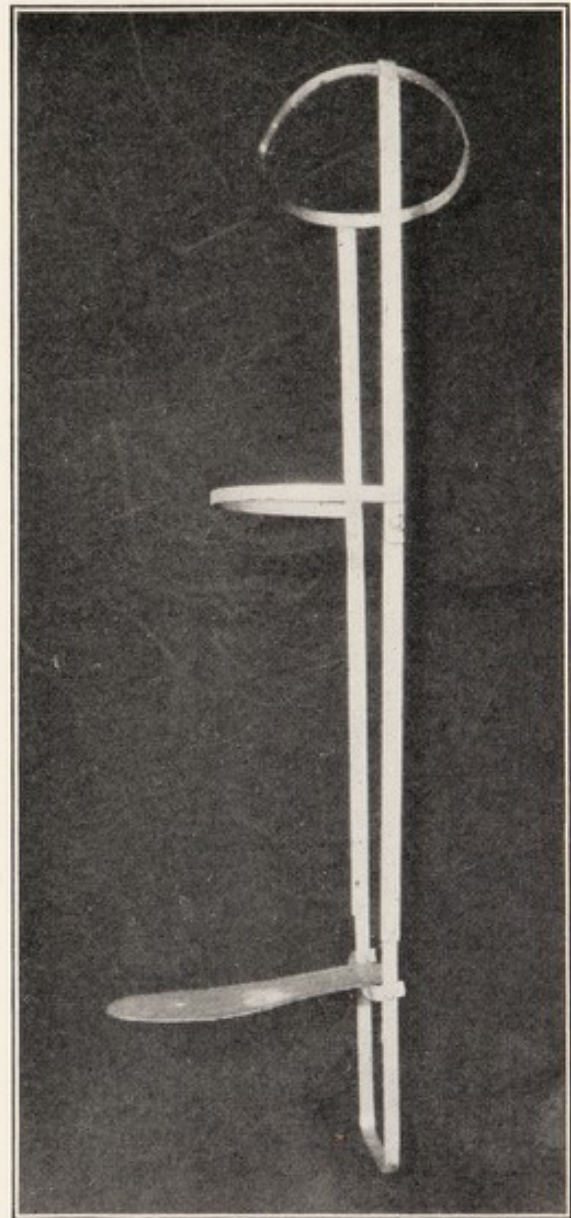


FIG. 35.—THOMAS KNEE SPLINT WITH HINGE AT KNEE AND ADJUSTABLE FOOT PLATE.

over the anterior aspect of the knee may be made to correct flexion contracture. The Thomas caliper splint is a convalescent measure by which there is a partial stilting with fixation.

The original Thomas knee splint consists of an upper ring, which must conform closely to the perineum, tuberosity of the ischium, gluteal fold, the greater trochanter and the anterior aspect of the thigh. Two steel rods are

attached to this ring, one in the perineum and one over the greater trochanter, which approximate as they descend to conform to the contour of the lower extremity. The two rods terminate below the sole of the foot in a horizontal rod or bar, which may be called the terminal bar. The

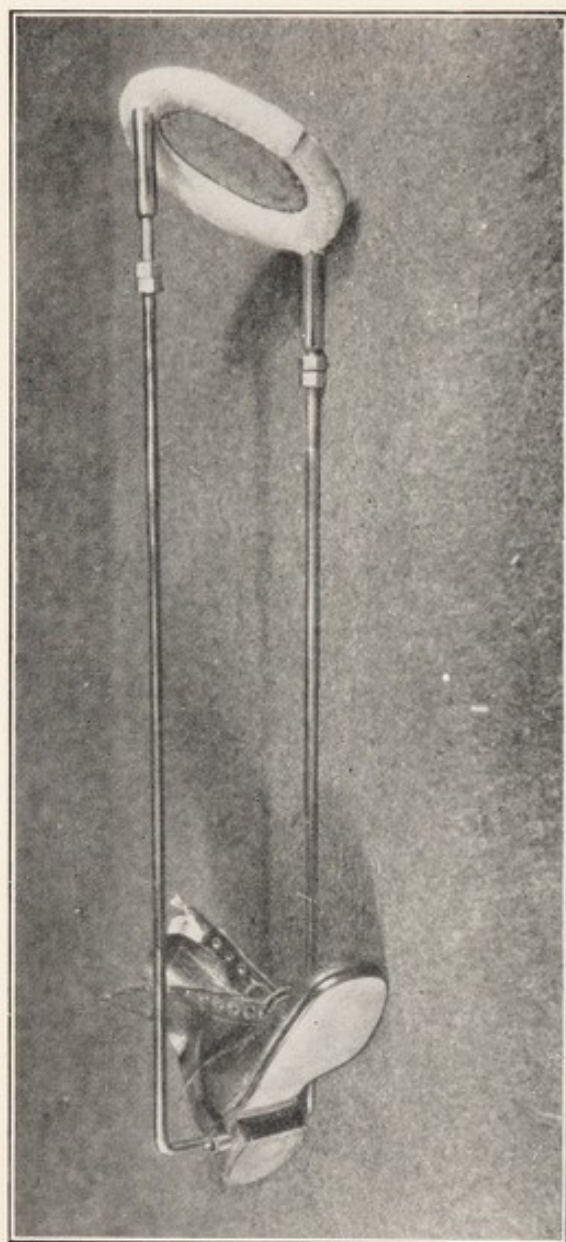


FIG. 36.—THOMAS CALIPER BRACE.

ring is well padded with felt and covered with cloth, chamois or leather. The plane of the ring is not level, but obliquely outward and upward at an angle of about 45 degrees. There are many modifications of the Thomas knee splint, but for average use three types are employed: (1) the splint in recumbency with traction; (2) the ambulatory splint to prevent weight-bearing with or without traction; (3) the ambulatory splint to permit partial weight-bearing. Measurement of the thigh for the ring is made with a tapeline following the course of the ring as above described, and allowing 2 or 3 inches for space occupied by padding. The measurements of the inner and outer steel rods for the brace in recumbency are taken above, from the perineum and the tip of the greater trochanter to 4 or 5 inches below the sole of the foot. The terminal bar which connects the inner and outer rods below should be about 1 inch broader than the ball of the foot. For the Thomas splint which permits partial weight-bearing, the measurement is made from the same points above but only to the sole

of the foot below. The terminal bar joins the inner and outer bars.

The general practitioner cannot always acquire promptly a Thomas knee splint which conforms accurately to each individual, but three sizes should be constantly kept in stock, which will meet the requirements of practically all cases in emergencies, and until such time as more efficient apparatus can be made and applied. The measurements of the stock splints are approximately as follows: For children from four to eight years of age, the circumference of the ring is 15 inches, the outer bar 25 inches, the inner bar 23 inches, the terminal bar 3 inches. For children eight to fourteen

years, the circumference is 19 inches, the outer bar 30 inches, the inner bar 28 inches, the terminal bar $3\frac{1}{2}$ inches. For those above fourteen and adults, the circumference is $22\frac{1}{2}$ inches, the outer bar 39 inches, the inner bar 36 inches, the terminal bar 4 inches.

The leg is prepared and adhesive plaster applied as in Buck's extension. Heavy cord about 18 inches in length is rolled into the loose end of the adhesive plaster as one would roll a cigarette. In applying the splint, the foot is passed through the ring, which is pushed well up into the perineum and against the tuberosity of the ischium. The ropes below are tied to the terminal bar after desired traction has been made. Strips of canvas or strong bandage are pinned or stitched to each rod, forming a hammock or posterior support to the entire limb. A retentive bandage of muslin, Canton flannel or outing cloth may be wrapped about the entire limb and brace from ring to ankle.

The brace for ambulation without weight-bearing may be applied in the same manner, but if required for a long period of time, a cloth or leather legging may supplant the adhesive to avoid irritation of the skin. Foot drop or equinus must be avoided by an additional attachment, which is fastened to the lateral rods to hold the foot at right angle to the leg; or if only slight traction is indicated, a strap stitched to the heel of the shoe, which fastens to a buckle on the terminal bar will obtain the same result. The

terminal bar transmits the weight through the lateral rods and ring to the perineum and tuberosity of the ischium. The terminal bar may be covered with leather and the shoe on the opposite foot must be elevated.

The Thomas knee brace for ambulation with partial weight-bearing is also known as the Thomas caliper splint, as it differs from those above described in that the lower rods terminate in a pair of calipers, which fit into a steel tunnel through the heel of the shoe.

Braces are often employed in the treatment of affections of the knee, and in some instances, to assist a permanently defective member. Short braces are at times used in mild conditions, but if fixation is required, the apparatus must be attached to the shoe and extend as high as possible on the thigh to permit walking with comfort. The brace is constructed of inner and outer metal bars connected by broad semicircular bands, which may be

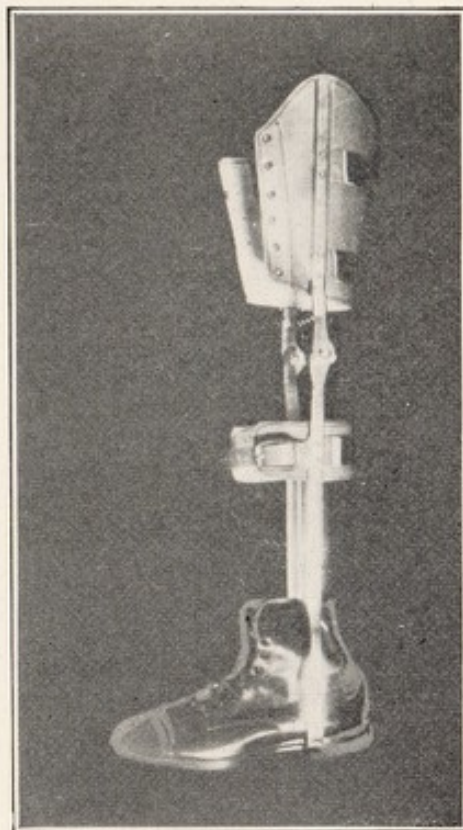


FIG. 37.—SIMPLE KNEE BRACE ATTACHED TO SHOE, EXTENDING WELL UP ON THIGH.

covered with leather. Straps or lacings hold the apparatus in position. Steel, properly tempered, is the only material from which braces should be made. Aluminum and alloys of aluminum are not durable. The efficiency of the brace also depends on the joint at the knee, which must be constructed commensurate with the requirements of each individual case. There may be no motion, or full motion permitted. There may be a locked

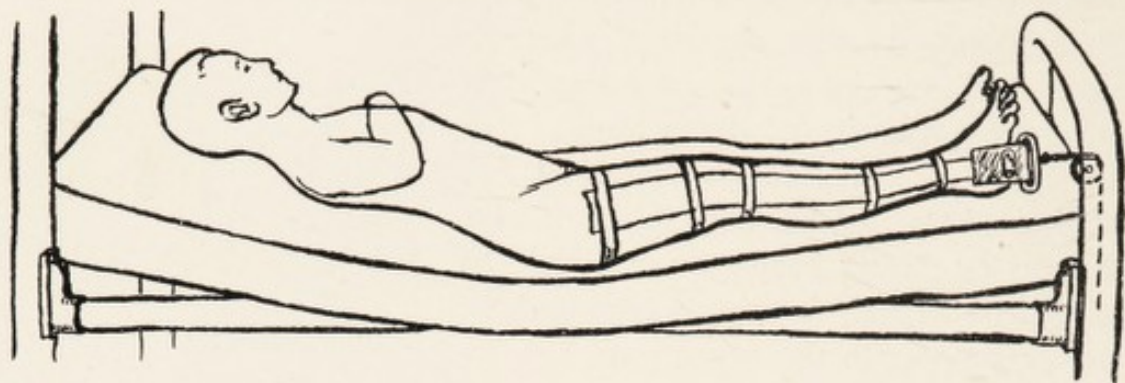


FIG. 38.—ILLUSTRATING UNDESIRABLE CONDITION OF BED, WITH CONSEQUENT SAGGING OF PELVIS.

joint in walking which permits flexion in sitting, or the joint may be so adjusted that motion can be gradually increased.

The Hip-Joint.—The successful management of affections of the hip-joint requires mechanical skill and special training; otherwise, the coöperation of an expert is imperative. The most serviceable position is slight flexion, 20 degrees abduction and midway between external and internal rotation. As in the knee, ankylosis in slight flexion is more useful than in

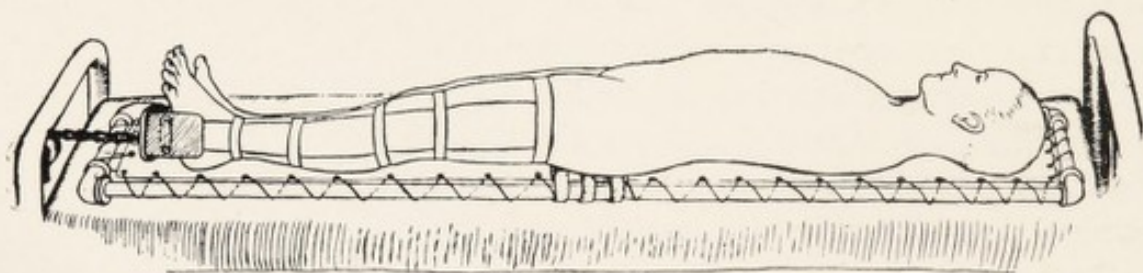


FIG. 39.—DRAWING SHOWING BODY SUPPORTED ON FIRM SURFACE FOR HIP TRACTION.

extension, but as the tendency to malposition is in this direction, flexion should be constantly avoided.

Buck's extension is useful when traction with recumbency is desired, and is applied in the same manner as for the knee-joint, except that the adhesive strips on the inner and outer sides are continued upward to just below the hip-joint. The patient must remain constantly in the reclining position and at no time be permitted to assume the sitting posture. The entire body is supported on a firm surface as the Bradford frame, which will be described later, or boards placed under the mattress may give a fair

substitute. Sagging of the bed from weight of the pelvis induces hip flexion and prevents attainment of the most serviceable position. Traction is instituted in the position of deformity and is adjusted to make a continuous pull in the direction of the limb as the malposition is reduced. About

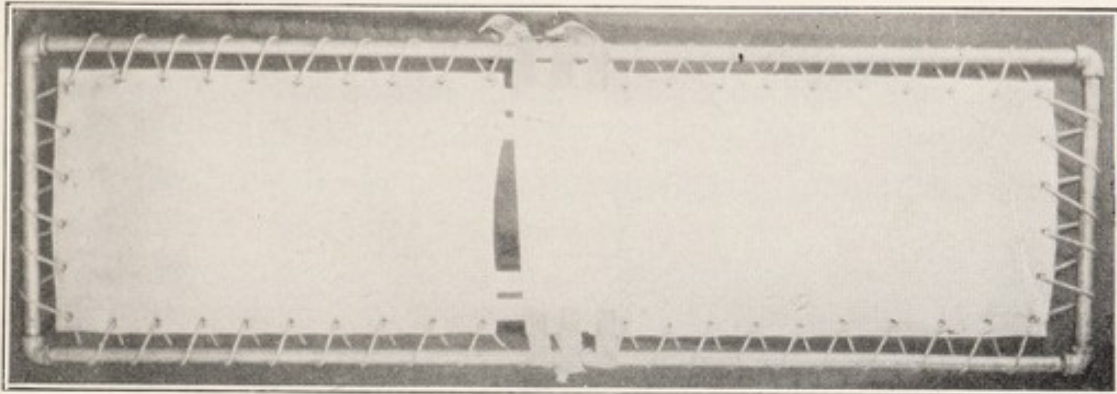


FIG. 40.—BRADFORD FRAME WITH SLIP COVER FOR USE OF BED-PAN.

4 pounds of weight is employed at first and gradually increased until 10 or 15 pounds are reached, or there is muscle relaxation.

The maintenance of the desired position requires apparatus which extends from the nipple line to the toes on the affected side, and, in some instances, the opposite hip and thigh must be included. Plaster-of-Paris is more frequently employed in America than splints, but some practical

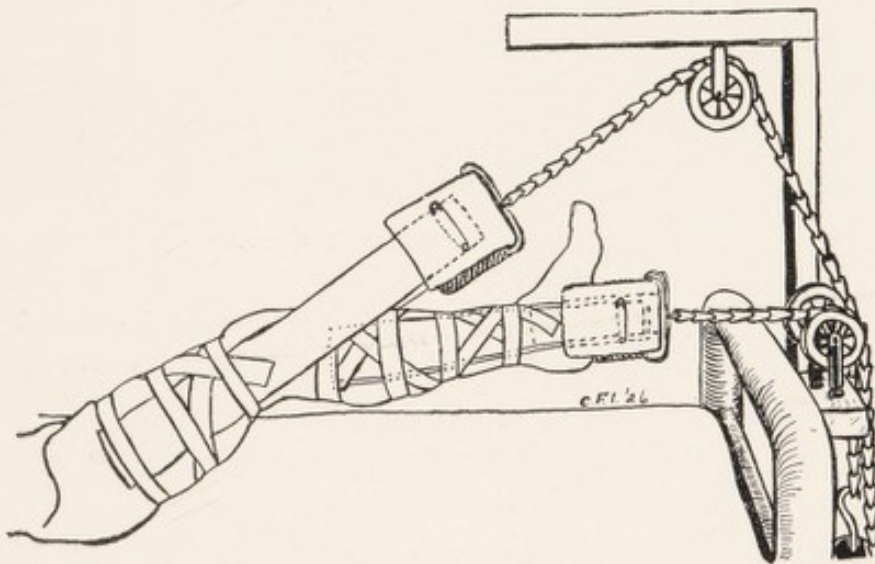


FIG. 41.—DRAWING SHOWING TRACTION IN LINE OF DEFORMITY OF HIP.

knowledge is essential for the application of an efficient spica cast. The body and hip must be suspended so that the cast may give efficient mechanical support on all sides, which can be accomplished by supporting the shoulders and the sacrum. This is facilitated by the use of an orthopedic table, which, however, is not always available. The shoulders may be supported by an ordinary box placed on a kitchen table; the sacrum placed

upon a small triangular pedestal, known as a hip rest; however, a small can of sufficient height will make a fair substitute. Under no circumstances should a large pan be employed, for then the supporting cast cannot be carried to the posterior aspect of the joint, which is essential to hip fixation. The limb is held in the desired position, which depends upon the affection present. The patient is prepared by applying a balbriggan or stockinet union suit from which all buttons have been removed. Sufficient padding is applied with special attention to bony prominences, as the sacrum and crest of the ilium, anterior aspect of the tibia, the malleoli and heel. In applying the cast, there should be reinforcements of plaster, not tin or wood, over the anterior and posterior aspects of the hip-joint; otherwise, breaking



FIG. 42.—DOUBLE SPICA CAST.

at these points may be expected. The plaster should be carefully molded to the crests of the ilia as consolidation occurs. Depending upon indications, the cast may extend from the nipple line to the toes of the affected side (the long spica), or from the crests of the ilia to the knee (the short spica). On certain occasions, a double hip spica from nipples to toes is employed, which requires a wooden bar between the thighs. Various abbreviations of the spica cast are at times required.

The Thomas hip splint or modifications thereof may be employed as a fixation and retentive appliance. This consists of a steel bar extending from the scapula above to the toes below on the affected side, conforming to the contour of the posterior aspect of the chest, loins, buttocks, posterior surfaces of the thigh and calf, and terminating in a sole plate. Steel bands with straps and buckles are attached to the posterior bar. These encircle the chest, the pelvis below the iliac crests, the upper and lower thirds of

the thigh and calf. The sole plate prevents rotation of the lower extremity. In bilateral affections, a double splint of this type may be required. The single Thomas hip splint is illustrated in Figure 43.

The Thomas caliper knee splint, as above described, is frequently employed as a convalescent measure in affections of the hip-joint, to partially prevent weight-bearing. The abduction hip splint of Bradford is also a valuable measure in affections of the hip-joint and is a modification of the Thomas knee splint. The anterior half of the perineal ring is omitted; the other half is continued upward over the pubic bone and genitals, then downward to the opposite groin, which it follows back to the middle of the opposite gluteal fold. This apparatus may be employed in recumbency, or as an ambulatory splint, and is applied in the same manner as the Thomas splint.

The Sacro-iliac Joint.—In affections of the sacro-iliac joint, support of the spine may also be required, as so-called sciatic scoliosis is frequently associated. This may be applied, if the condition warrants, by a plaster-of-Paris cast extending from the nipple line above to the knee, or by a low spinal brace. A simple broad canvas belt extending from the crest of the ilium to the trochanter is often efficient in mild affections. The belt may have a pad over the sacrum and anterior and lateral lacings to adjust pressure.

The Spine.—The most serviceable position is extension or hyperextension, which should be maintained by all apparatus employed. No appliance permitting ambulation will satisfactorily prevent deformity in certain parts of the spine. Each region is a separate problem and must be so considered, but there are some principles applicable to the entire spine. For fixation in recumbency, the frame described by E. H. Bradford, and commonly known as the Bradford frame, is the simplest and most efficient for general use. This consists of a rectangular gas-pipe frame made from piping ranging in size from $\frac{1}{4}$ inch for children to 1 inch for adults, and can be made by a plumber or any one who can use a simple Stillson wrench. The desired width is obtained by measurement from shoulder-joint to shoulder-joint. The frame should be about one foot longer than the patient. Pipe of the

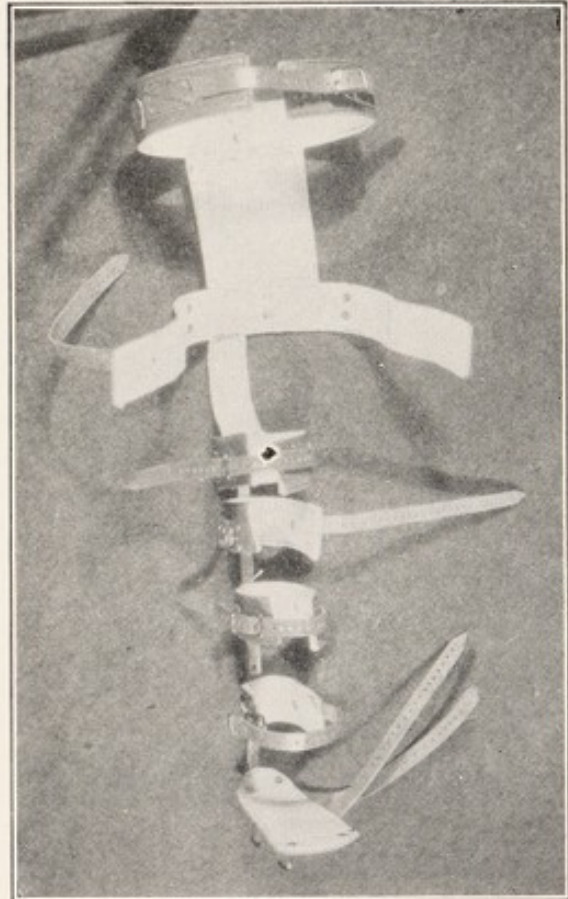


FIG. 43.—THOMAS HIP SPLINT.

required size and length is selected, together with four elbows. Threads are made on the end of each piece and in reverse directions at the opposite ends; all parts are joined and tightly screwed together. A canvas cover of required dimensions can be made by a seamstress, but a tent and awning maker is more expert. One-eighth inch eyelets, with apparatus for applying, may be secured from a hardware store and should be placed along the longitudinal borders. The cover is applied to the frame and held taut by moderate-sized rope lacing. A blanket is next wrapped about the entire

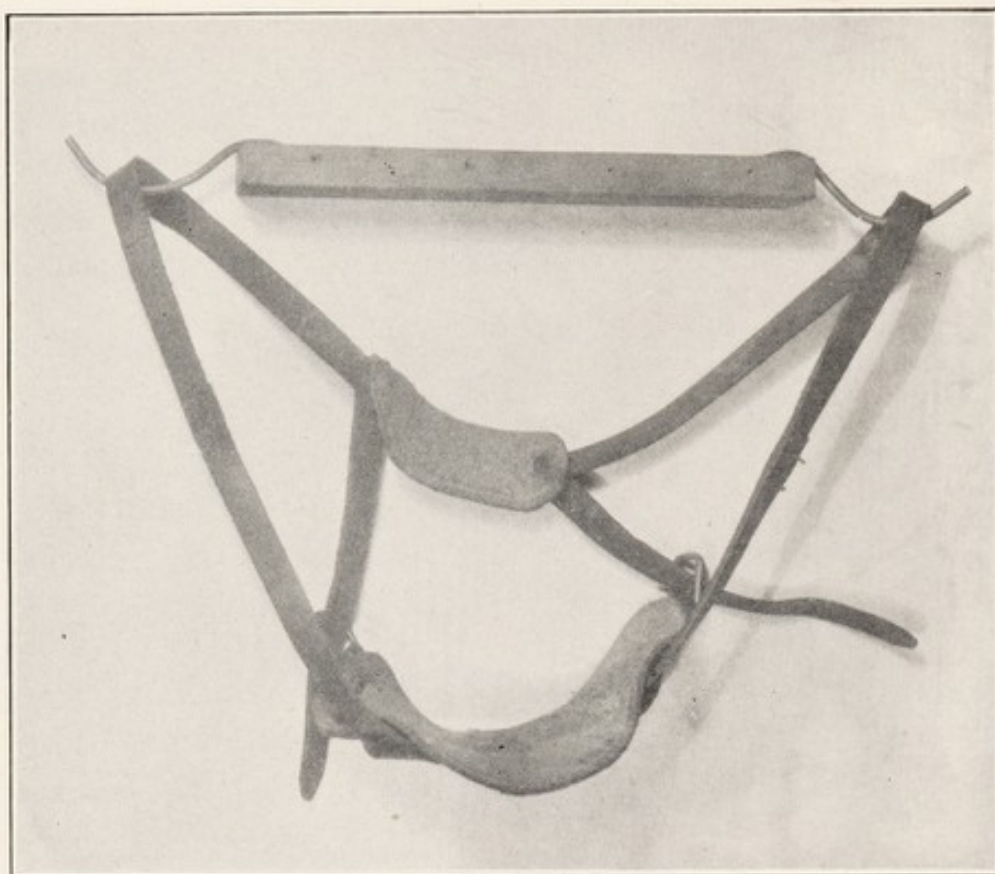


FIG. 44.—SAYRE HEAD TRACTION APPARATUS.

frame and held by large safety pins, and a sheet applied in the same manner. A sheet of rubber or oilcloth invests the region of the buttocks and is itself covered by a muslin draw sheet. If it is desired to hold the part in hyperextension to prevent kyphosis or "hunchback," the frame may be made convex to conform to any region of the spine, or heavy pads of any non-resilient material, such as saddler's felt, may be placed under the affected region for the same purpose. The patient is retained on the frame by bands of canvas, or any material of sufficient strength, applied in the region of the chest and pelvis. The douche or bed-pans in vogue are too high and cause flexion of the spine, and therefore must not be employed. The old-fashioned bed-pan with spout, obtainable at every corner drug store, is the most satisfactory. The pan should be slipped beneath the buttocks with the minimum elevation of the lower spine. Sec-

tional covers can be so arranged as to permit defecation without moving the patient, but are more complicated and not of practical application in the average home. The spine of the patient should be bathed daily, but every precaution should be taken to prevent a change in position. The patient on the frame is placed on a hard surface, as a table, and the retaining bands removed. The patient is held firmly against the frame with the left hand while the frame is turned with the right. The tendency is to grasp the child by the nape of the neck and buttocks when removing from the frame, which obviously induces kyphosis. Repeated warning is often necessary to stop such pernicious practices on the part of the parents and often so-called trained attendants. Traction on both lower extremities and also the head may be made, if necessary, through pulleys attached to the transverse bars at the extremities of the frame. For head traction, the pulley is placed in the center; for traction on the extremities, a pulley is placed near each end of the lower bar, so that traction can be made in a direct line with each lower extremity. Attachments can be made to each limb through adhesive strips, as in Buck's extension of the hip. The principle of the Sayre suspension apparatus is applied in making traction of the head and neck. A strip of muslin about 2 or 3 inches in width and about 2 feet in length is fastened to each end of an 8-inch bar, thus forming a hammock or loop, the center of which is placed beneath the chin with the crossbar above the head and parallel with the shoulders. A second strip of muslin is fastened to the loop above the right ear, and then passed below the occiput, pulled taut, and fastened to the same point above the left ear. Safety pins, a needle and thread or buckles may be employed to unite the two strips of muslin. Rope is tied to the center of the bar and passed through the pulley, as described, on the upper end of the frame. Tension on the end of the rope should make a pull that is evenly distributed on the chin and occiput. Traction is instituted with about 2 pounds' weight, and gradually increased until the desired amount has been added, which is usually indicated by relaxation of muscular spasm. The head of the bed should be elevated to prevent the patient from sliding upward and approximating the bar to the pulley, thus

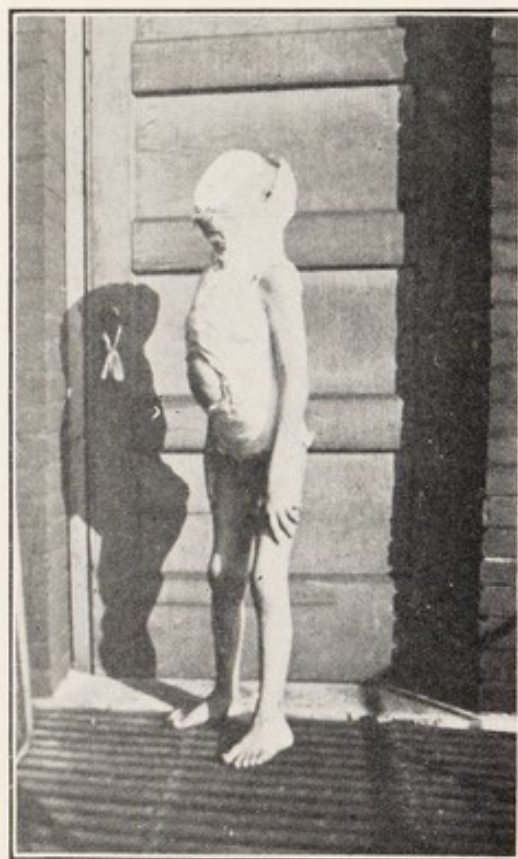


FIG. 45.—PLASTER-OF-PARIS BODY CAST, INCLUDING HEAD.

releasing traction. The Bradford frame with attached pulleys may be employed in all affections of the spine or lower extremities, with the exception of the ankles and feet, when recumbency with fixation and traction is indicated. The Bradford frame is also inimitable as an emergency appliance.

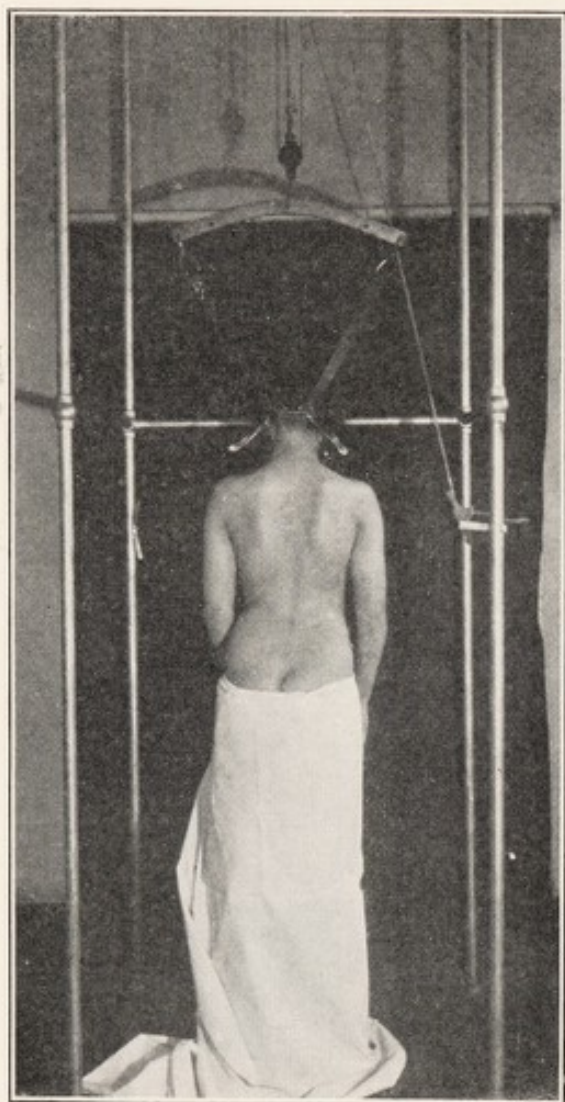


FIG. 46.—SAYRE HEAD TRACTION APPARATUS FOR APPLICATION OF PLASTER-OF-PARIS BODY CAST.

Plaster-of-Paris is more commonly employed than any other measure for ambulatory fixation, and three types of plaster jackets will be mentioned. These should be employed as indicated:

1. The routine or common plaster jacket
2. The plaster jacket incorporating the head
3. The plaster jacket incorporating one or both hips and thighs

The patient should be prepared by applying a shirt of stockinet and padding of all bony prominences, as the crest of the ilium, sacrum, etc. There are various apparatuses for applying plaster jackets, but only two will be mentioned: (1) the Sayre suspension; (2) the sling.

The principles of the Sayre suspension apparatus were described under the discussion of head traction. A leather halter is used to support the chin and occiput. The halter or head support is attached through straps to an overhead bar, and is applied to the

patient while standing. The center of the bar is connected to a block and tackle attached above to the ceiling, doorway, or any convenient point. Traction is made on the end of the rope until the heels are lifted from the floor and the balls of the feet merely balance the body. Suspension is thus maintained by attaching the end of the rope to some fixed point. The upper extremities are abducted to 90 degrees and supported by assistants or longitudinal bars. The cast is then applied.

The sling is used with the patient in recumbency, and consists of two boxes from 8 to 12 inches in height and of sufficient dimensions to support the shoulders on one end and the thighs on the other, thus suspending the entire spine. The arms are placed over the head. A sling of

heavy cloth or canvas from 3 to 5 inches in width is passed transversely below the affected area of the spine and attached at each end of a bar, which is suspended over the body by a block and tackle, as in the suspension apparatus above described. Traction through block and tackle on the sling hyperextends the spine to the desired degree, when a plaster jacket is applied. After solidification, the sling protrudes on both sides and must be severed close to the cast, which is reënforced by one or two additional plaster bandages.

The routine plaster cast to the spine should be applied from the sternal notch above to the thighs below. It must be trimmed with a sharp knife so that the upper anterior margin extends to the interclavicular notch; laterally, concavities are made in the axilla to permit free play of the upper extremity and posteriorly the margin is a straight line below the level of the spines of the scapulæ. Below, the anterior termination is the symphysis pubis. On either side concavities are made to permit flexion of the thighs in the sitting posture. The lateral margin terminates at the greater trochanter, and posteriorly at the tip of the sacrum, and not the coccyx, as usually stated. Every plaster jacket should conform closely, which requires careful molding with particular attention to the crests of the ilia.

The plaster cast in which the head is incorporated is applied by the Sayre apparatus, using simple muslin strips, which are sewed and permitted to remain within the cast until solidification occurs. The cast is applied over the top of the head and well under the chin, but trimmed with a sharp knife after solidification, so as to support chin and occiput with both ears free. This type is known as the Calot jacket.

A cast which includes one or both thighs may be applied with either the Sayre suspension or the sling apparatus. If the latter, a hip rest or a simple tomato can, as described in the application of a hip spica, must be substituted for the lower box.

The application of an efficient plaster jacket requires the services of an expert, but any physician who will devote sufficient time and study to the subject may become an expert. However, as a matter of fact, the plaster jacket as applied by the average physician is a caricature of efficiency and gives about as much support as placing the patient within a barrel.

The routine plaster jacket in young children is not effective as a fixation apparatus, regardless of the conformation to the spine. It is more efficient in the dorsolumbar region than any other portion, but even at this point deformity may not be prevented. In the lower lumbar and upper dorsal regions, the routine jacket is of little, if any, benefit.

All plaster casts give more satisfactory support to those who possess "good figures," in which the bony prominences are pronounced, as the crest of the ilium, waistline, etc. The shape of the body of a growing child

is similar to that of an egg; besides, the spine is comparatively short. Consequently, satisfactory fixation cannot be secured by a jacket, unless the head is included when the upper portion of the spine is affected, and one or both thighs when the lower portion is involved. When the mid-region of the spine requires support, the head and both lower extremities must be included. Plaster jackets conform and give more efficient support to older children and adults, unless obese. Any jacket may become inefficient

through loss of body weight, which may increase space between the body and jacket. Conversely, an increase in weight may require removal on account of discomfort. Plaster-of-Paris jackets possess the advantage that they cannot be removed at will by the patient, sympathetic friends or relatives.

There are many well-known spinal braces, but only the Taylor, or a modification thereof, will be considered. This brace consists of two steel bars on either side, parallel to the vertebral column, and conforming to the contour of the spine. Below, these are attached to a pelvic band, and above to a short crossbar about the level of the spine of the scapula. Shoulder straps are attached that pass over the outer end of the clavicle, and backward through the axillæ to the upper bar, thus forming a loop. A canvas apron covering the chest and abdomen is attached to the brace at different levels by straps and buckles, thus holding the brace in close approximation to the spine. The pelvic band should fit



FIG. 47.—TAYLOR SPINAL BRACE, WITH AUTHOR'S MODIFICATION, EXTENDING FROM OCCIPUT TO KNEES.

snugly below the crests of the ilia and be fastened anteriorly by buckles. The Taylor, or any other brace, will not secure absolute fixation of the spine. If support is desired to the upper dorsal or cervical region, an attachment must be added to transmit the weight of the head to the pelvis by supporting the chin and occiput. If the mid-region of the spine requires fixation, the head and neck must be braced by extending the two steel bars to the occiput, thus fixing but not supporting the head. If the lower dorsal or lumbar region requires fixation, two steel bars are attached to the pelvic band. These extend downward to the knee, conforming to the

posterior aspect of the buttocks and thighs and permitting knee flexion. These bars are held in position by two steel thigh bands with straps and buckles. Thus, in order to secure fixation of the entire spine in young children, the brace must extend from occiput to knees. It is astonishing how well a child can run about and play with complete fixation of the head, spine and both hips. In older children and adults, less extensive apparatus may often suffice. The modified spinal brace as described gives much better fixation, and may supplant the frame where long-continued fixation without traction is required. The Taylor brace is an excellent convalescent measure where only partial support is desired.

The Shoulder.—The most serviceable position for the shoulder is about 30 degrees' flexion, slight internal rotation and 45 degrees' abduction.

A plaster-of-Paris cast is probably the most efficient apparatus for absolute fixation, but must extend from the wrist upward and include the entire body to the crest of the ilium. This in reality is a plaster-of-Paris jacket with the incorporation of the upper extremity. Fixation of the shoulder and humerus may also be secured by an axillary pad with strapping of the entire arm to the chest wall, and supporting the forearm by an ordinary sling.

The author has found a very simple splint of great value in the immobilization of the shoulder and humerus, which he calls the traction humerus splint.¹ This splint consists of a large metal plate to conform to the lateral aspect of the thorax, united to an arm-piece in the axilla; the width of the arm-piece conforms to the size of the arm and passes down the inner aspect to the elbow, where the forearm piece is connected, extending down the palmar aspect of the forearm and hand, with the elbow at right angles and the forearm in mid-position. An inner metal bar is attached to the inner surface of the arm portion, extending to 3 or 4 inches below the elbow, where it is bent outward at right angle for the attachment of traction strap. Adhesive strips are applied to both sides of the arm just below the shoulder, or below the point where traction is desired, and extend loosely for several inches below the elbow. These strips are held in position by circular strips and bandage. The splint is applied and

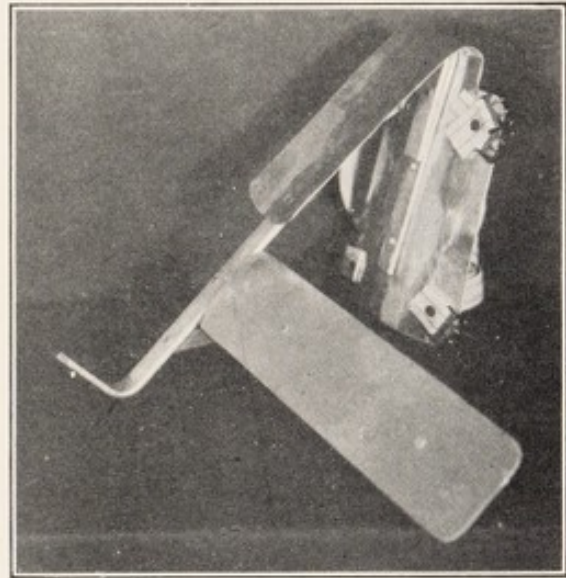


FIG. 48.—TRACTION HUMERUS SPLINT.

¹ The arm, forearm and chest parts of this splint were devised by M. S. Henderson, of the Mayo Clinic, Rochester, Minn., as a convalescent measure so that a coat might be comfortably worn. The other portions of the apparatus were added by the author to maintain fixed traction and approximation of fragments.

held in position by adhesive plaster and webbing straps. Desired traction is made through the loose ends of the adhesive, which are then tied to the terminal bar below the elbow.

The Elbow.—The most serviceable position for an elbow is slightly less than a right angle, with the forearm supinated or in mid-position.

The elbow may be supported by a plaster-of-Paris cast or a splint which extends from the metacarpophalangeal joints posteriorly as high on the arm

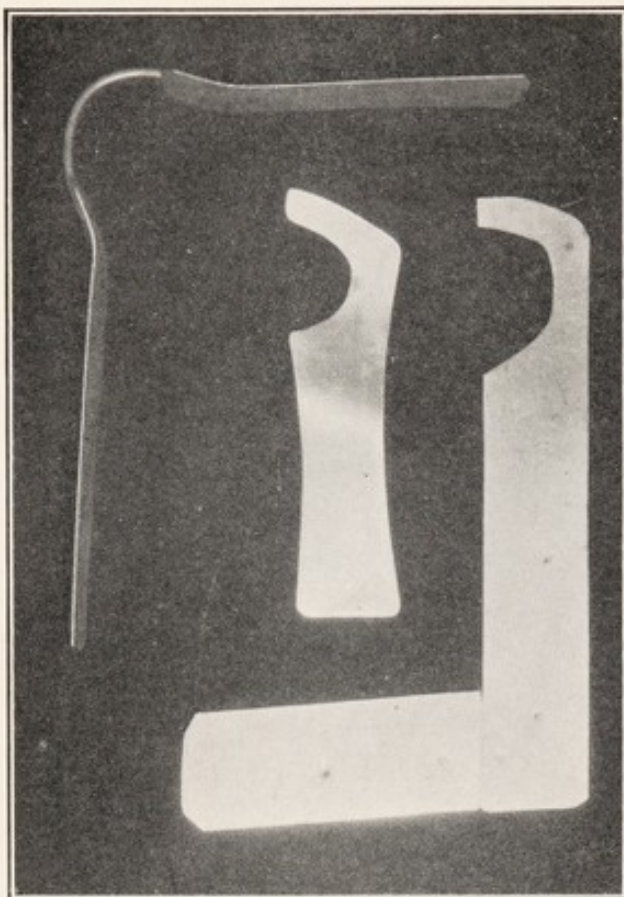


FIG. 49.—SPLINTS USED FOR SUPPORT OF ELBOW AND WRIST.

as possible. The fingers must be entirely free with full play of the metacarpophalangeal joints, which means that no support should extend below the mid-crease in the palm, and should not be so thick as to impair complete flexion and the ability to make a fist. Posterior metal splints of aluminum or sheet steel, padded and retained by adhesive and roller bandage will maintain any desired position. As the normal forearm is in valgus in relation to the arm, the forearm portion of the splint must deviate outward; otherwise the conformation of splint with efficient immobilization cannot be secured.

The Wrist.—The most serviceable position for a wrist joint is in extension or dorsiflexion. As the tendency of many pathological processes is to cause flexion with

forward luxation, the cock-up splint maintains the most desirable position. It may be made from very simple sheet metal, aluminum or sheet iron. A simple tracing of the affected hand and forearm is taken, or the opposite extremity if contractures are present; the splint may then be trimmed out with metal shears. Below, the splint extends to the middle of the hand, and above to the upper third of the forearm. Flexion of the fingers and particularly the metacarpophalangeal joints should be entirely free. If rotation of the forearm is to be controlled, the splint must include the elbow.

SYMPTOMS OF CONSTRICTION

After the application of any apparatus, splint, brace or cast, for an acute condition, as trauma, infection or after operation, the patient must be

carefully observed for symptoms of pressure or irritation. This applies particularly to the extremities. Most patients complain, and some more than others, but continuous pain in one locality should be investigated. When splints have been applied to the upper or lower extremity, the fingers and toes respectively should be under constant surveillance until all danger of pressure induced by swelling from an acute reaction has passed. This requires from three to four days, and in some instances, if symptoms persist, a week. The crucial period when serious pressure complications are more apt to occur is within the second twenty-four hours, usually the second night. As a rule, there is not sufficient reaction to cause severe pressure during the first twenty-four hours. There are a few cardinal signs of great significance which should be known by every physician and every nurse or attendant, which are as follows:

1. Pain, extreme or excruciating
2. Color, cyanosis, anemia or blanching
3. Depressed local temperature
4. Diminished sensation
5. Loss of motion
6. Sudden elevation of temperature which cannot be otherwise accounted for

Intense and continuous pain may occur rarely in the clinical course of certain affections, but if inspection is made, the possibility of a serious complication from pressure can be excluded. Cyanosis is an indication of venous stasis, usually a result of superficial pressure, caused by a crease in the padding or indentation of cast, etc. Anemia, sudden blanching, indicates impairment of arterial circulation, with a possible thrombosis, which is of extremely serious consequence. Depressed local temperature is of significance only when associated with other signs. Diminished sensation, if slight, is not significant, but complete loss usually indicates serious nerve impairment, especially if associated with loss of motion, provided, of course, that function previously existed. Diligent and constant care should be given by a competent attendant, who should notify the physician at once when any of the cardinal signs are observed. If significant, a portion of the splint or cast should at once be removed to permit inspection. If no improvement occurs, the entire apparatus must be removed and the position of the limb changed. Undoubtedly, if the careful management above described were carried out in every case, many serious complications with permanent impairment would be averted and many limbs saved that are uselessly sacrificed. This is not generally known, even to the profession, for very few, if any, such disastrous results are reported. Ischemic myositis, Volkmann's paralysis (p. 211), following arm fractures, is, in many instances, due to constriction by splints and bandages.

MEASUREMENT OF BRACES

Braces that are to be used in the treatment of orthopedic cases must conform to the contour of the part to be supported. They must be ordered

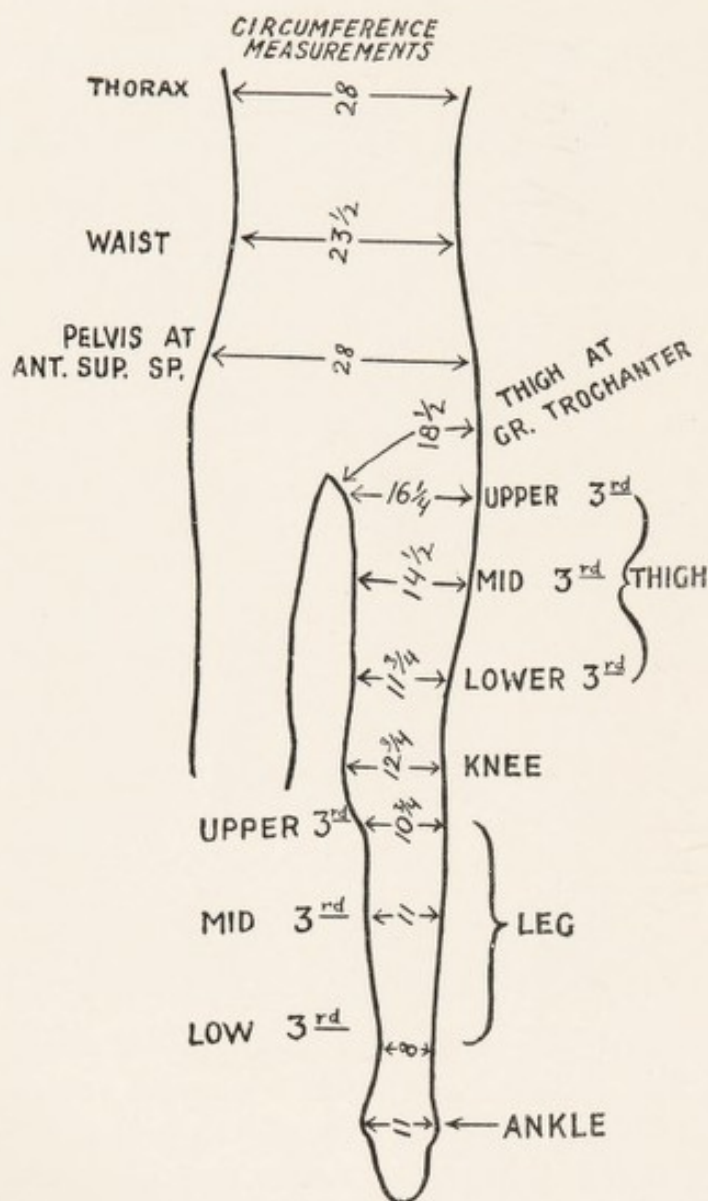


FIG. 50.—DRAWING OF OUTLINE OF BODY AND LEG, WITH CIRCUMFERENCES, TO BE USED IN MANUFACTURE OF BRACES.

straps are to be applied must be marked. Figure 50 shows a tracing of the body and leg, with the circumferences marked at the ankle, lower, middle and upper thirds of the leg, the knee, and the lower, middle and upper thirds of the thigh. The circumference of the thigh at the level of the greater trochanter is used where a Thomas ring is required. The circumference of the pelvis, waist and thorax at the level of the nipple is also indicated. If the mechanic then bends his bars to conform to this tracing, a proper fit is assured.

from the brace maker with as much care as a prescription is given to the druggist. In certain conditions, where an exact fit is required, a plaster-of-Paris model of the part must be made. A plaster jacket may be placed on the patient with all padding omitted. The plaster model is removed from the body by cutting down the front, after which a roller bandage holds the edges together. The model is sent to a brace maker, who makes a torso by filling with plaster-of-Paris, from which the desired appliance is made to conform to the contour of the body.

For the routine type of brace, however, this is not necessary. A tracing of the limb on ordinary strong wrapping paper is sufficient. On this, the location and type of the joints should be indicated, and the circumference of the regions about which circular bands and

CHAPTER III

CLASSIFICATION OF ORTHOPEDIC AFFECTIONS

The average physician, after perusing the orthopedic literature, often obtains a rather vague and confused impression of a long list of clinical entities, but has little knowledge of relation or differentiation. This is especially true in regard to diseases of the joints, in which there are such divergent opinions as to nomenclature. Two grand divisions are often made: tuberculous and non-tuberculous. Of the non-tuberculous joint lesions, there are frequently found several terms indicating the same conditions. Again, such affections as osteomyelitis and rachitis may be observed under the same caption.

It is also quite evident that no classification could be made on a purely scientific basis, nor could any definite system be followed, as this probably would not meet with general approval. Furthermore, any arrangement that might meet with the demands of the present day would be subject to change when additional knowledge was acquired. However, there are many affections which bear a more or less close relation etiologically, clinically, pathologically or otherwise, which will, in this work, be grouped together with the anticipation of presenting the broad principles involved in a more concise and comprehensive manner.

As the extremities of bones form an integral part of an articulation, a fine distinction must be made occasionally as to whether a bone or joint is involved in a pathological process. However, when either is exclusively invaded, there is such a marked difference in clinical manifestations that a separate classification is warranted. Orthopedic affections may be divided into six main groups, with further subdivisions when required, as follows:

- I. Affections of joints
- II. Affections of bones
- III. Affections of epiphyses
- IV. Affections of the soft tissues
- V. Affections of the nervous system
- VI. Static or postural anomalies
- VII. Congenital anomalies

I. Affections of Joints.—*Acute Infectious Processes.*—Acute infectious processes are the result of direct infection by pyogenic organisms from without through penetrating wounds; or indirectly from within through the blood stream. They are instituted by the sudden onset of the characteristic

constitutional symptoms of an acute infectious process, malaise, chill, high temperature, etc. In the joint or joints involved are observed all the cardinal symptoms of an acute inflammation: pain, heat and redness, when superficial, swelling, and limitation of motion. The course is definite, with final subsidence of symptoms and, if no destruction, restoration to normal; otherwise, permanent impairment of joint function.

Low-Grade Affections.—Low-grade affections, or infections beginning with a slow, insidious onset, run a course which is very indefinite, often attended by acute exacerbations, and even relapse after remaining quiescent for a period of years. Tuberculosis is the outstanding member of this group.

Traumatic Affections.—Traumatic affections follow a definite injury, as direct violence, sprains or fractures into the joint, or repeated slight injuries, which may render the joint more or less impaired, by inducing an acute or persistent arthritis.

Blood Dyscrasias.—Blood dyscrasias, as hemophilia, may cause, with or without slight injury, hemorrhage with extravasation of blood into the joint, which may induce extensive reaction and organization.

Neoplasms.—Neoplasms, benign or malignant, do not often primarily involve the joint, but usually invade by continuity from without.

II. Affections of Bones.—*Acute Affections or Infections.*—This condition arises as in joints, when there is a direct or indirect invasion of bone by purulent organisms. It is evidenced by characteristic local and constitutional symptoms, as in osteomyelitis.

Low-Grade Affections.—The same type may occur in bones as in joints, as above described. The symptoms, course and prognosis, however, are quite different.

Traumatic Affections.—Direct injury or violence may induce a simple contusion of the periosteum or superficial bone, or may cause a break in continuity—a fracture. Trauma may also be the predisposing factor in different and more serious pathological processes, which cannot be classed as traumatic.

Nutritional Disorders.—Very definite changes in the quality and contour of bones may arise from deficient or improper nutrition, as evidenced by such affections as rachitis and osteomalacia.

Disorders of Internal Secretion.—There are certain manifestations in the bones, as demonstrated by the roentgenogram, of deficiencies of the ductless glands, as the thyroid and pituitary, which are significant from a diagnostic point of view. The pituitary gland is held responsible for that rare affection known as acromegaly, and allied conditions.

Neoplasms.—Neoplasms, benign and malignant, of mesoblastic or connective-tissue origin, may occur in bone. They form, as will later be demonstrated, a most important group.

Congenital Deficiencies.—Congenital deficiencies in quality of bone are conditions in which some element in the bone is deficient, as manifested by defective quality in such affections as fragilitas ossium, or fragile bones.

III. **Affections of Epiphyses.**—Abnormal processes occur in certain epiphyses. They are demonstrable by the roentgenogram and manifest clinically definite symptoms and physical signs. Opinions vary as to the etiology, though it is suggestive of trauma or infection.

IV. **Affections of the Soft Tissues.**—Certain clinical entities occur, which may impair function or induce deformity from affections of the soft parts, as muscles, tendons, ligaments, fasciæ, bursæ and skin.

V. **Affections of the Nervous System.**—There are certain affections of the central and peripheral nervous system of common occurrence and of especial orthopedic significance, which impair function and cause deformity, notably: poliomyelitis or infantile paralysis, hemiplegia, spastic paralysis, and traumatic injuries to the peripheral nerves.

VI. **Static or Postural Affections.**—These conditions are purely mechanical. There is faulty posture or balance, which produces definite symptoms, impairment of function and deformity. For example, flat-foot, round shoulders, lateral curvature, etc.

VII. **Congenital Anomalies.**—This large group includes all the deficiencies, malpositions and deformities due to embryological, mechanical or other prenatal influences *in utero*, as illustrated by such well-known abnormalities as club-foot, wry-neck, and congenital dislocation of the hip.

CHAPTER IV

ACUTE JOINT AFFECTIONS

ACUTE INFECTIOUS ARTHRITIS

Acute infectious arthritis is an acute inflammatory process, due to the invasion of a joint by any of the pyogenic organisms—the staphylococcus, streptococcus, pneumococcus, gonococcus, meningococcus. The arthritis may arise from direct infection, as by a stab wound, or continuity from adjacent infections, but more frequently through the blood stream from distant foci, as tonsils, teeth, genito-urinary tract, furuncle of the skin, etc. Acute arthritis is also often a complication or sequela of acute infectious diseases, such as scarlet fever, whooping-cough, pneumonia or typhoid fever. The distribution may be confined to one joint, a monarticular infection; or two or more joints, a polyarticular infection.

The general impression prevails that tuberculosis is more frequently a causative factor in orthopedic affections than pyogenic organisms. However, careful investigation of a large series of cases in the author's clinic has shown that there were 723 of pyogenic bone affections and 374 of tuberculosis, the ratio being over two to one.

Pathology.—The pyogenic organisms induce an acute reaction, which is evidenced by the formation within the joint of an effusion which may be serous, seropurulent or purulent, depending upon the virulency of the infection and the resistance of the tissues. The pathologic changes are those of an acute inflammatory process, an active hyperemia of the synovia and intra-articular structures, with infiltration which is usually limited by the capsule, but may extend to the periarticular tissues. If virulent, necrosis ensues, with adhesions and fibrosis which may terminate in further organization into tough fibrous tissue, fibrocartilage or solid bone. In serous exudates there is rarely extensive destruction, and the joint usually returns to normal. In seropurulent exudates, the process is more severe and may result in extensive adhesions of articular surfaces. In purulent exudates, especially if virulent, as evidenced by formation of thick pus, the articular structures may be completely destroyed. In the exudate of pyogenic organisms is found a proteolytic ferment or enzyme which has a selective and digestive action on the cartilage and synovia. The cartilage is usually first invaded at the point of greatest contact; this invasion may progress until the entire articular surface is effaced. In children, the bone is invaded for a greater

distance than in adults, due probably to the inherent difference in structural quality. Sequestration rarely occurs unless an adjacent osteomyelitis invades by continuity, except in those joints in which the capsule includes a large area of adjacent bone. Partial or complete obliteration of the epiphyses is not uncommon. If partial, future growth will be irregular; if complete, growth is arrested, but may be compensated to some extent by hyperactivity of other epiphyses in the affected extremity. With subsidence of the process, there may be a return to normal or the joint may be more or less impaired. Under eight years of age, fibrous ankylosis is usual, bony ankylosis being very rare. Above this age, bony ankylosis occurs with increasing frequency directly as the age advances. Contractures of ligaments and peri-articular structures, with malposition, distortion, subluxation or complete dislocation, are of frequent occurrence in neglected cases.

Symptoms.—The intensity of the constitutional and local reaction depends on the virulency of the infection and the resistance of the individual. The onset is sudden, a chill or convulsion may be the first symptom, or rarely slight soreness or pain may have existed for a few days. A history of trauma is often elicited, but is more frequently a coincidence than a predisposing factor. The temperature is elevated and usually high. The affected joint is enlarged by increase in articular fluid. Fluctuation, local heat and redness are apparent in superficial joints, such as the knee. Tenderness is exquisite, being often exaggerated at one or more points. The joint is held in the most comfortable attitude, which may be termed the neutral position, that is, the point where articular pressure is least and muscle relaxation greatest. Unfortunately, the neutral position is usually flexion, or flexion combined with some other position. For example, in the hip, flexion may be combined with abduction and external rotation, which, if permanent, is a serious disability. Active motion is restricted, and may not be possible on account of pain. Passive motion is usually possible but limited. The symptoms may be confined to one joint, or may successively appear in many joints in polyarticular invasion, but the same degree of intensity of the process is rarely concurrent, some of the joints being more severely affected than others.

The clinical course is definite and may be divided into three epochs: (1) the febrile or acute stage, lasting from four to eight weeks; (2) the subacute, in which there is pain and tenderness persisting for several months, or very rarely, indefinitely, with progressive invasion of other joints; (3) the stage of residual impairment, which in reality is the end-result after the termination of the pathological process, when permanent defect in function, ankylosis, malpositions and dislocations may be observed. The problem at this stage is purely one of surgical mechanics and not pathology. When there is a resolution of the pathological process with a return to normal, the third stage is never reached.

Laboratory and X-Ray Observations.—In the febrile stage, the blood shows the characteristic reaction of an acute infection, by an increase in total white cells and a relative increase in neutrophils. The roentgenograms for two or three weeks after onset furnish no information that cannot be detected by physical examination. The first apparent sign is a mottling of the bone, as evidenced by irregular light and dark areas for a short distance beneath the articular cartilage. Later, unless the process is arrested, there will be a gradual decrease in width of joint space. After further destruction, obliteration with adhesion of articular surfaces may occur, denoted by a line of cleavage in a fibrous ankylosis; or there may result osseous fusion,—a solid bony ankylosis. Complete dislocation, especially of the hip-joint from distention of the capsule, may be a rather early manifestation. Atrophic changes may be seen in the shaft of the bone for a considerable distance during the subacute stage. There may also be osteomyelitis with definite periosteal proliferation, but sequestra are rarely apparent. Coincidentally with resolution there will be a gradual increase in density, and at times in dimensions of the bones, which give a massive clear-cut appearance that is often permanent.

Diagnosis.—In the acute stage, the diagnosis is apparent from symptoms. If, in the subacute stage, the process is polyarticular, there may be a close resemblance to low-grade infectious arthritis and arthritis deformans of childhood, which is known as Still's disease. In the former, differentiation can be made from the history of the onset; in the latter, from the history and hypertrophy of the lymphatic system, especially the spleen in Still's disease.

In the subacute stage of monarticular arthritis, the erroneous diagnosis of tuberculosis is far too frequently made, with the employment of measures which are often contra-indicated and deleterious. This is probably due to the prevailing opinion that a debilitated condition is found in joint tuberculosis from the onset, when, in fact, the general health at this time is usually excellent; whereas, after the acute stage of an acute infectious arthritis, there is always evidence of a recent severe illness. The history alone should exclude tuberculosis, but if not obtainable, the x-ray will clearly differentiate. In infectious arthritis, the roentgenogram reveals a mottling of bone in proximity to the joint, with destructive changes from within. This is unmistakable at the end of six weeks; whereas, in tuberculosis, at the end of six weeks and often as long as six months, there may be no manifestations visible in the roentgenogram except general atrophy. In tuberculosis, when destruction is observed, the process is active beneath the encrusting cartilage, which appears to be undermined from without.

After the stage of residual impairment, the diagnosis may be difficult, for the active process may have occurred so early in life that no detailed account can be secured. At this time it is most important that the cause be

determined, and that differentiation from tuberculosis be made, for when tuberculosis has been the etiological factor, surgical measures within the joint must be avoided if possible, though mechanical advantage might be gained thereby. But if the etiological factor has been one of the pyogenic organisms, radical surgery within the joint, when indicated, may be employed with impunity. If the history is not dependable, the roentgenogram is the only source of information, for the residual malpositions and defor-

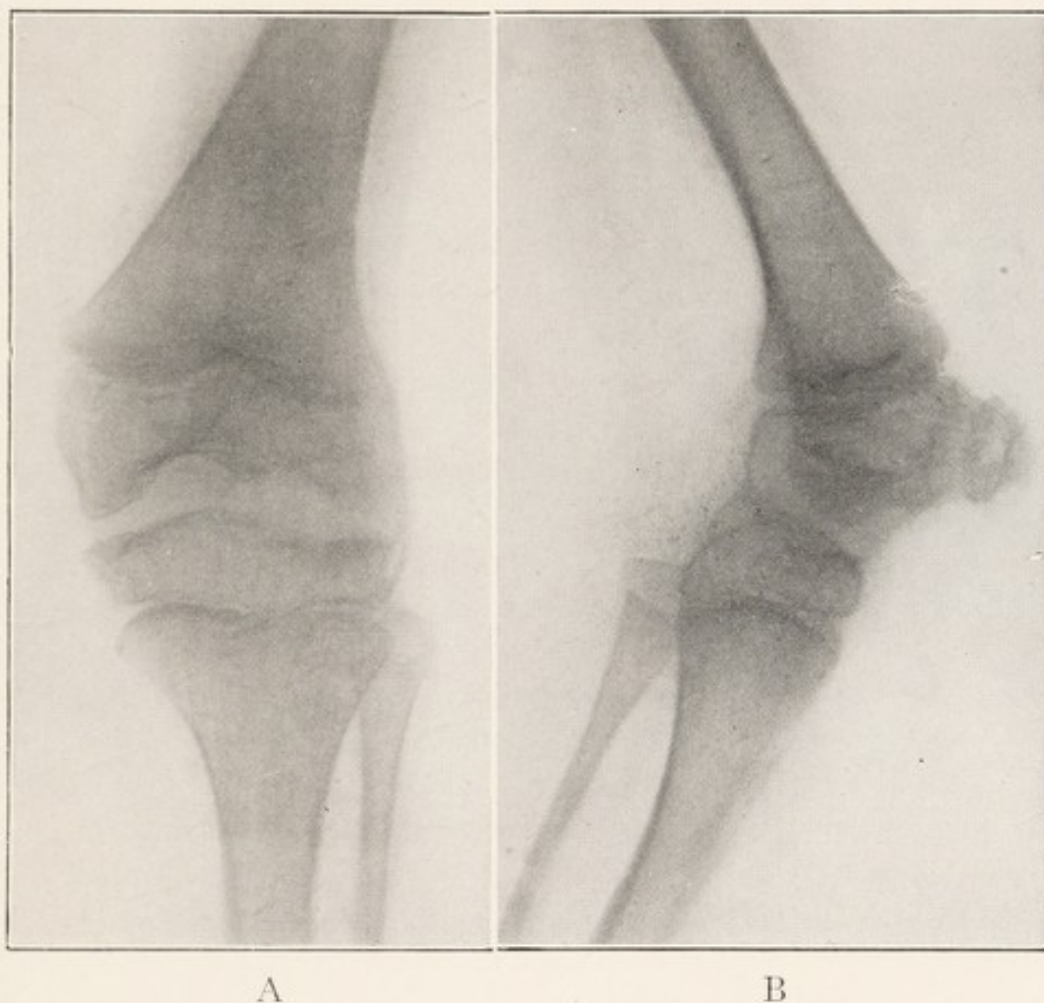


FIG. 51-A.—X-RAY SHOWING ACUTE INFECTIOUS ARTHRITIS OF KNEE, LATE STAGE, ANTEROPOSTERIOR VIEW.

FIG. 51-B.—SAME AS FIGURE 51-A, LATERAL VIEW.

mities of acute infectious arthritis and tuberculosis are practically identical in appearance. In tuberculosis not contaminated by secondary infection, differentiation by the roentgenogram is not difficult. Atrophy is more extensive with slight or no hypertrophic changes, and the joint line is usually visible by a dark zone designating an area of former destruction or encapsulated tuberculous detritus. When infectious arthritis has been the causative agent, there is slight, if any atrophy. Hypertrophy with increase in density and definition, and complete loss of bone space with organization and solid bony fusion are not uncommon. In those in whom tuberculosis has been

contaminated by a secondary pyogenic infection, an accurate diagnosis may be impossible; but differentiation may be made in a high percentage of such cases by the roentgenogram alone, when visualization of each condition has been acquired by practical experience.

Prognosis.—The prognosis in the acute stage depends on the intensity and distribution of the infection as indicated by the character of the effusion and the number of joints involved, and also upon the treatment employed. There is no affection in which the result is more favorably influenced by the proper measures, especially if instituted early, even though the infection

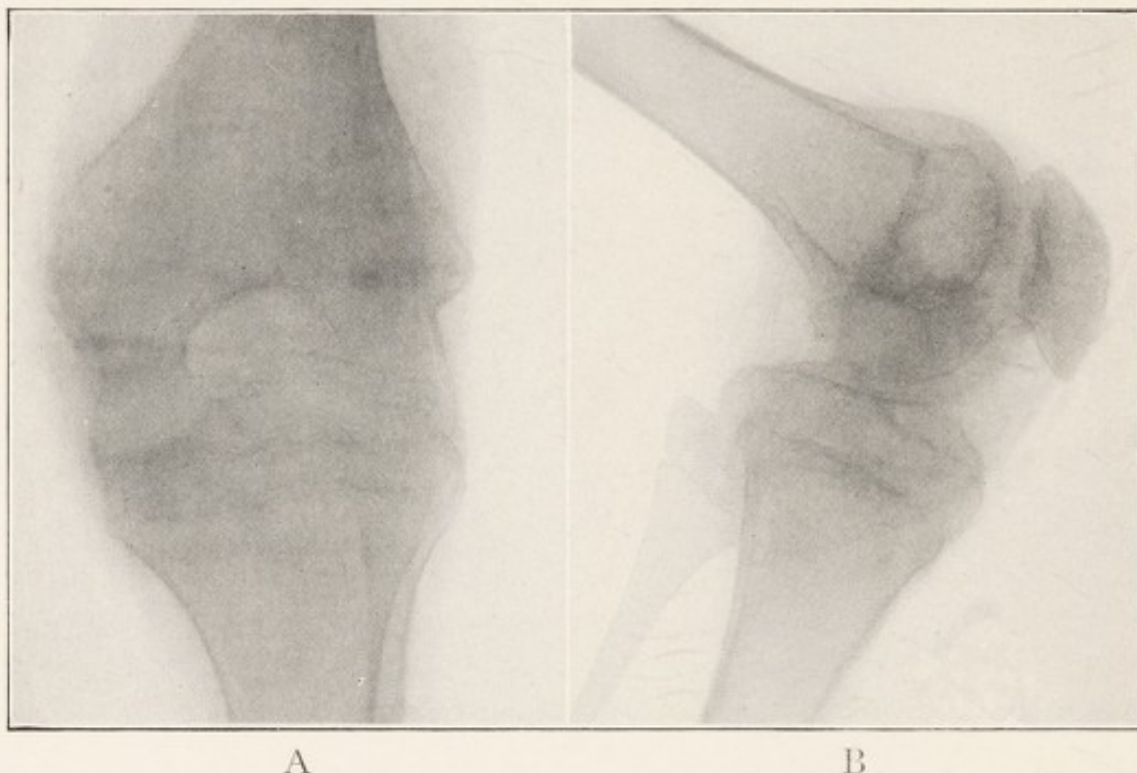


FIG. 52-A.—X-RAY SHOWING TUBERCULOSIS OF KNEE, LATE STAGE, ANTERO-POSTERIOR VIEW.

FIG. 52-B.—SAME AS FIGURE 52-A, LATERAL VIEW.

is virulent. The average results, however, are far from satisfactory, due largely to inefficient treatment, as indicated by a large percentage that terminate in malpositions and ankylosis. If the effusion is serous, complete resolution may be expected; if seropurulent or serofibrous, destructive changes more often occur, which may result in impairment of function by fibrous ankylosis or malposition. If purulent or suppurative, there is a still greater degree of destruction with frequent loss of function, or death may ensue as a result of sepsis. In the subacute state, the salvage of the joint depends on the extent of destruction by the infection, which is subsiding. In the stage of residual impairment, function may be restored to a large degree by mechanical and surgical measures.

Treatment.—A careful search should also be made for foci of infection, but the eradication of such foci rarely has any beneficial effect on the

pathological process after it is well inaugurated. When the acute symptoms have subsided, the focus should be removed in order to prevent recurrence of the infection in other joints and organs of the body. A discussion of the problem of focal infection will be found on page 106.

The local treatment is as essentially surgical as in appendicitis or osteomyelitis. The constitutional treatment is the same in acute infectious arthritis as in any acute infectious process and requires no elaboration. Salicylates are of doubtful but reputed value. The intravenous injection of various drugs has been employed from time to time in sepsis, but recently success has been reported by intravenous injection of 0.05 mg. mercurochrome, or gentian violet, per kilogram of body weight. However, such measures cannot be employed unless the indications, contra-indications and technic of administration are well known. Locally heat or cold may be applied, with probably more comfort than actual benefit to the patient. Aspiration should be employed in every case to determine the nature of the effusion. Distention must at all times be reduced by aspiration. If serous, aspiration must be repeated when distention recurs, or exacerbations of symptoms indicate. After the withdrawal of 10 or 20 c.c. of joint fluid, 2 per cent solution of formalin in glycerin, as advocated by John B. Murphy, may be injected. This solution should be prepared twenty-four hours or more before injection. If no improvement occurs after twenty-four or forty-eight hours, or if there is re-accumulation of fluid, repeated injections may be required. In conjunction, continuous traction is always employed. If seropurulent, copious irrigation of the joint with any sterile non-irritating solution, as normal salt or methylene-blue, is of value and may be repeated should the symptoms not be relieved in forty-eight hours. Irrigation is accomplished by the introduction of two small trocars and cannulas, one of which may be attached by rubber tubing to a 1-gallon douche can. Care much be exercised that the solution and all apparatus are sterile.

In purulent or suppurative effusions, the only rational treatment is efficient drainage, which is obviously an equation for each joint. Rubber tubes, gauze or other materials should not, except in extreme sepsis, be inserted into a joint, but only down to the joint. Strips of gauze bandage impregnated with vaselin usually answer all purposes. Active motion as advocated by Willems is a valuable adjunct, not only to prevent impairment of function, but also to render drainage more efficient. This, however, is impractical unless the patient can be under constant observation of a surgeon with the aid of an efficient corps of nurses. In young children, the method is impossible; in older children, difficult, and in the average private home, out of the question. In gunshot wounds of joints, this measure has been found especially effective. The technic consists first, of efficient drainage by incision, after which active motion is carried out for a few minutes at

intervals of one hour. The range of motion is gradually increased, but not to such an extent as to induce pain or inflammatory reaction. No passive motion should be attempted.

Orthopedic measures are indicated in all cases, the keynote of success being the prevention of deformity or malposition; otherwise, the affected joint or joints may be rendered useless with partial or total disability, though a fair range of active motion may remain. For example, if the result in one knee permits a range of 30 or 40 degrees' motion, but is in the flexed position and extension cannot be acquired beyond 90 degrees' flexion, walking is only possible by an extreme limp, a peg leg or crutches. Should both knees become so affected, the individual crawls on the knees or remains confined to a rolling chair. Conversely, if the knees are retained in the extended position, and 30 or 40 degrees' active motion remains, walking may be accomplished without difficulty, and the range of motion is always increased automatically by active use. Atrophy of bone structure is also prevented with a return to normal strength. Each joint is an individual equation and must be maintained in that position in which function will be most useful from the mechanical standpoint of the part involved. Should malposition exist when the patient is first observed, gradual correction must be obtained by simple splints or extension. (In the knee and hip, extension by weight and pulley should be routine.) A detailed description of mechanical apparatus for prevention and correction of deformities has been given in Chapter II. If actual dislocation is present, reduction can often be accomplished without force after drainage, and can be maintained by suitable apparatus.

In the subacute stage, the process is one of resolution and organization; therefore no injections or other treatment to the interior of the joint can be of the slightest value, and in fact are positively contra-indicated. However, function may yet be restored in many instances by rational procedures. If malposition exists, correction must be gradually effected by apparatus. The joint must be maintained in the most useful position by absolute fixation until there is a complete cessation of pain and acute inflammatory reaction, at which time passive motion is instituted by the patient or attendant. Special splints are required with joints arranged to lock at any angle desired, and after each exercise must be locked in the most useful position to prevent disability from malposition should ankylosis occur. Passive motion is facilitated by means of overhead slings and pulleys, which can be operated by any five-year-old child. No active motion is attainable until tenderness has subsided, but should be encouraged as soon as possible. If there should be a return of acute symptoms, indicated by pain and increased swelling, rest for at least two weeks is indicated before mobilization is again attempted. In early childhood, coöperation is impossible; in consequence, efficient fixation should be continued throughout. Ankylosis is, fortu-

nately, uncommon in early childhood on account of the preponderance of cartilage. Fixation should not be discontinued until the patient is able to maintain the joint in the most useful position by his own volition, or ankylosis is firm and painless. Disposal of fixation apparatus should be gradual, beginning with short intervals, which are increased daily, for malformation is possible as a late complication.

Under no circumstances should forcible passive motion, so-called *brisement forcé*, be employed, either with or without anesthesia. Unfortunately, such practices are very common but capable of producing serious damage. Adhesions are more resistant than bony structure, and gross fractures, crush-

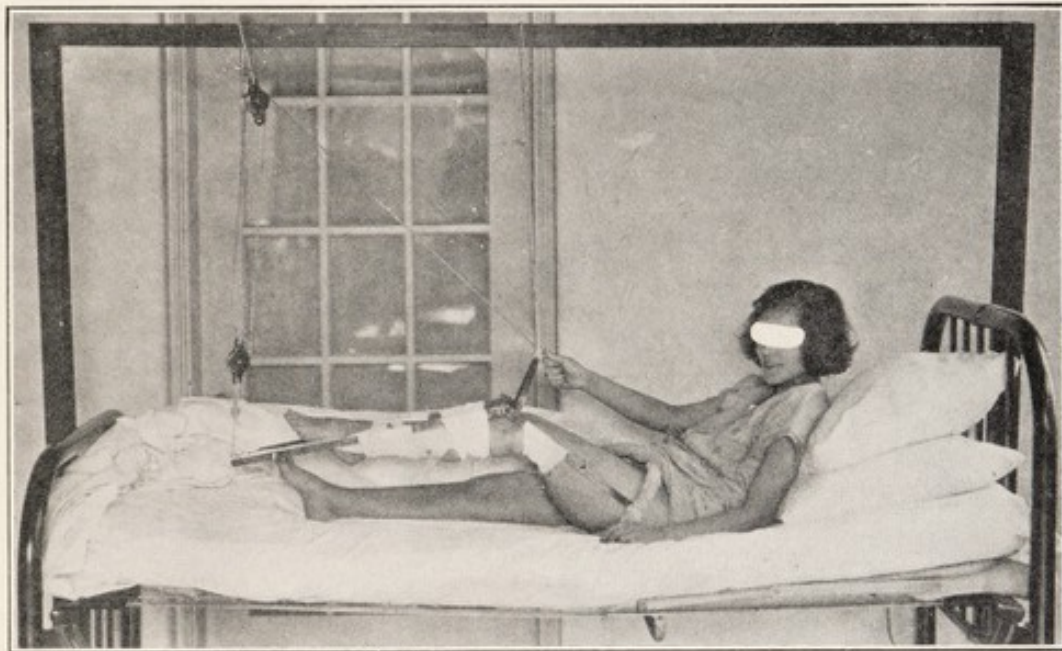


FIG. 53.—PHOTOGRAPH SHOWING METHOD OF INSTITUTING PASSIVE MOTION IN KNEE-JOINT BY MODIFIED THOMAS KNEE SPLINT AND OVERHEAD SLING.

ing of atrophic extremities of the bones and violent reaction within the joint, followed by further organization and stronger adhesions may result. There is no counterpart to *brisement forcé* in the treatment of inflammatory conditions elsewhere in the body—for example, no physician would advise forced feeding in the subacute stage of an acute enteritis.

Physiotherapy is a most valuable adjunct, but must be continuously and carefully administered by an expert who appreciates that the restoration of function can be accomplished only by gently applied force and never by sudden and violent movements.

In the stage of residual impairment, the active process having ceased from one to many years, the condition is a status, not a pathological entity, just as is the scar of an ancient burn. The problem is purely mechanical, often requiring extensive surgical procedures and various appliances for the correction of deformity and malposition. Even at this late stage, except in those with wide distribution and extensive involvement, material improve-

ment may be secured. When bony ankylosis is encountered in children, function cannot be restored by the reconstruction of a new joint, so-called arthroplasty, as in the adult, for such procedures might necessitate the invasion of the epiphyses; besides, coöperation in the essential after-treatment is not easily obtained. However, if the part is held in the most useful position with no retardation of growth, such measures may be anticipated in certain joints when maturity is reached.

In conclusion, too strong emphasis cannot be given to the importance of the prevention and correction of malposition and deformity from the onset and throughout the entire course of acute infectious arthritis.

The above discussion covers the subject as a whole, but there are certain problems of each joint which require detailed description.

The Ankle and Foot.—Fluctuation in the early stage of an acute infectious arthritis is elicited with difficulty in the ankle, though the bony contour may be more or less obliterated. Local heat is apparent early. Aspiration is made on the anterolateral aspect about one-half inch above the level of the external malleolus, at which point there can be no injury to vessels or nerves or subsequent infection of tendon sheaths. Drainage is accomplished in many instances by the anterolateral incisions, but at times an inner lateral and posterolateral incision is required to drain the inner and posterior compartments. The foot must be held constantly at a right angle to the leg by simple splint or bivalved plaster cast, or permanent equinus may result. If the tarsus is affected, the foot is held by a bivalved plaster cast in slight varus when the tendency of contracture is valgus, and slight valgus if the tendency is varus. A simple steel arch support, as described in the treatment of flat-foot, is valuable and essential in after-treatment. This should be worn until the bone has regained normal structure and resistance, as indicated by the roentgenogram. Dorsal flexion of the metatarso-phalangeal and phalangeal joints is often a sequela and throws the weight of the body on the heads of the metatarsals, causing painful callosities. Claw-toes, as this malposition is called, can be prevented if recognized early, by a digitated metal splint; or passive plantar flexion of the toes four or five times a day may be sufficient. So soon as walking is feasible, pads of felt are placed beneath the ball of the foot and retained by adhesive plaster. This not only relieves pressure, but induces plantar flexion of the toes. Later, a durable appliance with elevation under the ball of the foot may be placed into the shoe if dorsiflexion of the toes persists. In the subacute stage, deformity can often be gradually corrected by successive plaster casts, or a special apparatus. In the stage of residual deformity, operative measures are usually indicated, as lengthening of the contracted tendo achillis by the "Z" plastic method, described on page 228. Tarsal deformity can often be corrected by forcible manipulation, though a wedge-shaped tarsectomy may occasionally be necessary. In children, conservative operations only,

as tenotomies and fasciotomies, are indicated for contractures of the toes, radical resection being reserved until full growth is attained.

The Knee.—Signs of an acute inflammatory process are accentuated, as the knee is a large and superficial joint. The knee becomes flexed about 30 degrees. Fluid within the joint ranges in amount from complete distention to slight fluctuation. Local heat is increased. Aspiration is accomplished from either the anterolateral or anteromedial aspect of the joint on the level with the patella. Trocar and cannula are inserted with ease for irrigation. Drainage is best accomplished by longitudinal incisions on both sides of the patella. Though the most dependent point is from the posterior aspect, this route is inaccessible on account of the large vessels, but, fortunately, is rarely necessary. Regardless of the treatment instituted, complete extension is the position of choice. Flexion must be constantly prevented by efficient splinting and traction, such as Buck's extension.

In the subacute stage, flexion, if present, can be corrected occasionally in mild contractures by ordinary Buck's extension, but very close attention must be given to prevent subluxation of the tibia. The best and safest method is by a type of appliance routinely employed by the author, which gradually extends the knee, while pressure is made on the anterior surface of the thigh and posterior surface of the leg to prevent subluxation. When extension is complete, a brace is

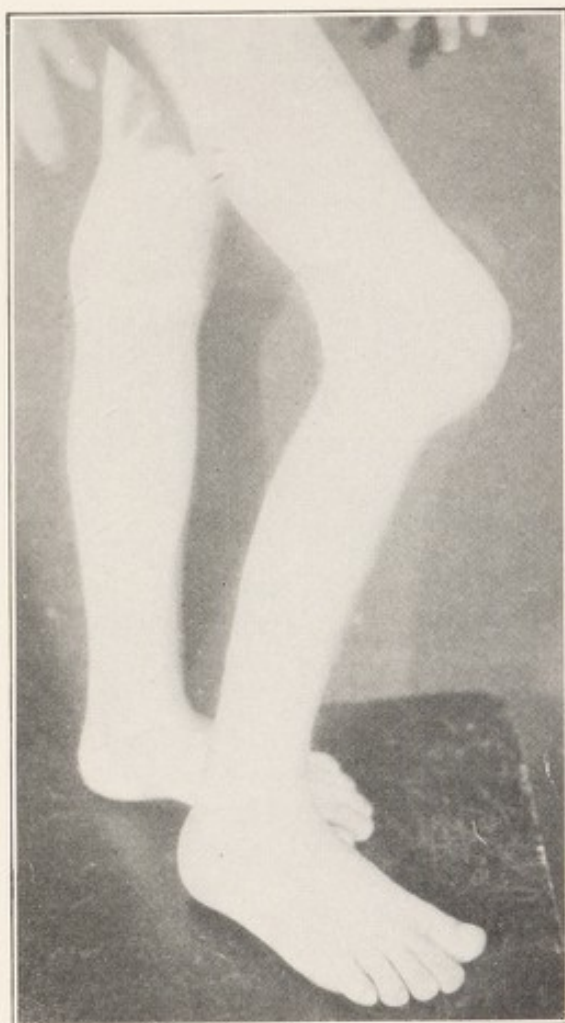


FIG. 54.—PHOTOGRAPH SHOWING SWELLING OF KNEE AND FLEXION DEFORMITY IN ACUTE ARTHRITIS.

applied to maintain the knee in the extended position. In the stage of residual deformity, if free motion persists even to a few degrees, the same type of apparatus may correct deformity by making the limb straight. In the extended position function may be so materially increased as to give a practical range for walking, the very act of which increases the range of motion. Plaster casts, the Thomas caliper brace, with and without joints at the knee, are employed to prevent flexion and to permit weight-bearing.

In the residual, as in the subacute stage, deformity may often be corrected by special appliances previously mentioned. After the maximal amount

of correction has been obtained in this way, surgery is often indicated, and in some, correction may be accomplished by surgery without the previous use of apparatus. Most excellent results are obtained in this type of deformity; and there is no reason for any individual to go through life with a deformed knee on which walking is difficult or impossible.

The Hip-Joint.—The hip-joint is held in flexion or flexion with abduction and external rotation. As the joint is deep seated, swelling, fluctuation, or local heat is not apparent as an early sign. Tenderness can be elicited about the joint, which is often accentuated by pressure over the trochanter, especially if osteomyelitis is associated. As the capsule of the

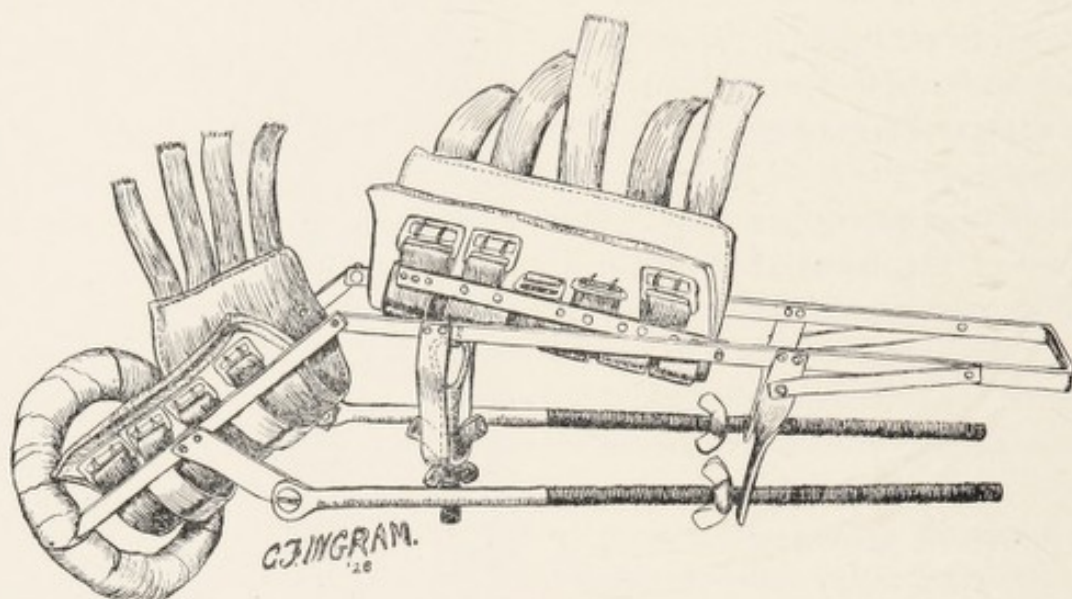


FIG. 55.—DRAWING OF CAMPBELL-MITCHNER KNEE SPLINT FOR CORRECTION OF FLEXION DEFORMITY OF KNEE.

hip embraces and encloses within the joint a large portion of the neck of the femur, osteomyelitis is of common occurrence. When distended, this wide distribution of the capsule also renders dislocation imminent and of frequent occurrence. Differentiation between acute infectious arthritis of the hip and psoas abscess may present some difficulty. In psoas abscess, there is often a large mass just about Poupart's ligament and motion is limited only in extension, whereas, in acute infectious arthritis of the hip-joint, there is no abnormal mass except as a late complication, and the hip is limited to some extent in all directions. Aspiration is rarely necessary, for the diagnosis can practically always be made by the constitutional symptoms and the local examination, but may be accomplished by inserting a large needle anterior to the greater trochanter, and upward and inward, parallel with the neck of the femur.

Incision and drainage are imperative just as soon as the diagnosis is made, not only to relieve purulent tension, but to prevent dislocation and to limit osteomyelitis. The lateral or posterior route may be selected, as indicated

by the distention of the capsule. A large drainage tube is inserted down to but not within the joint, after which symptoms usually subside. The hip-joint must be maintained constantly in line with the body in the recumbent position and on a firm surface, which is most efficiently accomplished by a Bradford frame of double width with Buck's extension, as described on page 34. The pulley must be so arranged as to make traction in abduction of about 20 degrees, and sand bags are placed along the

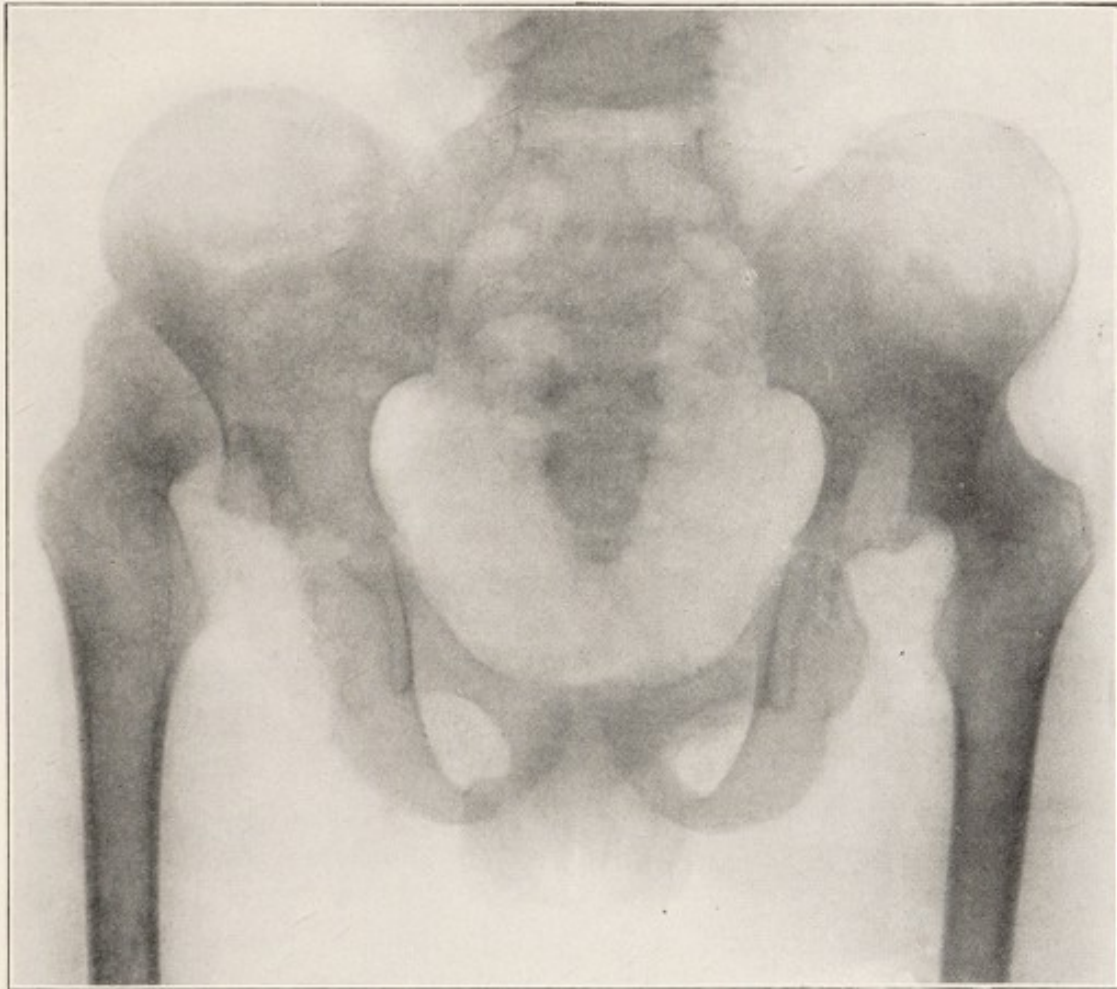


FIG. 56.—X-RAY SHOWING BILATERAL DISLOCATION OF HIPs RESULTING FROM ACUTE INFECTIOUS ARTHRITIS.

Note destructive changes in acetabula.

outer side of the lower extremity of the affected side to prevent outward rotation by gravity. Weight of 5 to 10 pounds is usually sufficient in children to relieve pain and muscle spasm. Too great emphasis cannot be placed on retaining the child constantly in the recumbent position, for if the sitting posture is assumed, permanent flexion from joint adhesions and periarticular contractures are an imminent danger. As soon as pain and tenderness subside, passive and active motion is encouraged by a sling and overhead pulley. If there is extensive destruction with impending ankylosis, fixation by a long plaster spica from nipple line to toes is advisable, or the Thomas hip splint may be employed. As there is a ten-

dency to flexion and adduction for several months, preventive mechanical measures, such as braces, are indicated for a long period of time. When atrophy or disintegration is apparent, weight-bearing should be controlled by the Bradford abduction, or the Thomas knee or caliper brace.

ACUTE INFECTIOUS SPONDYLITIS

Acute infectious spondylitis is far more frequent than might be presumed from the space occupied in the literature, and in consequence is considered of sufficient importance by the author to warrant a separate description.

The onset, cause, clinical course and blood manifestations are identical with acute infectious arthritis (except when a sequela of typhoid fever). The spine may be primarily invaded or involved in a polyarticular arthritis. The process may affect only one intervertebral disk and adjacent vertebræ, or may be diffuse throughout the entire spine, or any part thereof. There may be an extensive infection of the cancellous bone of the bodies—an osteomyelitis which cannot be clinically differentiated from a local arthritis, except that sepsis is more pronounced.

Symptoms.—The symptoms are pain in the affected region and along the peripheral distribution of the spinal nerves. This is due to neuritis caused by irritation at the point of exit of the spinal nerves from the vertebral column. For example, when the dorsal spine is involved, pain may be referred to the abdomen. If the lumbar spine is affected, the psoas muscle often becomes irritated, causing a well-known entity, psoas contracture, which is evidenced by the hip becoming flexed, with inability to extend actively or passively, though all other movements of the hip-joint are free. This may be unilateral or bilateral. A psoas abscess may arise by continuity, as denoted by a tender mass in the lower abdominal quadrant just above Poupart's ligament, which usually signifies existing osteomyelitis. Acute infectious spondylitis may be a complication or sequela of any of the acute infectious diseases, notably typhoid fever. Typhoid spine is a well-known clinical entity, but is infrequent in children. It differs from the common pyogenic infections in that the onset is not so sudden, the constitutional symptoms are not so acute, and the clinical course is more indefinite. There is a history of a preceding attack of typhoid fever, and differentiation can also be made by blood examination. In typhoid, there is no increase in white cells, nor is the differential count significant, and the Widal reaction is positive.

In the subacute state of acute infectious spondylitis, the constitutional symptoms subside, but tenderness and muscular rigidity persist indefinitely. Deformity may occur if the process is diffuse, as a rounded kyphosis; or if confined to one or two vertebræ, prominence of a spinous process,

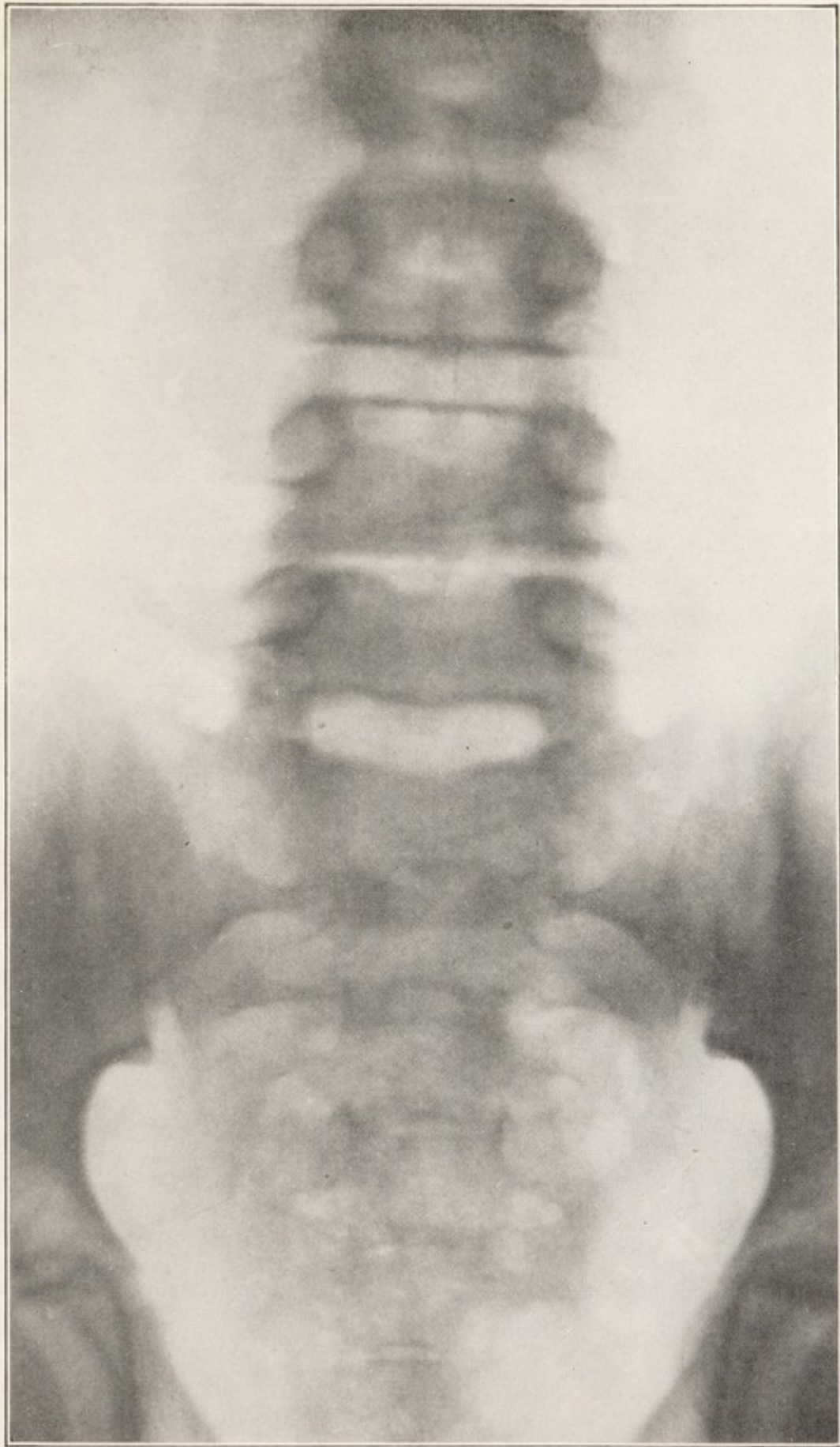


FIG. 57-A.—X-RAY SHOWING SUBACUTE INFECTIOUS SPONDYLITIS, WITH NARROWING OF INTERVERTEBRAL SPACE BETWEEN FOURTH AND FIFTH LUMBAR VERTEBRÆ, ANTEROPOSTERIOR VIEW.

a so-called "knuckle," is the first apparent sign. Deformity may be progressive, but rarely develops to an exaggerated degree, as the vertebral column is reënforced rapidly by bone production.

In the stage of residual impairment, the problem is entirely static. The symptoms are referable to faulty posture, although in all bone infections a recurrence is not uncommon many years after the initial infection. This recurrence may be induced by trauma, or retained dormant sequestra becoming active.

Roentgenogram.—As in acute infectious arthritis, there are no manifestations for several weeks. The first evidence is the characteristic mottling of the body of the vertebræ with a decrease in the width of the intervertebral space, until only a line of cleavage may be visible, or there may be a solid bony fusion. Coincidentally, the body of the vertebræ may become eroded or compressed. Eventually, osseous proliferation is apparent within and around the affected area. If the process is diffuse, there will be massive productive changes with areas of destruction and coalescence of vertebræ which are characteristic of an extensive osteomyelitis.

Diagnosis.—In the acute stage, the diagnosis is evident by the constitutional symptoms and local manifestations, but is frequently overlooked, as the examination of the spine is not a routine practice. When pain is referred to the abdomen in acute infectious spondylitis or other lesions of the dorsal spine, an acute inflammatory process as appendicitis is suggested. Unless the spinal symptoms are recognized, a serious error is often made and the patient subjected to a useless laparotomy. In the subacute stage, as in acute infectious arthritis, confusion with tuberculosis is too frequent. The distinction should be made from the history alone, but if this is not possible, the x-ray will differentiate. In tuberculosis, the symptoms exist for a much longer period before osseous destruction is apparent, and when evident, there is atrophy and destruction without proliferation. In the third, or stage of residual impairment, the deformity is not often so great as in tuberculosis and is rarely progressive. In fractures of the spine, there may be a slight resemblance which can also be differentiated by the history and x-ray.

Psoas abscess is also often mistaken for an acute infection of the hip-joint, but may be differentiated by a careful examination of the spine and hip. In psoas contracture, the spine is limited in all directions, but the hip is free except in extension, when tension is made on the psoas muscle, as demonstrated in Figure 19. When the hip-joint is invaded, motion is limited in all directions. There are also variations in points of tenderness, swelling, etc., as above described.

Prognosis.—In virulent infections, especially if there is an extensive osteomyelitis, death may ensue before an accurate diagnosis is made. Abscess from retained sequestra may arise months or years after the original



FIG. 57-B.—SAME AS FIGURE 57-A, LATERAL VIEW.

infection. In a large percentage, however, complete and permanent recovery may be expected without deformity or impairment of function if efficient measures are instituted early. Ankylosis, if not extensive, will be compensated by increased motion in the spine above and below the area involved.

Treatment.—In the acute stage, operative procedure is seldom required. If the constitutional symptoms are severe, pus may be located occasionally by aspiration, when incision and drainage are indicated. The patient should recline on a hard surface, as a Bradford frame. The spine is held in moderate hyperextension by felt pads or folded sheets or any non-resistant material under the affected region, as this position separates the vertebræ and prevents deformity. Body casts should not be applied until acute symptoms have subsided. Extension to both lower extremities, when the lower portion of the spine is involved, to the head when the upper portion, or to the head and lower extremities when the mid-region, may give great relief. Abscess, when well defined, should be opened and drained. Psoas abscess may be reached by incision in the outer aspect of the thigh just below Poupart's ligament, and blunt dissection beneath the ligament. Psoas abscess may also be drained through the lumbar muscles. These measures are continued into the subacute stage until pain and muscular rigidity decrease, when a plaster jacket or spinal brace commensurate with the region affected is applied and walking permitted. Fixation apparatus should be continued for six months to one year, or until the spine has attained sufficient strength to sustain the superincumbent weight. This can only be accurately demonstrated by the roentgenogram. When apparatus is discarded, there should be constant supervision by the mother and periodical examinations by the physician for another year. If there is permanent impairment, evidenced by ankylosis, compensatory motion can be developed by properly directed exercises, which, however, must not be given until several months after the cessation of acute symptoms. Should pain or other evidence of inflammation occur, the exercises should be discontinued for at least one month. Deformity and postural defects of the spine in the residual stage require corrective jackets and complicated apparatus which tax the ingenuity of the well-trained specialist.

The Shoulder Joint.—As the roentgenogram demonstrates a wide separation of the head of the humerus and glenoid cavity from distention, the diagnosis of dislocation is frequent with disastrous efforts to reduce. Radical measures are not indicated so frequently as in other joints, but if symptoms persist, drainage can be instituted on all sides. The position of choice is about 30 degrees' flexion, 45 abduction and slight internal rotation, and can be accomplished by the shoulder and humerus traction splint, described on page 43. Only slight traction is indicated and must be cautiously employed, for the joint is already distended. The prognosis

is unusually good in children, ankylosis in this joint rarely being observed. A return to normal function may be expected in a large percentage.

The Elbow.—As in the knee, symptoms and local physical signs are apparent in the elbow from the beginning of the process. Early drainage is indicated, by lateral or posterior incisions, but care should be taken not to injure important nerves. The joint space is so closely approximated that superficial changes often result in ankylosis. Besides, the wide attachment of the capsule renders the cavernous bone in the lower extremity of the humerus an easy prey to direct infection and a destructive osteomyelitis. A simple elbow splint which maintains the joint at an angle of 80 degrees meets all requirements as a fixation apparatus.

The Wrist and Hand.—The wrist is a rather loose joint, and, like the shoulder, does not require drainage so frequently as the elbow, though no time should be lost if a virulent infection exists. The most important consideration is to maintain dorsiflexion by the simple cock-up splint, to prevent the common deformity of subluxation and palmar flexion. The fingers must under no circumstances be maintained in the extended position. Flexion should be encouraged to permit approximation with the palm, which obviously increases the range of motion by inducing functional use. If first observed with the fingers rigid in the extended position, flexion with a return of function can often be gradually acquired by the application of special apparatus, as the reversed banjo splint. Tenosynovitis is a frequent and serious complication, and may cause permanent disability from adhesions of the tendons.

CHAPTER V

LOW-GRADE JOINT AFFECTIONS

In this class of joint affections, the onset is gradual and often insidious; rarely, however, the onset may be more or less acute. The course is long and indefinite. As the etiological factor has not been accepted for every entity of this class, the term "affection" is employed instead of "infection," though possibly pathogenic organisms may yet be demonstrated in all. As previously mentioned (p. 50), pyogenic infections are more frequently the causative agent in residual deformities than tuberculosis. The low-grade affections involving the joints are as follows:

1. Tuberculosis
2. Syphilis
3. Infectious arthritis
4. Osteochondritis—epiphysitis
5. Arthritis deformans (Still's disease)

TUBERCULOSIS

Tuberculosis is the most prevalent of the low-grade affections, but the other conditions are observed with sufficient frequency to warrant a careful differentiation. Tuberculosis is not a local but a constitutional disease. In children, an erroneous diagnosis of tuberculosis is far too frequent and often condemns the patient to unnecessary and long-continued treatment, or is the means of instigating false reports when some other milder process exists. Therefore, reliable and authentic correlation of statistics of tuberculous joints is rare.

The evolution of the process in each joint is a separate equation, but as there are many features common to all, a preliminary discussion of tuberculosis of joints in general is essential.

Etiology.—The etiological factor is the bacillus of tuberculosis. There are two types which affect joints, the bovine and the human. The differentiation is of no practical importance, as the treatment and prognosis are the same in both. Trauma of a severe nature is rarely, if ever, followed by tuberculosis, though mild trauma is an accepted predisposing cause. However, this must not be taken too seriously, as the tendency exists to attribute all lameness in children to remote injuries, and every normal child is daily subjected to falls and blows while at play. Heredi-

tary transmission can almost be excluded, and in most instances, when suspected, a history will reveal the probability of direct infection by some member of the family. The tendency to tuberculosis is said to be inherited, but children with weak parentage are more susceptible to any infection.

Tuberculosis occurs more frequently in early childhood, between the ages of three and five, while below two it is very rare. The spine is affected more often than any other part; next in frequency, respectively, the hip, the knee, and the ankle. The joints of the upper extremity are much less often involved, tuberculous shoulder joints being of exceedingly rare occurrence.

Pathology.—The infection is derived from a distant focus, usually the bronchial glands, though active pulmonary tuberculosis is very rarely

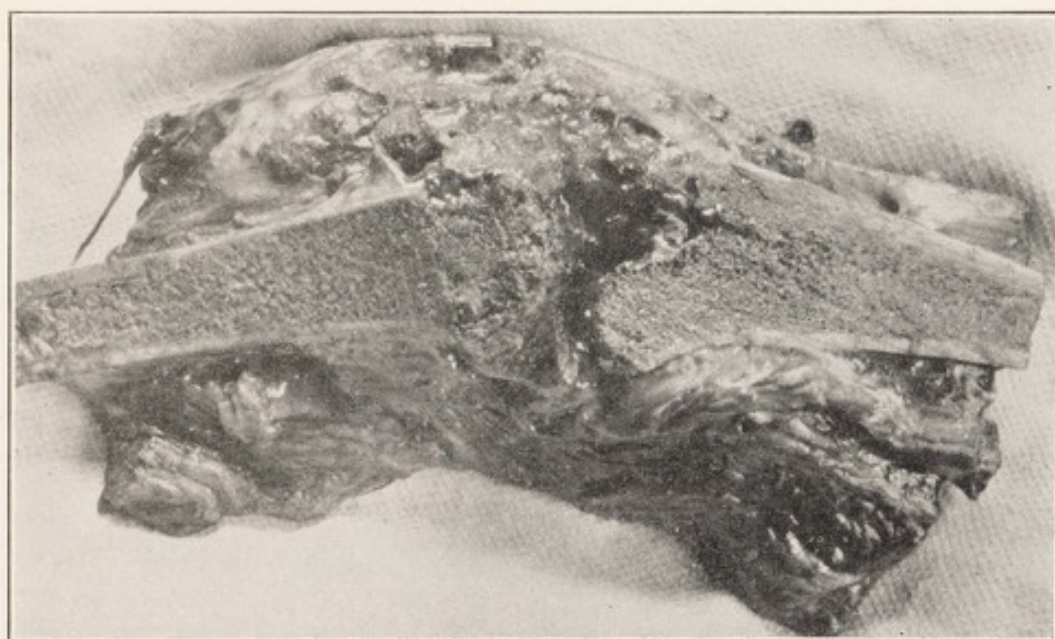


FIG. 58.—CROSS SECTION OF TUBERCULOSIS OF KNEE, SHOWING DESTRUCTION OF BONE BENEATH ARTICULAR CARTILAGE OF TIBIA AND OF ARTICULAR SURFACE OF FEMUR.

associated in children. The pathological process usually begins in the bone just external to the epiphysis, in the vascular area known as the metaphysis, though primary synovial infection is observed occasionally. Sympathetic inflammatory changes in the adjacent joint are coincident with the infection in the bone. The process is one of destruction and atrophy without proliferative reaction, except as a late manifestation or when arrested. The joint is invaded from without, the articular surfaces being undermined. Therefore, a long period may elapse before the encrusting cartilage is affected. The joint surfaces become gradually eroded and destroyed and often there is a change in relation, with malposition, subluxation, or complete dislocation. Abscesses filled with tuberculous pus and detritus are often a complication, and only rarely become encapsulated and rendered innocuous. As the process subsides, there is proliferation of new bone in

the affected area, but the structure is more dense and irregular than normal. Bony ankylosis is more frequent in some joints than in others, though fibrous ankylosis is more often observed. The infection is rarely entirely eradicated, though all clinical evidence may disappear. Latent foci are usually encapsulated and capable of "relighting" into an active infection if disturbed. Secondary infection with pyogenic organisms is frequent, engrafting and amalgamating an acute proliferative infectious process with tuberculosis.

Symptoms.—The clinical course is locally as follows:

- A. Onset gradual and insidious.
- B. Pain local in peripheral joints, elbow, ankle, etc.; referred in proximal joints, as the spine, hips and shoulders.
- C. Reflex muscular spasms limiting motion and causing malposition or peculiar attitude in the early stages.
- D. Swelling, with no fluctuation, but increase in thickness of capsule with lobulated masses, palpable within the joint except when the joint is primarily involved, causing a typical synovitis with increase in joint fluid.
- E. As the process advances, deformity, in addition to malposition, will be observed unless prevented.
- F. The process is usually confined to one joint.

Constitutional symptoms may not be apparent in the early stage, though a slight rise in temperature is always present. When the process is very acute, as indicated by the symptoms, the afternoon temperature may rise as high as 102° F. Failure of early diagnosis of a tuberculous process is often due to the fact that night-sweats and other symptoms of sepsis are expected; as a matter of fact, these do not occur except as late complications, usually after months or years, from secondary infection.

Diagnosis.—The diagnosis must be made largely from the symptoms, though there are several clinical observations of value. The blood examination gives no definite information, except to differentiate from acute infection. There is no increase or relative change in the white blood-cells of diagnostic importance.

X-Ray Examination.—The roentgenogram is of little, if any, value until there has been a definite change in the bone structure, which may require many months. The articular contour remains normal for a long period of time, and the only variation is that atrophy may occur early, as demonstrated by general loss of bone density or paleness of the x-ray as compared to the opposite joint. But even this is of slight significance only, as there are many tricks of photography which may influence the detail of a picture. However, as the evolution of the process advances, gross and typical manifestations of destruction and atrophy are quite evident.

Tuberculin Test.—The tuberculin test is of more significance if negative. The von Pirquet skin reaction is the method of choice, but it can only be regarded at best as suggestive, and by no means conclusive, evidence. The subcutaneous injection test is dangerous and should not be employed. Definite proof in the early stage of a tuberculous joint is best obtained by biopsy, or the excision of a specimen for examination, but this cannot be well carried out in such joints as the hip and spine. This measure, however, is not indicated unless a definite cure can be anticipated by surgery. The injection of the suspicious material into the guinea-pig is of little practical value in routine practice, as there are many possibilities of erroneous conclusions. Autopsy of the guinea-pig often fails to reveal any evidence of the infection.

Differential Diagnosis.—In osteomyelitis, the joint is not usually invaded, and tuberculosis is infrequent in the shaft of a bone. The onset in osteomyelitis is sudden and the white blood-cells quantitatively increased, with a relative increase in neutrophils. Osteomyelitis in the stage of sequestration with sinus formation and chronic discharge is more often mistaken for tuberculosis than any other condition. Syphilis of bones and joints gives a positive Wassermann in 88 per cent and presents other stigmata and a somewhat different clinical course, as described later. Low-grade epiphysitis, as osteochondritis juvenilis (Legg's disease), runs a much milder course. There is much less muscular spasm, and motion is rarely limited to a great degree, except in certain directions. Acute infectious arthritis in the subacute stage is often confused with tuberculosis, especially if monarticular, but differentiation can always be made by the history and the roentgenogram.

Prognosis.—The prognosis as to life in those receiving efficient treatment is better in children than in adults, but varies with the location of the infection. The mortality is greater in the spine and hip-joint, and less in the upper than the lower extremities. The chances of recovery with good function are very poor, unless the process is encapsulated and arrested before the joint is invaded. This, however, is seldom observed clinically. Most cases reported as perfect results with restoration to normal are errors in diagnosis, for tuberculosis is an evolutionary process that runs an indefinite course with destruction. The time required for the evolution of the pathological process differs to some extent with the location. Active treatment or observation is required for a period of three years and, in some instances, much longer. The only definite promise that can be made is that deformity can be prevented or restricted to a minimum degree. In those receiving inefficient treatment or no treatment, deformity is severe and often causes serious and permanent disability.

Primary tuberculous infection, unless involving vital centers, as the cerebrospinal system, is seldom fatal and can usually be arrested and prob-

ably eradicated. Death is always the result of a complication. Secondary infection always occurs when an abscess ruptures spontaneously or is incised. The synergetic action of pyogenic bacteria associated with *Bacillus tuberculosis* materially enhances the destructive process on an organism of diminished resistance and decreases the chances of recovery. Rarely, secondary infection may occur through the blood stream and from a distant infected focus. In addition to symptoms of tuberculosis there are also those of an acute inflammatory process and sepsis, elevation of temperature, leukocytosis, etc. If there is prolonged suppuration, there may be amyloid degeneration of the vital internal organs. The prognosis, when complicated by amyloid degeneration of the kidneys and liver, is notoriously unfavorable. Tuberculous meningitis always terminates fatally.

Treatment.—Tuberculosis cannot be eradicated except by increasing the natural resistance of the entire organism, and must not, therefore, be viewed as a purely local problem. The treatment is local and constitutional and cannot be disassociated except for convenience in description. The principle of the local treatment is rest and the prevention of deformity by fixation apparatus, which will be later described in relation to each joint.

The constitutional treatment is the same as the routine treatment administered in tuberculosis of the lungs and should be strictly enforced. Such measures as fresh air, sunshine, feeding, and tonics, as cod-liver oil and syrup of iodid of iron, are of as much value in the treatment of a tuberculous joint as of a tuberculous lung. They are dismissed with brief mention, as a detailed description can best be secured in special works on the subject. However, there is one measure that does have a definite action on the tuberculous process, which must be described in detail. This is heliotherapy, or the scientific application of the sun's rays. The employment of the solar rays for the treatment of disease is an ancient remedy, but was first systematized and put upon a scientific basis by Rollier, of Leysin, Switzerland, who erected special sanitariums for this purpose. Only general heliotherapy, or exposure of the entire body, will be considered.

Orthopedic apparatus for the purpose of fixation is absolutely essential, but must be so constructed as to permit insolation.

The author first applied the Rollier method in 1913, in an apparently hopeless case of tuberculosis of the spine and hip. A relatively rapid recovery ensued, without recurrence to the present time. Since that time, the method has been routinely employed in all children with tuberculous bones and joints, and in adults when feasible. The results have been more favorable when compared with those secured by routine antituberculous and orthopedic measures previously employed. Although Rollier advocates the solar rays at high altitudes, equally satisfactory results can be obtained at any level, and in many portions of America heliotherapy can be given for at least nine months of the year.

All glass filters out the actinic or ultraviolet rays, which are supposed to be the curative agent; consequently, direct exposure to the sun must be secured. A southern exposure should be selected where there is free access to both morning and afternoon sun, unobstructed by trees or other structures. In those who must be kept in the recumbent position, a porch should be connected with the house and arrangements made so that the patient may be conveniently rolled out for exposure to the sun. A wooden or cloth partition should be erected on all sides to afford protection from public view, but there must be plenty of space below for the circulation of air.



FIG. 59.—HELIO THERAPY AT CRIPPLED CHILDREN'S HOSPITAL, MEMPHIS, TENNESSEE.

All clothing is removed from the patient and a simple T-strap applied to cover the genitals. Amber eyeglasses or goggles are worn to protect the eyes from the glaring light. A sunbonnet or broad-brimmed hat protects the head from the heat of the sun. If the temperature is above 75° F., the entire body may be exposed in robust individuals for three minutes every two hours. This is gradually increased until eight hours per day is reached. If the sun is intensely hot, exposure during the midday hours must be omitted, beginning as early as possible and resuming in the late afternoon. In cloudy weather, exposures are given just the same, though they are not so effective. In debilitated patients, and when the weather is cool, beginning with the feet, the lower four inches are exposed for five minutes every two hours for the first day; on the second day, a new area above of four inches is exposed in the same manner, while the first four inches, beginning with the feet, are exposed for ten minutes every two

hours. In this manner, the entire body acquires tolerance to the sun and air. As the reaction of individuals differs, no arbitrary rule can be made; some will improve on ten hours, while others can stand only six. Heliotherapy must not be indiscriminately administered, or much harm may accrue. The dosage must be regulated to each individual. Headache, weakness and *ma-laise* are indications to decrease the dose, or to discontinue and resume later and more gradually. Especial care must be taken not to burn or blister, for the treatment will not only be delayed, but the patient discouraged and unnecessarily annoyed. Improvement is synchronous with pigmentation and



FIG. 60.—HELIO THERAPY ON ROOF OF PRIVATE CLINIC, SHOWING HOW HELIO THERAPY MAY BE SUCCESSFULLY ADMINISTERED IN CROWDED CITY DISTRICTS.

Note arrangement of wards by partitions.

is an index of efficient treatment. Response to treatment is not so satisfactory in those who do not pigment or freckle, as blonds, particularly red blonds. Brunettes will become a mahogany brown. In Negroes, the blackest become a shade blacker and there is slight danger of sunburn.

The roentgenogram demonstrates the influence of heliotherapy on the pathological process. About the time pigmentation is established, there is increased activity, as denoted by breaking down of the osseous structure. Later there will be observed absorption of necrosed areas, the bone becomes more opaque, and by the end of six months or more is often more dense than normal, with beginning fusion. The inflammatory exudate surrounding the affected area becomes irregular, thinner, gradually diminishing in circumference, or at times undergoes calcification. Rapid destruction of

joint surfaces, in cases which for a year or more have shown little material change, are often observed after a few months' exposure. This rapid evolution is probably due to the removal of devitalized tissue by natural forces, stimulated by the tonic action of the sun's rays, and might be easily mistaken for an acute exacerbation. This hastening of the evolutionary process is also evident in those with secondary infection and draining sinuses, the discharge of which is markedly increased after insolation but later subsides, becomes less purulent and more serous as healing progresses.

Undoubtedly, the incident fresh air also has a beneficial effect, but the relative improvement is much greater in those treated by heliotherapy and fixation than in those treated by fresh air without removal of the clothing. The results are also more lasting with less chance of recurrence than after any other method.

In children, heliotherapy is especially applicable, for there is no economic problem to consider and the treatment may be indefinitely continued. Excellent results have been obtained after so short a time as five months, but, as in all tuberculous affections, overtreatment is advisable. In every case, at least two seasons of nine months' insolation should be given, and in the majority, three years of continuous treatment.

The active principle of the sun's rays is the actinic or ultraviolet ray; but there must be some other agent, as the use of "canned" sun in the form of the mercury quartz light does not produce the same beneficial effect, though it is the best possible substitute in seasons of the year when exposure is impossible. The quartz lamp may be disconnected in the warmer months, so far as tuberculous bone lesions are concerned, and not be connected until the weather prohibits natural insolation. When the finances of the patient permit, there should be a close pursuit of the sun for the entire twelve months of the year, which can be acquired by moving to warmer climates, as Florida, Southern California or Texas during the winter season. The necessity of a change in climate is often more essential in bone than in pulmonary tuberculosis, as many clinicians believe that climate has no influence on the latter condition.

Routine heliotherapy will be administered to better advantage in institutions especially equipped for the purpose, but can be effectively carried out in the private home with intelligent coöperation and constant surveillance by the family physician. In many instances, instruction for several weeks in an institution will be of material advantage before continuing the treatment at home.

Marine treatment is the routine bathing of the tuberculous patient in the sea, and is of tonic value, especially when combined with heliotherapy.

Surgical Treatment.—Open surgery has recently been advised for the purpose of arresting tuberculous processes in the joints of children, by inducing periarticular osseous fusion, but the consensus of opinion is that opera-

tive measures are not advisable, and until more definite proof of their value is forthcoming, should not be routinely employed. In the stage of residual deformity, two or more years after the process is apparently arrested, correction may be made by open surgery, which, however, must not invade the diseased area. Under no circumstances, and at no time during the active process or thereafter, should forcible correction be attempted, for there is grave danger of inducing metastasis and tuberculous meningitis. In older children, certain surgical procedures are advisable in tuberculosis of the spine and will be discussed when this region is considered.

Tuberculous Abscess.—Tuberculous abscesses are treated conservatively, unless life is being endangered by their presence. Incision and drainage are invariably followed by secondary infection. The injection of sinuses with various substances has not proved successful. The injection of formalin and glycerin was at one time advocated by Murphy, but was discarded as a failure. However, the impression gained at that time has persisted, and formalin and glycerin are often injected into tuberculous areas. Such treatment is not only contra-indicated, but may produce actual injury. Murphy did employ formalin and glycerin in pyogenic infection in the joints with marked success, the method of administration of which is described on page 55. Secondarily infected abscesses require excision and drainage just as do primary pyogenic infections elsewhere in the body.

TUBERCULOSIS OF THE FOOT AND ANKLE

Tuberculosis is rarely observed in the metatarsal bones and phalanges, but, when present, is spoken of as *spina ventosa*. The symptoms are pain, swelling and induration of gradual onset. The x-ray demonstrates a fusiform mass, often with destruction of the shaft. No special fixation apparatus is required, but a sole plate or simple tin toe splint may give relief of pain. Heliotherapy should be employed, as there may be an invasion in some other organ, as the kidney, in later years. The local focus, however, being circumscribed, can be excised with rapid restoration to normal of the affected part. Any one of the tarsal bones may be primarily affected, or the infection may extend through the tarsus to the ankle. The treatment, when the process is confined to one bone, is the same as for the metatarsals and the phalanges. Tuberculosis of the metatarsals may require careful differentiation. Syphilis in the early stage is manifested by the x-ray as a periostitis with increase in size and density, which is quite characteristic and of more frequent occurrence. Pain is absent or much less severe than in tuberculosis. In tuberculosis, the process is destructive and atrophic from the onset. In osteomyelitis, the onset is acute, with the clinical course of an acute infection. In fracture of the metatarsals, the callus is fusiform and tender and may resemble a pathological process, but usually recedes

after a few weeks, while tuberculosis progresses. Osteitis fibrosa is almost painless, and the typical pathology is clearly defined by the x-ray. In the tarsus, differentiation can be made in the same manner, but there may be confusion with Köhler's disease of the scaphoid, which is much milder and presents a characteristic picture which will be later described.

The ankle-joint is more often invaded through the astragalus, or the process may begin in the tibia. The bony prominences, as the malleoli,



A

B

FIG. 61-A.—X-RAY SHOWING TUBERCULOSIS OF ANKLE WITH DESTRUCTION OF BONE AND NARROWING OF JOINT SPACE, ANTEROPOSTERIOR VIEW.

FIG. 61-B.—SAME AS FIGURE 61-A, LATERAL VIEW.

become obliterated, the swelling is of a boggy nature and may extend to the entire foot. Muscle spasm is first noticed by limitation of motion in adduction and gradually increases until all movements may be completely restricted. Pain, local tenderness and heat are always present. In the early stage, there is no deformity, but as the process advances, there is contraction of the tendo achillis and the foot is held in equinus. If the process is not arrested, abscesses and discharging sinuses with secondary infection may arise.

Diagnosis.—The diagnosis is not difficult when tuberculosis is present. The common error is to consider other monarticular affections tuberculous, as the subacute stage of infectious arthritis and chronic osteomyelitis, the differentiation of which is discussed in considering those conditions.

Treatment.—The treatment of tuberculosis of the ankle in the early stage is simple, and consists of a bivalved plaster cast, which must extend from toes to knee, with the foot at a right angle; or the simple posterior gutter ankle splint from toes to knee, with the foot at a right angle to the leg, is efficient. Crutches are used for ambulation. If the process is confined to the astragalus, excision may rarely give relief, but should not be employed if heliotherapy is available. Equinus, or plantar flexion, when present, can be corrected by successive plaster casts, making gradual dorsal flexion at each sitting. In those rare fulminating types which progress to every bone in the foot, with impending amyloid degeneration, regardless of every known scientific measure, amputation may be considered earlier than in tuberculosis of the proximal joints, as the knee and hip. An artificial limb below the knee gives excellent function, but amputation should rarely be advised in children. Weight-bearing is indicated by the cessation of symptoms and the restoration of bone structure, as demonstrated by the x-ray. Residual deformity after healing of the process should be corrected gradually by mechanical appliance, never by force. If surgery is employed, invasion of the infected area should be avoided if possible.

TUBERCULOSIS OF THE KNEE

The process may begin in the metaphysis of the femur or the tibia, with coincident irritation of the entire joint from proximity. The first apparent symptoms in the knee are stiffness, pain and swelling, which gradually increase. The pain is local, with tenderness at various points, depending upon the process in the individual case. There is moderate swelling with partial obliteration of the bony prominences, and definite induration of the synovial sac on palpation. Very little fluid can be detected except in those with primary synovial invasion, in which a persistently distended and fluctuating joint is found. Primary synovial infection is rare in children, but of sufficient frequency to deserve mention.

The knee becomes gradually flexed, with muscular spasm limiting, but usually not obliterating, motion. As the process advances and the articular surfaces are destroyed, there is characteristic deformity of subluxation of the tibia with external rotation, and genu valgum, or knock-knee. Local heat is increased from the beginning and is a valuable index to the activity of the process when surgery is considered. Abscess with rupture may be a complication, as the joint is superficial, and draining sinuses may persist for several months or years. As the pain in affections of the hip is so

frequently referred to the knee, the hip must be very carefully examined and differentiation made when tuberculosis or any other condition is suspected in the knee-joint; otherwise, the differential diagnosis may be made as described in the discussion of tuberculous joints in general.

Prognosis.—Recent statistics from clinics in large cities show exceedingly unfavorable results in tuberculosis of the knee-joint. However, a large percentage of these were treated either in outpatient clinics and lived in homes in which poor hygienic conditions existed, or returned to such environment as arrested after dismissal from convalescent country homes. In private practice, in other portions of the United States, where living conditions are better, the comparative results are probably much better with conservative treatment. The prognosis is even more favorable in those treated by efficient mechanical apparatus and routine heliotherapy throughout the entire course. The gross pathology in the knee is the same as in other joints, but as this joint is large and complex, solid osseous fusion is rare, and considerable motion remains which is often painful. This may obviously increase susceptibility to strain or injury, with recrudescence of an existing latent process. In those complicated by secondary pyogenic infection with discharging sinuses, the chances of recurrence are much greater after apparent arrest of the process than when tuberculosis was the sole active agent. The result is also much better when the joint has been maintained in extension by efficient apparatus than when subluxation with deformity is permitted. Recovery with more active motion is possible in the knee than in other joints.



FIG. 62.—PHOTOGRAPH OF TUBERCULOSIS OF KNEE, SHOWING BEGINNING SUBLUXATION OF TIBIA.

Treatment.—The constitutional treatment has been mentioned in the general discussion of tuberculous joints. The orthopedic treatment consists in maintaining the knee in complete extension until the process is arrested; this entails constant surveillance for two or more years. Complete fixation of the knee in extension by a plaster cast is possible only by extending the cast so as to immobilize the hip and foot, but this should be done only when heliotherapy is not available. A shorter cast will permit knee flexion. If flexion contracture is present before extensive destructive changes appear, Buck's extension should be applied below the knee. The patient should be placed on a firm surface and the pull made in the line of deformity, which necessitates the thigh being placed on an inclined plane. As the flexed position is reduced, the limb is lowered. In the acute stage, Buck's extension will also afford much relief from pain. Fixed traction can be made with the patient in bed during the acute stage, and traction with stiling and ambulation in the subacute stage. The Thomas knee splint is the accepted apparatus in the subacute stage. When the process is apparently arrested, as denoted by the x-ray and the subsidence of symptoms and joint manifestations, especially local heat, weight-bearing is gradually permitted by the Thomas caliper brace attached to the shoe.

Operative interference has been advocated recently, with the object of inducing osseous fusion. However, sufficient evidence has not been advanced to regard such procedures as standard or routine in children. Excision in a child is under no circumstances advisable, as this entails the removal of one or both epiphyses, which will be followed by too much shortening from deficient growth. There is practically no complication which would render amputation advisable. As the joint is superficial, rupture of abscess is often unavoidable. Therefore, when there is impending rupture, incision is required earlier than in deeper joints. The insertion of drainage tubes is not necessary.

If subluxation is observed during the active stage, correction should be accomplished gradually by special apparatus, constant force being applied to the posterior aspect of the leg and anterior aspect of the thigh, with fixed traction to the leg by the use of complicated apparatus (page 60). Forcible correction under anesthesia may induce remote complications by metastasis, notably in the central nervous system, as tuberculous meningitis, and is therefore a very dangerous procedure. In residual deformity, after the process has been completely arrested for at least one year, preferably two years, correction may be made by osteotomy above the knee-joint. Great care should be used to avoid invading the seat of former infection. Under no circumstances, if tuberculosis is the causative agent of ankylosis, should a knee-joint be entered for the purpose of mobilization. The possibility of lighting up a latent infection is sufficient definitely to contraindicate such a procedure.

TUBERCULOSIS OF THE HIP

The process in the hip usually begins adjacent to the upper femoral epiphyses, though it may originate in the acetabulum at the junction of the ilium, ischium and pubis. Synovial tuberculosis in the hip is very rare. The evolution of the pathological process can be followed by the roentgenogram. The first evidence of osseous invasion is one or more irregular and ill-defined areas of necrosis close to the epiphysis, which gradually progress in the direction of the joint. The encrusting cartilage of the joint is under-

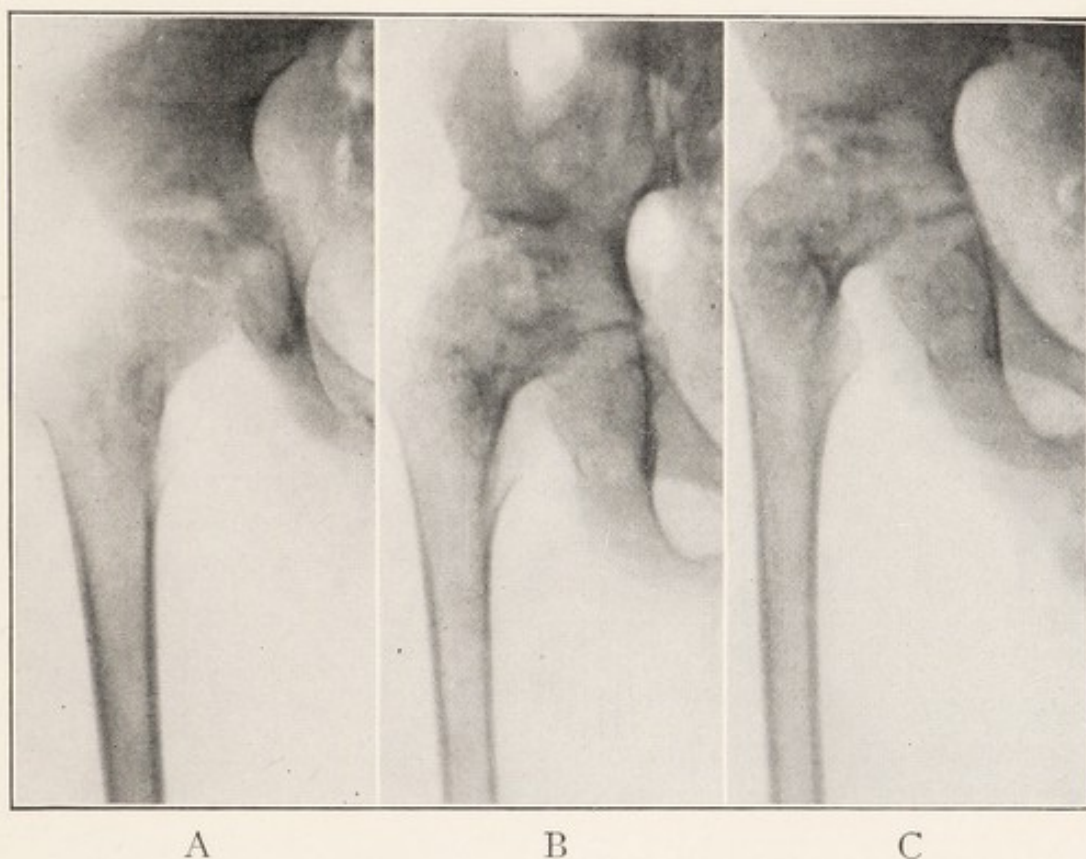


FIG. 63.—X-RAY SERIES SHOWING PROGRESSIVE DESTRUCTION OF TUBERCULOSIS OF HIP.

mined and becomes eroded with extensive destruction. Coincidentally, the acetabulum may be destroyed with extensive erosion of the ilium above, into which the upper extremity of the femur migrates—the so-called wandering acetabulum. The process is active only in living tissue, as small or large areas may be devitalized *en masse*, retaining their structural density as sequestra, in marked contrast to the necrosis and atrophy of the surrounding bone. The head and neck of the femur may be destroyed. Even complete dislocation of the upper extremity of the femur may occur, which is then supported solely by the gluteal muscles. The pathological process, however, is undoubtedly restricted in those securing continuous and efficient treatment.

Symptoms.—The first evidence is slight stiffness, especially in the morning on arising. Limp is at first intermittent, later becoming continuous and more pronounced as the process advances. Pain is almost invariably referred to the inner aspect of the knee, along the course of the descending branches of the obturator nerve, being referred from the upper branch which passes into the hip-joint. So soon as the process is established, the hip assumes the neutral position and is slightly flexed and held in abduction and external rotation, causing apparent lengthening or actual lengthening, as described in Chapter I. After extensive destruction, the hip becomes flexed, adducted and rotated inward, with actual and apparent shortening. In the early stage, the gluteal fold is below the normal, and after destruction, above the normal. On palpation, in the early stage, relatively slight information can be obtained, though induration over the anterior aspect of the joint and enlargement of inguinal glands may be detected. As the process advances, there may be extensive induration or fluctuation. Muscular spasm is more pronounced in tuberculosis of the hip than in any other joint, and when the process is well established, fixation may be so complete as to be indistinguishable from bony ankylosis, except under anesthesia. Night cries are more frequent and more pronounced than in tuberculosis of other joints. Atrophy of the thigh is marked when compared with the opposite limb and is noticed earlier than in other joint affections. The chief local complication is abscess, which more often appears posteriorly as a fluctuating mass. Secondary infection after rupture or incision always occurs and is a serious complication. Multiple draining sinuses may form in all directions and continue indefinitely. Tuberculous meningitis is more frequent in affections of the hip than in any other joint, even the spine.

Diagnosis.—So many affections of the hip are erroneously diagnosed tuberculous that a careful differentiation must be made. Psoas abscess, in which there is a definite limp with flexion of the hip-joint, is frequently diagnosed as tuberculosis of the hip. The range of motion in psoas abscess or psoas irritation, unless very acute, is limited only in extension, later also in abduction. A definite mass can often be palpated above Poupart's ligament, and there may or may not be manifestations referable to pathological changes in the spine. In the early stage of tuberculosis of the hip, motion is limited in all directions, in addition to other symptoms and manifestations above described. The x-ray may also be of value in differentiating the two conditions, but an apparently normal spine and hip do not exclude the possibility of tuberculosis of the hip or psoas abscess from a tuberculous spine. Syphilis is usually not so acute as tuberculosis of the hip, and muscular spasm and all other symptoms are less pronounced. The x-ray, blood Wassermann, and therapeutic tests are all of aid in the differential diagnosis, which is fully discussed under luetic joints. Acute infectious arthritis, during the subacute stage, may be differentiated by the history and the roent-

genogram. Coxa plana, so-called Legg's, Perthes' or Calvé's disease, is often mistaken for tuberculosis. In coxa plana, the hip is limited in only two directions, abduction and internal rotation, whereas, in tuberculosis, motion is limited in all directions. The pathological process demonstrated by the x-ray is almost pathognomonic and quite different from that of tuberculosis. Coxa vara, or separation of the upper femoral epiphysis, presents symptoms resembling coxa plana, and may be confused with tuberculosis. In coxa vara, motion during the early stage is limited in abduction and internal rotation, and the roentgenogram demonstrates characteristic changes in the neck and femoral epiphysis. Also, coxa vara is a disease of late childhood or adolescence. There are other affections which might be considered, but are of such rare occurrence as to render further discussion unnecessary. As may be observed, there are seven affections that present symptoms referable to the hip, which must always be carefully considered in concluding the nature of any lesion of chronic character: syphilis, acute infectious arthritis (subacute stage), low-grade infectious arthritis, coxa plana, coxa vara, tuberculosis and psoas abscess.

Prognosis.—The mortality in tuberculosis of the hip-joint is higher than in any other joint, and as in other joints, is greater in those untreated or inefficiently treated. Also, the chances of complete local recovery are less, which is probably due to the involvement of a larger area, as the hip-joint is surrounded by more cancellous bone which is less resistant than compact or dense bone. Secondary infection, with the development of abscesses and sinuses, renders the problem more difficult on account of the dense mass of surrounding soft tissue which makes possible deep pockets and ramifications. Tuberculous meningitis is a more frequent complication of tuberculosis of the hip than of tuberculosis in any other joint.

The process will be arrested and apparently cured in a large proportion of those receiving efficient orthopedic and constitutional treatment and heliotherapy. However, restoration of function should neither be expected nor desired, as there is much less chance of strain from slight injury with recurrence if there is solid bony ankylosis.

Treatment.—The hip must constantly be maintained in the position which will be most useful to the individual, for ankylosis, as above mentioned, is desirable. The position of choice is extension in line with the body, with about 20 degrees' abduction, and midway between internal and external rotation. In early childhood, and at any age when the condition is acute, recumbency on a non-resistant surface must be continuously enforced. Fixed or Buck's extension, previously described, should be employed during the acute stage. In early childhood, when the process is apparently arrested, or in older children, after the acute symptoms have subsided, ambulatory treatment may be instituted. When the process is acute, malposition may be corrected by extension in the line of deformity,

the limb being lowered as reduction is accomplished, until the desired position is reached. After the acute symptoms subside, fixation is best maintained by a plaster cast from the toes to the nipple line, but as previously mentioned, must be bivalved to permit heliotherapy. A modification of the Thomas hip splint or brace is probably the apparatus of choice during recumbency and may be continued for ambulation. The Bradford abduction brace is also an excellent appliance, permitting tilting and fixed traction. Elevation of the opposite shoe is necessary to balance the two limbs in walking. Crutches are rarely necessary. Mechanical fixation must be continued until the process is arrested, which is determined by cessation of symptoms and healing of osseous structure, as demonstrated by the x-ray. In most instances, at least two years are required; the average is three years, though rarely the process may continue indefinitely, regardless of all treatment. If observed a sufficient time after the subsidence of symptoms, correction of deformity is accomplished by extra-articular osteotomy of the femur, which must not enter the field of former infection. In addition, procedures on the soft tissues, as tenotomy of the adductors to overcome adduction, or the severance of the hip flexors by the Soutter operations or the author's transference of the crest of the ilium (*Infantile Paralysis*, p. 233), may be employed; no undue tension should be made on the joint. The correction of malpositions not only materially improves the function of the limb in walking, as there is compensatory motion by the lumbar spine, but also relieves strain from faulty posture of the spine and the entire body.

CHAPTER VI

LOW-GRADE JOINT AFFECTIONS (*Continued*)

TUBERCULOSIS OF THE SPINE

Tuberculosis of the spine (Pott's disease) is the most frequent seat of bone tuberculosis. The dorsal region is most often involved.

The process begins in the anterior portion of the body of the vertebræ, often on the margin, and gradually progresses until a portion of the body is destroyed. The body of the vertebra becomes wedge-shaped from pressure of the superincumbent weight on necrotic and atrophic bone, the intervertebral disk disintegrates and the adjacent vertebræ coalesce. Several vertebræ may be involved, or rarely there may be two foci in the same patient, as in the dorsal and lumbar region. The disease seldom invades the laminae and spinous processes, being usually confined to the body. The affected area is surrounded by an inflammatory exudate in the soft tissues. Pus may arise from the bone or within the exudate by caseation or disintegration, accumulating in large quantities, forming the so-called cold abscess. The spinal cord may be invaded, causing a local transverse myelitis and, rarely, a general tuberculous meningitis.

Symptoms.—There may or may not be a premonitory stage, in which the child is puny, anemic, underweight and undernourished, and does not enter into play with the usual normal enthusiasm. The clinical manifestations vary sufficiently in different portions of the spine to warrant a separate description of the symptoms common to each region.

In the upper cervical region, where the atlas and axis are involved, the head is held rigid in the midline with the chin usually elevated, simulating a sea lion, or may rarely be depressed with the neck in flexion. As this portion of the spine is normally flexible, local symptoms are apparent early. Any attempt to rotate the head is met with fixed resistance by muscular spasm. There is no active movement, and the child, when called, will turn on the legs and not in the neck, as under normal circumstances. Pain is often referred to the occiput, but may not be a prominent symptom. In the acute stage, the gait is somewhat guarded. If the process is not retarded, the head becomes dislocated forward, giving a rather grotesque appearance.

In the cervical vertebræ below the axis, there is marked spasm of all muscles, and the neck is flexed and held to one side in torticollis. Pain may

or may not be present at the side of the neck, and when present, is occasionally referred to the arms. There may be an effort to support the head by the hands. If deformity is not prevented, the neck may become permanently fixed in extreme flexion, with the eyes directed to the feet. There may also be a lateral deviation, but there is always a posterior kyphosis.



FIG. 64.—PHOTOGRAPH OF TUBERCULOSIS OF CERVICAL SPINE, SHOWING FORWARD LUXATION OF HEAD.

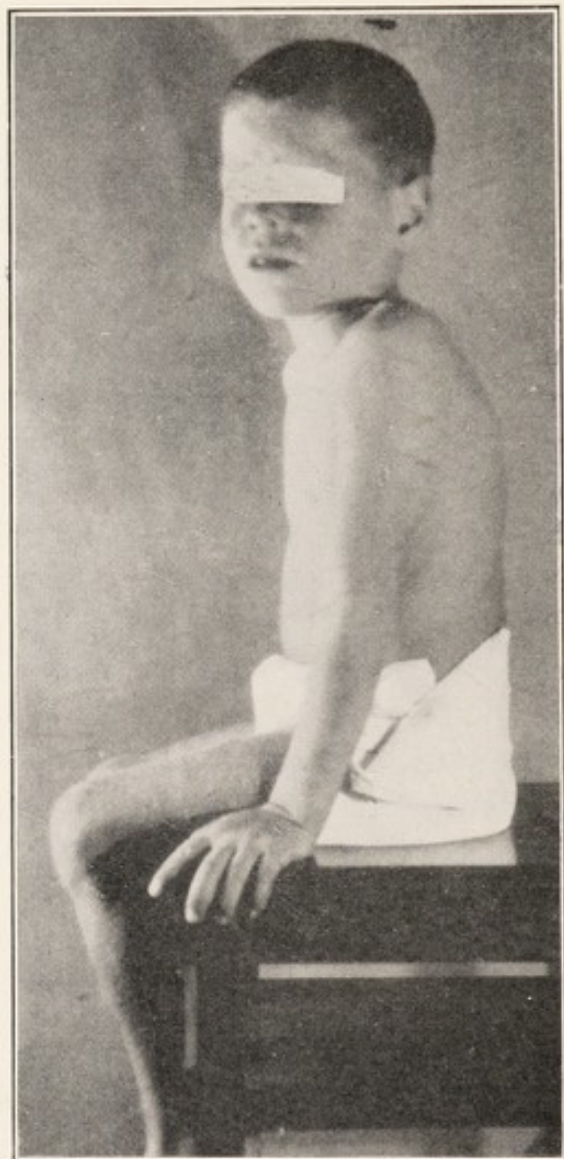


FIG. 65.—PHOTOGRAPH OF TUBERCULOSIS OF DORSAL SPINE, SHOWING ELEVATION OF SHOULDERS TO RELIEVE WEIGHT OF SPINE.

Below, there is developed a lordosis of the upper dorsal vertebræ, for whenever there is a deformity in one region of the spine, there will always be an adjacent compensatory adjustment in the opposite direction above and below.

In the upper dorsal region, pain is often referred to the lateral aspect of the chest. The shoulders are elevated in an effort to remove the weight

from the spine. As the spine is normally fixed by the attachment of the ribs, muscular spasm may not be grossly apparent, but is always present and can be detected by close observation. The first noticeable sign is usually the small "knuckle" or prominence of one spinous process. If not arrested, a rounded kyphos develops, which involves the upper ribs, and the anterior aspect of the chest becomes flattened above and protuberant below. Laterally, the thorax is compressed; below, in the spine there is a compensatory flattening, or lordosis. There is an expiratory grunt, which is constant when the process is acute, otherwise only on exertion, as in walking or running. This is due to pain from excursion of the chest, which is often exaggerated when excessive exudate or abscess is present. When the involvement is above the seventh dorsal vertebra, the child often sits with the elbows on a table, the chin supported by the hands, in an effort to relieve pain by decreasing superincumbent weight, and unconsciously making head traction. In the mid-dorsal and lower dorsal regions, pain is often referred to the abdomen, and may closely simulate acute inflammatory affections of the intestinal tract. In fact, symptoms are often apparent in the abdomen for many months before they are observed in the spine, which is due to failure to examine the spine routinely. The gait may be guarded and the child may often stumble. The knee reflexes are often exaggerated without other evidence of myelitis. Deformity is more pronounced in the dorsal region, as the destruction is on the concave side of the vertebral column. Deformity in this region is manifested by an angular kyphosis, lateral compression of the thorax, and a prominent chest (pigeon-breast). The length of the trunk may be so decreased that the extremities appear much out of proportion.

The lumbar spine, as the cervical, is flexible, and any restriction in motion or abnormality in movement, as awkwardness, is apparent early. The symptoms are pain referred to the periphery, caused by irritation of the spinal nerves at their exits. The pain is usually felt on the anterior aspect of the thighs. Muscle spasm is exaggerated, and the entire spine is held rigid, which is quite apparent when the child stoops to pick up objects.

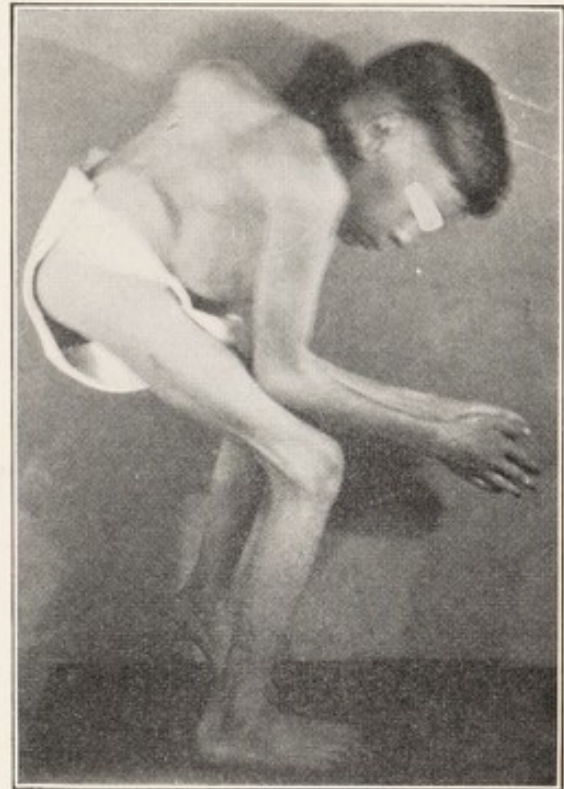


FIG. 66.—PHOTOGRAPH OF TUBERCULOSIS OF DORSAL REGION, SHOWING EXTENSIVE DORSAL KYPHOSIS WITH DOUBLE PSOAS CONTRACTION FROM DESCENDING ABSCESS.

Lordosis is increased and the abdomen becomes prominent and distended with gas; the gait is swaggering but very guarded. The child may be very

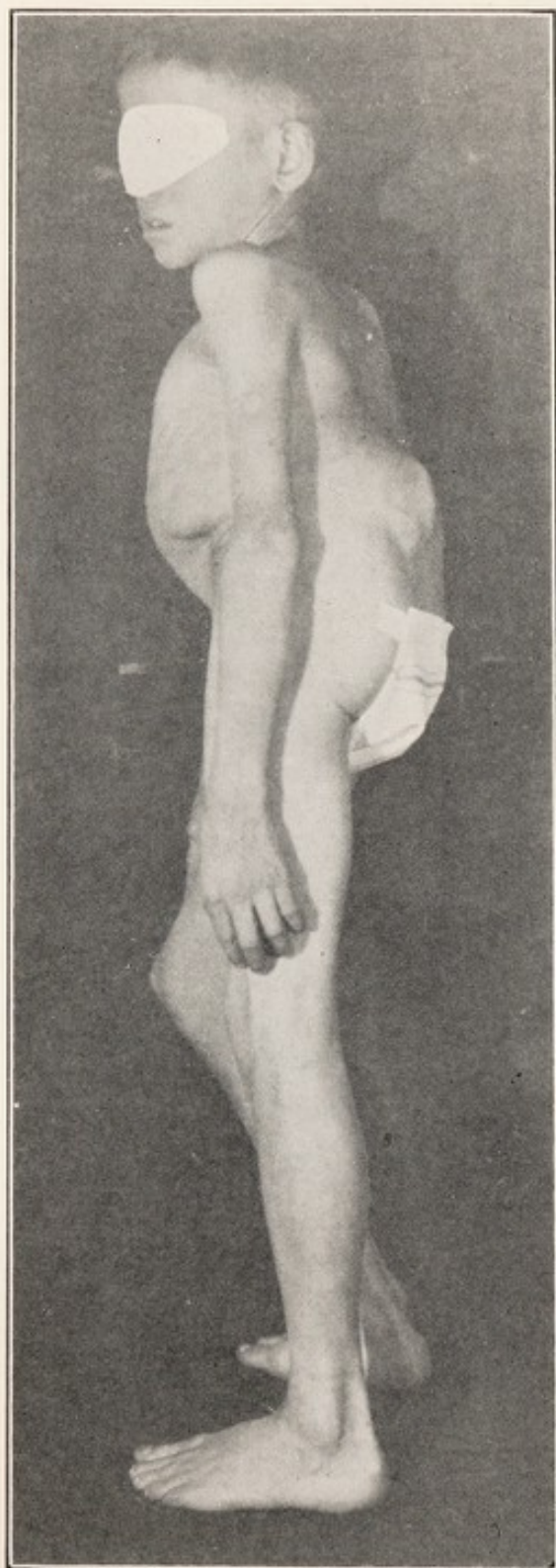


FIG. 67.—PHOTOGRAPH OF TUBERCULOSIS OF LUMBAR SPINE WITH EXTREME DEFORMITY.

sensitive to slight jars, as observed when riding in buggies or automobiles. Tenderness on palpation or percussion over the spinous processes may or may not be present. The psoas muscle, which is attached to the lumbar vertebræ, may be irritated and contracted, causing a limp, which is occasionally the first symptom noticed. Deformity occurs late and is not so extensive as in the dorsal region, for the normal contour of the spine is convex forward; consequently disintegration in the bodies of the vertebræ does not induce the column above to fall forward by the force of gravity. As a final result, if not arrested, there will be a posterior kyphos, somewhat angular, with compensatory lordosis above and a flattening of the entire chest. The stature is never so extensively decreased as it is when the dorsal region is affected. The symptoms and clinical course are transitional. For example, in passing from one region of the spine to another, as from the cervical to the dorsal, there is a gradual change in the anatomic characteristics of the vertebræ. In the same manner, there is a change in clinical manifestation. Tuberculosis at the junction of the dorsal and cervical regions will show symptoms characteristic of both the cervical and dorsal areas; the same transition is observed in the dorsal and lumbar regions.

Complications.—The principal complications of tuberculosis of the spine are abscess and paralysis. Abscess in the cervical spine may migrate to the posterior pharynx, or more often to the lateral aspect of the neck.

In the dorsal spine, the abscess may form in the posterior mediastinum or pass along the spinal column by gravity, behind the diaphragm to the psoas muscle and becomes a psoas abscess. In the lumbar spine, pus accumulates about the psoas muscle, whose course it usually follows to a point below Poupart's ligament. Abscess of the lumbar region may also pursue a posterior direction, dissecting the muscles of the back, pointing between the ribs and the ilium. There are no symptoms except pressure until the abscess reaches the surface, when there is fluctuation, with pain and elevation of temperature. In the cervical region, rupture may occur in the posterior pharynx, with resulting asphyxiation and death. In the dorsal

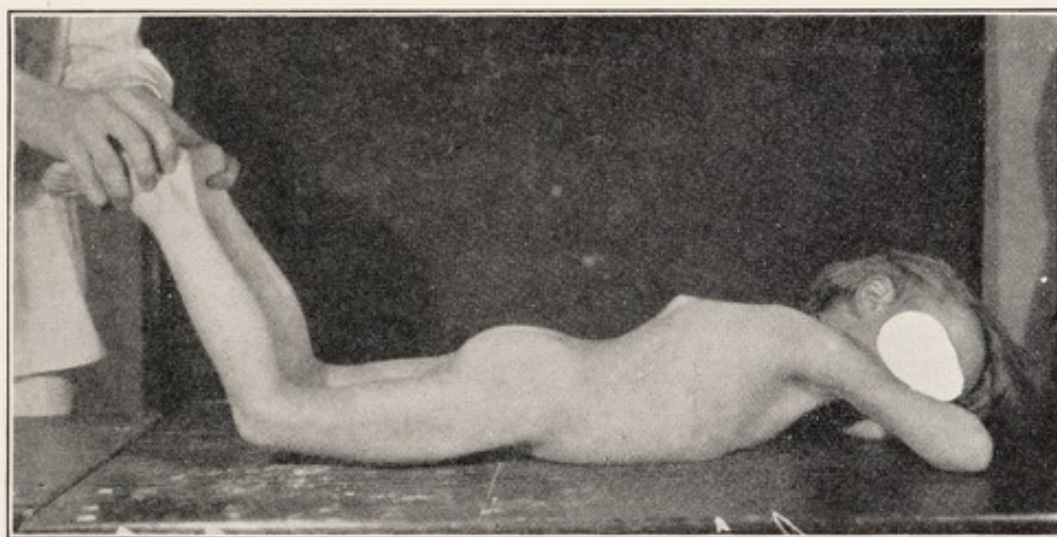


FIG. 68.—PHOTOGRAPH SHOWING BEGINNING SHARP ANGLE OF DEFORMITY OF TUBERCULOSIS OF LOWER DORSAL SPINE.

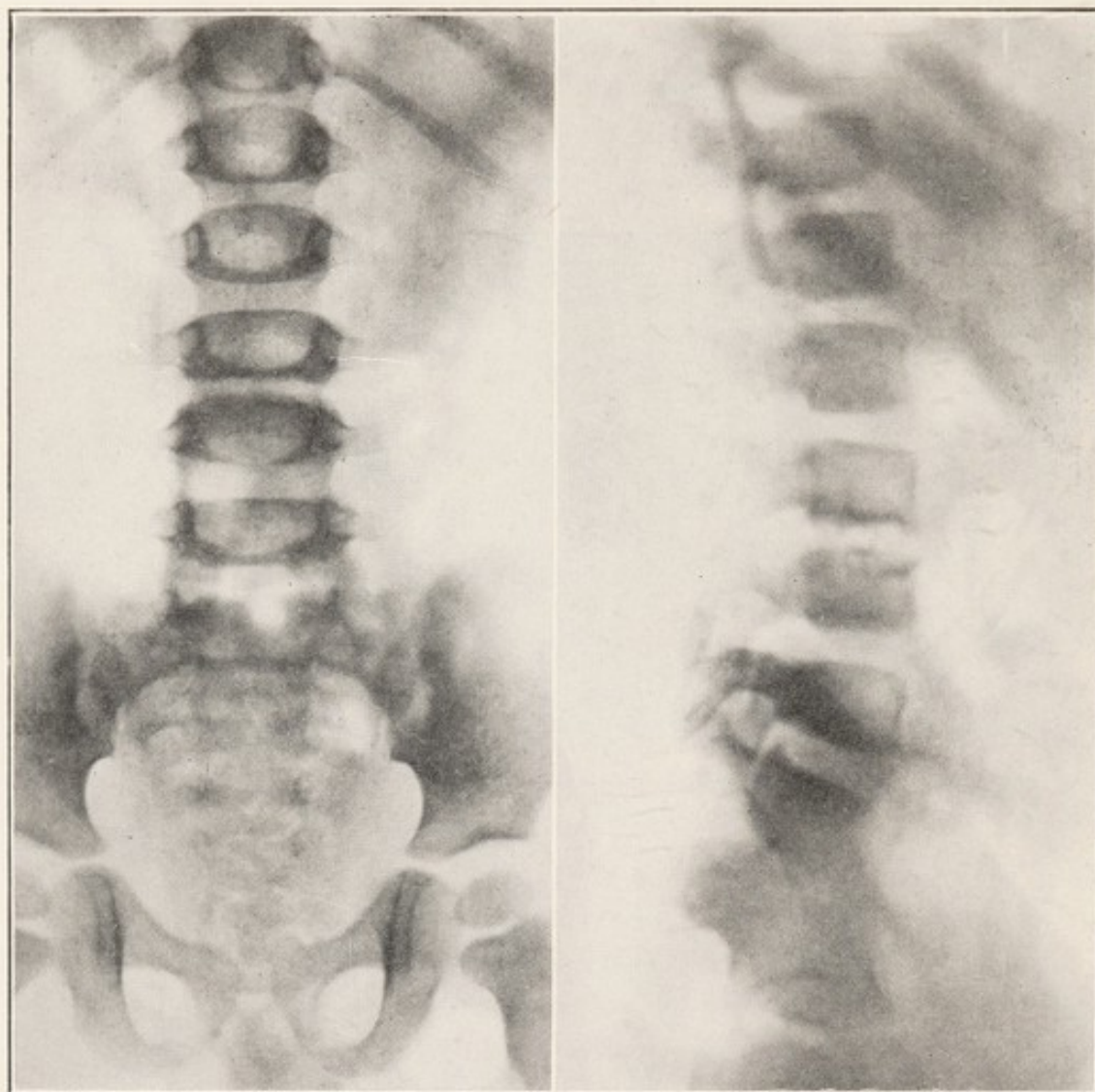
region, pressure in the posterior mediastinum upon the vagus nerve may produce serious dyspnea, and death may ensue unless relief is secured.

Paralysis occurs more frequently about two years after onset and is due to myelitis of the spinal cord by toxins or pressure from inflammatory exudate, but rarely from decrease in the lumen of the spinal canal by angulation of the column. In fact, paralysis often occurs when there is slight deformity. When the motor centers alone are impaired, as is usually the case, the paralysis is of the spastic type. Paralysis occurs more frequently when the dorsal spine is affected, as paraplegia, which begins by a spastic stiffness in the lower extremities, with increase in reflexes, ankle-clonus, and a positive Babinski sign. This gradually increases until voluntary motion may be lost. If the upper cervical region is involved, the arms may be affected in a similar manner, and rarely, all four extremities—a quadriplegia. Sensation may rarely be diminished, or the paralysis may progress to the loose or flail type, which usually indicates irreparable damage of the spinal cord from a complete transverse myelitis.

Tuberculous meningitis is, fortunately, not a frequent complication. It occurs more frequently as a complication in tuberculosis of the hip than

the spine. The first symptom is nausea, which may be persistent or recurrent, and may be present for many weeks before such classical symptoms as rigidity of the neck and Kernig's sign are manifested.

X-Ray Examination.—The x-ray, in contradistinction to tuberculosis of the joints, usually shows a definite pathological process in the spine when



A

B

FIG. 69-A.—X-RAY SHOWING TUBERCULOSIS OF SPINE WITH NARROWING OF INTERVERTEBRAL SPACE, ANTEROPOSTERIOR VIEW.

FIG. 69-B.—X-RAY SHOWING TUBERCULOSIS OF SPINE WITH NARROWING OF INTERVERTEBRAL SPACE BETWEEN THIRD AND FOURTH LUMBAR VERTEBRÆ AND EROSION OF ANTERIOR MARGIN OF BODY OF FOURTH LUMBAR VERTEBRÆ, LATERAL VIEW.

the symptoms become apparent to the average physician or surgeon. However, symptoms from which the diagnosis should at least be suspected are always perceptible before such changes are observed. Two views should invariably be made, as the lateral often demonstrates abnormalities earlier than the anteroposterior. The entire spine should be included, as two foci in the same spine may occasionally be detected. The first evidence is decrease in

width of one intervertebral disk, two of the bodies being closer together than their fellows above and below. Coincidentally, there may be seen an ill-defined area of necrosis or a punched-out notch, in contrast to the surrounding normal bone. This area of necrosis of the articular surface is seen on the anterior margin in the side view, or on the lateral margin in the antero-posterior view. The inflammatory exudate is more pronounced in the dorsal region and is seen as a circumscribed, somewhat spindle-shaped mass surrounding the affected area. As the process advances, the body becomes wedge-shaped, and the column above deviates forward and occasionally to one side.

Diagnosis. — The diagnosis is made by the history, the symptoms and physical findings; but as errors are so frequent by confusion with other affections, differentiation is necessary. In the cervical region, congenital torticollis may resemble by attitude alone, as the muscle spasm is on one side only, whereas, in tuberculosis, all the neck muscles are in tonic spasm; in torticollis there are no other clinical symptoms. Hysteria not infrequently simulates a rigid neck, and often requires careful observation before pathology can be excluded. In infected glands of the neck, tenderness to pressure may be elicited by palpation, and there is often rigidity of the muscles. Acute trauma or mild infections may produce symptoms which are identical with those of tuberculosis of the cervical or other portions of the spine, but

as a rule, are of more sudden onset, and also may give a definite history as to etiology. Low-grade affections of the spine, as epiphysitis, osteitis, Kummell's disease, old fractures, etc., may be suggested from the roentgenogram. The symptoms resemble tuberculosis, but are milder, and respond rapidly, as a rule, to any form of mechanical treatment, as fixation or traction to the neck. In rachitis, the deformity is rarely angular, but usually rounded and flexible while sitting, and disappears on assuming the recumbent position; when fixed kyphosis is present, there is no muscular spasm, and the x-ray will furnish a conclusive differentiation. In acute infectious spondylitis, the symptoms bear no resemblance to tuberculosis during the acute stage;

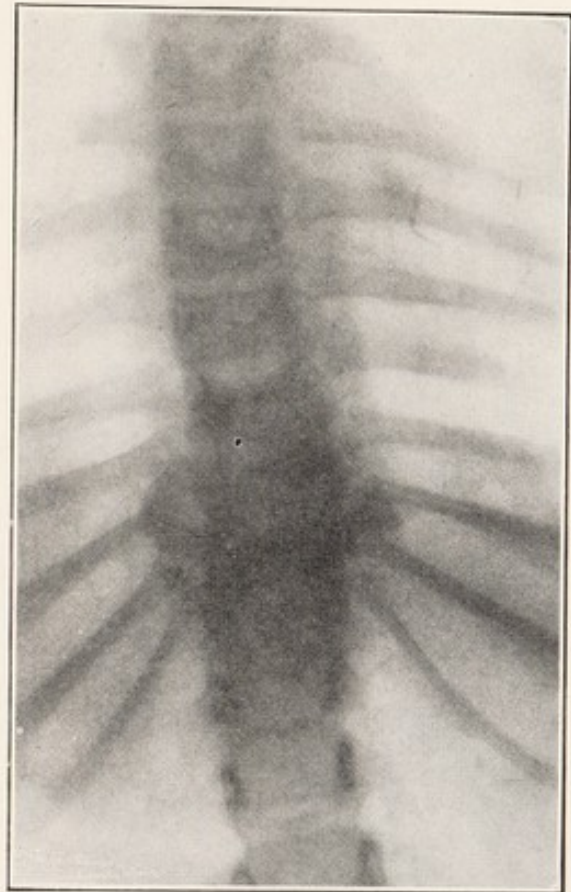


FIG. 70.—X-RAY SHOWING TUBERCULOSIS OF LOWER DORSAL AREA WITH SPINDLE-SHAPED MASS OF INFLAMMATORY EXUDATE.

in the subacute stage, there is frequent error in diagnosis, but differentiation can easily be made by the history and the x-ray (see Infectious Spondylitis, p. 62). In lateral curvature, the deformity bears no resemblance. In addition, there are no clinical symptoms, such as pain and muscular spasm, which are common in tuberculosis of the spine. Typhoid spine may be differentiated from tuberculous spine by the x-ray, and also by the destructive and proliferative process and the history of a previous attack of typhoid fever.

Prognosis.—The prognosis depends entirely upon efficient and continuous treatment. The highest percentage of recoveries is in the cervical region, and probably the lowest is in the dorsal region. The mortality rate, from various statistics, is given as 20 to 50 per cent, but undoubtedly is very much lower, possibly less than ten in those treated by properly adjusted orthopedic apparatus and heliotherapy. Paralysis or cold abscess may be successfully combated in a majority of cases, but abscess with secondary infection is a more serious complication. Deformity cannot always be prevented, but can be limited to a slight degree. In the dorsal region, deformity after every type of treatment is more frequent and more pronounced.

Treatment.—In early childhood, recumbency with fixation must be continuous for one or two years, as indicated by the symptoms, but ambulation may be advisable at any time if the general health becomes depressed. Recumbency is also advisable at any age when the process is acute. For this purpose, the child is placed on a Bradford frame, described in Chapter II; this is an excellent measure and often indispensable. Head traction is indicated to overcome muscle spasm when the cervical spine is affected, and Buck's extension to the lower extremities when the lumbar spine is involved. In other portions of the spine, the author has found a brace which fixes the head, the entire spine and both lower extremities to the knees to be very efficient. This brace can be adjusted to the contour of the spine and at the same time maintain hyperextension, which is usually desirable. The constant and natural effort to flex the spine by raising the head and often the hips is thus controlled, and micturition and defecation are permitted without disturbing the position. The anterior half of the body may be exposed for heliotherapy, but the child must be placed on the Bradford frame for exposure of the posterior half. Ambulatory measures are indicated in young children when the process is arrested, or in rare instances, when recumbency is not well borne. In older children, above seven years of age, ambulatory treatment is indicated so soon as the acute stage has subsided. In infancy and early childhood, the contour of the body is almost that of an egg, and there are no bony prominences to which apparatus will conform; therefore, no appliance to the spine alone will secure sufficient fixation. In consequence, the same brace employed in recumbency is continued, and it is surprising how well a child can run and

play with complete fixation from occiput to knees. This apparatus is indicated when any portion of the spine, except the cervical and dorsal above the eighth dorsal vertebra, is invaded. But when the process is above the eighth dorsal vertebra, the head must be supported in order to transmit the weight from the spine to the pelvis, by a head piece supporting the chin and occiput, which is attached to the back bars. Below the ninth dorsal vertebra, the brace extends above to the head, which is held in moderate extension, but not supported as in the cervical region, and below to both thighs just above the knee-joint to permit full flexion of that joint. As healing progresses, as indicated by an increase in density and subsidence of exudates (as demonstrated by the x-ray), the thighs may be released when the upper portion of the spine is involved, and the head when the lower portion is involved. This apparatus is the author's modification of the Taylor spinal brace, as described in Chapter II. The plaster jacket, bivalved to permit heliotherapy, and adapted to the mechanical requirements of the region affected, is efficient, but considerable experience is required for proper application. The plaster jacket is also of value in children in whom coöperation cannot be obtained. Apparatus must not be discarded until at least six months to one year after all muscular spasm and other acute symptoms have disappeared, though certain parts of the apparatus may at times be gradually discarded. In the cervical spine, the Thomas collar or similar apparatus may at times be substituted in the convalescent stage. The Thomas collar is a round leather collar, stuffed with sawdust, of sufficient dimension to support the chin and occiput on the clavicles and shoulders. In emergencies, much comfort may be afforded in any type of cervical spondylitis by bandaging the neck snugly with simple absorbent cotton; or the pneumatic inner tube from an old bicycle tire may be cut the desired length, sealed at both ends by ordinary rubber glue, placed about the neck of the patient and inflated with a bicycle tire pump.

Operative measures to produce fusion of the spine are of great value

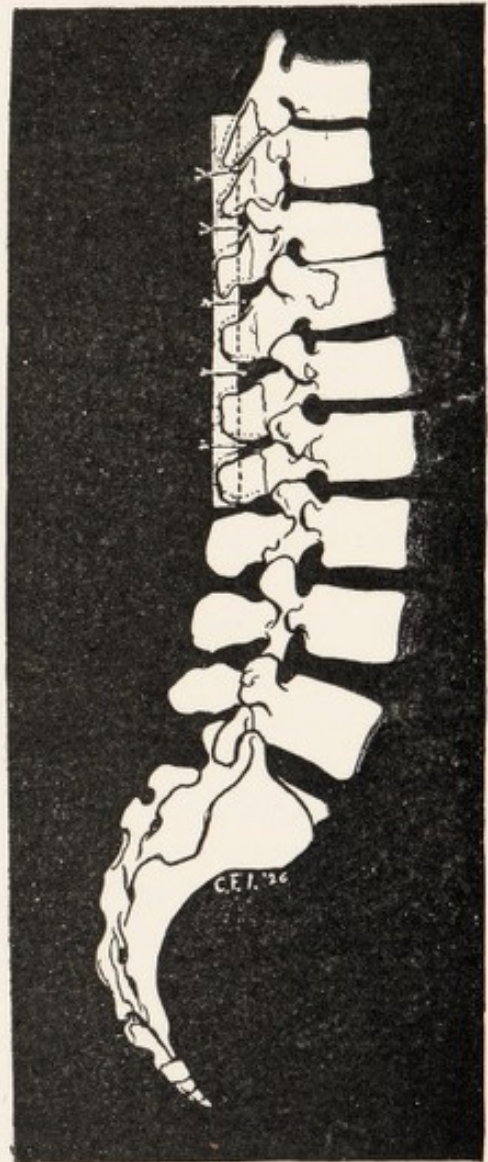


FIG. 71.—SCHEMATIC DRAWING OF SPINE, SHOWING METHOD OF ALBEE BONE-GRAFT OPERATION.

in older children, but the indication is doubtful in early childhood. The principle of these operations is to ankylose the spinal column over the affected area and for at least three vertebræ above and below the site of the lesion. The method of Hibbs by a bone plastic procedure on the articular processes, laminae and spinous processes, or the method of Albee by a bone-graft from the tibia into the spinous processes of the vertebral column, should be employed. In either operation there must be no invasion of the infected area, which is usually confined to the bodies of the vertebræ, and for this reason such procedures are well adapted to the spine. In tuberculous other joints, there is no analogy to the spine, as fusion cannot so readily be induced without invading infected tissue. As previously mentioned, extra-articular fusion of the larger joints cannot yet be considered a standard procedure in children.

An uncontaminated tuberculous abscess should be given conservative treatment unless life is endangered by pressure on vital parts. This occurs at two places only—the retropharynx and the posterior mediastinum. In the former, the abscess should be opened when sufficient fluid has accumulated to make spontaneous rupture probable. In the posterior mediastinum, dyspnea from pressure on the vagus may be so accentuated that removal of a portion of a rib and transverse process is necessary to permit evacuation of pus. In both of these locations, however, conservatism may be employed with success. The abscess in all other regions, if large or increasing, may be aspirated and compressed by pads and bandage; also, various injections, irrigations, etc., are advised, but are of doubtful value. The chief reliance is conservatism, efficient orthopedic measures to the affected region, and heliotherapy, as a result of which, the abscess will often disappear. However, even should rupture occur, there may be healing with closure, if secondary infection is avoided by strict asepsis, but this is almost never accomplished. If there is secondary infection of the abscess, as indicated by symptoms of sepsis, the treatment is exactly the reverse: radical incision and drainage is indicated, as in any pyogenic infection. Discharging sinuses, the result of secondary infection of tuberculous abscesses after rupture, or secondarily infected abscesses which have ruptured, may be treated by various injections, as bismuth paste, etc., with more or less value. After secondary infection, heliotherapy is a most valuable measure. Death from sepsis, however, may ensue, regardless of every known form of treatment.

Paralysis requires recumbent treatment when the first symptom appears, as indicated by increase in knee and other reflexes. The most rigid fixation with or without traction to head and lower extremities is required until there has been a restoration of normal reflexes and voluntary muscle control for at least three months, when ambulatory measures may be cautiously resumed.

TUBERCULOSIS OF THE UPPER EXTREMITIES

Tuberculosis of the upper extremities in children is extremely rare in America, even in the large cities, while in the less densely populated areas, it is probably even more infrequent. The elbow is involved more often than the shoulder, and the invasion of the wrist is almost unheard of. The pathology, clinical course and differential diagnosis closely resemble that in the joints of the lower extremities. The process is less extensive and of shorter duration, probably because there is no strain of weight-bearing. The prognosis is also more favorable, as the process is usually arrested by nature, regardless of treatment or the lack of it. However, unless treatment is efficient, the incident deformity may often be a greater handicap than when the lower extremities are involved. The eradication of tuberculosis is essential to the welfare of the individual, regardless of location or severity. The same careful treatment should be administered, including heliotherapy, for tuberculosis of the joints of the upper extremities as in the lower. The local mechanical treatment is simple and will be discussed in connection with each joint respectively, but must be accurate to avoid serious functional impairment.

The Shoulder.—In the shoulder, the process occurs more often in the head of the humerus. The first abnormality is inability to fully abduct, with gradual restriction in all movements until the range is limited to a few degrees. Pain is severe and is referred, as in all proximal joints, radiating down the arm, though it may be present locally if there is distention. Swelling is apparent and induration of the capsule may be detected on palpation in the early stage. Muscular spasm is present but cannot always be differentiated from contracted soft structures. Atrophy is apparent below the deltoid, but is obscured above this point by the periarticular and intra-articular exudates.

Treatment.—The shoulder must be maintained in about 45 degrees' abduction, with slight flexion and internal rotation, which may be accomplished by a plaster cast including the chest, or the author's shoulder traction splint, described on page 43.

The Elbow.—As the elbow is a superficial joint, all manifestations are local. The process originates more often in the humerus, but may arise in the radius or ulna. The first signs are stiffness with inability to fully extend and gradual decrease in range of motion. The elbow is fixed by muscular spasm at an angle of about 130 degrees, which might be considered the neutral position. The bony prominences are lost by a fusiform swelling, which becomes exaggerated by atrophy of the arm and forearm. Fluctuation, often apparent, is due to edema of the synovial membrane and periarticular structures, as very little, if any, fluid can rarely be aspirated.

Local heat, as in the knee, is pronounced until the process is entirely arrested. Pain is often of an acute and throbbing nature, and tenderness is constant. Muscular spasm completely restricts, or permits only a few degrees of motion. Abscess and secondary infection involving the joint cavity are frequent, but must not be regarded as so serious a complication as abscess in the spine and hip.

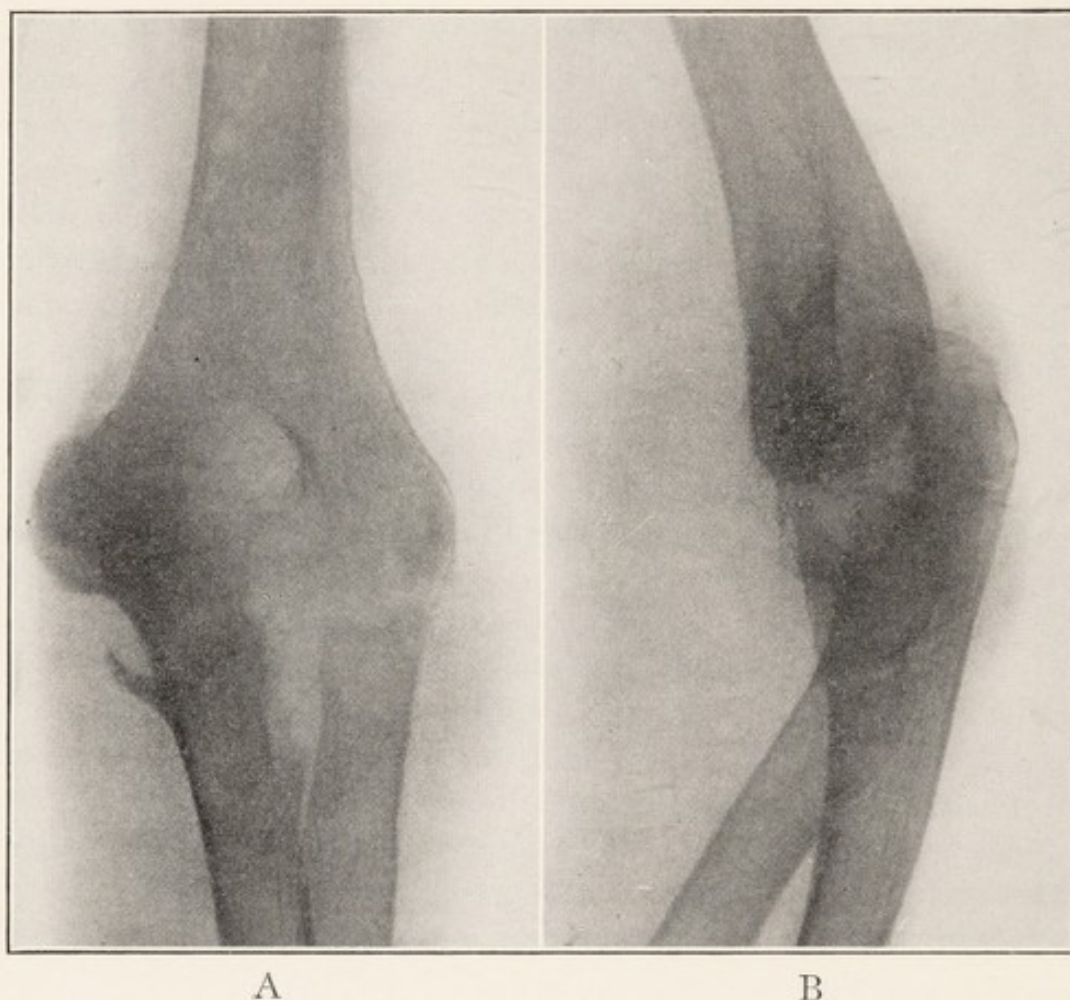


FIG. 72-A.—X-RAY SHOWING TUBERCULOSIS OF ELBOW JOINT WITH EXTENSIVE DESTRUCTIVE CHANGES, ANTEROPOSTERIOR VIEW.

FIG. 72-B.—SAME AS FIGURE 72-A, LATERAL VIEW.

The treatment consists in maintaining the joint at slightly less than a right angle, with the forearm in supination, by a simple posterior splint or bivalved plaster cast until the process recedes.

The Wrist.—In the wrist, the process usually begins in the carpus or lower extremity of the radius and is most insidious in onset, as there is very slight limitation in motion in the early stage. Swelling increases slowly from low-grade indurated inflammatory tissue. As the capsule is not resistant, there may be extensive exudates within the joint without producing tension and severe pain. There is a tendency to flexion and forward subluxation as disintegration progresses.

The local treatment consists of maintaining the wrist in extension or dorsiflexion by a plaster cast or cock-up splint. This fixation affords relief from pain and protection from slight injuries. The author prefers a leather corset for this purpose. Free motion must at all times be permitted from the metacarpophalangeal joints to the tips of the fingers.

Tuberculosis of the metacarpals and phalanges is similar to that of the corresponding bones of the foot.

CHAPTER VII

LOW-GRADE JOINT AFFECTIONS (*Continued*)

SYPHILIS

Syphilis affecting the joints in children is congenital through hereditary transmission, and is observed only in the tertiary stage. Acquired syphilis is so rare in children as to be dismissed as negligible. As bone forms the basis of all joints, syphilitic arthritis and osteitis must to some extent be discussed conjointly, though the difficulty of diagnosis is encountered only when the joints are involved, as the manifestations in bones are quite characteristic.

Congenital syphilis more frequently invades the joints in early childhood and the bones in late childhood. In the experience of the author, the distribution between the bones and the joints in children has been about equal; however, in adults the bones are more frequently involved.

Any joint may be invaded by syphilis, the knee being more often affected. A diagnosis of syphilis of the spine is rarely made, though in all probability it occurs more often than is generally known.

Pathology.—Syphilis is usually confined to one joint, though a polyarticular invasion is not uncommon. Syphilis of joints is manifested as follows: (1) simple synovitis with copious serous effusion and thickening of the synovial sac; (2) extensive proliferation of the synovia, as a low-grade inflammatory process. If not arrested, such process may be complicated by degenerative changes and the formation of typical gummata, which may erode and disintegrate the cartilage with destructive changes in the bone; (3) gummata arising in the epiphyses with the formation of cavities filled with liquefied necrotic detritus and often sequestra, which may break into the joint, causing extensive disintegration, with subluxation or malposition. Associated with or complicating joint syphilis, one or more bones composing an articulation may show evidence of syphilis, or the process may begin in the shaft of one bone with extension into the joint by continuity. In this manner, there may be destruction of the epiphysis with complete separation, causing malposition and deformity. In syphilis of joints, the process is usually spontaneously arrested with more or less irreparable damage to the joint, but solid bony ankylosis practically never occurs.

Symptoms and Joint Manifestations.—The constitutional symptoms are not characteristic, though the child may be physically subnormal. The stigmata or history of syphilis may or may not be elicited. The onset is slow and the course indefinite. The local symptoms of pain, tenderness and limited motion are much less than the existing pathology would indicate until there has been extensive destruction. As function is so slightly



FIG. 73.—DRAWING FROM X-RAY, SHOWING SYPHILIS OF ANKLE WITH PUNCHED-OUT AREAS ON THE ARTICULAR SURFACES OF TIBIA AND ASTRAGALUS.



FIG. 74.—DRAWING FROM X-RAY, SHOWING MULTIPLE PUNCHED-OUT AREAS OVER BOTH FEMORAL CONDYLES, END RESULT OF CONGENITAL SYPHILITIC ARTHRITIS.

impaired, atrophy in the affected limb is also much less than might be expected. The local manifestations may be divided into three types: (1) synovial; (2) proliferative; (3) degenerative.

In the synovial type, there is persistent distention of the joint with fluid and thickening of the synovial membrane, detected on palpation. The range of motion may be slightly restricted mechanically by effusion, but there is no muscle spasm. Local heat may be slightly elevated. The knee-joint is involved more often than any other joint, and a persistent hydrops of both knees is not uncommon.

In the proliferative type, there is definite swelling, and on palpation lobulated masses and thickening of the capsule can be detected, but slight, if any fluid. If syphilis is also present in the bone, there will be symmetrical hypertrophy. Pain may be present, but tenderness is slight and there is usually no muscle spasm. Motion may be normal or only slightly restricted.

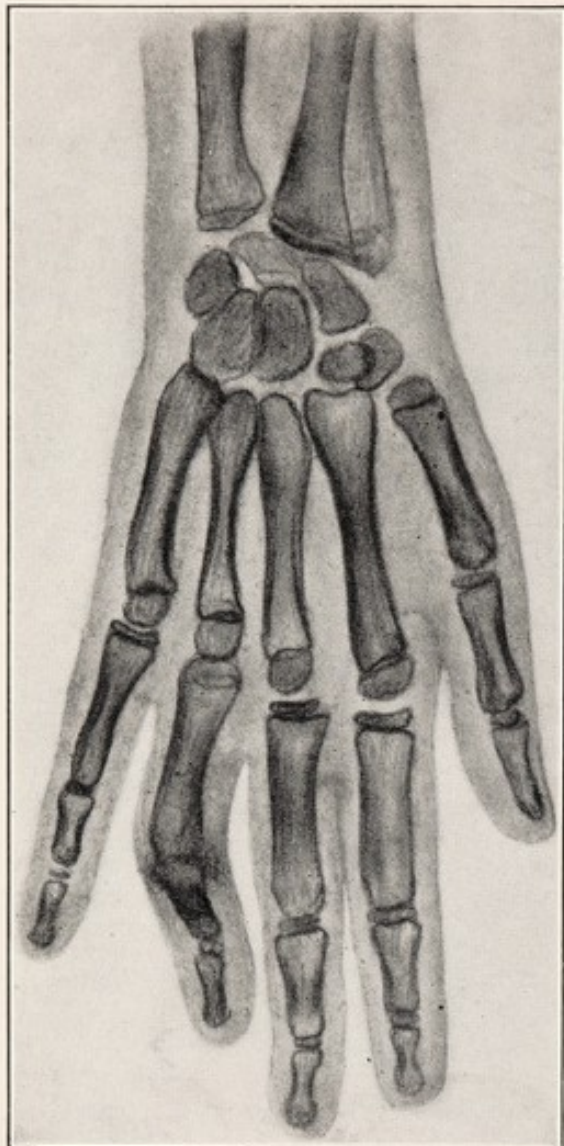


FIG. 75.—DRAWING FROM X-RAY, SHOWING TYPICAL SYPHILITIC DACTYLITIS, ONE OF THE MANIFESTATIONS OF POLYARTHRITIS.

The destructive type ensues if the proliferative process is not arrested. Pain, tenderness, local heat and muscular spasm are often pronounced if there has been extensive invasion of bone. However, the extent of destruction without acute local reaction is often astounding. In those in whom there is invasion from without, as in gumma of the epiphysis, the local symptoms are not pronounced until the process breaks into the joint, or until there is a pathological separation of the epiphysis.

In syphilitic polyarthrititis, there may be a gradual invasion of all joints, which is manifested by swelling of the soft structures. The involvement of the wrist and some of the phalangeal joints is more often apparent. Pain and limited motion are slight until there is extensive destruction, when subluxations and malpositions are also observed.

X-Ray.—As syphilis of the joints is often not recognized, a detailed description will be given of the x-ray findings.

1. There is no abnormality of the bone when the soft tissue of the joint only is involved, as in synovitis with effusion, or so-called proliferative arthritis.

2. An increase in density of one of the bones of the articulation, or often of gross hypertrophy, which is an extension of bone syphilis by continuity.

3. Proliferation of the periosteum on one of the bones forming the articulation, but extra-articular, or a short distance from the joint surface.

4. Definite punched-out areas on the articular surface, or, rarely, extra-

articular on the lateral or mesial surface of one of the bones, but very close to the joint.

5. Extensive erosion of the articular surface, with disintegration of bone as a late manifestation.

6. Osseous atrophy is absent and the normal structure is retained in adjacent bones until disuse is enforced by extensive destruction within the joint.

7. Typical manifestations may be present in other bones, especially an increase in dimension of the cortex of the tibia, which should always be x-rayed for diagnostic purposes, regardless of the location of a suspected lesion.

Diagnosis.—Opinions vary regarding the value of the Wassermann as a diagnostic agent in bone and joint syphilis. The author has made a very careful analysis of 130 cases of bone or joint manifestations of undoubted luetic origin. In 100, accurate records of the Wassermann test were found, in which 88 were positive and 12 negative. In those with congenital lues of joints, all were positive. As the blood test has given such reliable evidence, the spinal fluid examination is not deemed routinely necessary. Therefore, the Wassermann test is regarded as most valuable, but not absolutely conclusive. The therapeutic test, by the administration of antiluetic treatment, is also of value when symptoms are suggestive, but must be pushed to the limit if conclusions are to be derived from its use. The diagnosis is suggested in the synovial and proliferative types by the local objective manifestations being excessive when compared to the subjective symptoms of pain, tenderness and muscle spasm. In those in whom there are destructive changes, with acute symptoms as above described, differentiation from tuberculosis may be clinically difficult. In tuberculosis, the roentgenogram usually demonstrates that the process begins from without, while in syphilis, the joint surfaces are eroded in a rather characteristic manner from within, except when the process begins in the epiphysis as a gumma. In syphilis, there is often evidence of an area of necrosis with massive destruction of one portion of the articular surface, while the remainder of the joint is approximately normal or only slightly affected. If extra-articular bone syphilis is associated, there will be typical proliferative changes, whereas, in tuberculosis, the process is destructive and atrophic. In the residual stage of acute infectious arthritis, confusion might arise, but differentiation can be made by the roentgenogram, as previously described, and by the history of an acute onset.

The statement is frequently made that syphilis may simulate every known joint affection, but this might be said of many joint affections. It must also be remembered that syphilis and non-syphilitic joint affections are very common, and both might exist coincidentally in the same patient. The author has recently tabulated thirty-three joint affections of varying pathology and

origin, in which the Wassermann test was strongly positive. Seventeen of these were given intensive treatment without the slightest beneficial effect on the local process, indicating that the joint manifestations were probably due to other agents, even though syphilis was present.

The diagnosis of syphilitic polyarticular arthritis is also difficult, but differentiation from infectious arthritis, arthritis deformans, etc., can usually be made by the history, physical and clinical findings.

Prognosis.—In the synovial and proliferative types, recovery with excellent function, when efficient treatment is given, should be accomplished in all instances. If there has been extensive necrosis, or sequestration, the salvage of a good functional joint may be impossible, and the best that might be expected is the most useful position with limited, if any, voluntary motion. The diagnosis, therefore, should always be made before extensive destruction ensues.

Treatment.—In syphilis of bones and joints, the most intensive anti-luetic treatment is necessary. In children, arsphenamin in doses commensurate with the age should be administered intravenously, when possible, for at least six injections, with daily mercury rubs and potassium iodid internally. After an interval of one month has elapsed, a second series of six injections is given, and the mercury and iodids should be continued to the point of tolerance. This system should be enforced until the Wassermann is negative, if possible. However, in many with congenital syphilis, this may not be accomplished until the treatment is continued at intervals for years. In refractory children, sulpharsphenamin by intramuscular injections into the buttocks may be substituted for arsphenamin. Neo-arsphenamin is also recommended in children. In addition to the arsenic preparations, mercury and iodids should be vigorously administered.

Deformity or malposition should be corrected by mechanical apparatus, described in Chapter II, and the joint maintained in the most useful position. In those in whom joint destruction has rendered weight-bearing mechanically impossible without increasing deformity, apparatus should be used until full growth is obtained, when a reconstructive operation may be indicated to restore or improve function. Rarely, operative procedures may be indicated after intensive treatment, for the purpose of removing massive sequestra. Also, incision and drainage may at times be required for those with secondary infection.

LOW-GRADE OR CHRONIC INFECTIOUS ARTHRITIS

A low-grade infectious arthritis is of more frequent occurrence in children than is generally recognized; the process may be monoarticular or polyarticular. The cause is probably an attenuated virus of one of the pyogenic organisms, which may be carried to the joint by the blood stream

from a distant focus and instigate a definite infection; or bacterial toxins from a distant focus may possibly act in a similar manner. In children, any remote infection may be the etiological factor, but the tonsils, ears, sinuses of the nasal tract, and the genito-urinary tract are more frequently responsible.

Pathology.—The process begins within the joint, which becomes congested with thickening of the synovia and proliferation of the joint villi. Fluid may be excessively increased and is always serous. A low-grade inflammatory tissue with predominating fat may encroach upon the articular surfaces, and occasionally granulation tissue and pannus formation may be observed on the articular cartilage. Subsynovial adipose tissue may be increased, causing hypertrophy of the joint villi, which may rarely undergo metamorphosis with the formation of cartilage which may break off within the joint as large, loose bodies. Ossification may occur in the cartilaginous bodies, producing a condition known as osteochondromatosis, which, however, is extremely uncommon in children. Erosion of the articular surfaces is rare, and the bone is apparently not invaded to any extent, except in those representing the sequelæ of an acute infectious process. These manifestations are not pathognomonic of an attenuated infection, but of the reaction of joint tissues to persistent irritation, one of which is infection. In other words, the same gross pathological changes within a joint may be induced by several causative agents.

After the subsidence of the acute stage of acute infectious arthritis, an active but attenuated infection involving other joints may persist indefinitely. This process may extend over many years; coincidentally, there may be atrophy or osteoporosis, with malposition and dislocation until the child is totally disabled. Also, an infection beginning insidiously may pursue a similar course. After the child is totally disabled, intestinal disturbances may appear, but whether the cause or the effect of prolonged confinement, it is difficult to determine. Hypertrophic changes, or osteo-arthritis with osteophytes, so common in adults, is not prevalent in children, which is possibly due to the inherent difference in skeletal tissues. In the adult, bone is nearer the articular surface, and therefore more susceptible to irritation, which usually causes proliferative reaction in this type of infection.

Symptoms and Clinical Course.—The child may or may not be slightly under weight or puny. The temperature may remain normal or be only slightly elevated. The first local manifestation is slight swelling and soreness, which may be more pronounced as the process advances. There are two types: (1) synovial, with persistent effusion; (2) periarticular, in which both the synovia and the surrounding soft structures are indurated, as apparent on palpation. In the synovial type, the only manifestation is persistent effusion, with thickening of the capsule, which may be detected by palpation. Pain and tenderness are present but not exaggerated. In the

lower extremities, in the early stage, a slight constant or transitory limp may be present. Movement in the joint may be normal or only slightly restricted; for example, if the knee is affected, complete extension or flexion may be impossible. In the periarticular type, there is more pain and tenderness, with induration of soft structures. There may be no increase in local heat, or only a slight elevation. Motion is usually somewhat restricted in all directions, and may rarely be markedly limited by muscular spasm, especially when the hip is involved. Malposition with permanent deformity may occur, if not arrested by nature or treatment. The process is often



FIG. 76.—PHOTOGRAPH OF CHRONIC POLYARTICULAR INFECTIOUS ARTHRITIS, SHOWING INVOLVEMENT OF JOINTS OF HAND.

more extensive and symptoms are more pronounced when confined to one joint.

Low-grade infectious processes may occur in the spine as in other joints. Infectious spondylitis is evidenced by symptoms of pain and stiffness, and the x-ray will show that one or more vertebræ are wedge-shaped. Such conditions are frequently observed in fixed round shoulders or so-called static kyphosis.

The course of infectious arthritis of either the synovial or periarticular type may be prolonged and indefinite. The blood picture may show a slight leukocytosis, but not sufficient to be regarded as significant.

X-Ray.—There are no distinctive manifestations shown by the roent-

genogram. The soft tissues are thickened and there may be slight atrophy with mottling of the bone. Rarely there may be proliferation and condensation in the bone of the articular extremities, with destruction of cartilage, as indicated by diminution of joint space.

Diagnosis.—If polyarticular, the nature of the affection is quite evident by the symptoms and joint manifestations; but if monarticular, a very careful differentiation is often necessary to formulate a definite conclusion. The symptoms and local reactions are usually not so severe as in tuberculosis and can only be determined by prolonged observation or biopsy. However, incision into a joint for the purpose of diagnosis is not advisable, for no practical advantage is gained, and a differentiation can finally be made from the x-ray and physical findings, by a simple course of watchful waiting, while the joint is maintained in the most useful position. Syphilis is excluded by the Wassermann test, the absence of certain stigmata of

syphilis, and the exaggeration of local manifestations and pathological processes in comparison with the symptoms. Pain and tenderness in syphilis are much less than might be expected from the appearance of the joint. When syphilis is suspected, though the Wassermann reaction is negative, the therapeutic test is of great value. In the hip, coxa plana may be differentiated by the roentgenogram. The resemblance to low-grade traumatic arthritis may be so close that differentiation is impossible, for joint tissues often react in the same manner to different irritants. In traumatic arthritis there may be a definite history of injury, and the roentgenogram may give definite evidence of trauma. In such cases, it will obviously be to the best interest of the patient to consider the lesion infectious, as the local treatment is the same in both conditions. Polyarthritis with a progressive invasion of joints for an indefinite period may be confused with Still's disease, or arthritis deformans of childhood, but it is doubtful whether such conditions are not a special type of infectious arthritis. For all practical purposes, differentiation is unnecessary, since the treatment is identical.

Prognosis.—In monarticular infections, or in the event a small number of joints are invaded, the process usually terminates in complete recovery. If there has been actual destruction of bone, which occurs rarely, function may be more or less impaired. In those of lowered resistance, with progressive invasion of different joints, the arrest of the process may be difficult and often impossible, in spite of every known scientific measure.

Treatment.—In all types, attention should be given first to the eradication of foci of infection. A painstaking examination should be made of the tonsils, the nasal tract, including x-rays of the sinuses, ears, teeth, genito-urinary tract, digestive organs, and every possible location where latent foci may be found. This examination must be very thorough, complete, and by experts competent to make accurate discriminations, for too frequently an obvious focus of infection is overlooked or observed too late. However, at no stage can assurance be made that the process will be arrested by the removal of infected foci, for there is no method by which a focus of infection can be convicted of being the actual source of a distant infectious process. And even should a particular focus be the undoubted source, there is no reason to presume that the metastatic infection may not further propagate. However, there is abundant evidence to demonstrate that foci of infection are a source from which distant joints may be invaded, and that removal of such foci frequently does result in the rapid cessation of the pathological processes. Autogenous vaccines should be prepared from the excised material, but it is difficult to estimate their actual value.

There are no drugs which have any specific action on the pathological process, but salicylates may be employed for the relief of pain; this is seldom necessary except in those with progressive polyarticular infections. The diet

should be observed closely and must be well balanced and nourishing. A sufficient amount of food should be eaten, the index of which is the weight of the child. Heliotherapy has no local beneficial action, except as a tonic. Proper hygiene, fresh air and sunshine are, of course, essential. The joints should be held in the most useful position and all deformities prevented by apparatus applicable to the affected part (see Chapter II). As symptoms subside, active motion, with physiotherapy, may be instituted. In fact, massage, diathermy, and other physiotherapeutic measures may often be employed with benefit while the process is active. If observation is first made after malposition has occurred, correction should be acquired by apparatus or operative procedures, previously discussed in considering residual deformities of other affections (Acute Infectious Arthritis and Tuberculosis, pp. 57 and 76).

ARTHRITIS DEFORMANS OF CHILDHOOD

Arthritis deformans of childhood, or Still's disease, is essentially a polyarticular affection which may invade every joint in the body, and is associated with splenomegalia and lymphadenoma. The occurrence is more frequent in middle childhood, though very young children may be affected.

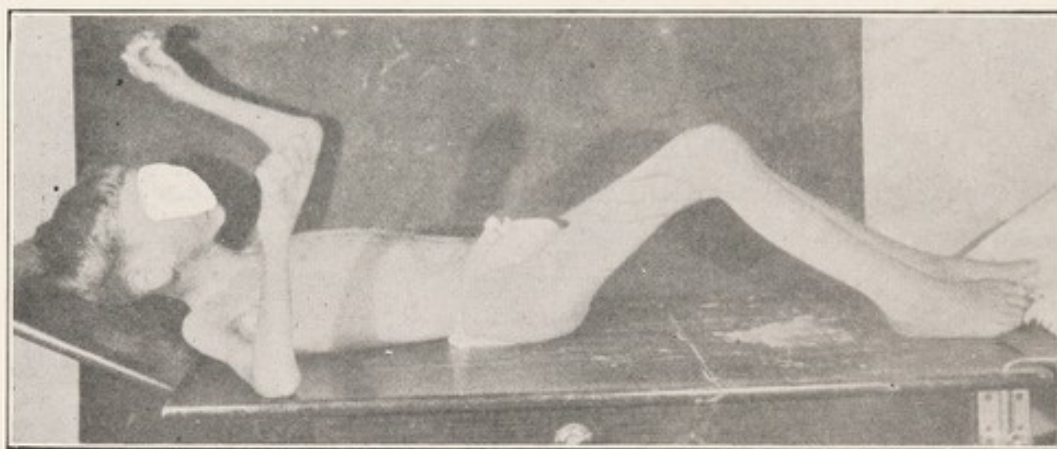


FIG. 77.—PHOTOGRAPH OF ARTHRITIS DEFORMANS (STILL'S DISEASE), SHOWING INVOLVEMENT WITH DEFORMITY OF PRACTICALLY ALL JOINTS.

The cause is unknown, but is probably of infectious origin; therefore, the condition may be considered in connection with the infections.

The onset may be gradual or rather sudden, with elevation of temperature. The child becomes emaciated. The course is slow and indefinite, but attended by acute exacerbations, with very high temperature, which may range to 106° F. The joints are painful, with intra-articular and extra-articular swelling. Exaggerated deformities, with contractions and luxations are complications, unless prevented by mechanical appliances. The process may continue indefinitely, and is rarely completely arrested. The x-ray shows atrophic changes and diminution of joint space.

Treatment.—No treatment has the slightest effect on the pathological process, the arrest of which, though rare, is always spontaneous. A search for infected foci should be made and, when found, eradicated, if possible. During the active stage, the joints should be maintained in the most useful position by apparatus; however, this is not always feasible, for the condition of the patient may not permit.

After the process has been arrested, a correction or partial correction can be made of the deformities by complicated appliances, which make gradual pressure in the desired direction. Also, operative procedures, as osteotomies, tenotomies, etc., are of material value. By these measures, chair- or bed-ridden individuals may be enabled to walk with or without crutches, and by vocational training earn their own livelihood.

OSTEOCHONDRITIS

Osteochondritis, epiphysitis, epiphyseal strain, and irritation occur in numerous epiphyses of the skeleton.

Affections of the intra-articular epiphyses will be considered here; those affecting the extra-articular epiphyses will be considered in the chapter on Bones (p. 144).

OSTEOCHONDRITIS OF HEAD OF SECOND METATARSAL

(Köhler's Disease)

The lower epiphysis, or head of the second metatarsal bone, may show atypical changes which are often called Köhler's disease of the second metatarsal bone. However, as there is usually a definite history of trauma, as stubbing the foot in running up steps or in playing tennis, Freiberg has termed the condition, "infraction of the head of the second metatarsal



FIG. 78.—PHOTOGRAPH OF ARTHRITIS DEFORMANS AFTER CORRECTION OF DEFORMITIES, SHOWING ABILITY TO STAND WITH BRACES.

bone." The second metatarsal is nearly always injured, as it is longer than the other metatarsals.

The local manifestations are pain, exquisite tenderness and definite enlargement of the head of the second metatarsal. The x-ray shows flattening of the head, proliferation of the epiphysis, and free bodies within the joint.

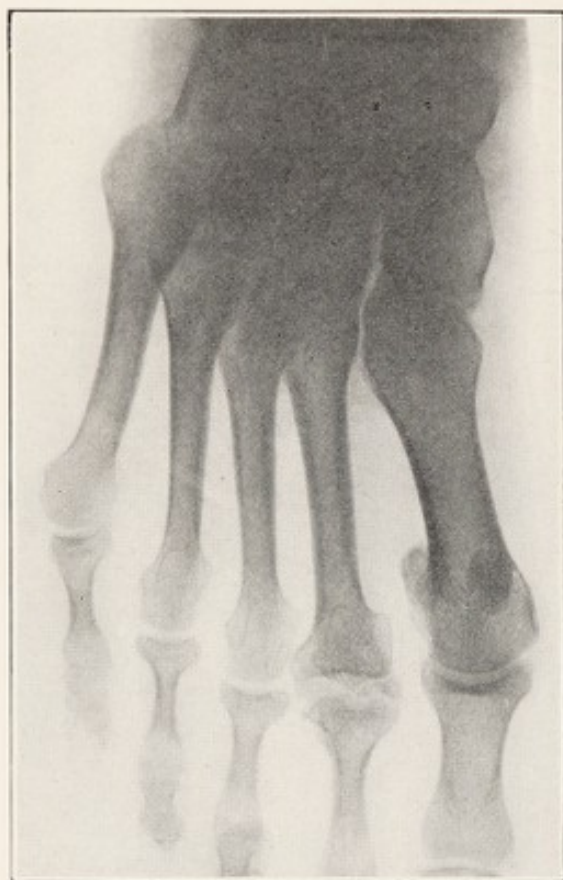


FIG. 79.—X-RAY OF OSTEOCHONDritis OF HEAD OF SECOND METATARSAL, SHOWING TYPICAL CORPORA LIBERA IN THE JOINT.

The treatment consists of elevation of the anterior arch by simple felt pads or special supports. If no relief is obtained by these measures, the head of the bone should be excised, and excellent results may be secured.

COXA PLANA

The clinical entity recognized as coxa plana was first described by Legg, in 1910, and three years thereafter by Perthes, of Prague; but for some unaccountable reason, the observation of Legg was passed unnoticed and the affection has been more commonly known as Perthes' disease, or osteochondritis deformans juvenilis. The term coxa plana, suggested by Jansen, is most convenient, if not appropriate, as it conforms to the nomenclature of

certain affections of the upper extremity of the femur. The affection occurs during the middle years of childhood between the ages of five and ten, rarely thereafter.

Coxa plana, as the name implies, is a flattening of the head of the femur, the knowledge of which has been acquired largely from the roentgenogram, as there has been no mortality and no gross pathological specimen of an entire joint. There are three well-known theories as to the etiology of this condition namely: (1) traumatic; (2) congenital malformation; (3) infectious.

Legg, who first described the condition as flat head of the femur, concluded from the history of his cases that trauma was the causative agent. Jansen and Delitalia have demonstrated a malformation of the pelvis in coxa plana which renders the articular surface irregular, so that weight is not equally distributed as in the normal child. They believe this unequal distribution of weight acts as an insidious or repeated cause of trauma, pro-

ducing flattening of the head and the characteristic changes. Freiberg¹ considers the process to be an infection from a distant focus. Kidner² and Phemister³ have operated during the active stage of coxa plana and found definite low-grade inflammatory changes. Kidner isolated the *Staphylococcus albus* in one case. Calvé believes the condition to be of rachitic origin, though no evidence is found in other bones to support this theory. Coxa plana, in all probability, may be induced by any one of the etiological factors above mentioned, as certain reactions in bones, as has been demonstrated in joints, may be produced by different causative agents.

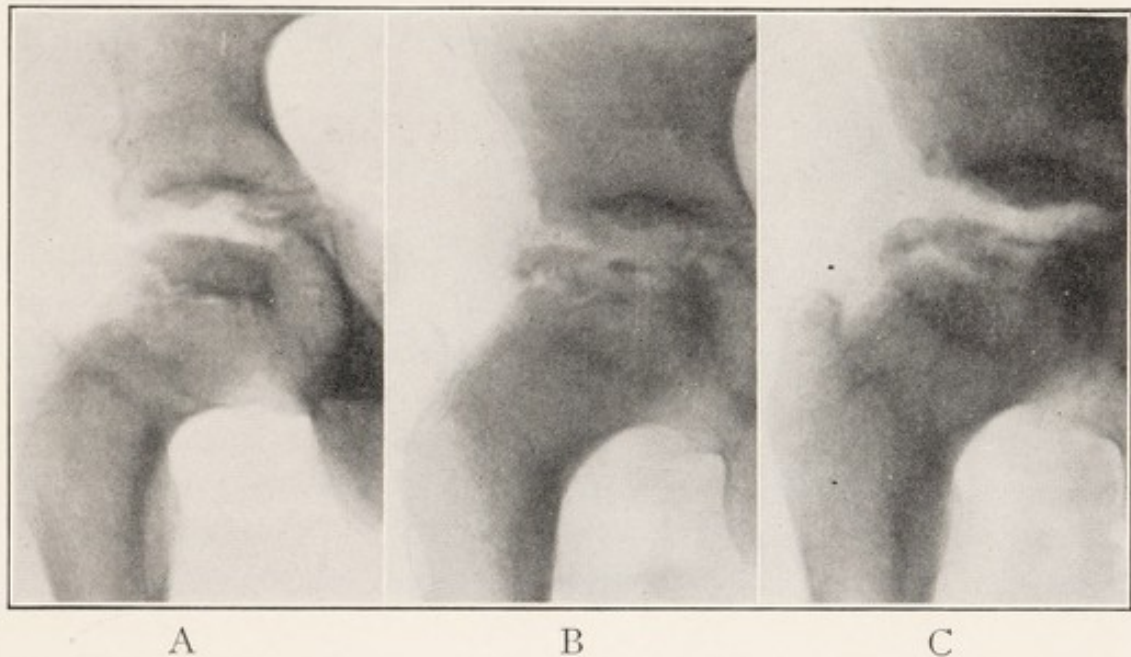


FIG. 80.—X-RAY SERIES OF COXA PLANA, SHOWING PROGRESSIVE FLATTENING AND FRAGMENTATION OF HEAD AND BROADENING OF NECK OF FEMUR.

Symptoms.—There are no constitutional symptoms. The first apparent abnormality is a slight limp. Pain, with rare exceptions, is very slight and referred to the anterior aspect of the thigh or knee. The trochanter becomes gradually more prominent, and slight adduction may develop, but there is rarely gross malformation. At the onset, motion is limited chiefly in abduction and internal rotation, but as the process advances, partial limitation is observed in other directions. Mensuration at the onset may show the limbs to be of equal length, but as destruction occurs, the affected limb becomes about one-half inch shorter, rarely as much as one inch, with the trochanter above Nélaton's line. The process is evolutionary, requiring about one year for the usual course.

¹ A. H. Freiberg, "The Evolution of Osteochondritis Deformans Juvenilis," *J. Am. M. Ass.*, 1916, 67: 658.

² F. C. Kidner, "Perthes' Disease," *Am. J. Orthop. Surg.*, 1916, 14: 339.

³ E. B. Phemister, "Operation for Epiphysitis of Head of Femur," *Arch. Surg.*, 1921, 2: 221.

X-Ray Examination.—In the early stage, the x-ray shows that the head of the femur is losing its normal globular shape and is slightly flattened, with upward displacement of the head on the neck. Coincidentally, irregularity or proliferative changes in the acetabulum, resulting from mechanical irritation, may be demonstrated. The dimension of the neck of the femur is somewhat increased. After several months there is fragmentation of the flattened head, which partially disappears, terminating in an irregular articulation with impaired function, but never ankylosis.

Diagnosis.—The diagnosis is made by the local manifestations and the characteristic roentgenograms. In early tuberculosis, observation for several months may occasionally be necessary before differentiation can be made, but when a tuberculous process is established, motion is definitely limited in all directions, and the symptoms are more exaggerated. The erroneous diagnosis of tuberculosis, when coxa plana exists, undoubtedly accounts for many cures reported by physicians as well as by various cults. Also, as coxa plana has been recognized only for a few years, the diagnosis of tuberculosis must have previously prevailed and obviously renders all but recent statistics of tuberculosis of the hip unreliable.

In psoas muscle irritation resulting from abscess or affections of the spine, motion of the hip is chiefly limited in extension or hyperextension, and there are often manifestations in the spine. A psoas abscess may often be palpated above Poupart's ligament. In coxa vara from epiphyseal separation, the symptoms are identical with coxa plana, but the occurrence is at a more advanced age, about adolescence. Coxa vara of congenital rachitic origin cannot be confused, as there are definite signs of rickets elsewhere in the skeletal system; in addition, the x-ray must be used for differentiation.

Prognosis.—Good function may result in untreated cases, but recovery, with less impairment and a more normal joint, is accomplished by efficient treatment. The resulting irregularity of the joint may be conducive to arthritic changes, though the individual may undoubtedly go through life with little, if any, inconvenience.

Treatment.—As there is a possibility of infectious origin, a careful search for possible foci should be made, though no effect on the local process has ever been observed from the eradication of such foci. When the process is unusually acute, recumbency with extension is advisable until the symptoms disappear. At the onset, the child should be anesthetized and the hip placed in extreme abduction and internal rotation, and so maintained by a plaster cast for two or three months, after which a Bradford abduction splint is worn for ambulation. As the process recedes, a simple Thomas knee splint, or caliper, is quite sufficient. Heliotherapy and the Alpine light are also beneficial. As soon as the process has subsided, as indicated by the x-ray, the apparatus should be gradually discarded. In those observed very late in the process, no treatment may be required.

COXA VARA

Coxa vara is a confusing term, as it is applied not only to the clinical entity at present under discussion, which decreases the normal angle formed between the neck and shaft of the femur; but also, when there is a decrease in this angle from any other etiological factor, as fracture, rachitis, or a destructive process. The normal angle between the neck and shaft in children is about 160 degrees; in adolescents, about 140; and in adults, 130. If below 115 degrees, the condition is abnormal and coxa vara exists. When there is a lowered resistance at this point, there will obviously be a tendency for the head of the femur to slip downward on the neck; this is caused by the weight of the body being received on an oblique axis. An inward deviation of the shaft is thus produced, and from this the nomenclature was derived, to conform to that of similar anomalies in other locations, as genu varum, etc.

Coxa vara, an epiphyseal separation of adolescence, only, is pertinent to the subject under discussion, as a low-grade affection involving the upper femoral epiphysis. This condition occurs between the ages of twelve and eighteen, or until such time as the epiphysis is obliterated by solid bony fusion between the neck and head of the femur. Endocrine disturbance is so frequently associated as to be regarded as a predisposing cause, for coxa vara is frequently observed about the age of puberty in large, fat, neuter types with hypopituitarism and hypothyroidism. Latent rickets is also considered an etiological factor. Boys are more frequently affected, in the proportion of about four boys to one girl, in the author's series of twenty-four cases. The process is more often unilateral, but may occur in both hips. Coxa vara of adolescence is also observed in normal, healthy individuals. Trauma is undoubtedly an active causative agent, and is usually definite or severe in normal individuals, but may be slight and not apparent in the neuter type. Bilateral coxa vara in the neuter type is hardly compatible with trauma, unless we accept the fact that excessive weight may act, by the force of gravity, on an area of decreased resistance. The observation of a large number of cases at different stages indicates that trauma often causes a partial separation, which may not be manifested by definite symptoms until there is a material change in relation between the head and neck of the femur induced by weight-bearing.

Pathology and X-Ray.—A proliferative and degenerative process is apparent in the epiphysis, with definite separation; the head is displaced downward in relation to the anatomical neck, which gradually decreases until the angle becomes acute. Atrophic changes may occur in the head, which may become broadened, flat or irregular—the so-called mushroom head. The diameter of the neck from above downward is increased. The

powerful external rotators and the natural gravity of the lower extremity turn the limb outward, so that the neck becomes convex or bowed forward, except rarely, when the opposite forces may be active and the limb may be rotated inward with backward bowing of the neck. The roentgenological manifestations are definite and characteristic, and cannot be confused with other conditions.

Symptoms.—The symptoms of coxa vara are almost identical with coxa plana. There are no constitutional manifestations. Local pain is re-

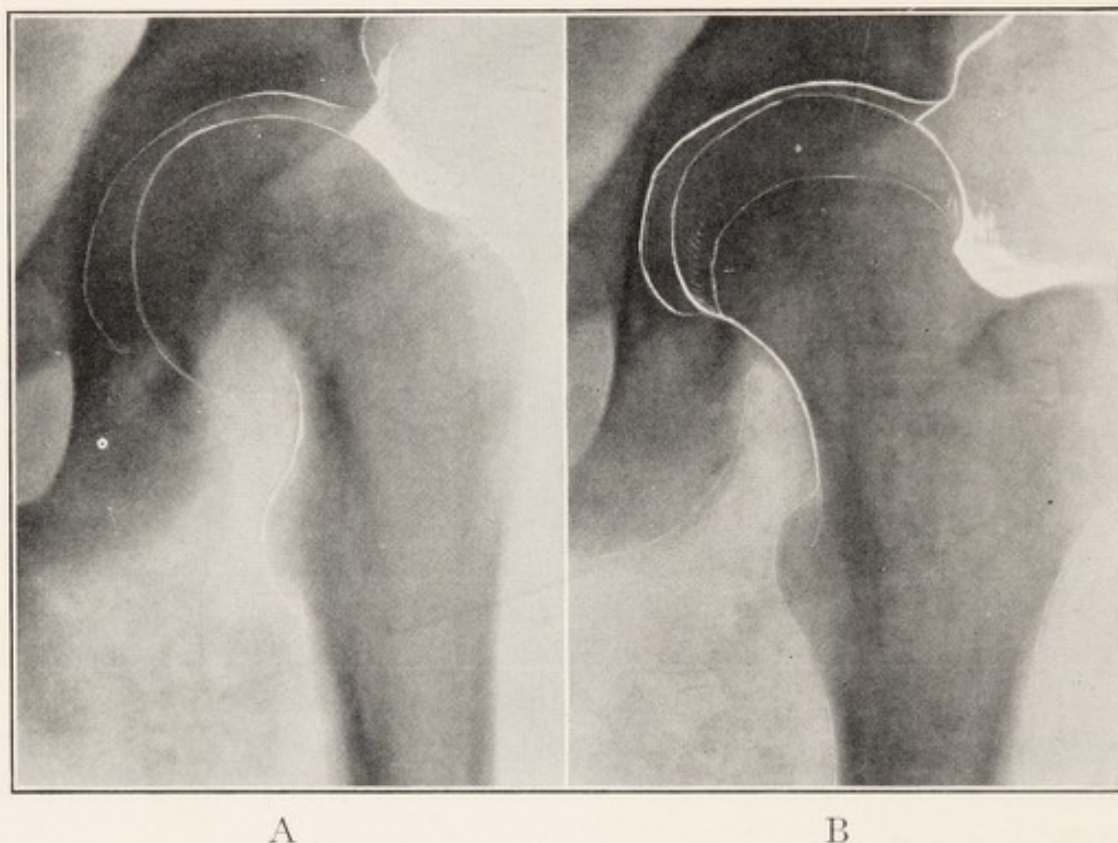


FIG. 81-A.—X-RAY SHOWING COXA VARA WITH DOWNWARD DISPLACEMENT OF HEAD ON NECK OF FEMUR.

FIG. 81-B.—SAME AS FIGURE 81-A AFTER CORRECTION BY MANIPULATION, SHOWING NORMAL RELATION OF HEAD AND NECK OF FEMUR.

ferred to the thigh or knee; atrophy and muscular spasm are slight at the onset. Motion at the onset is limited chiefly in abduction and internal rotation. This is mechanical, as the greater trochanter impinges on the dorsum of the ilium when abduction is attempted, and the anterior convexity of the neck on the rim of the acetabulum when rotated inward. The limb is held in external rotation so that the toes turn outward. The trochanter is prominent and above Nélaton's line, with commensurate shortening of the limb. The limp is one of shortening, no effort being made for protection, as pain is slight, except after excessive exercise. In the bilateral form, there is a peculiar waddle with out-toeing, which is characteristic. If the process is not arrested, the neck may bend to an acute angle with extreme adduction

deformity and blocking of the hip-joint. The duration of the process varies from six months to two years.

Diagnosis.—The diagnosis is easily made by the symptoms and joint manifestations, and confirmed by the x-ray. In coxa plana, the age of occurrence is different, as are also the roentgenological findings. In tuberculosis of the hip, motion is limited in all directions, while in coxa vara, at the onset, it is limited chiefly in abduction and internal rotation. In tuberculosis, atrophy of the limb and all symptoms are more exaggerated, and the roentgenogram shows slight, if any, changes at the onset. In coxa vara, the characteristic process is detected early by the roentgenological examination, and the process is demonstrated to be more rapid. In psoas contracture, motion is limited chiefly in extension. In congenital dislocation of the hip, the limp is elastic with excursion of the trochanter upward, and movement is free in all directions. Hip manifestations in the neuter type of fat boys are usually due to coxa vara.

Prognosis.—Regardless of the efficiency of the treatment, there may be appreciable shortening and impairment of function. Whenever an epiphysis is injured or becomes the seat of any pathological process, growth may be arrested or impaired. However, a good functional limb should be obtained with either no limp or a very slight limp. In those untreated or inefficiently treated, there may be extensive shortening with deformity, impaired function and permanent disability. There is no mortality.

Treatment.—If deficiency is present in the endocrine glands, appropriate treatment is administered. Also, in the fat neuter type, reduction in weight should be made by dietetic measures. When observed at the onset, or before extensive structural changes occur, the patient should be placed under deep anesthesia and the limb completely abducted and rotated inward; slight force may be required. This position should be maintained by a plaster cast from toes to nipple line. At the end of three months, the cast should be removed, and if there is sufficient consolidation, the Bradford abduction hip brace is applied, with stirrup extending below the foot in order to prevent weight-bearing on the affected area. If the process is still active when the cast is removed, a second cast is applied for two months, but ambulation is allowed with crutches and an elevated shoe on the opposite foot. When the process is receding, gradual weight-bearing is permitted by the Bradford abduction brace or the Thomas caliper brace. Apparatus should not be discarded until there is consolidation.

In normal individuals with epiphyseal separation produced by definite trauma, there may be rotation of the head within the acetabulum, so that approximation is impossible; open operation with complete and accurate approximation then becomes imperative. In those with endocrine disturbances, and of the neuter type above described, open operation is not indicated during the active process. After the process is arrested, if there is residual

deformity, operative procedures should be employed. The operation consists of an osteotomy of the femur at the level of the lesser trochanter, and forcible abduction of the limb to about 45 degrees, and at the same time, rotation inward to overcome fixed outward rotation. A plaster cast is applied until union is solid, when walking with or without a brace is permitted. After the operation, the x-ray may demonstrate a rather grotesque



FIG. 82.—X-RAY SHOWING COXA VALGA IN ANTERIOR POLIOMYELITIS.

Note upper articular rim which has been made by turning down chips of bone from the ilium to prevent paralytic subluxation of hip.

appearance, but the angle is increased or restored to normal and the functional result is usually excellent. In those with an angle of 90 degrees or more, the normal angle can be completely or partially restored, with material improvement in function and decrease in disability. In the event extensive structural changes with acute angulation have occurred, only partial correction may be expected, but anatomical alignment, with definite improvement, can be obtained.

COXA VALGA

Coxa valga is considered here only because it is the opposite condition to coxa vara. The angle of the neck is increased and the femur elongated. Coxa valga is caused by a lack of weight-bearing, as after amputation and infantile paralysis. The normal angle is induced by the weight of the body, and the trabeculae of bone are arranged to give support on the

oblique axis. As age advances, this angle is decreased, so that in old age it may be as low as 120 degrees. Coxa valga is not pathological, but is simply a question of functional adaptation. There are no symptoms. The roentgenogram shows the angle between the neck and shaft to be increased, and the femur may form almost a straight line. The entire bone is smaller, with structural atrophy from disuse. The only treatment is to increase weight-bearing, which may require special apparatus.

OSTEOCHONDRITIS OF THE SPINE

The spine in children may be involved in a low-grade process with definite destructive changes, which pursue a course similar to that of coxa

plana or osteochondritis juvenilis of the hip. As no special term is applied, for convenience of description this group will be called osteochondritis of the spine.

Etiology.—The etiological factors, with the exception of the congenital theory, are the same as in coxa plana: (1) traumatic; (2) infectious; (3) rachitic.

Kümmell's disease, or compression fracture, pursues approximately the same clinical course, and in consequence, is considered in conjunction with osteochondritis.

Pathology.—The pathology is demonstrated by the x-ray, which shows that one or more vertebræ have been compressed and are more or less wedge-shaped. If the compression is from above downward, the abnormal contour may be apparent only on side view, and if the compression is lateral, only on anteroposterior view. The dimension of the intervertebral space is diminished. The process is spontaneously arrested, with more or less permanent irregularity of the affected vertebræ, or there may be an almost complete regeneration, so that abnormality may not be detected by the x-ray.

Symptoms and Clinical Course.—The onset and subsequent clinical course are slow and indefinite. A history of acute trauma occurring several weeks previously is often obtained. Pain and muscular spasm are present, but in a milder degree than is observed in frank inflammatory affections of the spine. The first manifestation may be a beginning kyphos, evidenced by a prominent spinous process.

Diagnosis.—The diagnosis is made by the mild symptoms and the roentgenogram. In the past, this affection has been almost universally treated as tuberculosis, or Pott's disease, which accounts for many of the remarkable cures reported. In tuberculosis, the symptoms are more exaggerated. The x-ray usually demonstrates an inflammatory exudate surrounding the affected region; also, disintegration is often more apparent. However, the process as demonstrated by the x-ray in osteochondritis of the spine and tuberculosis may so closely resemble that differentiation is impossible for several months.

Prognosis.—Recovery is usually spontaneous. Deformity is rarely severe, and if treatment is efficient, no abnormality may result. If wedging of the vertebræ persists, there will be a permanent mechanical defect, which may induce static and postural deformities in later years, as round shoulders and lateral curvature.

Treatment.—The same principles are involved as in the treatment of tuberculosis of the spine. Apparatus appropriate to the region affected is applied to secure fixation and prevent deformity. So soon as the symptoms subside, which is usually from one to two years, appliances are gradually discarded. The patient must be carefully observed, especially through the

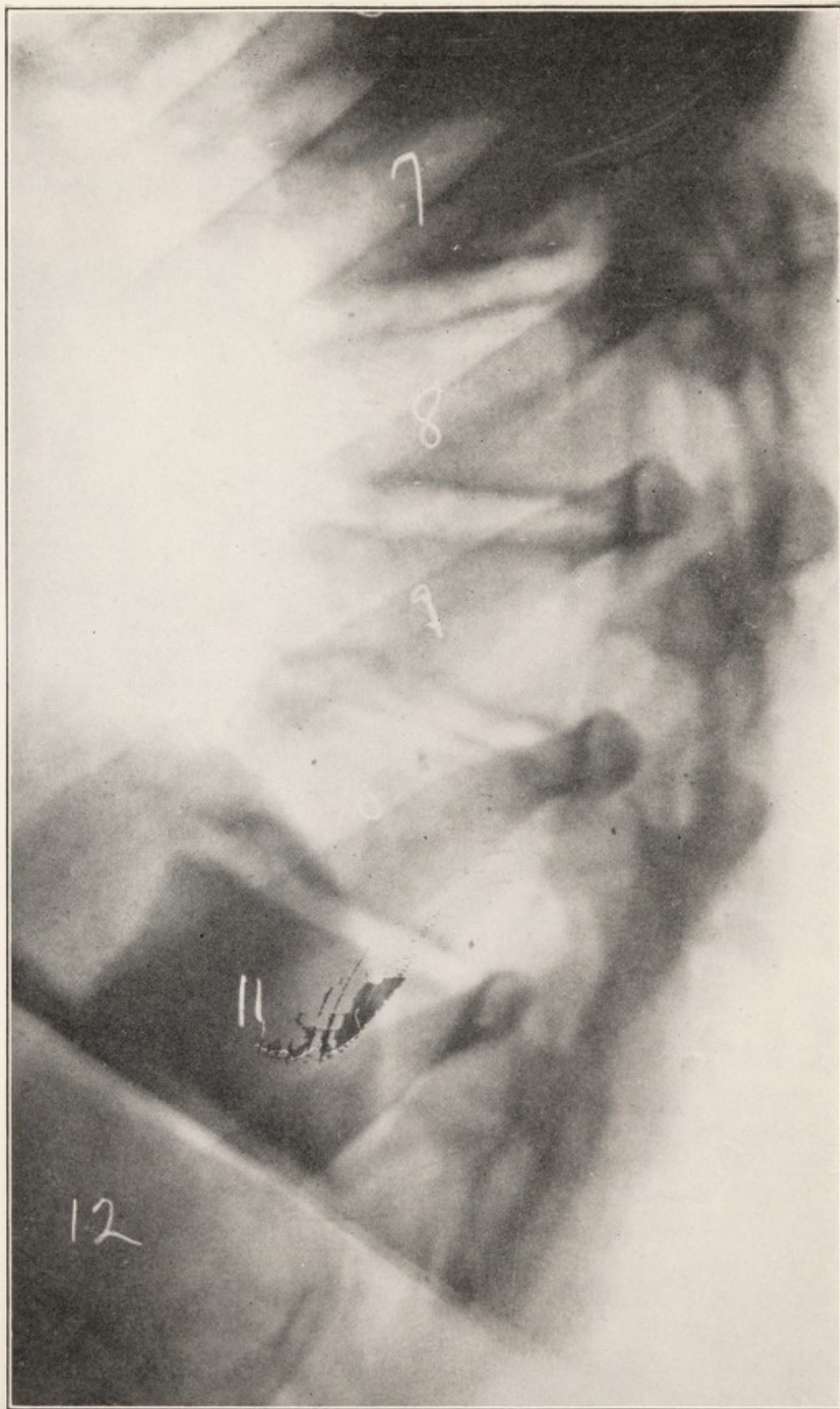


FIG. 83.—X-RAY SHOWING OSTEOCHONDritis OF SPINE WITH WEDGE-SHAPED COMPRESSION OF VERTEBRÆ.

period of puberty and until full growth is attained, so that static deformities may be arrested at the onset, should such complications arise.

REFERENCES

- CALVÉ, JACQUES, Sur une forme particulière de pseudo-coxalgie greffée sur des déformations caractéristique de l'extrémité supérieure du fémur, *Rev. de chir.*, 1910, 30: 54.
- CAMPBELL, W. C., An Analysis of Bone and Joint Lesions of Known Syphilitic Origin, *Radiology*, August, 1925.
- DELITALIA, F., Perthes' Disease, *Am. J. Orthop. Surg.*, 1914, 12.
- JANSEN, M., On Coxa Plana and its Causations, *J. Bone & Joint Surg.*, 1923, 5: 265.
- KÖHLER, ALBAN, Typical Disease of the Second Metatarsal Phalangeal Joint, *Am. J. Roentgenol.*, 1923, 10: 705.
- LEGG, A. T., An Obscure Affection of the Hip Joint, *Boston M. & S. J.* 1910, 162: 202.

CHAPTER VIII

TRAUMATIC JOINT AFFECTIONS

TRAUMATIC ARTHRITIS

Trauma is considered a remote factor in many affections of bones and joints in childhood, but the types to be discussed are those of undoubted traumatic origin.

Traumatic arthritis may be: (1) acute, (2) subacute or chronic. Acute traumatic arthritis, or sprain, will be first considered.

Acute Traumatic Arthritis.—Acute traumatic arthritis is caused by direct or indirect violence, and is usually followed by immediate reaction within the joint. A sprain is induced by indirect violence, in which there is a wrenching, stretching or tearing of ligaments. The extent of reaction depends entirely upon the degree of force and the resistance of the tissues. In those with severe injury, the joint becomes distended with fluid, admixed with more or less blood. Ligamentous displacements and ruptures, tears of the muscles and tendons, and fractures, usually of small particles of bone into or adjacent to the joint, are often associated. Extensive fractures may also be a complication, which renders the equation more complex and not pertinent to the subject. Rarely, the reaction in the joint may not occur for a week or more after the injury; such delayed reactions are probably due to trauma which affects the cartilage only, as it is an inert substance which may require several days for vascularization or innervation. The symptoms of pain, swelling, with obliteration of bony prominences, and fluctuation from joint distention are well known and require no description. The diagnosis is self-evident and the prognosis excellent, though serious complications may follow in those improperly treated.

An x-ray examination should always be made, which will demonstrate only distention of the capsule of the joint when uncomplicated. However, excessive swelling of the soft parts often obscures slight luxations and fractures, which might result in permanent disability unless discovered. The roentgenogram alone is dependable, the fluoroscope being unreliable near joints, especially in children in whom a large amount of cartilage is found.

Treatment.—The treatment will be considered in the joints, which are more frequently subjected to trauma.

The Ankle.—The manifestations of a sprained ankle are well known. There is only one treatment—the Gibney adhesive dressing.¹

¹ Virgil P. Gibney, "Sprained Ankle," *New York M. J.*, 1895, 61.

The child reclines on a table or sits on a chair with the knee flexed, relaxing the heel cord. If hair is present, the limb should be shaved to the knee. Strips of ZO adhesive plaster of sufficient length, and from one to one and one-half inches in width, are used. The foot is held at a right angle to the leg with slight inversion. In order to obtain efficient fixation, care must be exercised to avoid the constant tendency to involuntary plantar flexion. The first strip of adhesive plaster begins on the outer aspect of the leg about at the junction of the middle and upper thirds, is passed downward under the arch of the foot in line with the outer malleolus, and then across the sole of the foot, making firm traction and pressure. When the inner border of the foot is reached, the adhesive strip is passed over the internal malleolus and to the inner aspect of the leg, terminating above, opposite the beginning of the strip on the outer side. As the inner portion is attached, a firm upward pull is made, thus forming a stirrup with definite upward traction. A second strip is placed at right angle to the first strip, beginning on the outer aspect of the dorsum of the foot, passing behind the heel and terminating on the inner aspect, thus making a forward pull or push on the heel. The third strip is applied similarly to the first strip, but posterior to it. The fourth strip begins on the outer aspect of the dorsum of the foot just below the second strip, passes behind the heel, terminating on the inner aspect. In this manner, alternating strips about the leg and foot enclose the entire ankle except a small area on the anterior aspect. Small circular strips are placed about the whole, but without pressure, in order to retain the dressing.

The Gibney method of strapping should be applied as soon as possible after injury, to prevent swelling. Walking is not only permitted, but should be enforced, and can usually be accomplished without pain. Two or three dressings at weekly intervals are usually sufficient.

The Knee.—Slight injuries may require only strapping and bandaging, with careful observation for a few days. In severe injuries, with excessive fluid and increased tension, the joint should be aspirated, after which a firm compression bandage is applied. If there is a re-accumulation of fluid, which is rare, the same measure should be repeated. A plaster cast from the ankle to the groin, or a posterior gutter splint may be applied. As soon as the acute symptoms subside, walking is permitted, but fixation should be continued for at least three weeks, and sometimes for a longer period. In the knee, such complications as displacement of cartilage, tear

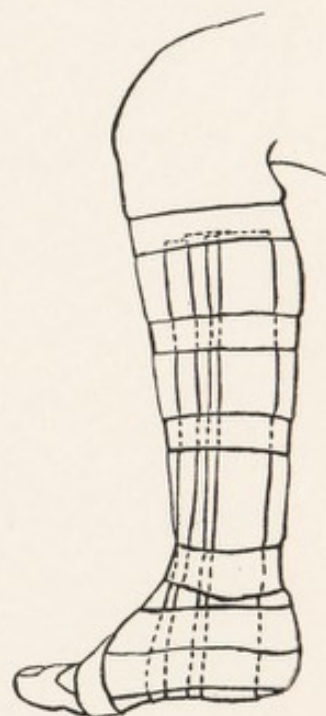


FIG. 84. — DRAWING SHOWING METHOD OF APPLYING GIBNEY STRAPPING FOR SPRAINED ANKLE.

of ligaments, etc., are not infrequent, but their harmful effect can be prevented in a large percentage by sufficient and efficient treatment. Physiotherapy should be employed in children when available and practicable, but is rarely essential to recovery.

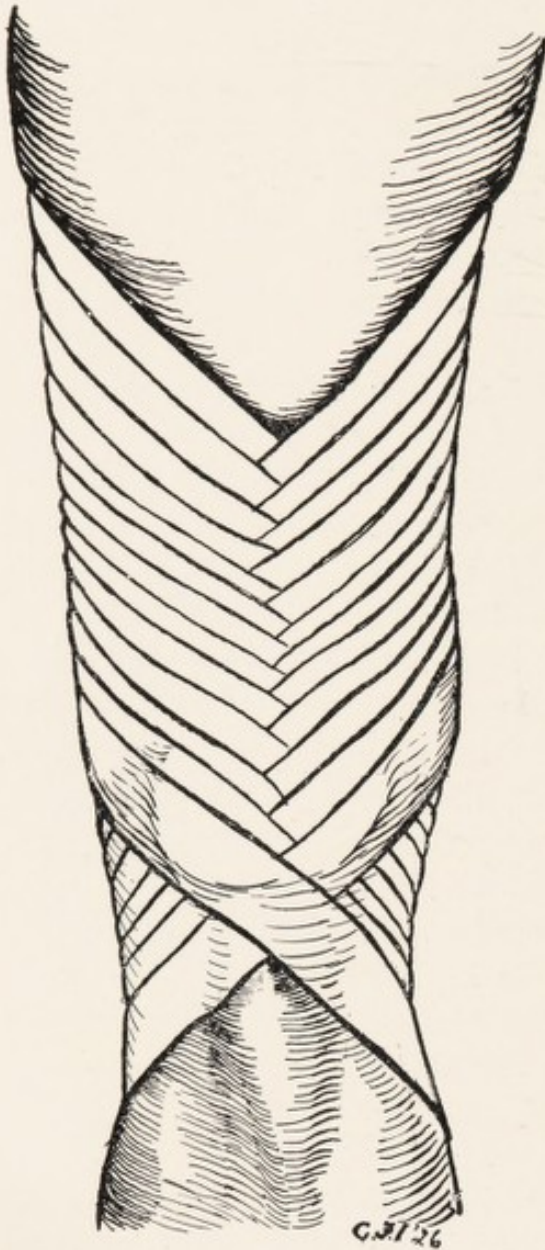


FIG. 85.—DRAWING SHOWING STRAPPING OF KNEE WITH ADHESIVE PLASTER, BASKET-WEAVE METHOD.

The Hip.—Slight injuries involving the hip-joint should not be lightly dismissed. The child should be kept in bed so long as there is limitation of motion by muscular spasm, as very serious affections may be induced by trauma, which might be prevented. No walking should be permitted until the limp has disappeared. In those with acute symptoms and synovitis, evidenced by pain, muscular spasm, etc., a Buck's extension apparatus should be applied until the joint is approximately normal, which may require from one to three weeks. Except in very slight injuries, the child should be kept under observation for at least one month. If such measures were instituted in every instance, many children would be prevented from becoming permanently crippled.

The Sacro-iliac Joint.—Symptoms referable to the sacro-iliac joint cannot always be dissociated from those of the lumbosacral articulation. Trauma of this region is comparatively rare in childhood. Later in life the sacro-iliac joint is so frequently the seat of injury or irritation from various indefinite agents, which are attributed to trauma, that brief mention should be made.

Trauma, infection, or irritation in this region from any cause may induce a symptom complex which is fully described on page 122.

X-Ray.—The x-ray in sacro-iliac strain usually shows no abnormality in relation to joint surfaces or osseous structure. Occasionally an elongated and bifid transverse process of the fifth lumbar vertebra is present and is supposed to have some leverage action by pressing on the sacrum, thereby predisposing to injury. This, however, is purely theoretical.

Diagnosis.—Differential diagnosis is made by various clinical and laboratory tests. A history of definite trauma is obtained in traumatic arthritis, or sacro-iliac strain.

Treatment.—If the symptoms are slight, strapping, followed by a simple belt, is applied (described in Chapter II), compressing the sacro-



FIG. 86.—X-RAY SHOWING ENLARGED TRANSVERSE PROCESS OF FIFTH LUMBAR VERTEBRA.

iliac joint; or if severe, the patient may be placed on a Bradford frame with extension to both lower extremities until the contour of the spine is normal. Also, under anesthesia, the hip with the knee extended may be forcibly hyperflexed and then retained in the anatomical position (in a straight line with the body and slightly abducted) by a plaster cast closely conforming to the iliac crests and extending from the nipple line to the knee on the affected side. The cast is removed in three weeks. The

modus operandi of this maneuver is forcible traction by the hamstrings on the innominate bone, hoping that an obscure luxation in the sacro-iliac joint or elsewhere will be reduced, but just what happens cannot be explained by the roentgenogram or otherwise. Consequently, this procedure is purely empirical. After either extension or fixation in plaster, a spinal brace with sacro-iliac attachment or simple sacro-iliac belt is applied. Apparatus is discarded at the end of three or six months, when symptoms have usually subsided.

Sciatic Scoliosis.—In affections of the sacro-iliac joint, the patient may assume unconsciously a position of scoliosis, which is characteristic of the condition. This is known as sciatic scoliosis. The lumbar lordosis is decreased; the lumbar spine is curved, usually in the opposite direction, in an effort to relieve the pain. There is spasm of the spinal muscles and limited motion of the spine in all directions. There may be tenderness over the sacro-iliac joint or sciatic nerve and pain referred down the back of the thigh to the calf.

The treatment is similar to that for arthritis of the sacro-iliac joint.

Acute Traumatic Spondylitis.—Definite symptoms of pain and muscular rigidity may be observed in any region of the spine as the result of trauma, but the cervical and lumbar spine is more frequently injured. There may be a similarity to early tuberculosis of the spine, which may require several weeks for differentiation. The x-ray shows no abnormalities, but should always be made when symptoms are first observed, as fractures or luxations may complicate. Six weeks after any severe injury of the spine, a second roentgenogram should be made, as fractures which cannot be demonstrated at the time of the accident may be apparent later. Compression of the spinal cord resulting from fracture is exceedingly rare in children, due possibly to the greater elasticity of the tissues than is observed in the adult spine.

Treatment.—Mechanical measures, appropriate to the region affected, are applied. In the cervical spine, head traction is beneficial, usually relieving symptoms within a few hours, but must be continued until muscular spasm has completely disappeared. In other portions of the spine, recumbency in bed or on a Bradford frame may be indicated. Rarely, a plaster cast or brace may be necessary for several weeks or months. The prognosis in spinal injuries must be guarded, but with efficient early treatment, recovery is practically assured.

The Elbow.—The elbow is frequently traumatized without incident fracture, and is peculiarly resistant to treatment. Limitation of motion may persist for several weeks and is especially noticeable in extension. A strip of periosteum may be displaced within the brachialis anticus muscle with callous formation, inducing so-called myositis ossificans, which may permanently block joint motion.

Treatment.—Physiotherapy or simple massage is indicated, but spontaneous recovery may be expected in time. In those in whom myositis ossificans mechanically obstructs motion, absorption may occur with restoration of normal function. Excision of the bony mass is indicated after organization into solid bone occurs, but not before, as recurrence may be expected.

SUBACUTE TRAUMATIC ARTHRITIS

Long-continued impairment of a joint may result from severe or repeated trauma, or from a slow-acting trauma, as unequal distribution of weight, faulty weight-bearing, or overuse, as in certain vocations.

Subacute or chronic traumatic arthritis may be manifested as a persistent serous synovitis, or there may be proliferative changes of the soft structures within the joint, which cannot be differentiated from a low-grade infectious arthritis, as joints react in the same manner to different etiological factors. Any joint may be so affected, but the knee is more susceptible to such reactions from injury, and will therefore be considered in detail.

The Knee.—Trauma may cause mechanical derangements within the knee-joint, inducing characteristic manifestations, which are as follows:

1. The semilunar cartilages may be torn loose from their attachment and displaced, the internal being more frequently deranged. Only a portion of the cartilage is detached at its circumference. The cartilage may be caught between the articular surfaces of the internal condyle of the femur and the internal tuberosity of the tibia. Sudden pain is experienced, and the joint cannot be fully extended until the cartilage is disengaged. An acute arthritis, evidenced by effusion, follows, and there is tenderness over the upper internal margin of the tuberosity of the tibia. Attacks may be of frequent occurrence, and may induce permanent organic changes within the entire joint. Displacement or derangement of the internal cartilage is observed rarely until late childhood. Symptoms of external derangement are the same, but on the outer aspect of the joint. The diagnosis is made by the symptoms alone, as the x-ray shows no abnormality, there being no break in continuity of bone or change in contour of joint space. The treatment should be conservative after the first attack, by simple fixation for several weeks, when the cartilage may re-attach or adhere in a harmless position. Should there be repeated displacements, an incision is made into the joint and the anterior two-thirds of the cartilage removed, as the posterior portion can cause no injury and is inaccessible. Recovery should be complete, as the absence of semilunar cartilage has no appreciable effect thereafter. However, when the loose cartilage has existed for a long period of time, more or less proliferative arthritis may persist, but even when this has occurred, excision of cartilage may give material relief.

2. Anomalies of the external semilunar cartilage. As a result of

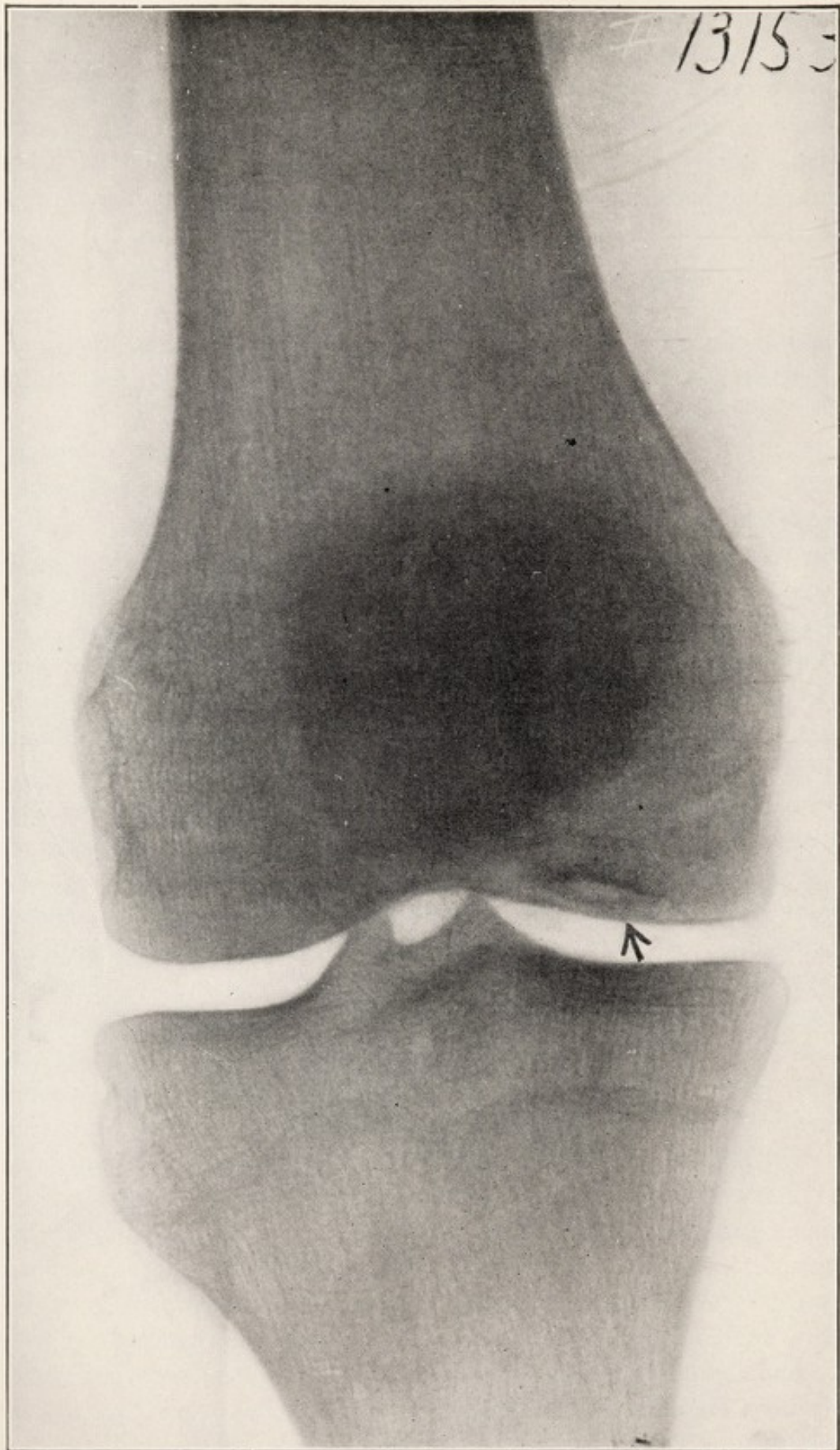


FIG. 87.—X-RAY OF OSTEOCHONDritis DISSECANS, SHOWING TRIANGULAR AREA OF RAREFACTION ON MEDIAL CONDYLE OF FEMUR SURROUNDING SMALL AREA OF INCREASED DENSITY; ARTICULAR CARTILAGE STILL INTACT.

trauma, the external semilunar cartilage may become hypertrophic, causing a loud snap or click, the location of which may be detected with the stethoscope. A dull ache is usually associated, and if severe, treatment may be requested. If relief is not obtained by fixation, excision of the cartilage is indicated. Cysts of the external semilunar cartilage occur more often in childhood than is commonly supposed, and are probably the result of trauma. They appear as a small globular mass which is palpable on the external aspect. On aspiration of the tumor, a viscous or clear gelatinous fluid is found. If withdrawal of the fluid does not give relief, excision of the cyst with the entire external semilunar cartilage is indicated.

3. Rupture of ligaments may cause false motion in the joint and permit slight rotary displacements, with pain and effusion. This condition, however, is exceedingly rare in children.

4. Loose bodies may be found as a result of trauma to the articular cartilages. A small portion of cartilage breaks off into the joint, or a small mass of cartilage with adherent bone may be crushed and later exfoliated. The latter type is also called osteochondritis dissecans. Loose bodies may also be derived from an extensive proliferation of the synovia and the formation of teatlike processes, which undergo metamorphosis into cartilage and bone. These processes may become free bodies within the joint cavity. This condition is known as osteochondromatosis. Loose bodies within the joint may be impinged between the articular surfaces, causing pain and effusion. The same symptoms may also be produced by the impingement of large synovial villi. Loose bodies can usually be detected by the roentgenogram and, if causing symptoms, should be removed.

BLOOD DYSCRASIAS

As a result of deficiencies in the blood, coagulation may be delayed. Hemorrhage may occur spontaneously into a joint or following a slight injury. This condition may be induced by some toxin, but is more often due to a congenital deficiency of the blood known as hemophilia. The joint becomes distended suddenly and there is pain with fever. After the subsidence of symptoms, there may be adhesions within the joint, and deformity. The prognosis and constitutional treatment is that of hemophilia. The local treatment is conservative, with fixation. Operative measures are obviously contra-indicated.

NEOPLASMS

Neoplasms affecting joints may be classed as: (1) benign, (2) recurrent, (3) malignant. With rare exceptions, they do not arise primarily within the joints in children. Therefore, a discussion of bone tumors will appear

in the chapter on affections of bones, to which reference may be made (p. 192). Joints are often invaded by a new growth from without, which causes an extensive destructive or proliferative process with local manifestations and symptoms of arthritis. However, an osseous tumor often becomes first apparent from symptoms in an adjacent joint. Clinically, therefore, they present a definite class requiring special consideration for the purpose of differentiation from other joint lesions.

Benign Tumors.—Benign tumors primarily arising in joints, as lipoma, fibroma, xanthoma, etc., are so infrequent in children as to be negligible. Osteoma or osteochondroma adjacent to joints may interfere with muscle play or induce bursa formation, and thus interfere indirectly with function. The joints may show evidence of irritation with pain, tenderness and effusion. As giant-cell tumors are always observed near the articulation, an arthritis may be induced, or an invasion of the joint, with massive destruction and deformity, may occur.

Recurrent Tumors.—Recurrent neoplasms are tumors that recur locally after removal, but do not metastasize. These are usually fibroma or chondroma. However, the line of distinction is often so fine between the recurrent and malignant types that the prognosis must be guarded. Recurrent neoplasms rarely occur in bones or joints in children. Their action is usually mechanical, as in benign tumors. The treatment is complete extirpation with cauterization, but after repeated occurrence, amputation may be necessary. Radium and x-ray therapy are also indicated.

Malignant Tumors.—Malignant tumors often arise in the extremities of bones adjacent to the joints; hence, invasion by continuity is frequent, but rare from metastasis. The symptoms and joint manifestations are not constant; but when the tumor is established, there is usually intense throbbing pain, and the joint is held in the flexed position. In incipiency, motion is slightly limited, but as the invasion advances, no movement may be possible on account of pain. There is often mottling of the skin, due to the instinctive application of heat by the patient. In the country, children with bone tumors soon discover that sitting near the open fire decreases the local pain to some extent. Increased local heat is often present from an associated destructive arthritis. The superficial veins are distended. On palpation, there is definite hypertrophy of the extremity of the bone involved, and evidence of increased intra-osseous tension, which is demonstrated by intense pain on deep and continuous pressure, which may cause the child to scream with agony.

A new growth or neoplasm can usually be differentiated by the x-ray, but differentiation as to the degree of malignancy or type cannot always be made.

The diagnosis is usually made by the local manifestations and the x-ray.

However, a biopsy and microscopical examination of an excised specimen may be indicated. As only one joint is involved, with rare exceptions, the erroneous diagnosis of tuberculosis is often made.

The prognosis and treatment will be discussed under bone tumors.

CHAPTER IX

AFFECTIONS OF THE BONES

ACUTE INFECTIONS

Acute pyogenic infection of bone is analogous to acute infectious arthritis, and is known as acute infectious osteomyelitis, which signifies an inflammatory process involving the central canal and the osseous structure. Acute periostitis denotes an inflammatory process confined to the periosteum, but is of such rare occurrence as to be dismissed with mere mention. All prefixes will be omitted and the term "osteomyelitis" will be employed in this discussion for convenience in description, to signify an inflammatory process induced by the invasion of pyogenic organisms alone; though in the literal meaning, an inflammatory process in bone from any cause is osteomyelitis. The staphylococcus and streptococcus are usually the causative agents of infection, and are derived from distant foci, as the tonsils, ears, furuncle of the skin, paronychia, etc., and conveyed to the bone by the blood stream. Osteomyelitis may also be caused by direct infection from without, as in gunshot wounds and compound fractures; but such cases present very different surgical problems.

Etiology.—Osteomyelitis is of more frequent occurrence than any other destructive process in bone and is more prevalent during the period of osseous growth. Trauma, by decreasing local resistance, is often a predisposing agent. Boys are affected more frequently than girls. Any part of the skeleton may be the seat of osteomyelitis, but the infection more often lodges in a long bone adjacent to the epiphyseal cartilage, which usually acts as a defending wall, preventing entrance into the joint. The bones affected in the order of frequency of occurrence, in the author's series of over five hundred cases, are as follows: tibia, femur, humerus, radius.

Pathology.—Osteomyelitis may be *local* or *diffuse*; if local, the process is confined more often to one bone, but may extend through the epiphysis and joint cavity into adjacent bones. Diffuse osteomyelitis is the dissemination of the infection into many bones. The infection begins more often in the central canal, near the epiphysis, inducing an intense hyperemia, which is followed by pus encased within the bone under great tension. After several days, the pus may be forced through the haversian system and separate the periosteum from the bone as an abscess. The periosteum in turn may be ruptured with an extravasation of pus into the surrounding

tissues. Bone is either slow to reaction from irritation, or the local reaction may not be apparent in the roentgenogram for a considerable time. The inner surface of the periosteum proliferates with the formation of callus surrounding the original bone in the affected region. This new bone gradually solidifies into a cylinder of dense, hard, eburnated bone known as the "involucrum," through which irregular fenestra are made by the flow of the purulent discharge from within. Coincidentally with the evolution of the involucrum, the original bone dies *en masse* or in disseminated areas, and is known as "sequestrum." The sequestra become gradually detached from the living bone, remaining loose within the involucrum, surrounded by pus, necrotic detritus and atrophic living bone. The entire process requires from three to six months for development, after which it remains *in statu quo* with purulent discharge flowing through the fenestra in the involucrum to the surface. This condition may persist throughout life, or after months or years, sequestra may be extruded, with closure of the sinuses. In rare instances, sequestra may be encapsulated by healthy granulation tissue, with closure of sinuses; however, retained sequestra are prone to become active at any time. The soft tissues surrounding the infected bone are involved in the inflammatory process, which is followed by cicatrices which cause the skin to adhere in the bone.

Symptoms and Local Manifestations.—The symptoms and clinical course of osteomyelitis may be divided into three stages: (1) acute; (2) subacute or chronic; (3) stage of residual impairment.

Acute Stage.—The acute stage begins with sudden onset, often with chill or convulsion. The temperature is high, ranging from 103° F. to 106° F., except in those with attenuated infections, which are exceedingly uncommon. The pulse rate is rapid and there may be stupor or delirium with the facies of an intense sepsis. Pain is typical of intra-osseous pressure—intense, constant, throbbing and boring in character. Slight, if any, swelling is observed until the purulent exudate reaches the periosteum, when there is swelling of the soft parts. The blood shows a high leukocytosis and marked increase in polynuclear leukocytes. In from three to seven days there is definite swelling and the constitutional symptoms may decrease

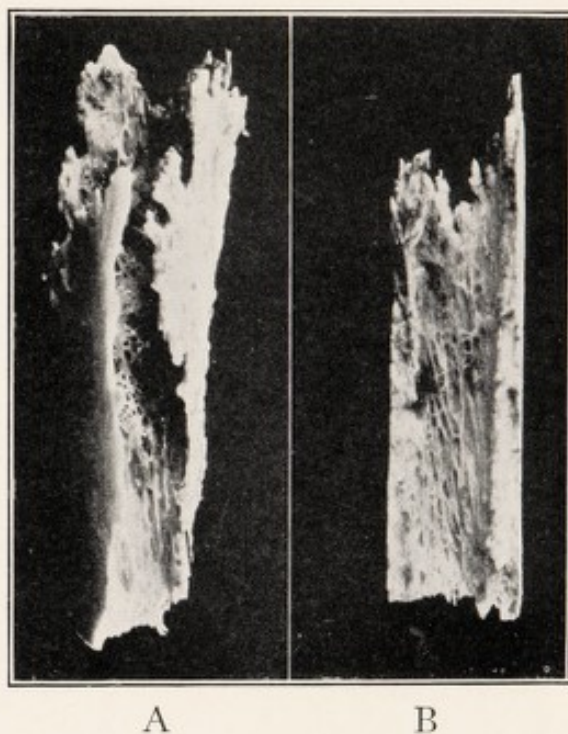


FIG. 88.—PHOTOGRAPHS OF SEQUESTRUM REMOVED AT OPERATION FROM CHRONIC OSTEOMYELITIS OF TIBIA.

if death has not ensued from sepsis. As the process advances, there is cellulitis with abscess in the soft tissues, which may be evacuated through the skin. The duration of the acute stage is from four to six weeks or may be continued indefinitely. The constitutional symptoms subside simultaneously with the evacuation of pus, and the subacute or chronic stage is reached.

Subacute and Chronic Stage.—During this stage, the general condition improves, but one or more sinuses at various points continue to drain. On palpation, there is induration of the soft parts and hypertrophy of bone.



FIG. 89.—X-RAY OF ACUTE OSTEOMYELITIS OF LEFT FEMUR, EARLY STATE, SHOWING VERY SLIGHT STRUCTURAL CHANGE.

Stage of Residual Impairment.—The stage of residual impairment is a permanent status and is observed after the sinuses have healed. On palpation, the bone is usually hypertrophic, being often twice the normal size. The skin may be adherent over a large area, especially when such superficial bones as the tibia are involved. Pain is often experienced in cold weather or after fatigue, though the individual may not be seriously incapacitated unless contractures of the soft parts, or destruction of bone and joints have induced deformity or arrested function. Acute exacerbations may occur from trauma or spontaneously in after years.

X-Ray.—At the time of the onset and often as long as three weeks thereafter, there may be no apparent reaction in the bone that can be

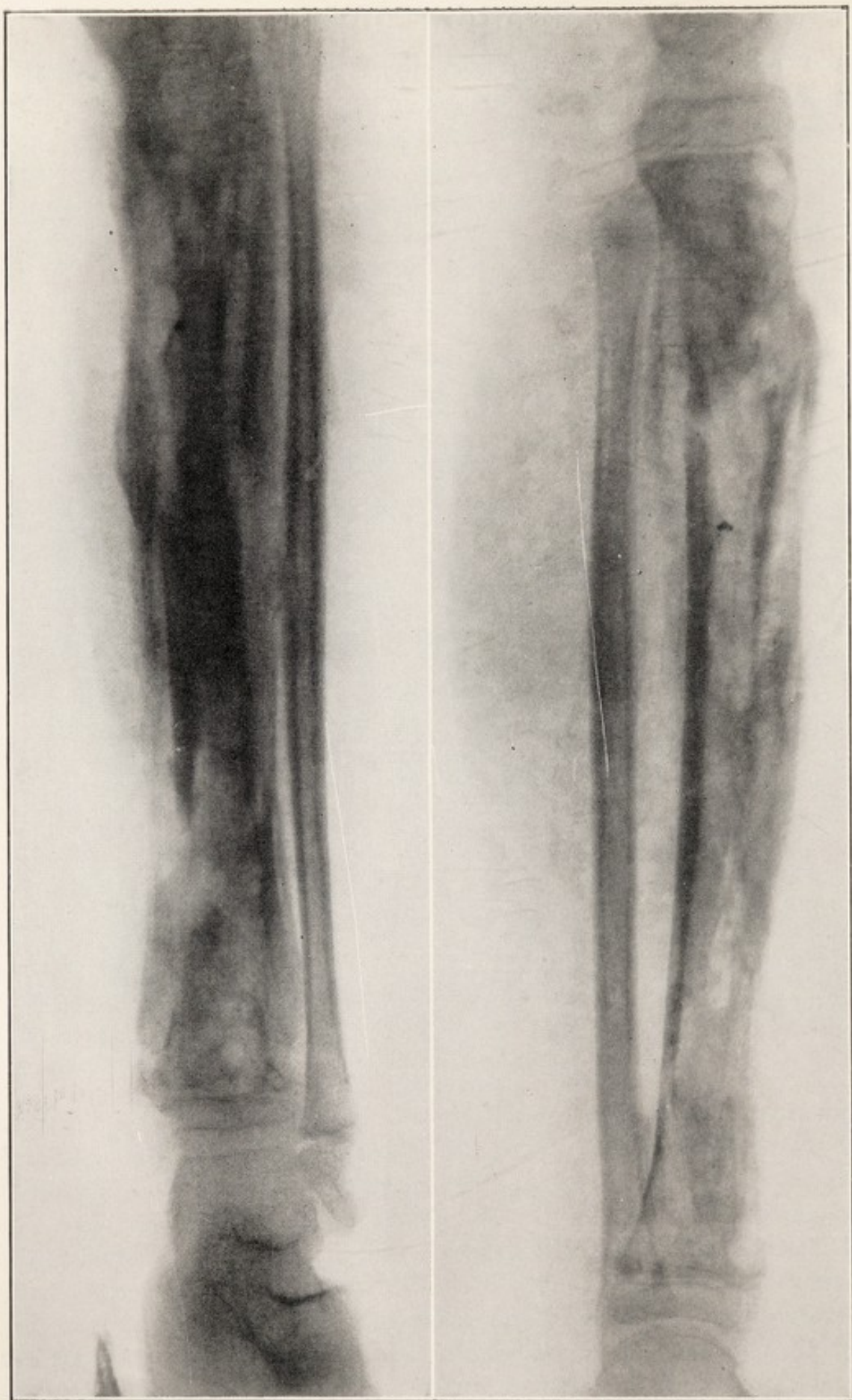
demonstrated by the x-ray; consequently, the x-ray is of diagnostic value only in the early stage in excluding other pathological processes. The first manifestation, proliferation of the periosteum about the infected area, is observed from one to four weeks after the onset. Subsequently, extensive destruction with atrophy of osseous structure is apparent. Sequestra or dead bone retain the same density as at the time of death, and consequently stand out in marked contrast to the surrounding atrophic bone. As the process advances, the dense involucrum of the chronic stage is observed



FIG. 90.—SAME AS FIGURE 89, FOUR WEEKS LATER, SHOWING EXTENSIVE PROLIFERATION AND DESTRUCTION.

surrounding necrotic and atrophic bone and sequestra. Massive hypertrophy, and often cavities within, are seen at this stage. The bone may become so dense and hypertrophic that active processes, sequestra or cavities are obscured.

Diagnosis.—The correct diagnosis at the onset, though essential to the conservation of bone and often to life, is seldom made. In every case, however, an early diagnosis can be made by the observation of the following symptoms and local manifestations: sudden onset, high fever, more or less general sepsis, high leukocytosis, pain without swelling, pain of intra-osseous tension, which is intense and boring, and increased on deep, firm, continuous pressure. The suspected area is palpated, and after locating the tender points, the index finger is used to make deep, firm pressure. If there



A

B

FIG. 91-A.—X-RAY OF CHRONIC OSTEO-MYELITIS OF TIBIA SHOWING SEQUESTRUM, DENOTED BY DARK AREAS OF CONDENSED BONE SURROUNDED BY PROLIFERATION AND FORMATION OF INVOLUCRUM, ANTEROPOSTERIOR VIEW.

FIG. 91-B.—SAME AS FIGURE 91-A, LATERAL VIEW.

is osteomyelitis or intra-osseous pressure from any cause, intense pain will be experienced and the child will scream with agony. The roentgenogram at the onset is of no diagnostic value.

The diagnosis in the chronic stage and the stage of residual impairment can be made by the history, the local manifestations and the x-ray, any one of which is pathognomonic. In spite of the well-known manifestations of chronic osteomyelitis, the erroneous diagnosis of tuberculosis is made almost universally. This common mistake could be avoided if it were known that tuberculosis and osteomyelitis begin near the end of the bone, but tuberculosis almost invariably travels in the direction of the joint which it invades, while osteomyelitis travels in the opposite direction down the shaft. When osteomyelitis invades a joint, the shaft is also involved in a hypertrophic process, whereas, in tuberculosis, there is atrophy and the area of destruction is confined to the vicinity of the joint and does not involve the shaft or bone for an appreciable distance. The onset, clinical course and roentgenological manifestations of osteomyelitis and tuberculosis are also obviously different. In tuberculosis of bone with secondary purulent infection, the differentiation is more difficult, but can be distinguished by the history of a low-grade infection prior to acute symptoms.

Prognosis.—In the acute stage of osteomyelitis in the extremities, the prognosis as to life and osseous destruction depends entirely upon the diagnostic acumen of the attending physician and the immediate relief of intra-osseous tension by drainage of the affected area. In virulent infections, death may ensue from sepsis, regardless of treatment, but in a high percentage recovery and restoration to normal may be expected if the proper procedures are efficiently carried out. The prognosis is also influenced by the location of the process. Virulent infections with extensive involvement of the spinal vertebræ are usually fatal.

In the chronic stage, there is no affection in which the results depend more upon efficient procedures. In certain inaccessible locations, as the lower extremity of the femur and the pelvis, where extraction of sequestra with efficient drainage is often impossible, the process may continue indefinitely. If sequestra and necrotic detritus are removed, and sufficient drainage established, complete healing may be expected.

The stage of residual impairment should never be reached, as immediate drainage in the acute stage is followed by restoration to normal. However, as this is rarely accomplished, there is extensive destruction in a high percentage, and replacement is effected by dense eburnated bone with deficient blood supply. In consequence, symptoms of pain in cold weather or after fatigue may persist throughout the life of the individual. The younger the child affected with osteomyelitis, the nearer normal in structure will be the substituted bone. Abscesses or local relighting, with or without trauma, may occur many years after the original infection, but if there



FIG. 92-A.—SAME AS FIGURE 91-A, ELEVEN MONTHS AFTER RADICAL OPERATION, SHOWING DENSE NEW BONE FORMATION, ANTEROPOSTERIOR VIEW.

FIG. 92-B.—SAME AS FIGURE 92-A, LATERAL VIEW.

are no retained sequestra or large cavities, the process usually subsides after a short course. Therefore, there is no method by which a permanent cure can be determined, though in a large percentage there is no recurrence.

Treatment.—In the acute stage, surgical interference is imperative at the onset, but obviously cannot be carried out unless the diagnosis is made. The test for intra-osseous pressure, above described, localizes the point of greatest activity of the infection. An incision is made over this point, down to and through the periosteum, which is peeled away from the bone. With a drill, two or more holes are made into the central canal. One drill hole will not suffice, as the principle of siphonage is involved. A small trapdoor may be made with mallet and chisel, instead of the drill holes. Hospital facilities and expert surgical aid should be obtained, when available, within a few hours; otherwise the operation should be performed by the physician in charge. Drainage of the affected area can be accomplished with an ordinary gimlet or drill of any kind. A small wire nail and hammer can be employed if too much force is not used. After drainage, the child can be transferred safely to the nearest hospital for further treatment, if necessary. The most common error is to make too shallow an incision and fail to reach the periosteum.

Deformity should be prevented when the process is in the vicinity of a joint, or when there is the slightest evidence of muscle contracture, by applying apparatus to retain the affected part in the most useful position. Apparatus should be continued until the inflammatory process subsides, and should be re-applied at the slightest sign of recurrence of deformity or malposition.

In the subacute or chronic stage, sequestra, when apparent, should be extracted, necrotic detritus removed, and cavities obliterated. When there are draining sinuses, but no large sequestra, a course of watchful waiting may often be rewarded by the best results. There is no condition requiring more skill and experience than chronic osteomyelitis. The frequent error is made of adding insult to injury by repeated curettage, when sufficient time alone would effect a cure and conserve tissue.

In the stage of residual impairment, correction of deformities by apparatus or operative measures is indicated. Slight pain in cold weather and after fatigue requires no treatment except rest. When there is intense, throbbing pain an attenuated infection is often present within a bony cavity, which may require considerable skill to locate. Frequently, cavities whose contents are filled with infectious material or dense fibrous tissue may remain quiescent for a lifetime. Consequently, great difficulty may be encountered in distinguishing a latent from an active process.

Large areas of scar tissue adherent to bone predispose to frequent superficial infections and ulcerations after slight trauma, and therefore should be excised and the bone covered by plastic procedure with freely movable soft

tissues and skin. Adhesion of skin to bone is more prevalent in the tibia, which is obviously more susceptible to injury.

Osteomyelitis by direct infection, as in compound fractures and gunshot wounds, does not present the symptoms of intra-osseous pressure observed in primary infection, as the central canal is open. The treatment is efficient drainage and débridement when necessary.

LOW-GRADE AFFECTIONS

Low-grade affections of bone, like those in joints, have a gradual and insidious onset. The most common affections of the bones in this class are tuberculosis, sclerosing osteomyelitis, and osteitis fibrosa cystica.

Tuberculosis.—Tuberculosis occurring in the shaft of the bone is very rare and is worthy of mention only because of the frequent erroneous diagnosis of tuberculosis when osteomyelitis in reality exists.

Pathology.—The pathology is the same as in tuberculosis of the joints, and has been described in that connection.

Symptoms.—The onset is slow and insidious. The process begins with local pain, which may become intense and of a boring nature, with symptoms of intra-osseous pressure but rarely so severe as in acute infectious osteomyelitis. Such pain may be present for months without swelling; in fact, there is no swelling or induration until the process reaches the surface of the bone, when there is a reaction on the part of the soft tissues. The temperature may be normal or slightly elevated, usually ranging from 99° F. to 100° F. in the evening.

X-Ray.—The x-ray shows destruction of bone with atrophy, and often a large cavity forms in the center, which may remain encased within the bone or break through to the surface and discharge tuberculous detritus into the soft tissues.

Prognosis and Treatment.—If treatment is instituted early, the prognosis is favorable. When foci may be excised, operative measures should be employed. Since a local manifestation of tuberculosis indicates that the patient is tuberculous, heliotherapy, when feasible, is indicated.

Syphilis.—Syphilis of the bones has been discussed in connection with syphilis of the joints, to which reference may be made. In children, syphilis of the bones, as of the joints, is congenital, and therefore is observed only in the tertiary stage. Syphilis may involve any bone in the body, but the tibia is affected most frequently. In luetic individuals, trauma has a definite influence in inducing syphilitic manifestations in the bones. Syphilis may be present in the fetus or at birth, or may occur at any time during infancy or childhood. The manifestations of congenital and acquired syphilis in the bones are practically the same.

Congenital syphilis of the bones manifests itself as follows: (1) osteo-

chondritis; (2) periostitis or sclerosis; (3) osteomyelitis or destructive process.

Osteochondritis.—In infants, syphilis is manifested more frequently by osteochondritis of the epiphyses, which may be apparent as an irregular proliferation in one epiphysis, or in several epiphyses. The most frequent

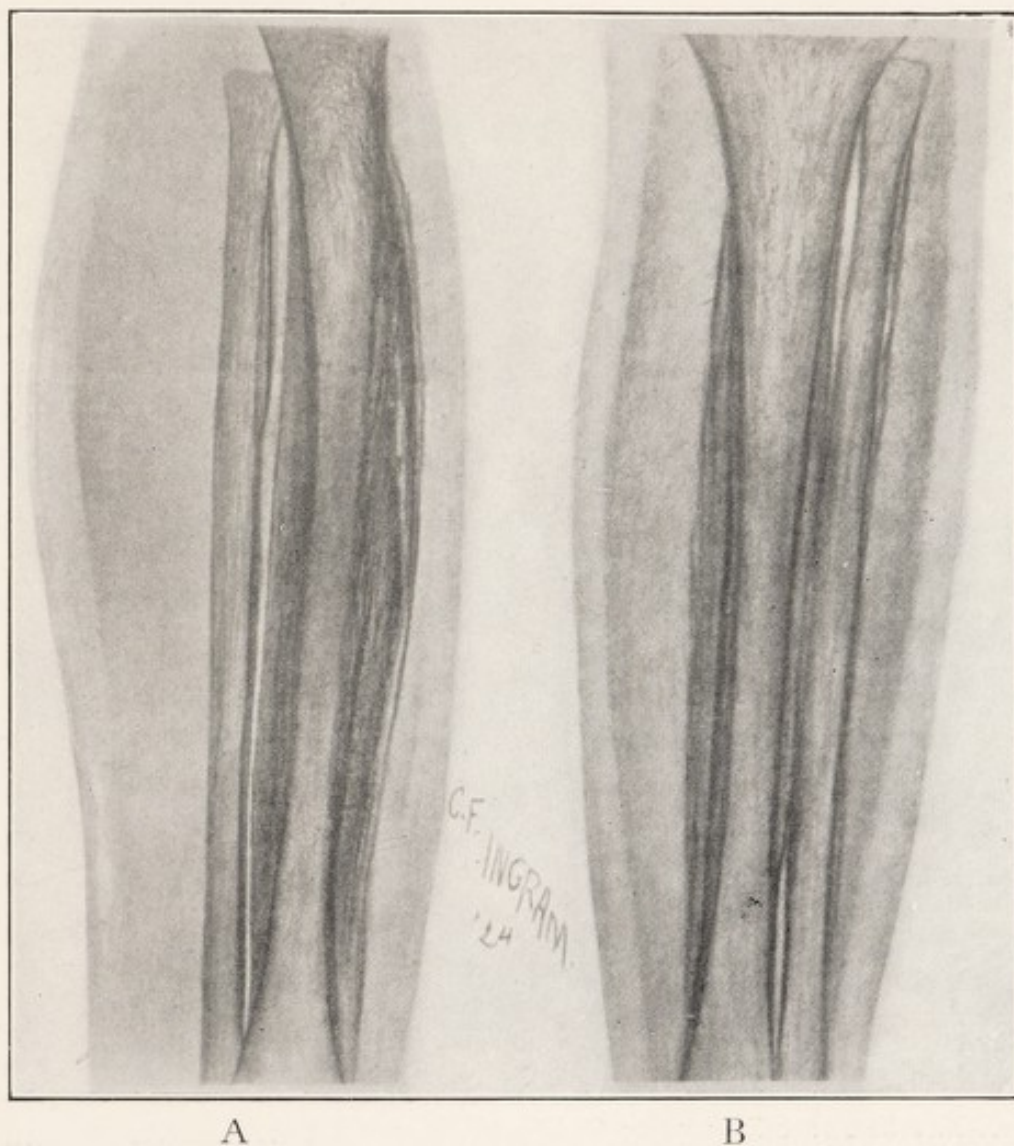


FIG. 93-A.—X-RAY OF SYPHILITIC PERIOSTITIS OF TIBIA, SHOWING LONGITUDINAL DEPOSITION OF NEW BONE IN LAYERS, ANTEROPOSTERIOR VIEW.
FIG. 93-B.—SAME AS FIGURE 93-A, LATERAL VIEW.

locations are the lower femoral epiphysis, the upper and lower ends of the tibia and fibula, and the epiphyses of the forearm.

Periosteal Stage or Periostitis.—The onset is slow, characterized by pain and gradual enlargement of the affected bone. On palpation, the enlargement can be detected, and there is increased tenderness on pressure.

The pathology is demonstrated by the x-ray, which shows a definite periosteal proliferation. In congenital syphilis, definite strata of new bone may be observed, which is not so apparent in acquired syphilis. Small areas of destruction may be associated, but proliferation of the periosteum,

or sclerosis, predominates. From observation, the periosteal stage is possibly the precursor of destructive changes, or is the early stage of bone syphilis.

Osteomyelitis or Destructive Stage.—In the osteomyelitic or destructive stage, there is usually a history of long-continued enlargement of bone. Pain may be present but is not so severe as in the periosteal stage, as intra-osseous pressure is relieved by the necrotic process breaking through the cortex. On palpation, there is massive enlargement of the bone, with



FIG. 94.—X-RAY SHOWING SYPHILITIC OSTEOMYELITIS WITH PATHOLOGICAL SEPARATION OF UPPER FEMORAL EPIPHYSIS.

tenderness; fluctuating areas may be detected and open sinuses may be present.

The pathology is demonstrated by the x-ray. There is massive enlargement of the bone in the affected area. Extensive necrosis is intermingled with proliferation, and opaque areas suggest a spurious effort of nature to reproduce new bone. The process may invade an epiphysis, causing separation. Pus and necrotic detritus may accumulate in the soft tissues from breaking through the bone. The x-ray shows very slight atrophy unless dissolution in continuity has occurred. The visualization of bone syphilis, as with roentgenoscopy in general, is a matter of intuitive judgment, which is acquired only by experience.

Diagnosis.—The diagnosis of syphilis of the bones is suggested by the x-ray alone in practically all cases, and is usually confirmed by the Wassermann. Syphilitic bones do not present the same difficulties in diagnosis as joints. If syphilis be suspected from the x-ray and the Wassermann is negative, therapeutic tests should be employed. Syphilis may be differentiated from practically all other infections by the x-ray, the Wassermann, the history of the case, and the stigmata of syphilis, when present. In congenital syphilis, it is rarely possible to secure a history of primary infection in the parents. Blood Wassermann should, of course, be made of both parents when possible.

The sclerosing osteomyelitis of Garré very closely resembles syphilis of the periosteal stage, but there is no similarity in the destructive stage. The x-ray findings in syphilis demonstrate that the periosteal proliferation is more pronounced on the convex surfaces, whereas, in the osteomyelitis of Garré, the proliferation is distributed about the entire bone and the whole mass forms a definite spindle. However, as the two processes so closely resemble, therapeutic tests must often be given in order to differentiate.

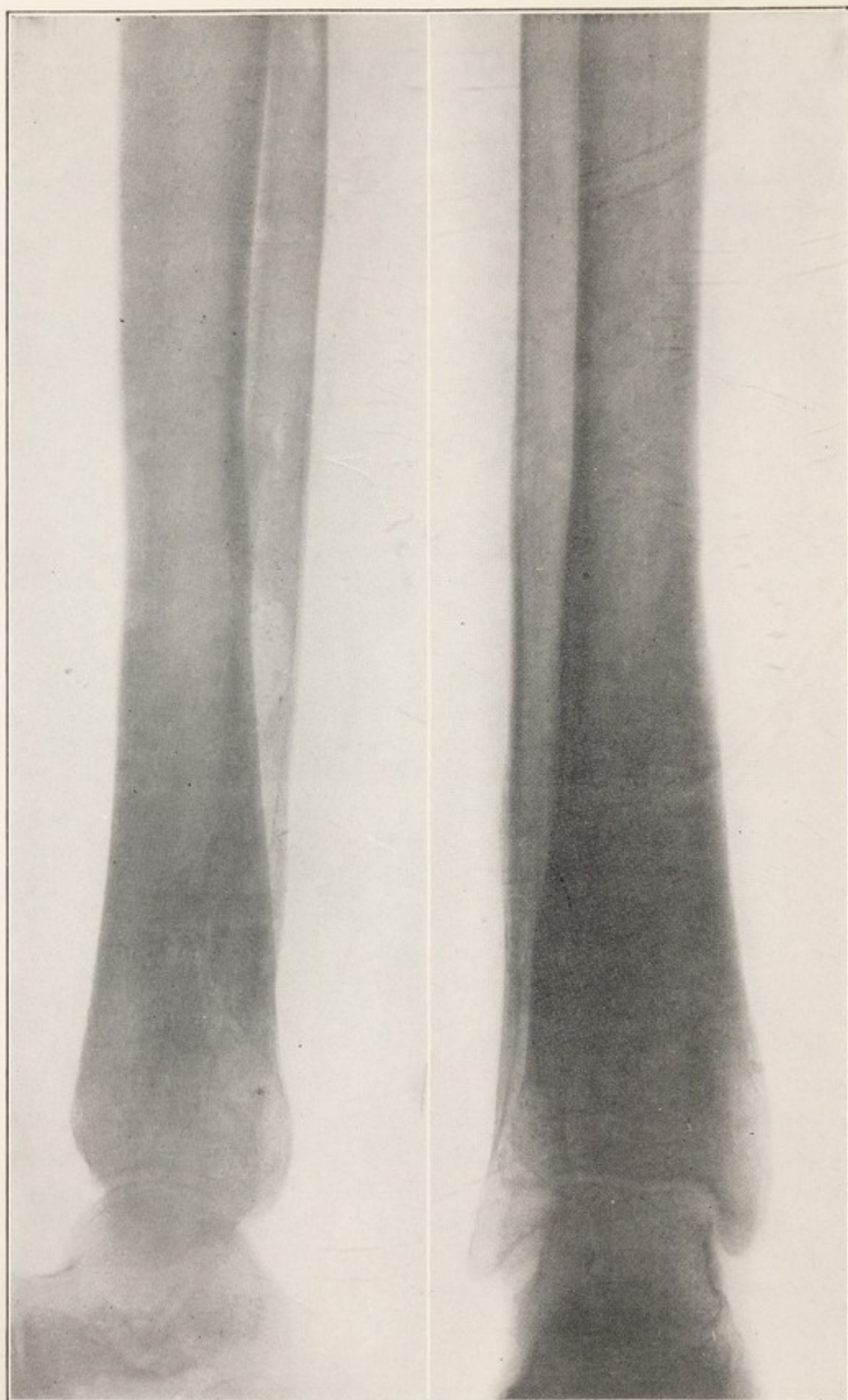
Prognosis and Treatment.—Before dissolution of continuity occurs, the prognosis is excellent with efficient antiluetic treatment, vigorously administered. In those cases in which there has been separation of the epiphyses, destruction of articular surfaces, or loss in continuity, permanent impairment of function and deformity result.

Sclerosing Osteomyelitis of Garré.—Sclerosing osteomyelitis is a rare affection described by Garré.¹ The cause is unknown, but is probably a low-grade infection, or trauma may be a possible predisposing factor. This affection has not been observed in very young children, but usually occurs in late childhood, and is more frequently observed in boys than girls. It is rarely bilateral, occurring more often in one bone. The shafts of the bones, especially the tibia, are affected more frequently, the process being found occasionally, however, in the cavernous bone of the extremities.

Pathology.—There is regular spindle-shaped hypertrophy of the affected area involving the entire dimension of the bone with marked proliferation and increase in thickness of the periosteum, without suppuration or fistulous formation. The central canal is filled with low-grade inflammatory tissue; no pus or sequestrum is present. Ulceration of the skin over the affected area is rarely observed.

Symptoms and Local Manifestations.—There may be a history of acute onset, accompanied by elevation of temperature, swelling of the affected limb and local pain of a dull aching character at the site of the bone lesion, but the course is usually slow and insidious. There is a definite swelling over the affected area in the subcutaneous bones, which, on palpation, is found to

¹ C. Garré, *Einige seltene Erscheinungsformen der akuten infectiösen Osteomyelitis*, 1891.



A

B

FIG. 95-A.—X-RAY SHOWING SCLEROSING OSTEOMYELITIS OF GARRÉ OF LOWER END OF TIBIA, WITH INCREASED DENSITY OF BONE, ANTEROPOSTERIOR VIEW.
FIG. 95-B.—SAME AS FIGURE 95-A, LATERAL VIEW.

be hard, dense, and of smooth contour. Definite tenderness and intra-osseous tension are evidenced by deep, firm pressure over the affected area. Later in the process, ulceration of the skin may be observed in such subcutaneous bones as the tibia.

X-Ray.—In the shafts of long bones, the x-ray demonstrates spindle-shaped enlargement with increase in density, the surface of which is smooth and regular. The central canal may not be apparent. In spongy bone, the process is indicated by sclerosis, periosteal thickening and increased density.

Diagnosis.—The diagnosis is usually apparent from the symptoms and local manifestations, but may closely resemble syphilitic periostitis, from which differentiation can be made by the Wassermann and the x-ray. In syphilis of the bones and joints, the Wassermann test is positive in 88 per cent. In the destructive stage of syphilis, there is no resemblance. In syphilitic periostitis, the new bone is formed in a more irregular manner and often an area of destruction, though small, may be demonstrated. The periosteal proliferation of syphilis is usually more exaggerated on the convex surface, whereas, in sclerosing osteomyelitis, there is a spindle-shaped enlargement of the entire bone about the area involved.

Prognosis.—The course is very indefinite and may persist for years, regardless of treatment, but usually terminates in spontaneous cessation of symptoms, though the structure of the bones does not become normal, even with surgical treatment, described below.

Treatment.—Deep x-ray therapy has been employed by the author, but with no apparent improvement. On account of the close resemblance to syphilitic periostitis, vigorous antisyphilitic measures have also been instituted, but without relief of symptoms or change in bone structure, as demonstrated by the x-ray. The only treatment which may have any beneficial effect on the pathological process is surgical, though at times the process is not arrested by such measures. Two methods are employed: First, a wide incision is made over the affected area, down to the bone, the periosteum elevated and numerous drill holes made through the cortex into the central canal, after which the wound is closed in the routine manner. The second method is a more radical procedure, which consists in removing a portion of the cortex longitudinally over the affected area, cleaning out the medulla, and closing the tissues and skin without drainage. Relief of pain usually occurs immediately after the operation and is apparently due to the removal of intra-osseous tension, but may recur when the cortex is closed by new bone. In one patient, a boy of fourteen, with a bilateral sclerosing osteomyelitis involving both tibiae, the one giving the more severe symptoms was operated upon, while in the other no treatment was administered. The same indefinite course was observed in both, recovery being accomplished spontaneously in about two years.

Osteitis fibrosa cystica.—Osteitis fibrosa cystica, or bone cyst, is rather a rare affection of bone occurring in children, usually from the age of four years to adolescence. The cause is unknown, though as usual there is a theory of infection and trauma. The process may occur locally or may be generalized; when general, it is associated with osteomalacia in rare in-

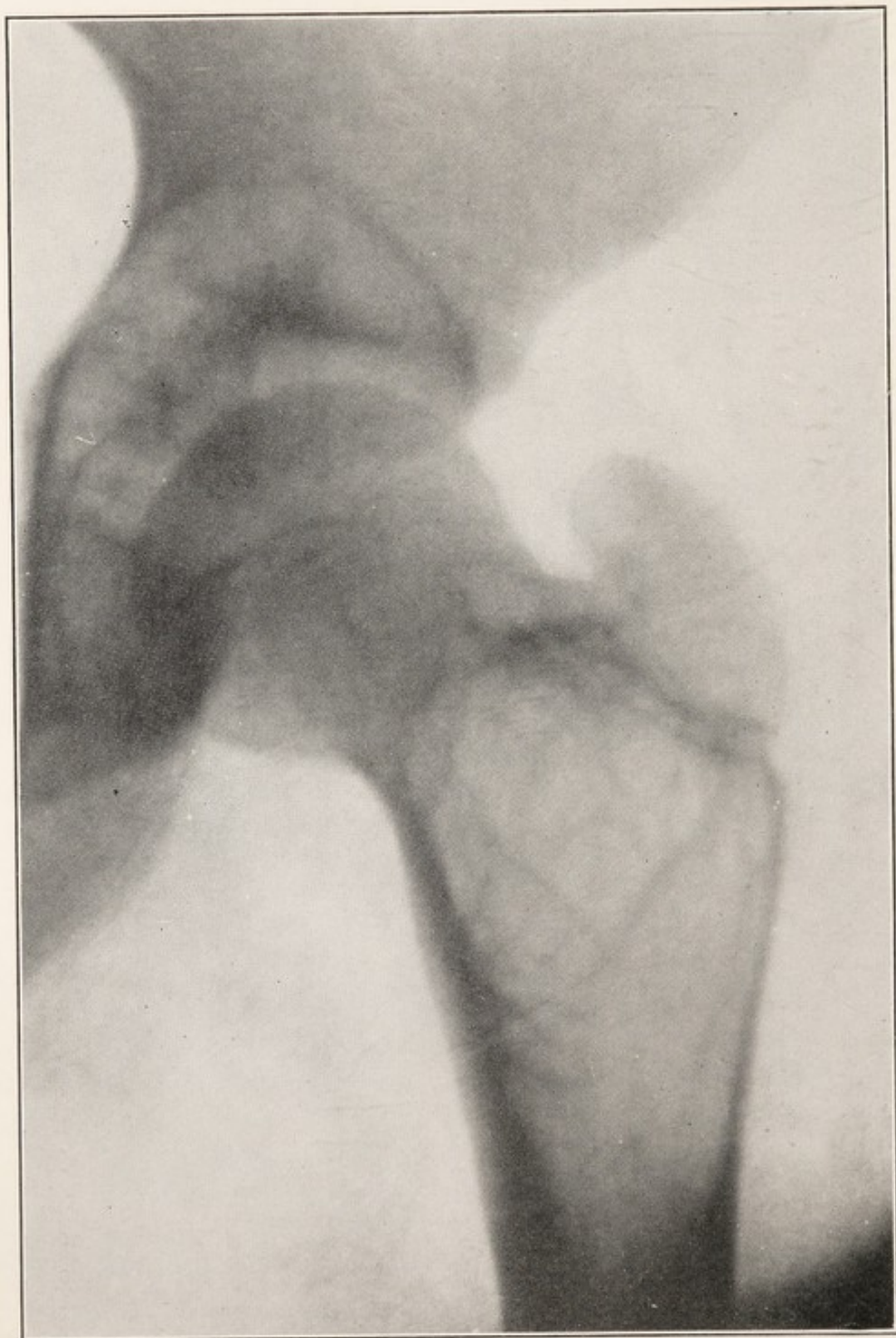


FIG. 96.—X-RAY OF OSTEITIS FIBROSA CYSTICA OF UPPER END OF FEMUR, SHOWING MULTILOCULAR CYST WITHOUT EXPANSION OF BONE CORTEX.

stances. The most common site is the upper or lower extremity of the femur and humerus.

Pathology.—There is a fibrous substitution of bone with gradual thinning of the cortex, which may form one large cyst or multilocular cysts separated by thin partitions of bones. This fibrous marrow consists of fibrillar connective tissue with few nuclei, and is usually not vascular. In places it becomes infiltrated with round-cells and appears similar to granulation tissue.

Symptoms.—There may be no local symptoms, or rarely a dull aching. The first manifestation is usually a fracture through the affected area by some slight injury, or by less force than would ordinarily cause a fracture in normal bone. In the generalized type, there may be extensive deformity, and when associated with osteomalacia, permanent invalidism often occurs.

Diagnosis.—The x-ray shows characteristic changes from which the diagnosis is made. When the process is local, there may be a close resemblance to giant-cell tumor, often erroneously called sarcoma, which, in fact, is thought to be the same or a very closely related condition. However, differentiation is unnecessary, as the treatment and clinical course are the same. In osteitis fibrosa cystica, the x-ray shows a cyst within the bone and thinning of the cortex. The cortex, however, is rarely expanded, whereas in giant-cell tumor the cortex is usually expanded. Tuberculosis, osteomyelitis and syphilis may be differentiated by the history, clinical manifestations and x-ray.

Prognosis.—The prognosis is excellent when the affection is local and may terminate in spontaneous recovery; when generalized, spontaneous recovery usually occurs, but often with severe deformity which may seriously impair function. When associated with osteomalacia, no improvement is to be expected. Complicating fractures unite as readily as simple fracture in normal bone; fractures through the affected area often have a beneficial influence and may arrest the process.

Treatment.—When the condition is local, conservatism should be employed unless the process is advanced. X-ray treatment may be beneficial. With impending deformity or fracture, surgical procedures are indicated. The operation consists of opening the bony cavity and crushing in the wall so that small bony particles may partially fill the cavity. Particles of bone should also be removed from normal bone adjacent to the cyst or from a distant point, as the tibia, and placed into the cystic area. These particles are multiple grafts, capable of osteogenesis, or bone production, and may reproduce strong, healthy bone, thus reënföring the defective area.

If osteitis fibrosa cystica is general, deformity should be prevented by appropriate apparatus, and if observed after deformity has occurred, correction may be made by plastic procedures on the bone and contracted soft parts.

EPIPHYSITIS OF EXTRA-ARTICULAR EPIPHYSES

An epiphysis may be involved in an abnormal process which may be manifested by symptoms of pain and tenderness, with characteristic changes demonstrated by the x-ray. Trauma is probably the etiological factor; the anatomical location of these epiphyses subjects them to injury by external force and by internal muscle contraction, as powerful muscles are inserted into the extra-articular epiphyses. Infection is also considered a possible



FIG. 97.—X-RAY SHOWING EPIPHYSITIS OF OS CALCIS WITH FRAGMENTATION.

causative agent. Epiphysitis may be confined to one epiphysis or may involve two or more epiphyses. The condition occurs more frequently in late childhood, or near puberty, and boys are more often affected than girls. The process may occur in any epiphysis, but will be described only in those locations most frequently affected. These conditions very closely resemble, from x-ray appearance, coxa plana, which has been described as a low-grade affection of joints, and is probably the same process, but affects the extra-articular epiphyses or epiphyseal disks.

Epiphysitis of the Os calcis.—Epiphyseal irritation may be observed in the posterior epiphysis of the os calcis and is known as apophysitis of the os calcis. The process as demonstrated by the x-ray is pathognomonic.

The treatment consists in removing the counter from the heel of the shoe so as to decrease pressure on the heel. The counter is the stiff leather reinforcement which gives shape to the posterior half of the shoe, and is between the inner lining and the outer covering.

Epiphysitis of Scaphoid.—In older children, about twelve years of age, there is often irritation on the inner aspect of the scaphoid which is apparently an epiphysitis between the adjacent supernumerary bone and the scaphoid. The anatomists do not recognize an epiphysis in this location, but as the os tibiale externum is apparently often fused to the scaphoid bone,

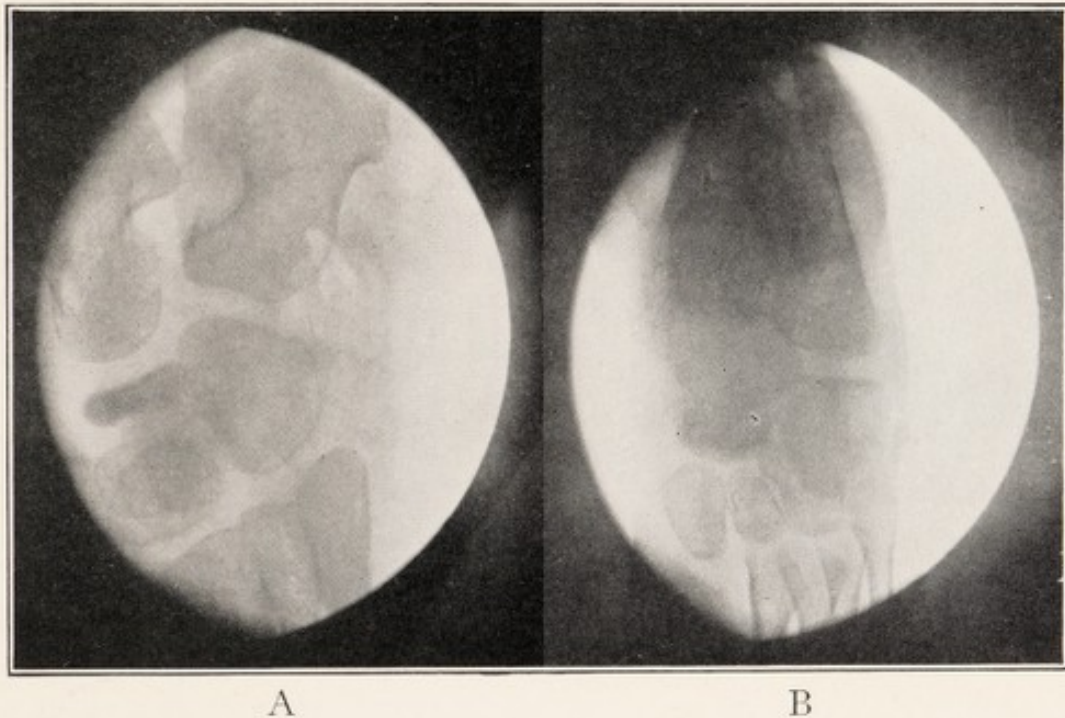


FIG. 98-A.—X-RAY SHOWING OSTEITIS OF SCAPHOID, ANTEROPOSTERIOR VIEW.

FIG. 98-B.—SAME AS FIGURE 98-A, LATERAL VIEW.

Note narrowing of bone with increased density and mottling.

it is believed by the author to be a true epiphysis. The typical clinical manifestations and x-ray findings of an irritated epiphysis are also found in this region when there is irritation of other extra-articular epiphyses, in cases of diffuse epiphysitis. As the condition is of such frequent occurrence, the author considers it a clinical entity. Recovery may be expected in all cases. The treatment is strapping with adhesive plaster, as described for flat-foot (p. 259), followed by an arch support.

Köhler's Disease of the Scaphoid (Osteitis of Scaphoid).—The scaphoid bone may be involved in a process which runs practically the same clinical course as epiphysitis. The affection occurs in young children, usually between the ages of three and six years, and is probably the result of trauma. The first symptoms are a limp and slight pain in the foot. On examination, there is tenderness over the affected scaphoid. The mid-

tarsal joints show evidences of irritation and limitation of motion, especially on adduction. The x-ray findings are confirmatory and show the scaphoid bone flattened in the anteroposterior direction with very much the appearance of a coin, except that the circumference is fuzzy.

Treatment.—In exaggerated cases, a cast may be required for a few weeks, but a simple arch support, as in the treatment of flat-foot, is usually sufficient. Recovery is certain, though indefinite. The x-ray will later demonstrate restoration of normal contour to the scaphoid bone.

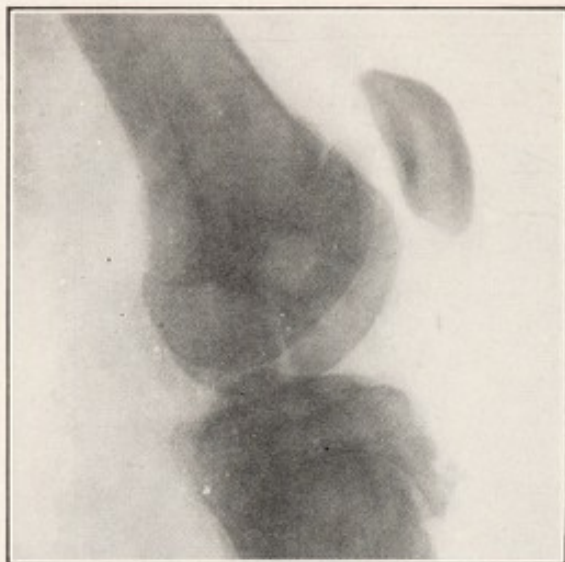


FIG. 99.—X-RAY SHOWING EPIPHYSITIS OF TIBIAL TUBERCLE.

slight edema. The x-ray shows a proliferative and degenerative process of the tibial tubercle, often with separation of the epiphysis, which is quite characteristic.

Treatment.—There is no material disability and, in the opinion of the author, no local treatment is indicated, though operative intervention has been advocated. Complete recovery may be expected in all cases, though one or more years may elapse before the symptoms entirely subside.

Generalized Extra-articular Epiphysitis.—In late childhood, there may be irritation and proliferation of many epiphyses, with slight pain and tenderness. These children are usually undernourished. The treatment is cod-liver oil, artificial and natural heliotherapy, together with local measures applicable to the epiphyses affected.

Epiphysitis of Tibial Tubercle.
—Epiphysitis of the tibial tubercle (Osgood-Schlatter's disease) is of frequent occurrence in late childhood or about puberty, and is observed more often in boys than in girls, being known in the common parlance of boys as a "hickey." The affection is seldom of bilateral distribution. On examination, there is a pronounced enlargement of the tibial tubercle, slight pain and tenderness, and rarely

CHAPTER X

AFFECTIONS OF BONES (*Continued*)

TRAUMATIC AFFECTIONS

Fractures.—Any type of fracture that occurs in an adult may also occur in a child, but the inherent difference in osseous structure and the areas of growth of epiphyses influence to some extent not only the character of fracture, but also the treatment and prognosis. For example, the bones in children are more pliable and may be distorted to a marked degree without actual severance, the so-called greenstick fractures. The muscle power is weaker in children; therefore, displacement after reduction from muscular spasm is not so frequent as in the adult.

The general principles in the treatment of fractures are approximation, anatomical alignment and efficient fixation. In transverse fractures of the long bones, perfect approximation is often impossible, but restoration of function may be expected if the ends are merely engaged with anatomical alignment, and even should there be an overlap of fragments, anatomical alignment alone may give an excellent result. In young children, after union has occurred with a definite overlap of fragments, all irregularity may be obliterated by the process of growth, so that after one or more years it may be impossible to detect any evidence of previous fracture by inspection or the x-ray. However, there is no intention to imply that every effort should not be made to obtain the most perfect approximation possible. In oblique or comminuted fractures of the long bones, satisfactory approximation can usually be secured by lateral pressure with traction under anesthesia, until efficient splints or casts have been applied. In fractures adjacent to or involving joints, the most accurate anatomical approximation is necessary to prevent permanent impairment of function.

The mechanical principles in the reduction of transverse fractures of the long bones are rarely accomplished by a pull, but by angulation until there is approximation which can be distinctly detected by the surgeon. The part is then placed in perfect anatomical alignment and efficient fixation applied. The position of the fractured member must, when possible, permit relaxation of those muscles in which spasmodic contracture would tend to displace fragments.

X-Ray.—The fluoroscope is of value in reducing fracture of the shaft of the bone, but is unreliable and often misleading in fractures adjacent

to joints, as existing cartilage in the extremities of the long bones is not apparent. In all fractures, roentgenograms must be made before reduction, and the approximation of fragments confirmed after splints have been applied. Two or three weeks after the reduction, the splints should be removed and the contour and anatomical alignment observed, and the relation of the fragments again confirmed by x-ray. If the position at this time is not satisfactory, adjustment can always be made and malunion with

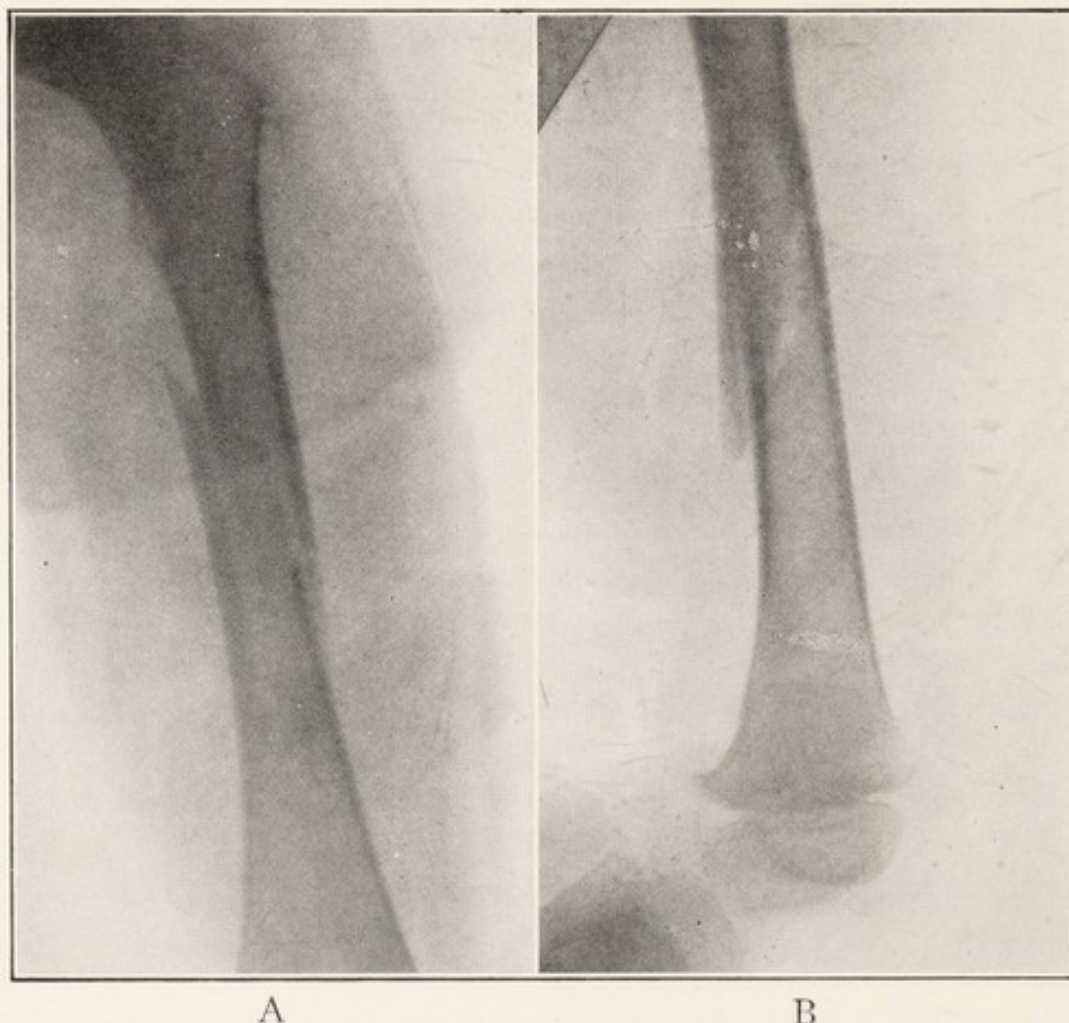


FIG. 100-A.—X-RAY SHOWING TRANSVERSE FRACTURE OF SHAFT OF FEMUR, ANTEROPOSTERIOR VIEW.

FIG. 100-B.—SAME AS FIGURE 100-A, LATERAL VIEW.

deformity avoided. If this routine is carried out in every fracture, there will be little opportunity for the occurrence of the unfavorable results so frequently observed. The physician must be able to interpret the relation of the fragments shown by the x-ray; otherwise, he may be influenced to make repeated attempts to reduce when sufficient approximation is present and may thereby cause damage to important structures as well as to the bones (myositis ossificans, massive callus). This is observed especially in fractures adjacent to joints.

Open surgery may be employed in malunion with deformity or in ununited fractures, but is indicated very rarely in fresh fractures of childhood.

Epiphyseal separations seldom occur in young children; they are usually seen in late childhood, about puberty, and are considered in connection with fractures. On account of the possible interference with future growth and the close relation to joints, accurate reduction is necessary in every case. However, the prognosis should always be guarded in spite of perfect reduction, for deformity or relative shortening may occur after the lapse of one or more years from irregularity in or arrest of growth.

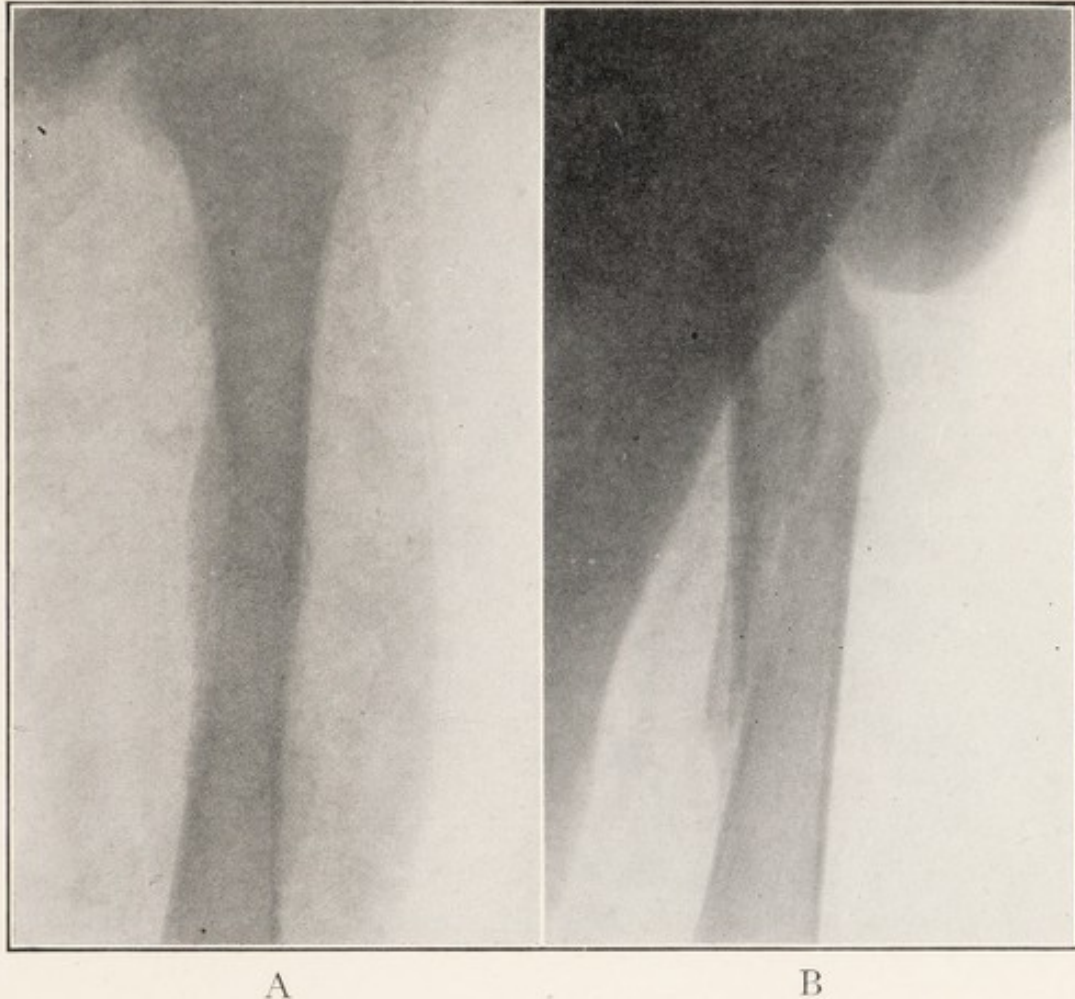


FIG. 101-A.—SAME AS FIGURE 100-A, AFTER REDUCTION. FIG. 101-B.—SAME AS FIGURE 100-B, AFTER REDUCTION.

Not all fractures common to children will be discussed, and only the essential features of those of frequent occurrence, in which the results of average treatment often terminate in deformity and impaired function.

The Shaft of the Femur.—Fractures of the shaft of the femur may be transverse or oblique, and are observed more often in the middle and upper thirds. In transverse fractures, the child is placed under complete anesthesia, preferably ethylene or gas ether, and the thigh is flexed to relax the psoas muscle, which draws the proximal fragment upward. As the proximal fragment is displaced forward and outward, a sharp angulation forward is made until the bones can be felt to engage, when the lower

fragment is brought into anatomical alignment with the upper. If the engagement is stable, distinct resistance will be felt on pushing the lower against the upper fragment. Fixation is applied with the hip flexed 40 degrees in slight abduction, to relax and prevent forward displacement of the upper fragment by contraction of the psoas magnus muscle. A plaster cast extending from toes to nipple line on the affected side and to the knee on the normal side is the best method of fixation. A fracture table is almost essential. In oblique and comminuted fractures, the same position is employed with fixed traction until the cast is applied. In the lower third of the femur, the same principles are employed, but it is unnecessary to apply the cast on the opposite limb.

Obviously, the average general practitioner may not have the necessary facilities to employ such procedures. A Thomas knee splint, described on page 31, may be applied, and will in a large percentage of cases, give

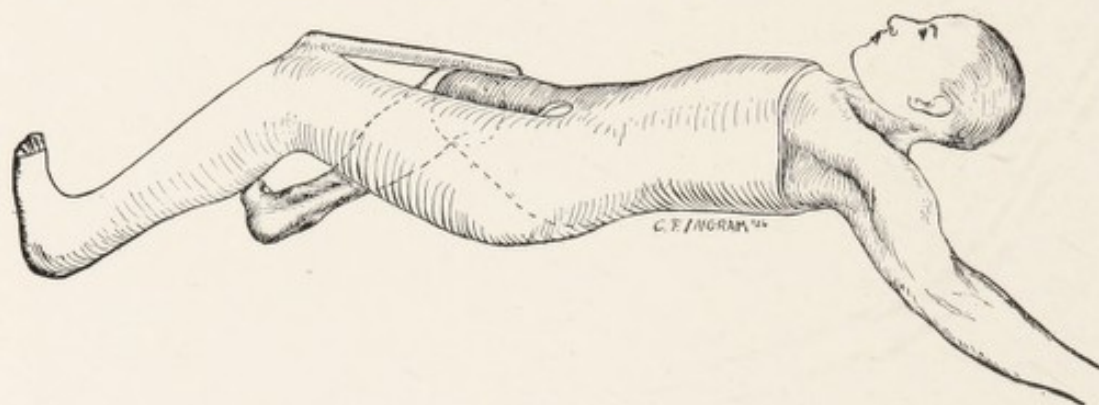


FIG. 102.—DRAWING OF PLASTER-OF-PARIS DOUBLE SPICA CAST, SHOWING FLEXED POSITION OF HIP AND KNEE, USED IN TREATMENT OF FRACTURED FEMUR.

good functional results, but will not maintain fragments in accurate approximation. The Thomas splint is also most valuable when transportation of the patient is necessary. If not available, a long lateral wooden splint should be applied as a temporary measure. This splint, extending from axilla to heel, and an internal splint from perineum to heel, are well padded and bound to the affected limb and body. Much damage may occur by the common practice of transporting children with fractured femurs on pillows or with insufficient splinting.

Fractures of the shaft of the femur are third in frequency of occurrence at birth, those of the humerus and clavicle being more common.

Birth fractures of the femur cannot be approximated, but anatomical alignment can be maintained by a posterior splint extending from toes to scapula, with the hip and knee flexed at right angles. This splint is made of sheet iron, which may be procured at any tin shop. With ordinary tin shears it can be cut of correct dimension and bent to conform to the contour of the back, thigh and leg. At the end of one week, the splint is removed and the anatomical alignment of the extremity noted. Union at

this time is beginning, but correction of angulation, if present, can easily be made. The splint should be worn for at least three weeks. If anatomical alignment is maintained, the result will be perfect in every case.

The results of fractures of the femur in children should be 100 per cent excellent. Such measures as dangling children from the ceiling have been advised, but require constant attention of trained assistants throughout

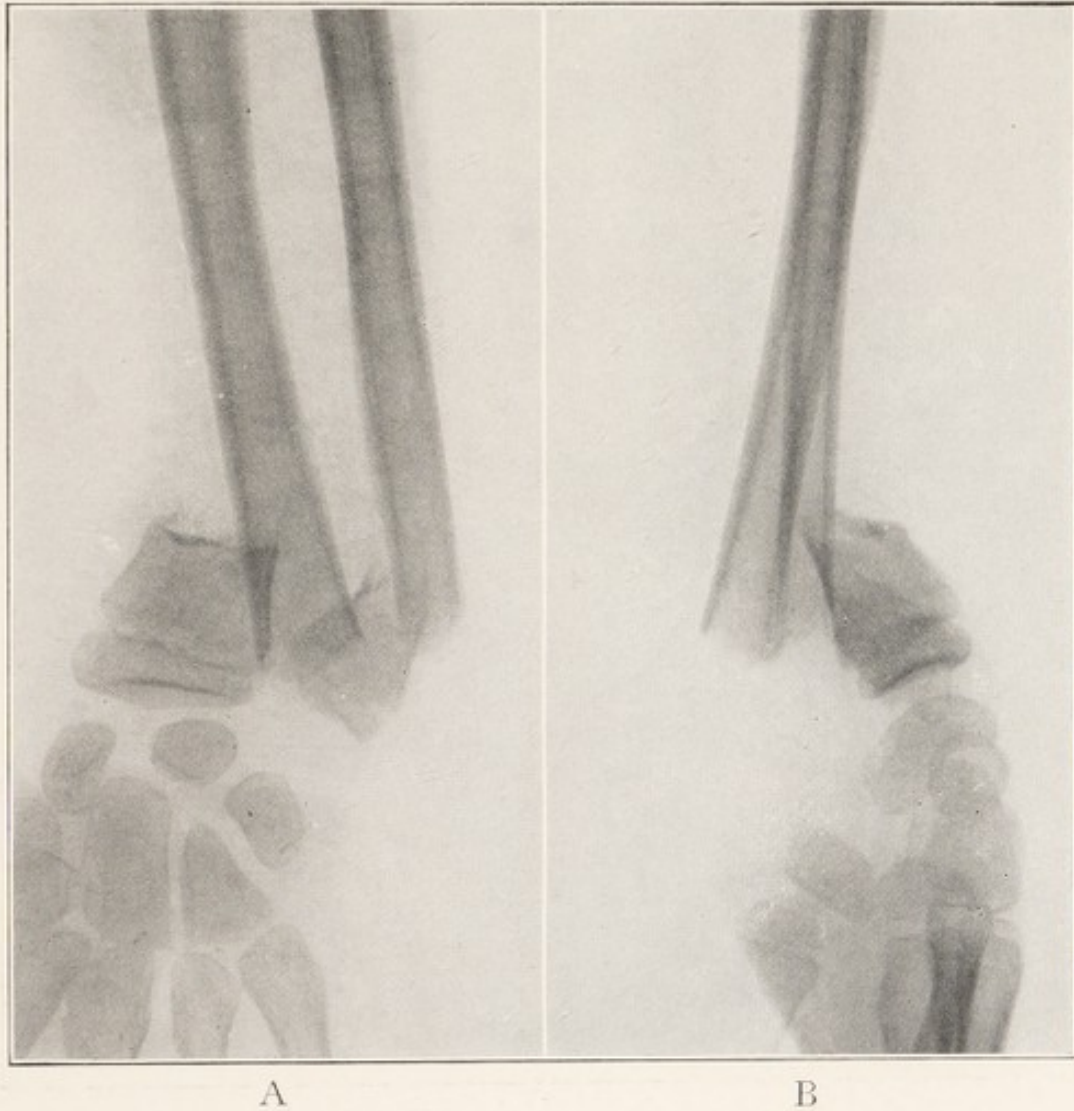


FIG. 103-A.—X-RAY OF FRACTURE OF BONES OF FOREARM, ANTEROPOSTERIOR VIEW.

FIG. 103-B.—SAME AS FIGURE 103-A, LATERAL VIEW.

convalescence. With the treatment mentioned, only a short time is required in the hospital, and the after-care is simple. Young children suffer very little discomfort in casts.

The Spine.—Fractures and injuries of the spine are of great importance and are discussed in connection with traumatic arthritis of the joints (p. 122).

The Forearm.—If young children fall upon the outstretched hand, Colles' type of fracture, so common in adults, is not produced, but a fracture of both bones of the forearm from one-half to one inch above the

wrist joint results. The lower fragments are displaced backward and there is the typical silver-fork deformity.

Reduction is made by considering both bones as one, and very much in the same manner as the Colles' fracture. The hand is first dorsiflexed or extended to disengage fragments from entanglements in soft tissues. In this position, traction is made upon the wrist until the fragments can be



FIG. 104-A.—SAME AS FIGURE 103-A, AFTER REDUCTION. FIG. 104-B.—SAME AS FIGURE 103-B, AFTER REDUCTION.

felt to engage partially, when the hand is forcibly placed in palmar flexion. Perfect reduction can usually be secured, but 50 per cent approximation with anatomical alignment is satisfactory. Simple anterior and posterior wooden splints are employed, with a felt pad on the anterior splint about one-half inch in thickness at the lower end of the proximal fragments. The splints should not extend below the middle of the hand, thus permitting free movement of the metacarpophalangeal joints and fingers. Above, the splint should extend to just below the elbow.

Fractures of both bones of the forearm in the lower and middle thirds are reduced by angulation, as if one bone, but unless their contour permits, cannot always be approximated. However, if engagement of one bone is accomplished, preferably the radius, anatomical alignment of the other is



A

B

FIG. 105-A.—X-RAY SHOWING FRACTURE OF HEAD OF RADIUS WITH VICIOUS UNION, ANTEROPOSTERIOR VIEW.

FIG. 105-B.—SAME AS FIGURE 105-A, LATERAL VIEW.

usually sufficient. If the ulna alone is fractured, approximation usually can be effected under the fluoroscope. If the lower third of the radius alone is fractured, reduction may be impossible without open operation, because of the action of the pronator quadratus, but should be attempted. The upper third of the radius may also be difficult, and open reduction may be required, as the biceps muscle may cause displacement through its attach-

ment to the bicipital tuberosity of the radius. The radius should be reduced as this bone performs the movement of rotation. However, anatomical alignment with overlap is not incompatible with perfect function. In extensively comminuted fractures of the head of the radius, the fragments must be removed; otherwise, accuracy in approximation is essential to insure rotation.

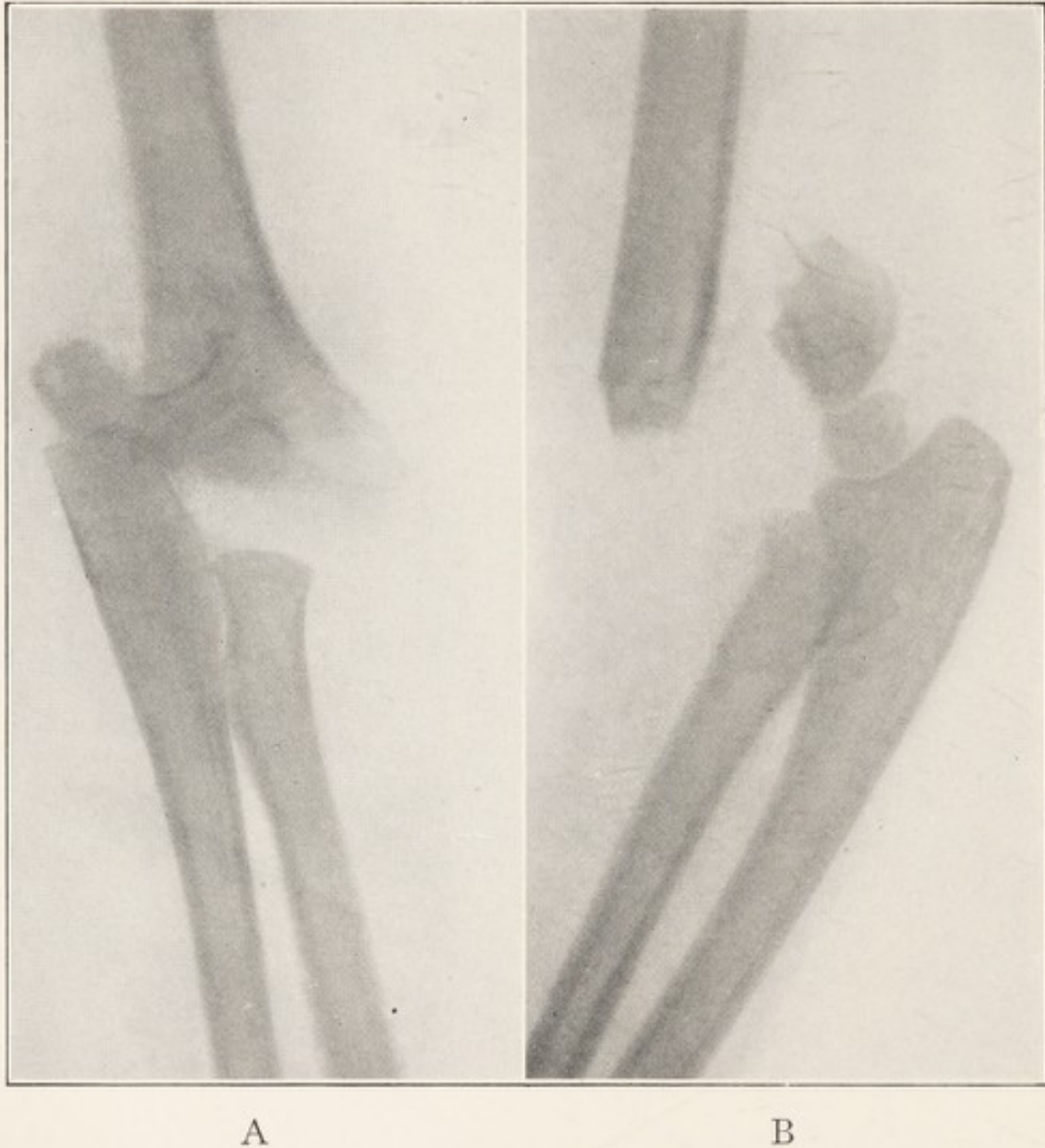
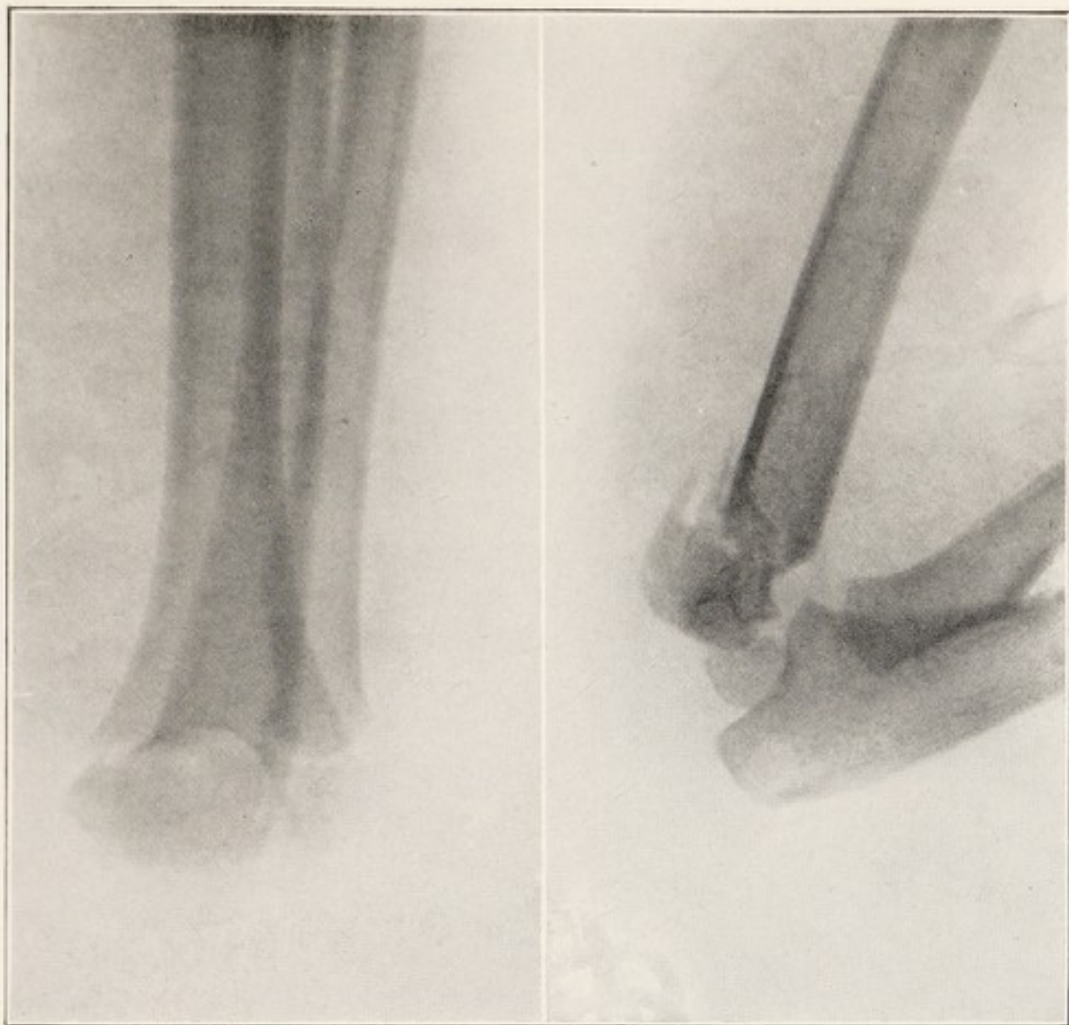


FIG. 106-A.—X-RAY SHOWING SUPRA-CONDYLAR FRACTURE OF HUMERUS, ANTEROPOSTERIOR VIEW.

FIG. 106-B.—SAME AS FIGURE 106-A, LATERAL VIEW.

When both bones of the forearm are fractured, especial care throughout the entire treatment should be taken to prevent the natural tendency toward backward bowing. The elbow should be held at a right angle and the forearm should be in supination when compatible with reduction. In all fractures of the forearm, fixation apparatus must be applied from the palm of the hand to just below the shoulder to prevent anteroposterior and lateral displacements. For this purpose a plaster cast is most effective, but



A

B

FIG. 107-A.—SAME AS FIGURE 106-A,
AFTER REDUCTION.

FIG. 107-B.—SAME AS FIGURE 106-B,
AFTER REDUCTION.

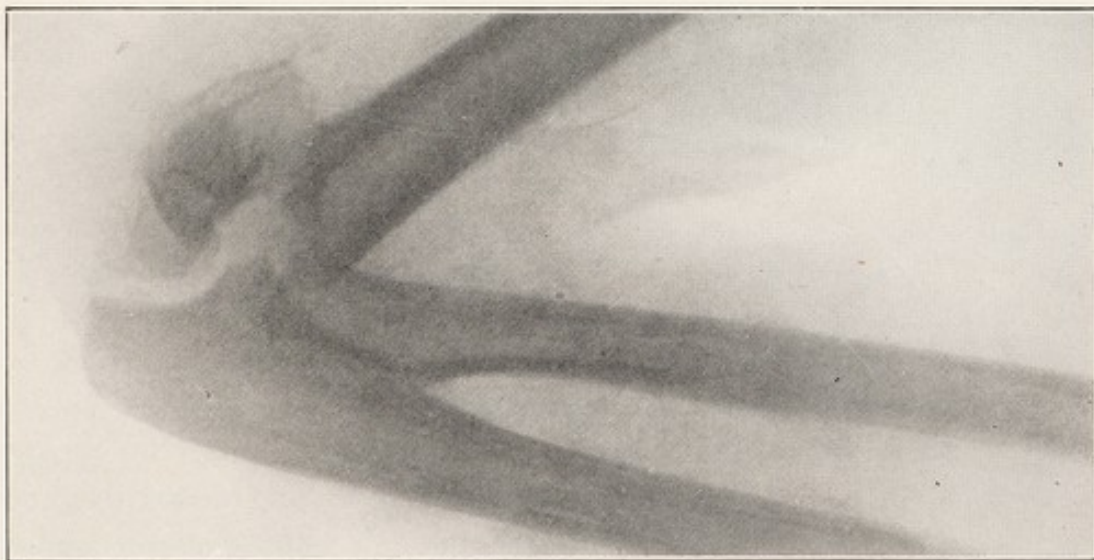


FIG. 108.—SAME AS FIGURE 107-B, SHOWING THAT ACUTE FLEXION ALONE DOES NOT
ALWAYS REDUCE SUPRACONDYLAR FRACTURE OF HUMERUS.
Illustrates necessity of check-up by x-ray.

should always be bivalved to prevent circulatory disturbances from edema.

Fractures of the olecranon are of rare occurrence, but require very careful treatment. If approximation can be obtained by placing the elbow in complete extension, this may be sufficient; otherwise, open reduction with internal fixation is indicated.



FIG. 109.—PHOTOGRAPH SHOWING METHOD OF FIXING ARM IN ACUTE FLEXION BY ADHESIVE STRAPPING.

Hand is compressed for few days by snug bandage to prevent swelling.

and then firm traction. The lower fragment, composed of the lower extremity of the humerus, is grasped and pushed forward as the elbow is flexed to an acute angle, with the forearm in supination. The triceps holds in position the lower fragments, which are counterbalanced by pressure of the forearm against the arm. After reduction is secured and confirmed by an x-ray in two views, an adhesive dressing is applied about the arm and forearm with cotton pad between the arm and forearm. The wrist is fastened to the neck by a soft Canton flannel bandage. Accurate reduction is essential to success in this fracture, but will not be accomplished in many cases by the flexed position alone, as has been repeatedly demonstrated.

The Elbow (Humerus).—One of the most common fractures observed in children is about one-half to one inch above the elbow transversely across the humerus, and is known as a supracondylar fracture of the humerus. The lower fragment is displaced backward and usually toward the inner aspect. This fracture is one of the most important, as it so frequently results in impaired function from failure in reduction, and is also very commonly and erroneously diagnosed as a dislocation of the elbow. The pulse may often be entirely obliterated by injury to the brachial artery, though the fingers may remain rosy or only slightly cyanotic. This does not contra-indicate reduction and the flexed position, but does require the closest observation in hospital or constant supervision for at least three days. Ischemic paralysis occurs most frequently following supracondylar fractures of the humerus.

Reduction under the fluoroscope is performed by: first, full extension,

However, in the majority of instances, the flexed position is undoubtedly the only one in which reduction can be held satisfactorily, and should therefore be routinely employed. Frequently, after there is apparent reduction under the fluoroscope, x-ray pictures will show that there is marked displacement.

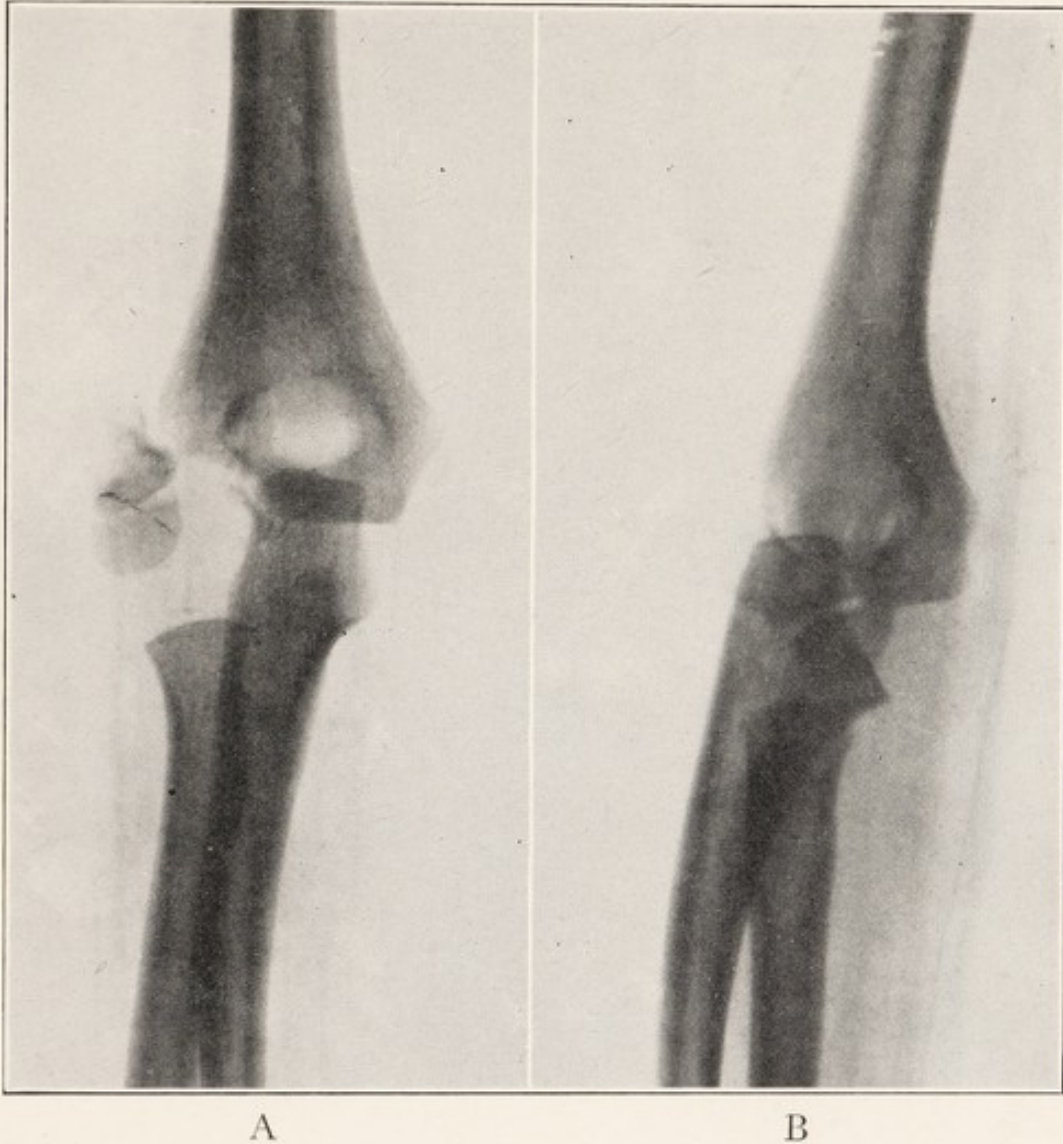


FIG. 110-A.—X-RAY SHOWING FRACTURE OF EXTERNAL CONDYLE OF HUMERUS WITH WIDE SEPARATION, ANTEROPOSTERIOR VIEW.

FIG. 110-B.—SAME AS FIGURE 110-A, LATERAL VIEW.

After ten days, the adhesive dressing is removed and x-ray pictures are again made. If the reduction is unsatisfactory, adjustment can be made; if satisfactory, a simple right-angle splint is applied, but removed twice daily for active and passive motion. At the end of three weeks the splints may be discarded. Convalescence is always slow in fracture or other injuries of the elbow, often requiring from three to six months. The results are excellent in a high percentage.

The external condyle of the humerus may be fractured with wide separa-

tion of fragments. Since this is a terminal fragment, unless approximation is accurate, non-union is frequent. If no reduction can be obtained, an operative procedure is imperative, which consists in nailing the bone fragment in position by a wire nail. The results of this simple procedure are satisfactory.

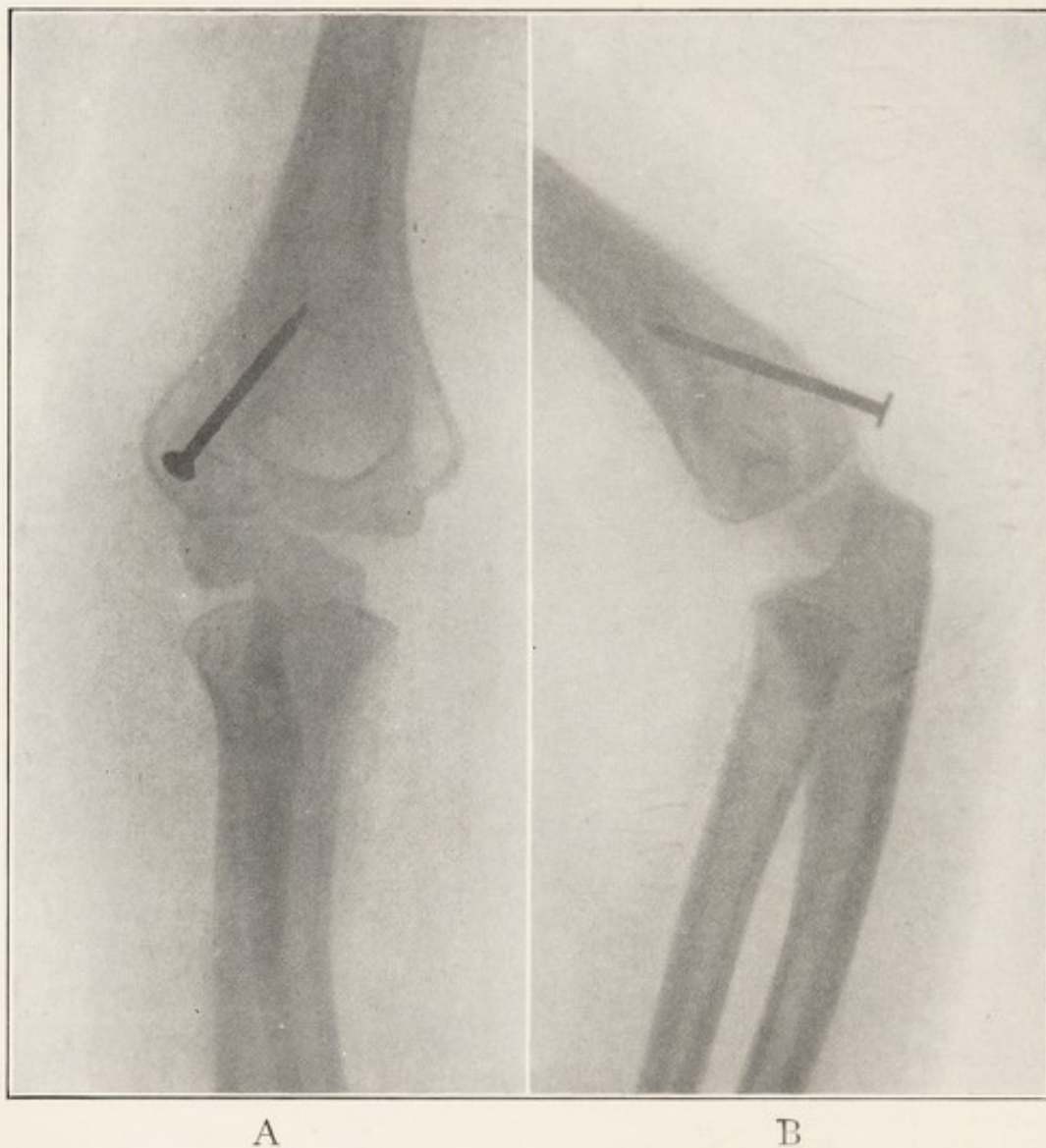


FIG. III-A.—SAME AS FIGURE 110-A,
AFTER OPEN REDUCTION AND
FIXATION WITH WIRE NAIL.

FIG. III-B.—SAME AS FIGURE 110-B.
AFTER OPEN REDUCTION.

The Shaft of the Humerus.—Fractures in the lower third of the shaft of the humerus can usually be reduced under the fluoroscope and retained in plaster casts or by the author's humerus traction splint. After reduction, care should be taken to prevent inward deviation of the lower fragment. The elbow must be held at a right angle and the shoulder in about 30 degrees' abduction. Under no circumstances should fractures of the lower third of the shaft of the humerus be placed in splints with the elbow ex-

tended, as this position causes acute angulation with backward displacement of the lower fragment, which may compress the brachial artery, thereby inducing circulatory disturbances or gangrene. Traction may be made on the elbow and forearm by adding to the arm-piece of the humerus splint (see p. 161) an anterior flange, which extends over the anterior aspect of the arm, and to the forearm piece a heavy wire loop ex-

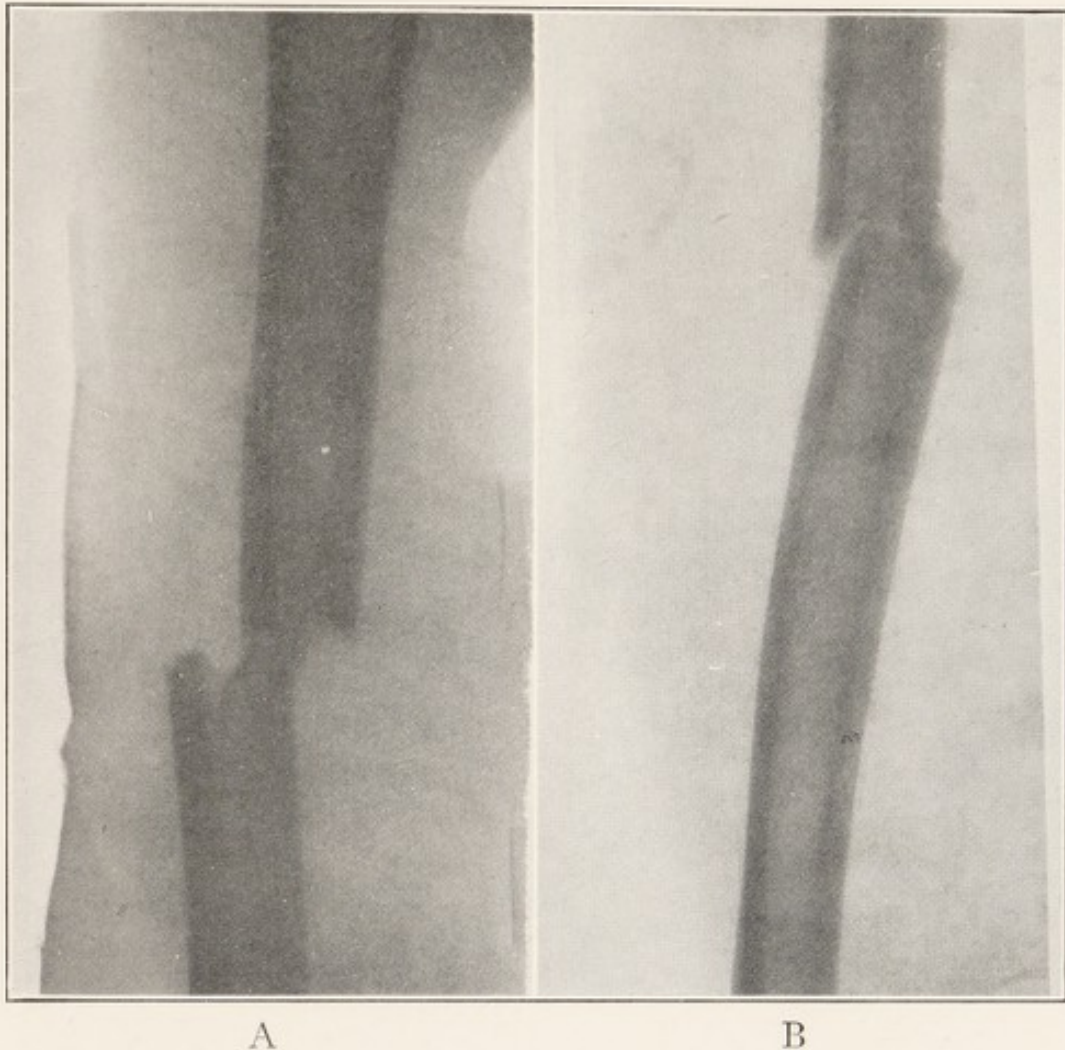


FIG. 112-A.—X-RAY SHOWING FRACTURE OF MIDDLE THIRD OF HUMERUS, ANTEROPOSTERIOR VIEW.

FIG. 112-B.—SAME AS FIGURE 112-A, LATERAL VIEW.

tending below the hand—the so-called banjo attachment. Fixed traction is secured by adhesive strips attached to the forearm and tied to the wire loop below.

In all fractures of the middle and upper thirds of the shaft of the humerus, the thorax may be employed as a splint by binding the arm thereto until roentgenograms can be made demonstrating the exact relation of the fragments. In those of the lower third, a simple right-angle elbow splint can be employed as a temporary measure.

In transverse fractures of the middle third of the shaft of the humerus,

reduction can be secured, as previously demonstrated in the discussion of fractures in long bones, after which the author's traction humerus splint or a plaster cast may be applied. As in all fractures of the shaft, the elbow is held at a right angle and the shoulder in about 30 degrees' abduc-



A

B

FIG. 113-A.—SAME AS FIGURE 112-A,
AFTER REDUCTION AND OSSEOUS
UNION.

FIG. 113-B.—SAME AS FIGURE 112-B,
AFTER REDUCTION AND OSSEOUS
UNION.

tion. The cast, when employed, should extend from the palm of the hand and include the entire body to the crest of the ilium. A cast which includes only the chest is usually very uncomfortable, as the weight of the upper extremity and the cast causes listing of the body to the affected side. This results in the lower border of the cast pressing against the body. In

oblique fractures, the humerus traction splint is advisable, or a cast may be applied while traction is made.

In fractures at the surgical neck of the humerus, the lower fragment is practically always displaced forward and appears as a mass anterior to the head of the humerus. An erroneous diagnosis of dislocation of the shoulder is too frequent and attempts are often made to reduce, which obviously add insult to injury. This fracture can be usually reduced in chil-

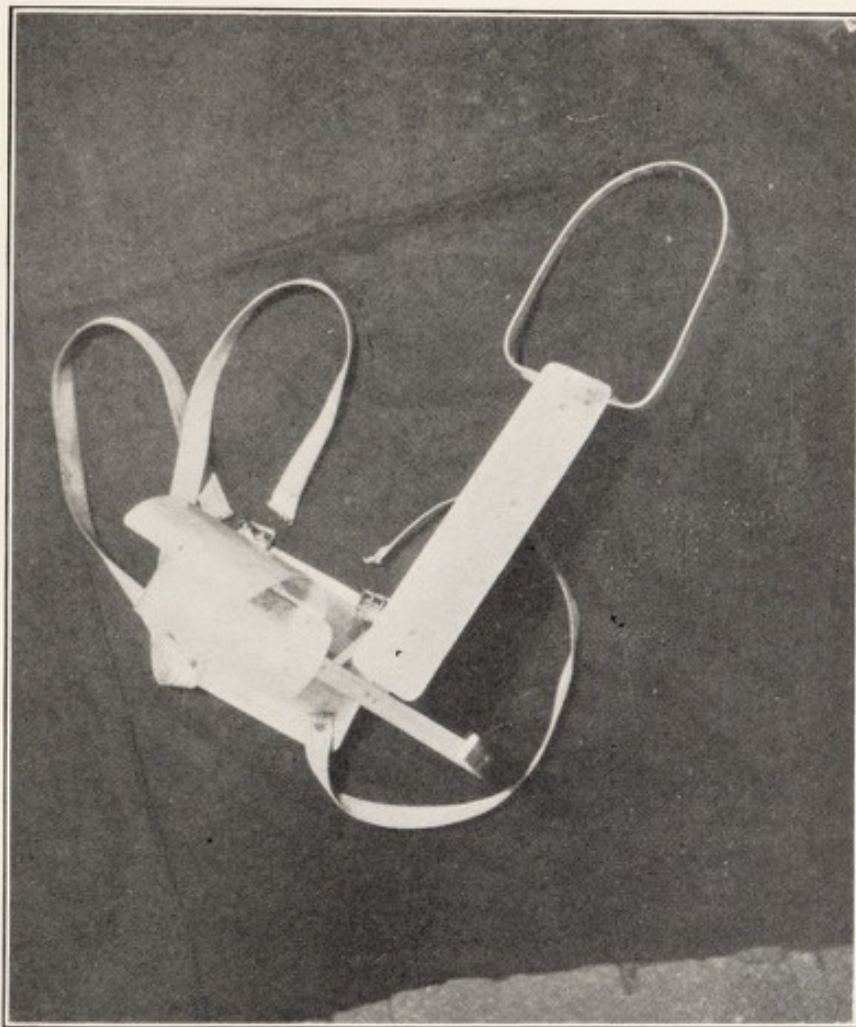


FIG. 114.—PHOTOGRAPH OF TRACTION HUMERUS SPLINT WITH BANJO ATTACHMENT FOR TRACTION OF FOREARM.

dren by angulation backward, when the fragments can be felt to engage. After reduction, the traction humerus splint is simple and will usually retain the fragments in satisfactory coaptation. Operative reduction will very rarely be required. A plaster cast, as for fractures of the shaft, may also be employed.

Birth fractures of the humerus are more common than in any other location, and are treated on the same principles as fractures of the humerus at any other time of life.

The Clavicle.—The clavicle is probably more frequently fractured in childhood than any other bone. The cause may be direct violence, but is

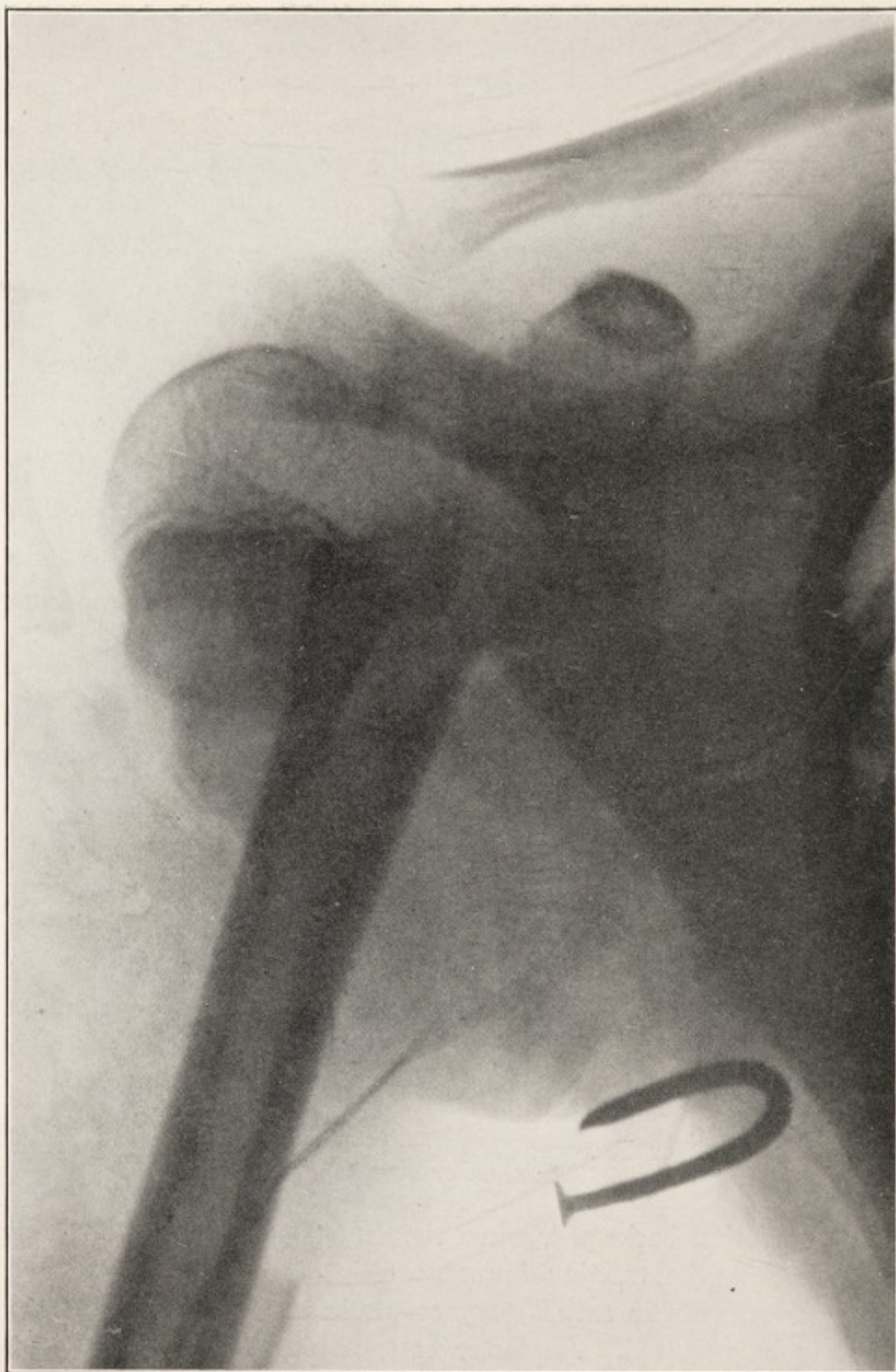


FIG. 115.—X-RAY SHOWING FRACTURE OF SURGICAL NECK OF HUMERUS.



FIG. 116.—SAME AS FIGURE 115, AFTER REDUCTION.

usually indirect violence by a fall on the outstretched hand. The most common site of fracture is at the junction of the middle and outer thirds of the bone. The fracture may be complete or incomplete, and the deformity varies with the site of the lesion, due to the action of the sternocleidomastoid muscle, the trapezius muscle, the coracoclavicular ligament, and the weight of the arm.

Symptoms.—The attitude of the child is diagnostic. The shoulder is depressed downward and forward. The child's head is bent toward the

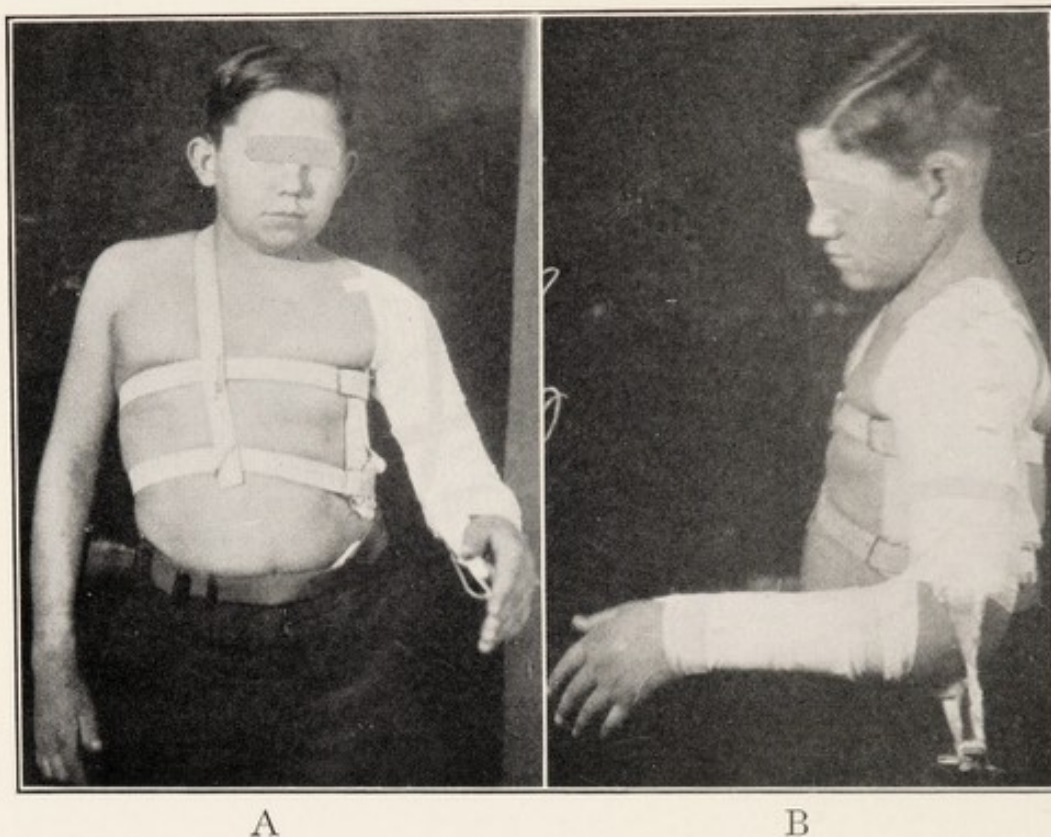


FIG. 117-A.—PHOTOGRAPH OF TRACTION HUMERUS SPLINT APPLIED, ANTEROPOSTERIOR VIEW.

FIG. 117-B.—SAME AS FIGURE 117-A, LATERAL VIEW.

affected side and he supports his arm with the uninjured hand. There may be swelling, ecchymosis and tenderness over the site of fracture, and pain and crepitus on motion of the arm. The displacement of the fragments is usually slight in children.

If the fracture is incomplete, the deformity is usually an upward angulation of the fragments. If there is complete fracture at the usual site, the inner fragment is displaced upward and the outer fragment is displaced downward and forward by the weight of the arm and shoulder. There may be considerable overriding of the fragments. If the fracture is at the insertion of the coracoclavicular ligament, the fragments are held in place by it and there is little deformity. When the fracture is external to the ligament, the lateral fragment is usually carried downward by the

weight of the arm. Rarely, it may be pulled upward by the trapezius muscle.

X-Ray Examination and Diagnosis.—The x-ray shows the fracture and the displacement. The diagnosis rarely causes difficulty, but may be overlooked in the "greenstick" variety, if no x-ray is made. Dislocation of the clavicle may occur either at the sternoclavicular or acromioclavicular

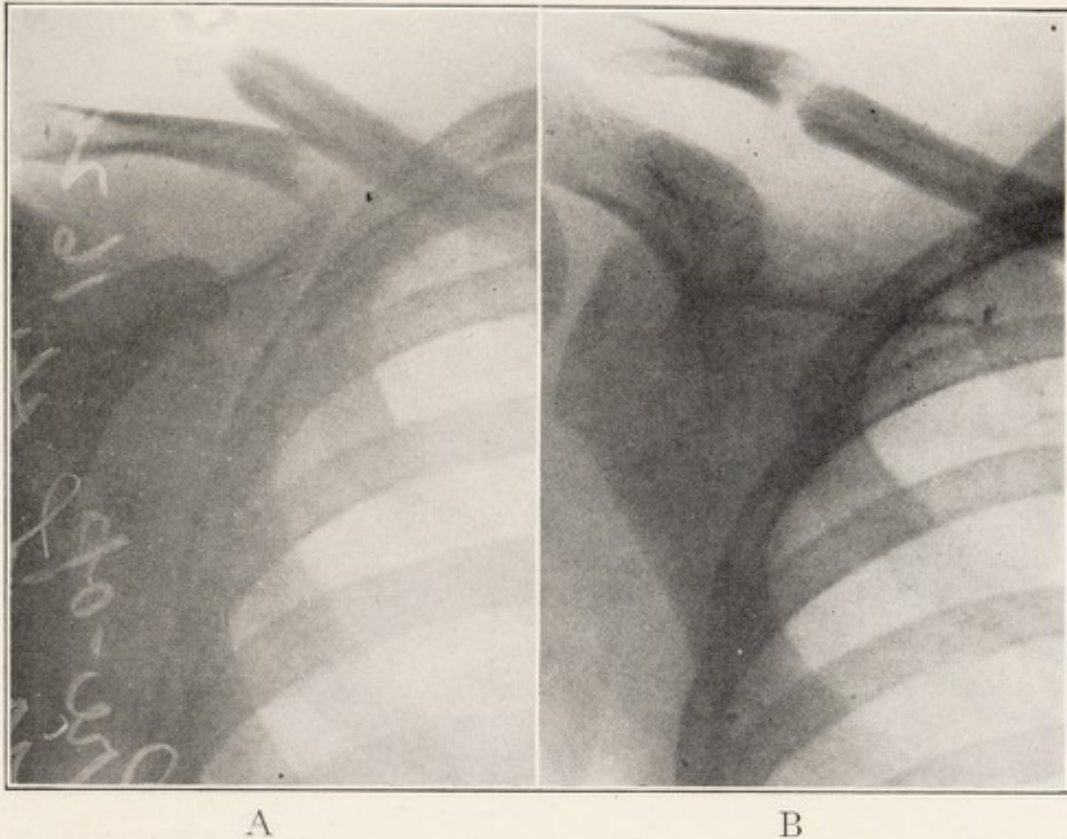


FIG. 118-A.—X-RAY OF FRACTURE OF CLAVICLE, JUNCTION OF MIDDLE AND OUTER THIRDS, SHOWING UPWARD DISPLACEMENT AND OVERRIDING OF MEDIAL FRAGMENT.

FIG. 118-B.—SAME AS FIGURE 118-A, AFTER REDUCTION.

joints. The symptoms and treatment in children are similar to those of fracture.

Prognosis.—The prognosis of fracture of the clavicle is good. The deformity is slight, even when perfect reduction cannot be obtained, and function of the arm is seldom impaired. In girls, better anatomical reposition is often more desirable than in boys because of the cosmetic effects.

Treatment.—The reduction is accomplished in the ordinary type, with downward displacement of the lower fragment, by elevation of the arm and shoulder outward and backward. At times, the manipulation must be done under anesthesia. The position is best retained by the Sayre adhesive dressing with an axillary pad of cotton or felt (Fig. 119). The barrel-stave splint or the T brace may be used. They have the advantage of allowing

free use of the hand, but are not satisfactory routinely for the primary dressing, because, if sufficient pressure is made to control the position, it may impair circulation of the arm by pressure in the axilla. The barrel-stave splint is useful as a convalescent splint (Fig. 120). Recumbency in bed, on the back, without a pillow and with a small sand bag between the shoulders, is an ideal method of treatment, but the patient, especially a child, will seldom submit long enough to the necessary confinement. Recumbency, however, in addition to other fixation, is advisable for the first week or ten days, if the prevention of deformity is desired. When the displacement is excessive, usually when associated with rupture of the cora-

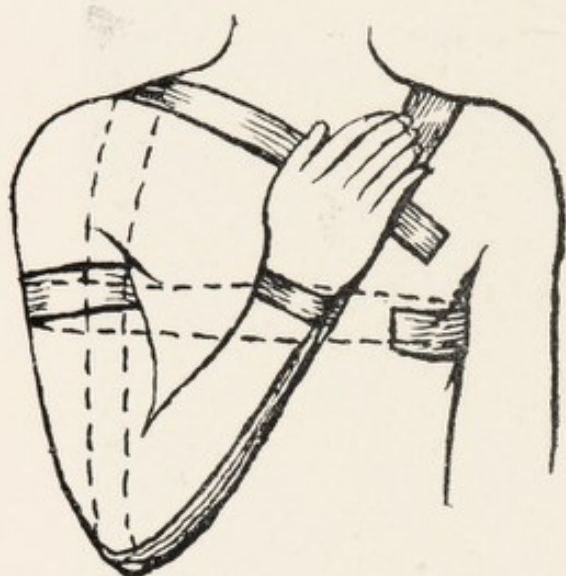


FIG. 119.—DRAWING SHOWING METHOD OF APPLYING SAYRE ADHESIVE DRESSING.

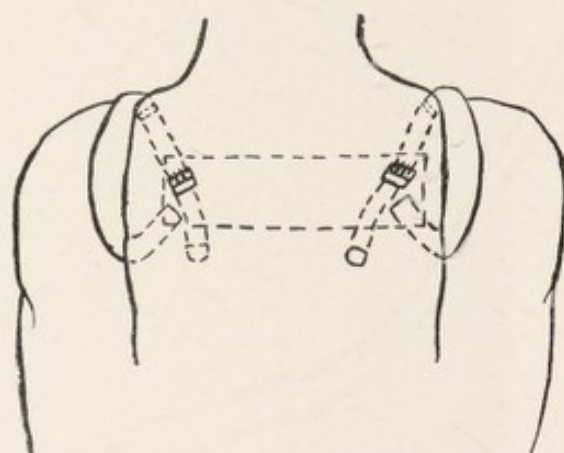


FIG. 120.—DRAWING OF POSTERIOR SPLINT FOR RETENTION OF FRACTURED CLAVICLE.

oclavicular ligament, open reduction may be necessary, and internal fixation of the fragments by heavy absorbable sutures or silver wire.

Epiphyseal Separations.—Epiphyseal separations rarely occur until late childhood, and are treated on the same mechanical principles as fractures, except that perfect approximation is essential. Future growth may be irregular or retarded, with subsequent deformity or shortening, though this will rarely be appreciable if complete coaptation is secured. However, in any separation of an epiphysis, the parents must be warned that future growth may possibly be inhibited. Any epiphysis may be separated, but only those of more frequent occurrence will be considered.

The lower femoral epiphysis may be displaced backward or forward after severe trauma and may impinge upon the popliteal artery with serious circulatory disturbances; consequently, close observation of the pulse in the leg is advisable, and if weak or obliterated, reduction must be made at once; or, if this cannot be accomplished, blind shifting of the fragments may relieve pressure on the artery.

Separation of the lower femoral epiphysis may also induce genu valgum

or other irregularities. External inspection may show apparently normal anatomical alignment, while internally there is gross displacement, which obviously impairs the function of the knee-joint with complete arrest of growth at this point.

If reduction cannot be performed under the fluoroscope, lateral incision should be made down to the point of fracture and the fragments replaced.

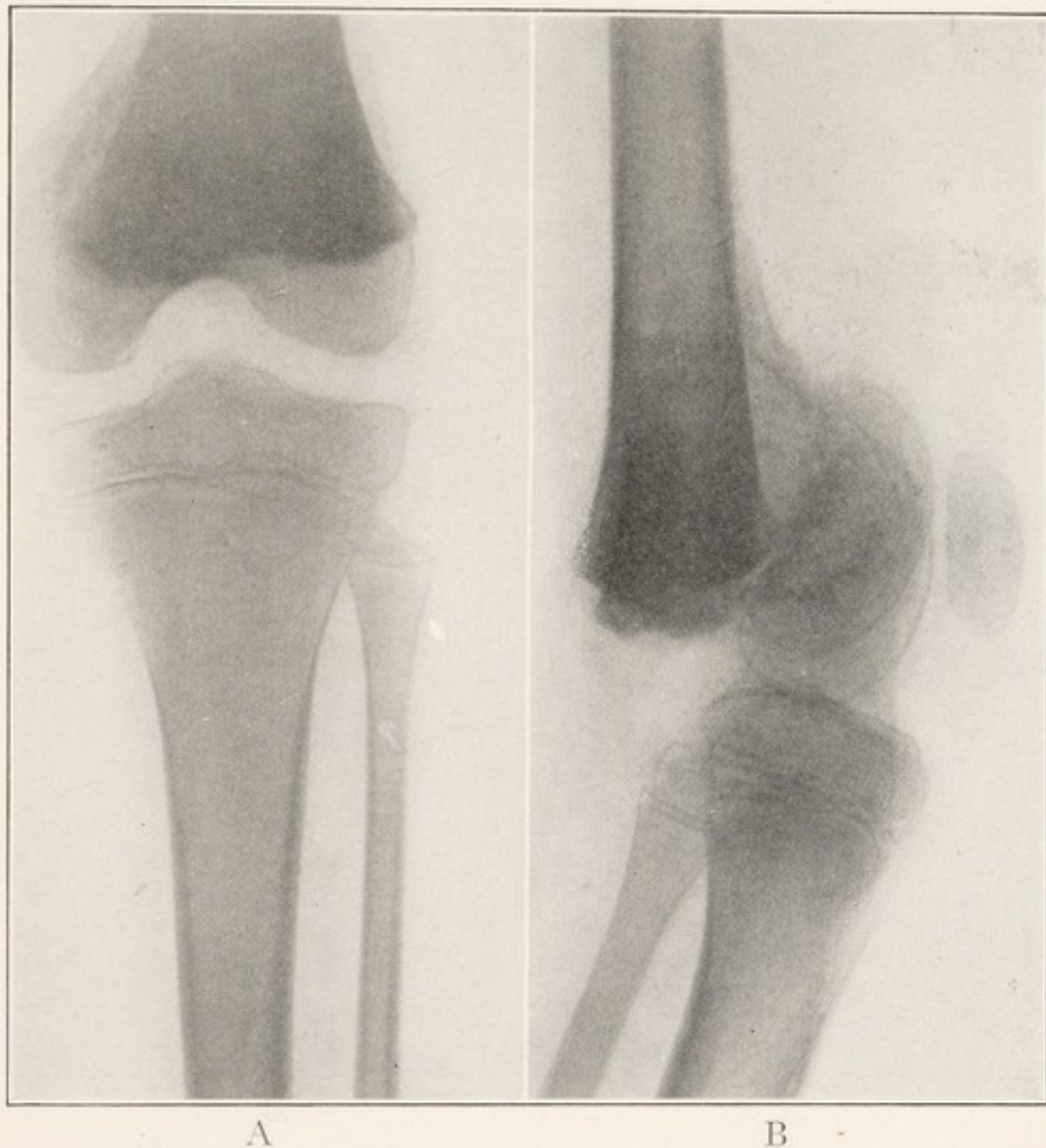


FIG. 121-A.—X-RAY SHOWING SEPARATION OF LOWER FEMORAL EPIPHYSES, ANTEROPOSTERIOR VIEW.

FIG. 121-B.—SAME AS FIGURE 121-A, LATERAL VIEW.

Before closing the wound, an x-ray picture should be made in both dimensions to confirm reduction, as it is impossible to determine accurately the relation of fragments by inspection through the incision. A plaster cast extending from the toes to the crest of the ilium is the most efficient method of retention, for lateral as well as anteroposterior displacement is prevented until union is complete.

Epiphyseal separation of the upper femoral epiphysis has been described

in the discussion of coxa vara, to which reference is made (p. 111) for detailed description. Separation of the upper femoral epiphysis is rarely observed until late childhood or about adolescence. In early and middle childhood, the same force that produced epiphyseal separation will cause fractures of the neck of the femur or, more often, the upper third of the shaft.

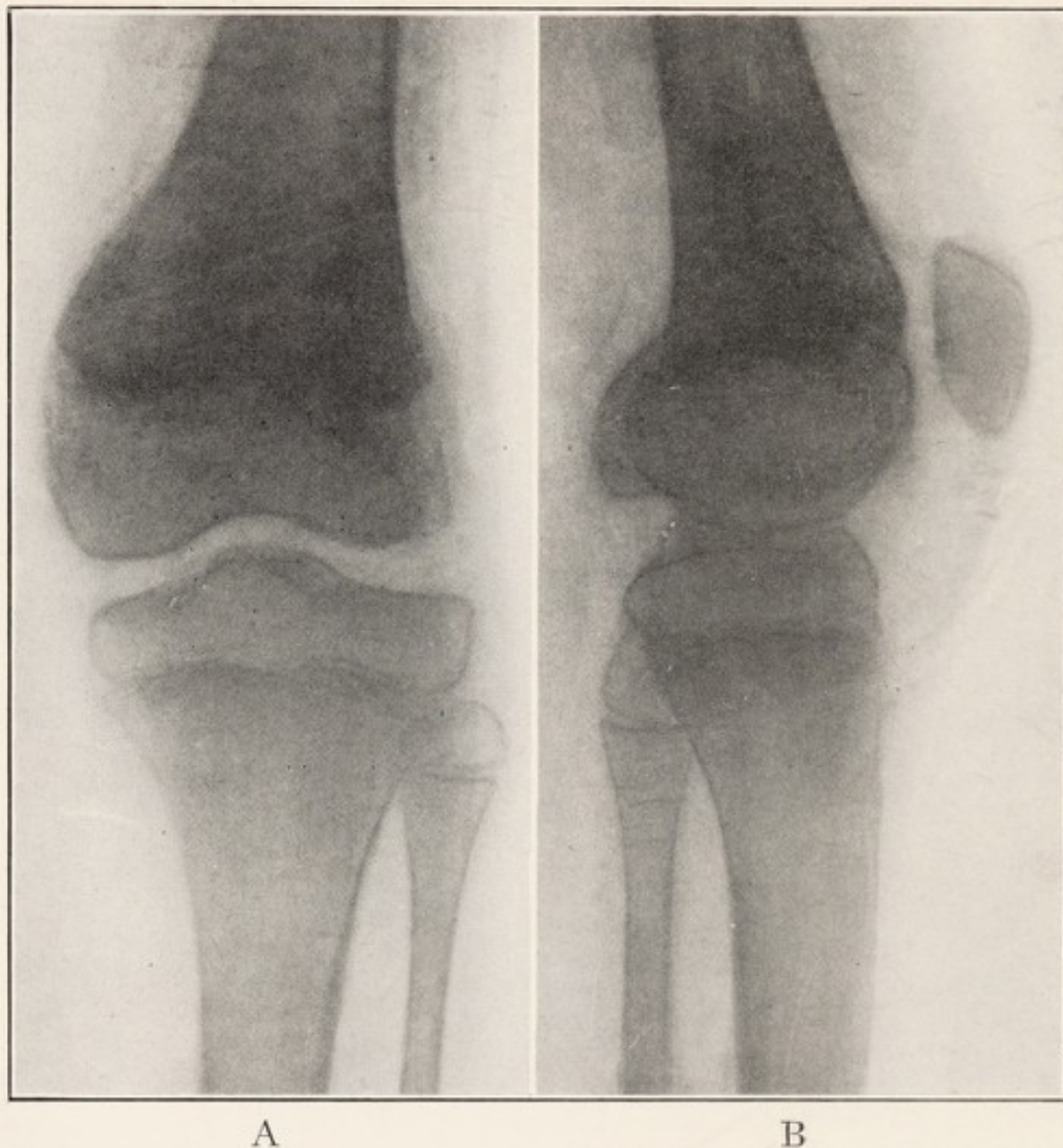


FIG. 122-A.—SAME AS FIGURE 121-A, AFTER OPEN REDUCTION. FIG. 122-B.—SAME AS FIGURE 121-B, AFTER OPEN REDUCTION.

The mechanical principles of reduction of separation of the upper femoral epiphysis are the same as for central or intracapsular fractures of the neck of the femur in adults, and consist in placing and retaining the hip in full abduction with moderate internal rotation and hyperextension, as advocated by Whitman. For the purpose, a plaster cast is most efficient, which extends from the toes on the affected side to the nipple line and to the knee on the normal limb. Flat view x-rays are not sufficient to determine the relation of the head to the neck, and stereoscopic x-rays should be made

in every case. If replacement is not accurate, reduction by open operation is required. Malunion after separation of the upper femoral epiphysis is discussed as a type of coxa vara.

Separation of the lower radial epiphysis is treated as a Colles' fracture, as previously described. Separation of the lower humeral epiphysis is

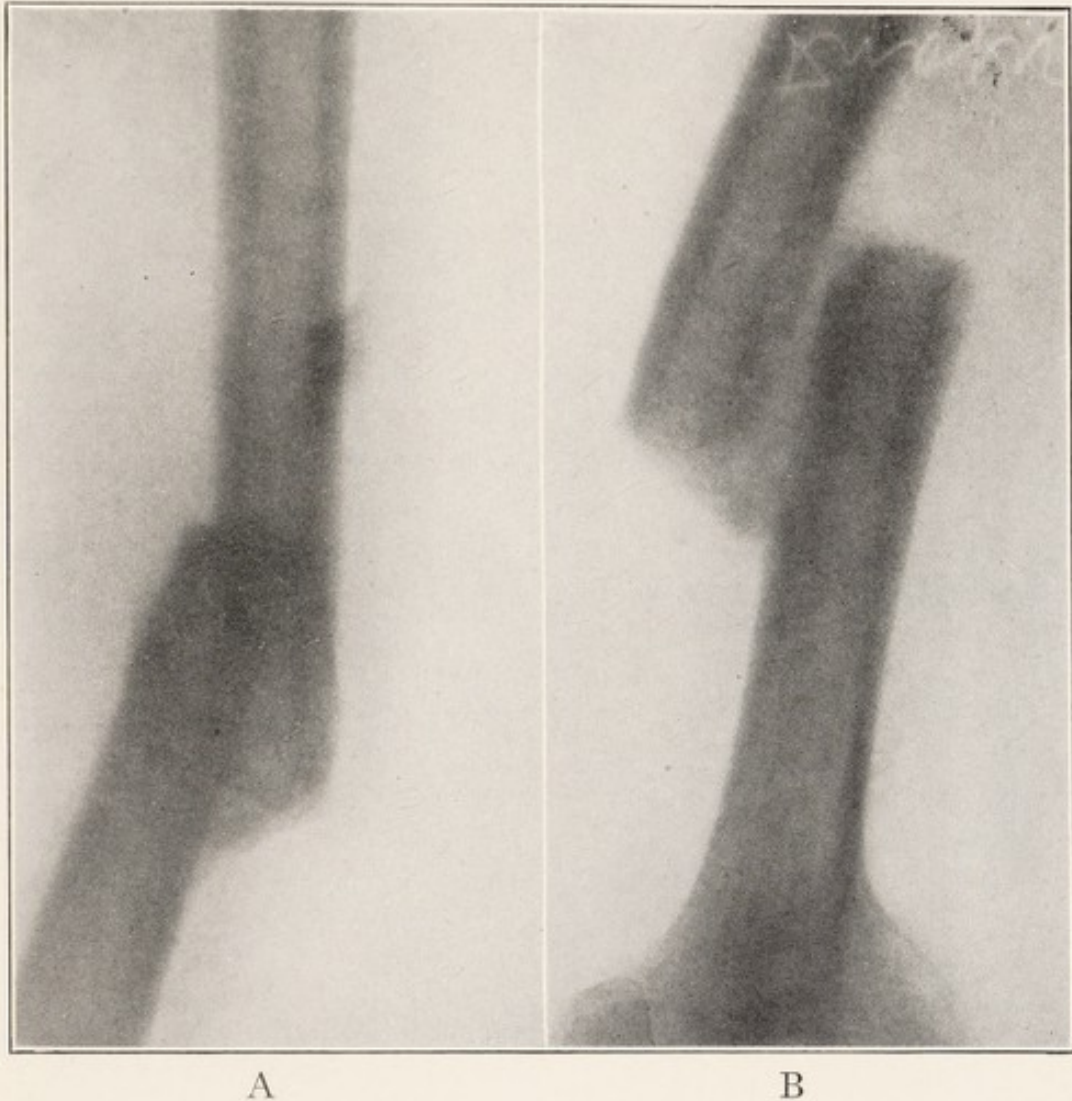


FIG. 123-A.—X-RAY SHOWING MAL-UNITED FRACTURE OF SHAFT OF FEMUR, ANTEROPOSTERIOR VIEW.

FIG. 123-B.—SAME AS FIGURE 123-A, LATERAL VIEW.

often erroneously diagnosed, and is exceedingly rare. The treatment is the same as for supracondylar fractures of the humerus.

Separation of the upper humeral epiphysis closely resembles fractures of the surgical neck of the humerus and should be treated on the same principles, after which, reduction can be maintained by the author's splint for fractures of the humerus. For this condition, the shoulder is frequently placed in extreme abduction and so retained by a plaster cast, but this posture is awkward, confining, and is necessary only in exceptional instances.

Malunited Fractures.—Malunion in fractures and epiphyseal separa-

tions is too frequent in occurrence, due to the lack of appreciation of the basic principles involved in the treatment of fractures. The chief cause of deformity resulting from fracture is undoubtedly inefficient splinting, though, of course, approximation of fragments is to be considered. Malunions of more frequent occurrence only will be discussed.

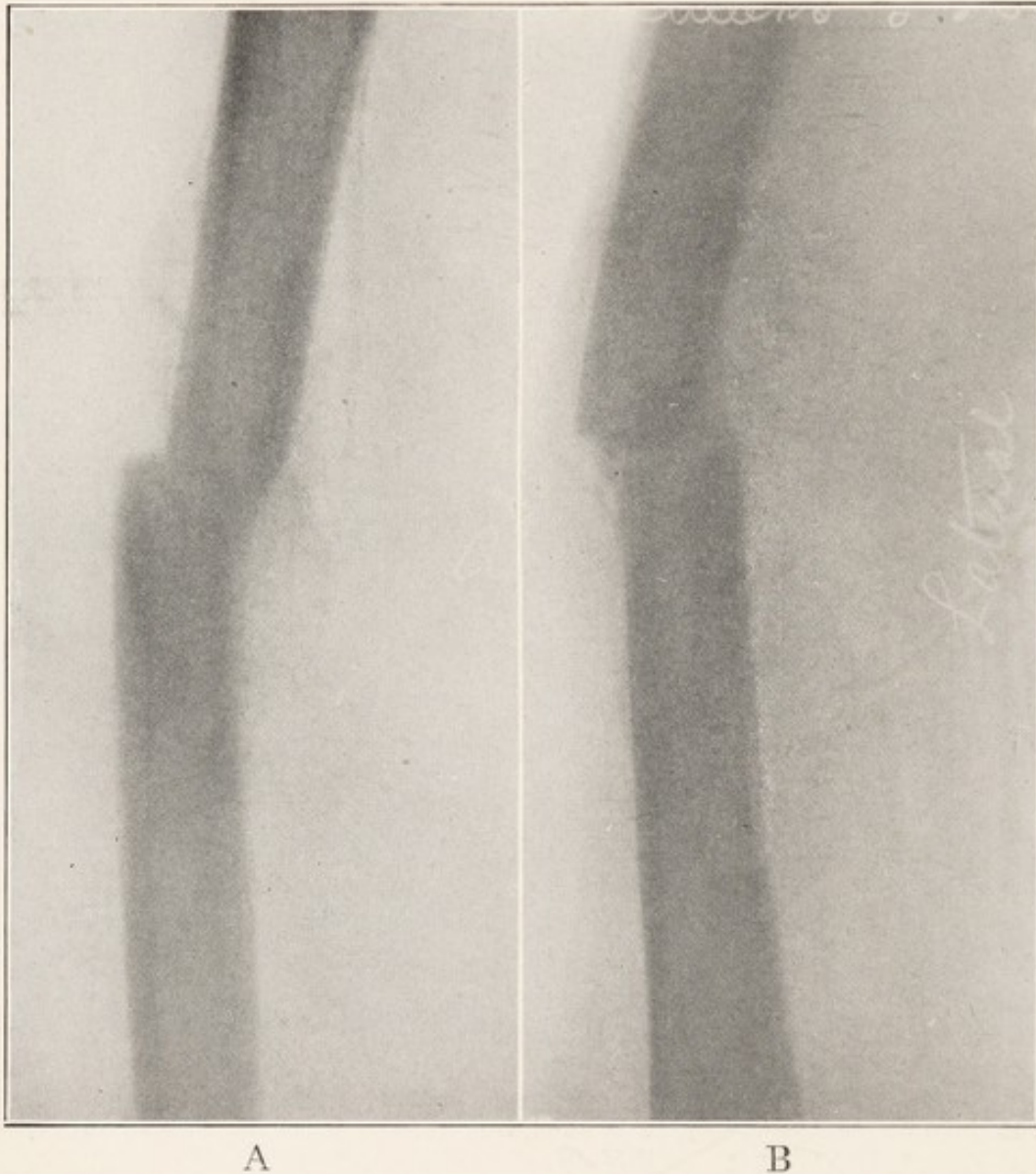


FIG. 124-A.—SAME AS FIGURE 123-A, AFTER REDUCTION: PERFECT FUNCTIONAL RESULT. FIG. 124-B.—SAME AS FIGURE 123-B, AFTER REDUCTION.

The Shaft of the Femur.—Malunited fractures of the shaft of the femur are manifested by an outward bowing, an inward or outward rotation and decrease in length. If observed before firm consolidation, a fair reduction, with perfect anatomical alignment and increase in length, may often be obtained by simple manual correction. In those observed after firm consolidation, open operation is required.

Upper Extremity of the Humerus.—Malunion in fractures of the surgical neck of the humerus and separation of the upper humeral epiphysis are

of common occurrence, but do not produce the impairment of function frequently observed in the adult. This is due to the laxity of the shoulder joint in children and the development of compensatory motion in the scapula. However, impairment of function after malunion in this region does occur, and limits movement chiefly in abduction. In such cases, operative measures are required to restore anatomical alignment and function.

The Elbow.—Permanent impairment in function of the elbow is observed more frequently than in fractures of other bones. Unreduced supracondylar fractures often result in loss of the carrying angle and limitation of motion in the elbow-joint, particularly in flexion, as the upper fragment



A

B

FIG. 125-A.—X-RAY OF MALUNITED SUPRACONDYLAR FRACTURE WITH IMPINGEMENT OF LOWER END OF SHAFT ON CORONOID PROCESS OF ULNA.

FIG. 125-B.—SAME AS FIGURE 125-A, AFTER SURGICAL REMOVAL OF MASS OF BONE AND RESTORATION OF FUNCTION.

impinges against the coronoid process of the ulna. If observed before union is solid, approximation can often be made by manual correction under the fluoroscope and confirmed by the x-ray, after which the elbow is placed in acute flexion and treated as a fresh fracture. In addition, physiotherapy is frequently essential to the restoration of normal function. In those observed months or years after supracondylar fracture, operative measures offer the sole chance of relief, which may consist only of excising the protuberance made by the lower end of the upper fragment; or a complete refracture, with after-treatment as in fresh fractures. During the process of consolidation, constant supervision is required to prevent changes in the relation of the fragments and to restore the angle of abduction between the arm and forearm, known as the carrying angle.

In old comminuted fractures of the elbow, there may be ankylosis, deformity, pain and weakness, for which no relief can be secured until full growth is attained, when a very satisfactory joint may be reconstructed by the procedure known as arthroplasty.

The External Condyle.—Fractures of the external condyle of the humerus often terminate in non-union. There is exaggeration in the carrying



FIG. 126-A.—X-RAY SHOWING FRACTURE OF EXTERNAL CONDYLE OF HUMERUS WITH NON-UNION, ANTEROPOSTERIOR VIEW.

FIG. 126-B.—SAME AS FIGURE 126-A, LATERAL VIEW.

angle and instability of the joint. The loose fragment is prominent and gives a bizarre appearance to the elbow. Motion is usually unlimited and often an exaggeration of normal. Pain and weakness are frequently experienced. As the growth of the displaced fragment is not commensurate with the parent bone, re-attachment will not restore contour unless the condition is observed a short time after the occurrence of the fracture; moreover, union in a terminal fragment cannot often be induced. The author, therefore, removes the loose fragment with resulting improvement in



A

B

FIG. 127-A.—X-RAY SHOWING UN-UNITED FRACTURE OF UPPER END OF RADIUS, ANTEROPOSTERIOR VIEW.

FIG. 127-B.—SAME AS FIGURE 127-A, LATERAL VIEW.

function and relief of symptoms, but the joint, of course, remains mechanically defective.

Ununited Fractures in Children.—Ununited fractures in children are of exceedingly rare occurrence and most resistant to treatment. The treatment is the same as of non-union in adults, which entails a careful search

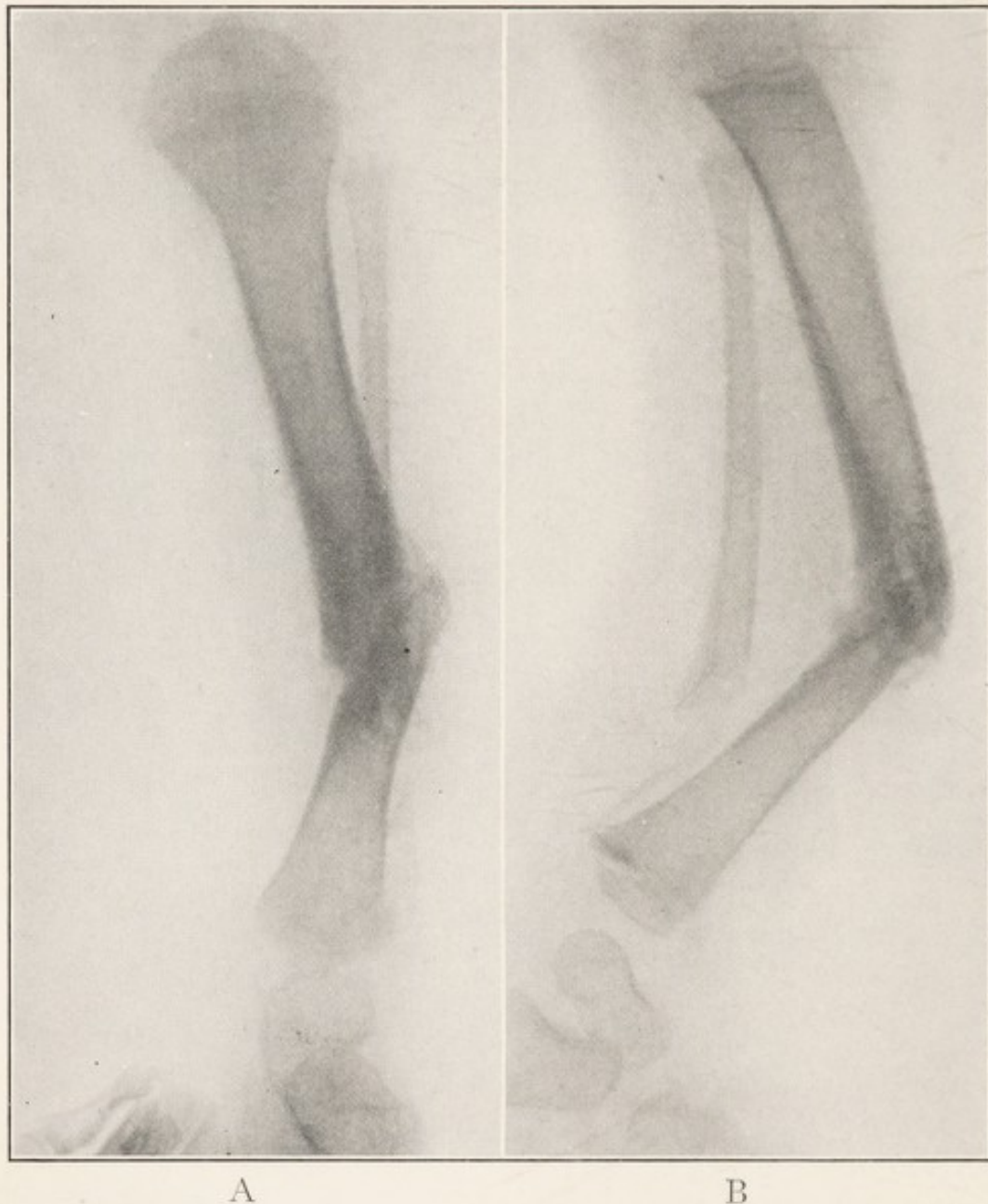


FIG. 128-A.—X-RAY SHOWING CONGENITAL FRACTURE OF TIBIA AND FIBULA, ANTEROPOSTERIOR VIEW.

FIG. 128-B.—SAME AS FIGURE 128-A, LATERAL VIEW.

for some constitutional disturbance, with eradication, if discovered. Many ununited fractures are probably due to congenital deficiency in bone production and are perhaps closely related to congenital fracture.

The operative treatment is by autogenous bone-grafts. The author prefers the massive graft with the transference of small particles of spongy bone about the affected area, as spongy bone has been found to possess a

marked reproductive quality. The Delanginere graft is also employed in the treatment of ununited fractures and consists of a wide strip of the periosteum removed from the tibia, together with small flakes of the cortex. Bone-grafts are also used to fill defects where continuity has been



FIG. 129-A.—SAME AS FIGURE 128-A, AFTER HOMOGENEOUS BONE-GRAFTING FROM MOTHER, SHOWING CALLUS FORMATION AND SOLID UNION.

FIG. 129-B.—SAME AS FIGURE 128-B, AFTER BONE-GRAFTING, SHOWING CALLUS FORMATION AND SOLID UNION.

lost. Firm attachment at both ends is necessary, and when possible, throughout the entire length of the graft.

Congenital Fractures.—Congenital fractures must be differentiated from birth fractures. Birth fractures are those which occur from trauma during childbirth, and are the same as any other type of fracture. Con-

genital fractures are due to developmental errors, and there is a definite embryological defect which must be combated in addition to the fracture.

Congenital fractures are of rare occurrence and resistant to every attempt at treatment. There are three types: (1) those which are loose and flail at birth; (2) those in which there is a feeble malunion and are refractured later in childhood by some slight injury; (3) those in which



FIG. 130.—PHOTOGRAPH OF CHILD (FIGURES 128-A, 128-B, 129-A, 129-B) SHOWING CONTOUR OF RIGHT LEG AFTER OPERATION.

there is feeble union in good position, but the bone is weak at the point of union and refractured later in childhood. The second and third types respond better to operative measures, whereas the first type is considered by many as hopeless.

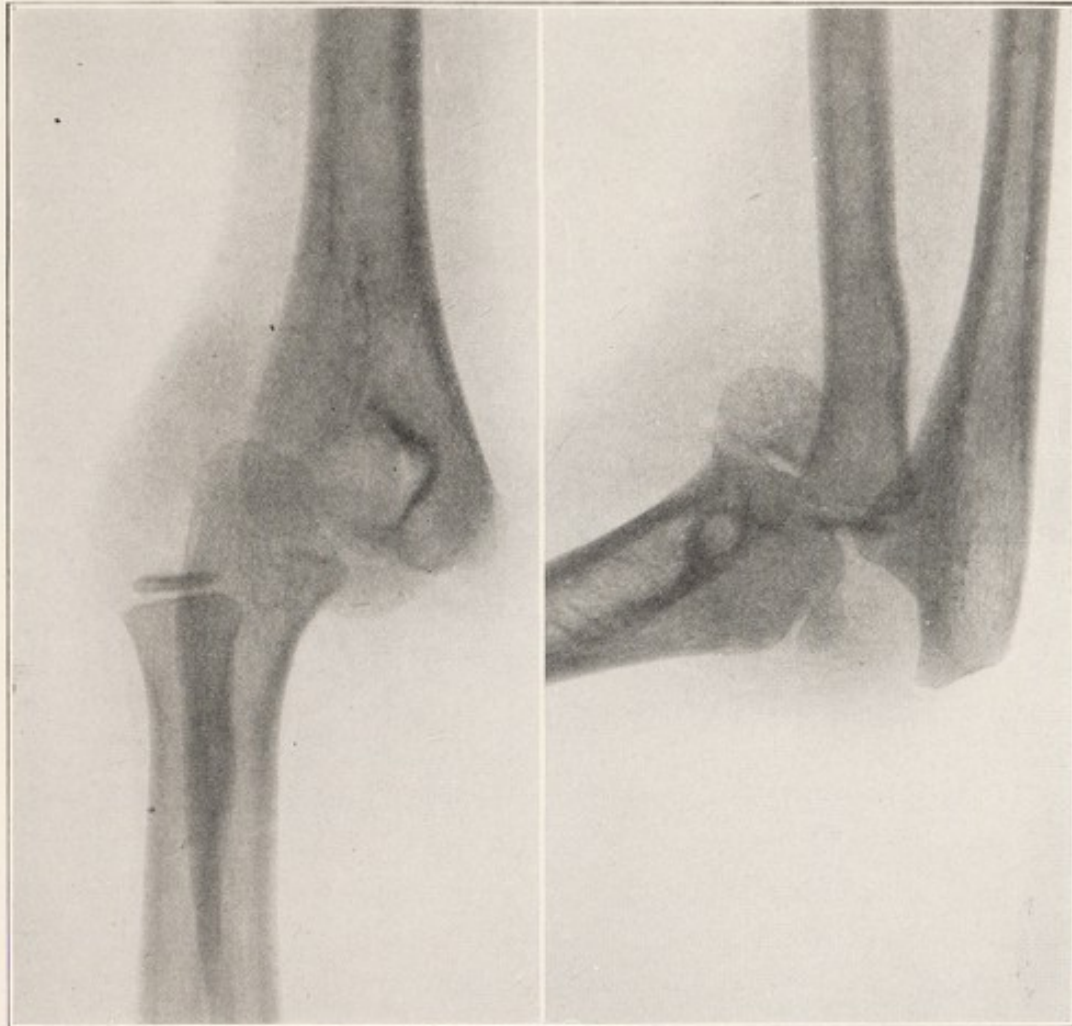
Treatment.—Every form of bone-graft has been employed in the treatment of congenital fractures. The author has been successful in a case of the first type. The patient was a child of two years of age with involvement of both bones of the leg. A homogeneous graft from the tibia of the mother was employed. The blood of the mother and child was first typed and found to be compatible, after which both were placed under anesthesia. An incision was made over the tibia of the child. The fragments were found to be sclerotic, tapering to thin points with no effort to unite. A large graft was removed from the tibia of the mother and fastened to the tibia of the child by silver wire, as autogenous bone nails would not hold in a bone so small and sclerotic.

Small particles of endosteum with spongy bone from the medullary canal of the mother were placed about the fracture. Union was solid in three months and has persisted for the past year with gradual proliferation and consolidation. Wires or other metal are not usually advisable in ununited fractures, but in this instance no other material would accomplish efficient fixation.

Bone-grafts in children are not satisfactory, as a rule, until a child has reached the age of eight years, as the quality of the bone is such that repro-

duction cannot be expected. In late childhood and about puberty, the bone-graft is very effective, as in young adults.

Bone-grafts may be of various sizes, but the author prefers the massive graft, as he regards fixation and osteogenesis the essential elements. The Delanginere graft is more effective when used in conjunction with a massive graft than when used alone, and is often a valuable adjunct. Also, when possible, small particles of spongy bone are placed about the graft.



A

B

FIG. 131-A.—X-RAY SHOWING POSTERIOR DISLOCATION OF ELBOW, ANTEROPOSTERIOR VIEW.

FIG. 131-B.—SAME AS FIGURE 131-A, LATERAL VIEW.

Foreign materials, such as silver wire or bone plates, are not usually advisable in children; autogenous nails, which can be made from the graft, are to be preferred.

Dislocations Recent and Ancient.—Traumatic dislocations in children are exceedingly rare, fractures usually resulting from the same force which would induce dislocations in an adult. Dislocation of the shoulder, so common in young adults, is extremely rare in childhood. Therefore the diagnosis should not be made without much hesitation and a satisfactory x-ray.

The elbow is more often dislocated in children than any other joint, and next in frequency, the hip; hence, only dislocations of these two joints will be considered.

The Elbow.—The most frequent type of dislocation of the elbow is posterior displacement of the ulna and radius. Fractures are often associated and, unless gross, may be disregarded. The diagnosis should be made by local examination, which shows the olecranon process prominent and posterior to its normal position in relation to the condyles. Confirmation should always be made by the x-ray. Reduction can usually be accomplished by a continuous strong pull upon the forearm while the patient is under deep anesthesia. With the left hand the arm is grasped above the elbow, while the wrist is grasped with the right hand. In this manner a strong pull can be made without danger of injury to the shoulder. Forcible flexion is contra-indicated, as supracondylar fracture of the humerus can easily be caused in this manner. Reduction must always be confirmed by the x-ray, as the external appearance may be deceptive, especially if there is excessive swelling.

A dislocation of the elbow must be considered ancient at the end of three weeks and thereafter. Old dislocations of the elbow are fixed in extension at about 170 degrees, with very slight motion—practically a fibrous ankylosis in this position. In old dislocations, there are dense adhesions and the bones forming the articulation are atrophic. Consequently, sufficient force to effect reduction will usually cause fracture, which most seriously complicates and often prevents restoration of function.

The only treatment to be considered in ancient dislocations of the elbow is open reduction. The author¹ employs a special technic by the posterior route. After operation, the elbow is placed at about 75 degrees' flexion and so retained by a posterior splint for three weeks, when physiotherapy should be instituted. Restoration of normal function is not always obtained on account of subsequent adhesions, but a useful joint may be expected.

The Hip.—Traumatic dislocations of the hip-joint in children are frequently overlooked until too late to expect satisfactory reduction without open operation. Even if observed immediately after dislocation, reduction by various maneuvers advised in traumatic and congenital dislocations may be difficult or impossible without incision. Excessive force should not be employed, as the head of the femur in children has very slight resistance and irreparable damage may accrue.

Dorsal dislocation of the hip is most common, though excessive force may even displace into the perineum. In dislocations of the head upon the dorsum of the ilium there is definite shortening, the trochanter is above

¹ W. C. Campbell, "Arthroplasty of the Elbow," *Ann. Surg.*, Nov., 1922.

Nélaton's line, and the hip is flexed and adducted. — The head and neck may be palpated above the socket. The x-ray confirms the relation of the articular surfaces.



FIG. 132.—X-RAY OF TRAUMATIC DISLOCATION OF HIP AFTER REDUCTION. Apparently excellent result. Note Figure 133 two years thereafter.

In ancient or old dislocations which have existed over three weeks, Buck's extension may be employed for one or two weeks, after which reduction may be attempted by careful manipulation with the child under deep anesthesia. If unsuccessful, reduction by open incision is indicated. In those in whom dislocation has existed for months or years, a preliminary



FIG. 133.—X-RAY OF OLD TRAUMATIC DISLOCATION OF HIP, SHOWING EPIPHYSEAL DISTURBANCE.

Same as Figure 132, which was satisfactorily reduced.

treatment by traction may be given, but the actual reduction can be effected only by operative procedures.

The prognosis must always be guarded in traumatic dislocations of childhood, for there may be injuries to the epiphysis or head of the femur which do not become apparent for years; or possibly the nutrient vessels may be destroyed and natural evolution of growth and development retarded. Often excellent functional results may follow closed or open reduction; but, also, a result apparently excellent for months after operation may present a gross defect and functional impairment in later years. (See Figs. 132 and 133.)

Traumatic Osteitis.—Traumatic osteitis, or periostitis, is the reaction of bone to trauma. There may be a definite proliferation of the periosteum with swelling of the soft tissues. The process usually subsides spontaneously, but is of interest, as mild trauma is a predisposing cause in many affections of the bones and joints.

X-ray pictures should be made as often as practicable. If symptoms persist, roentgenograms should be made at regular intervals, since in this way certain pathological processes, as malignant tumors, may receive early diagnosis and treatment, thereby increasing the possibility of arrest.

Osteoporosis.—Osteoporosis, or bone atrophy, is a clinical entity which is usually observed as a sequela of mild or severe trauma, but is also seen in any condition which enforces disuse of a part. In children, the symptoms are not so pronounced as in adults, but when present, there is a dull, constant ache which is more exaggerated after exercise.

X-Ray.—The x-ray shows the condition to be more pronounced in the cavernous bone of the extremities of long bones and in the small bones of the hands and feet; however, it is also observed in the shaft or dense bone. The bone is paler than normal, and the bone trabeculae are ill-defined or only partially apparent, giving a mottled appearance.

Diagnosis.—The diagnosis is made from the x-ray, which is pathognomonic. The condition, however, is very frequently mistaken for a destructive bone lesion, as tuberculosis, and unnecessary operations or even amputations are performed.

Prognosis and Treatment.—The prognosis is favorable and recovery may be expected by appropriate treatment, the principles of which are increased functional use of the affected part. If the condition occurs in the lower extremity, the bones may be so soft and the pain so great that weight-bearing must be gradually resumed. This may require special apparatus. The small bones of the feet often require arch supports to prevent a change of contour. In the upper extremity, intensive muscle training is indicated and the patient is encouraged to use the affected part as much as possible. Physiotherapy is especially efficacious.

CHAPTER XI

AFFECTIONS OF BONES (*Continued*)

DISORDERS DUE TO NUTRITION

Rickets.—Rickets is a constitutional disorder which affects all tissues, but the manifestations in the skeleton are more pronounced. The etiology is chiefly nutritional, which may be due to a deficient diet, or lack of assimilation of a well-balanced diet. Insufficient sunlight has also proved to be an etiological factor. The affection is one of late infancy and early childhood.

Pathology and X-Ray.—The bone-producing process in normal growth is disorganized, as demonstrated by irregularity of cell arrangement of the epiphyseal cartilage. The deposit of lime salts is insufficient. The x-ray shows a cloudiness or haziness of the epiphysis. The end of the shaft of the bone, or diaphysis, is much broader than the epiphysis, whereas, in normal bone the epiphysis and diaphysis are the same width.

Symptoms.—The symptoms and osseous manifestations are well known and do not require elaboration. There is a diffuse enlargement of epiphysis, more pronounced in the wrist, ankle, knee, elbow and shoulder and rachitic rosary of the ribs. A transverse groove is observed across the anterior surface of the thorax, with flaring of the lower borders of the ribs (Harrison's groove). The thorax is laterally compressed. The spine may show a rounded kyphos from base of neck to buttocks on sitting, which disappears in the recumbent position. Deformities of bones and joints may be present, as bow-leg, knock-knee, scoliosis, coxa vara, etc. There is a lack of muscular tone, evidenced by flaccidity of muscles and prominence of the abdomen. Digestive disturbances are of frequent occurrence.

Prognosis.—The prognosis is excellent, if assimilation of required food elements can be reëstablished, but evidence of rickets usually persists in some of the bones throughout life, for example, pigeon-breast, square high forehead, etc.

Treatment.—The constitutional treatment is in the domain of pediatrics and will not be discussed. Heliotherapy and ultraviolet rays or artificial heliotherapy undoubtedly have a beneficial effect on the process, independent of diet, and should be routinely employed. In severe cases, while the process is active, the child should be held in the recumbent position on a Bradford frame or hard surface until the x-ray demonstrates that the

structure of the bone is approaching normal. This requires from three to six months. Recurrence of deformities may be expected if operative measures are instituted before the active process has entirely disappeared and the structure of the bone has become normal. Bow-leg and knock-



FIG. 134-A.—X-RAY SHOWING EPIPHYSEAL DISTURBANCE CHARACTERISTIC OF RICKETS, ANTEROPOSTERIOR VIEW.

FIG. 134-B.—SAME AS FIGURE 134-A, LATERAL VIEW.

knee are the most common residual deformities, requiring special treatment and consideration.

Bow-Leg (Genu varum).—Bow-leg, or genu varum, is an outward bowing of the shaft of the tibia and fibula through the upper and middle thirds, with an inward rotation or twist of the lower third. The term varum is used to indicate an inward deviation of the leg. If the condition

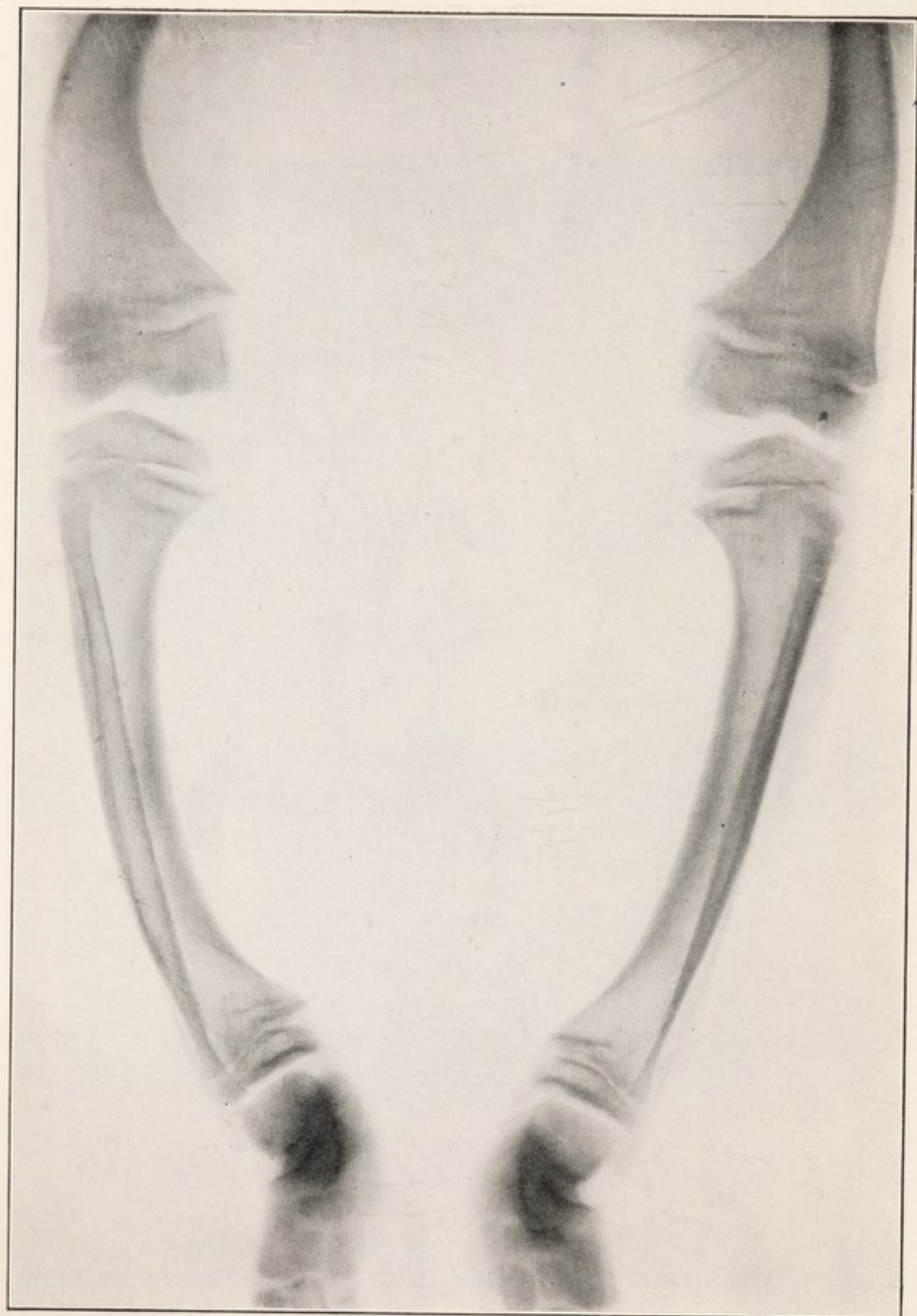


FIG. 135.—X-RAY OF BOW-LEG FOLLOWING RICKETS.

is observed before there is consolidation, or when the process is active, correction may often be accomplished in mild cases by simple manual manipulation. Grasping both extremities of the leg and bending outward for a few minutes three or four times a day are sufficient. In addition, a simple bow-leg splint, consisting of an inner bar extending from foot to thigh, with a broad strap making pressure over the highest crest of the curve may be applied. This splint should be worn during rest periods in the day and at night. If the deformity is severe, walking braces on the same principles, which make a definite pull or pressure over the curve, may be employed. After the subsidence of the process, if the deformity is exaggerated, operative procedures are required. Fracture by chisel or special apparatus known as an osteoclast is induced at the greatest prominence of the tibia, which is usually in the upper third; the fibula is then fractured by manual force, after which a plaster cast, extending from the toes to the groin and retaining the limb in slight knock-knee or overcorrected position, is applied.

Prognosis.—As the process subsides and normal growth is instituted in the epiphyses, there is a tendency to spontaneous correction, which is undoubtedly of frequent occurrence. However, this does not always occur, and when an unsightly deformity is permanent, there will be unequal distribution of weight on other joints, which may induce arthritic changes and symptoms in later years.

Knock-Knee (Genu valgum).—Knock-knee, or genu valgum, is an outward deviation of the leg, as the term valgum indicates. An angle is formed with the femur at the knee-joint, and in exaggerated cases there is also outward rotation. The feet, in walking, usually turn in (pigeon-toe) in a compensatory effort to clear the knees. However, flat-foot, instead of pigeon-toe, may be a complication, especially in those who develop the habit of outward rotation of the hips in clearing the knees.

Prognosis.—The prognosis for spontaneous recovery is not so favorable as in bow-leg, though material improvement may often be observed after normal growth has continued for a number of years.

Treatment.—As in genu varum, daily manual manipulation is indicated during the active stage. This consists in grasping the lower extremity of the femur with one hand and the ankle with the other, then bending the leg inward with the internal condyle of the femur as a fulcrum. Corrective splints are also applied during rest periods in the day and at night. In progressive deformities, steel braces are required for ambulation, extending from the foot to groin, with straps holding the knee outward and the leg inward. Deformities existing after the active process has subsided are corrected by operative procedures. The femur is fractured just above the epiphysis by a type of chisel known as an osteotome, or a special apparatus known as an osteoclast, by which force can be directed or controlled so as to produce a closed fracture at the desired point.

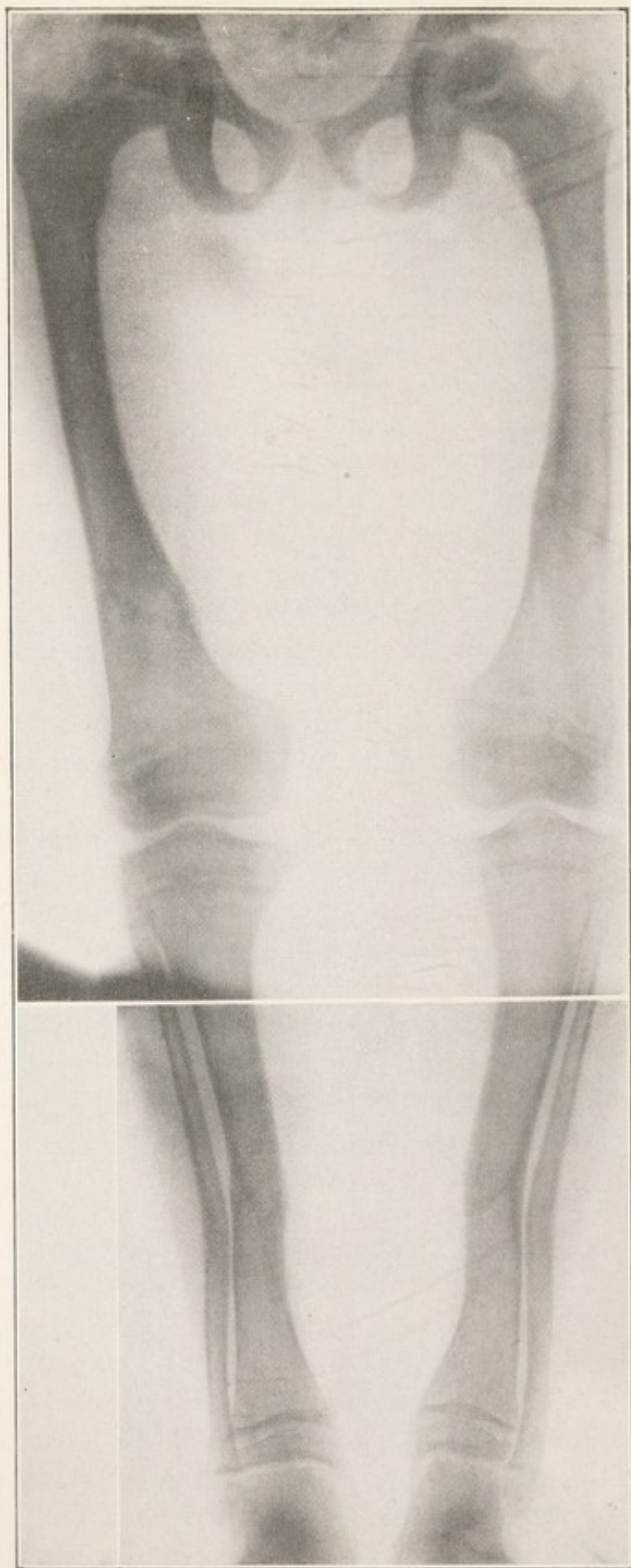
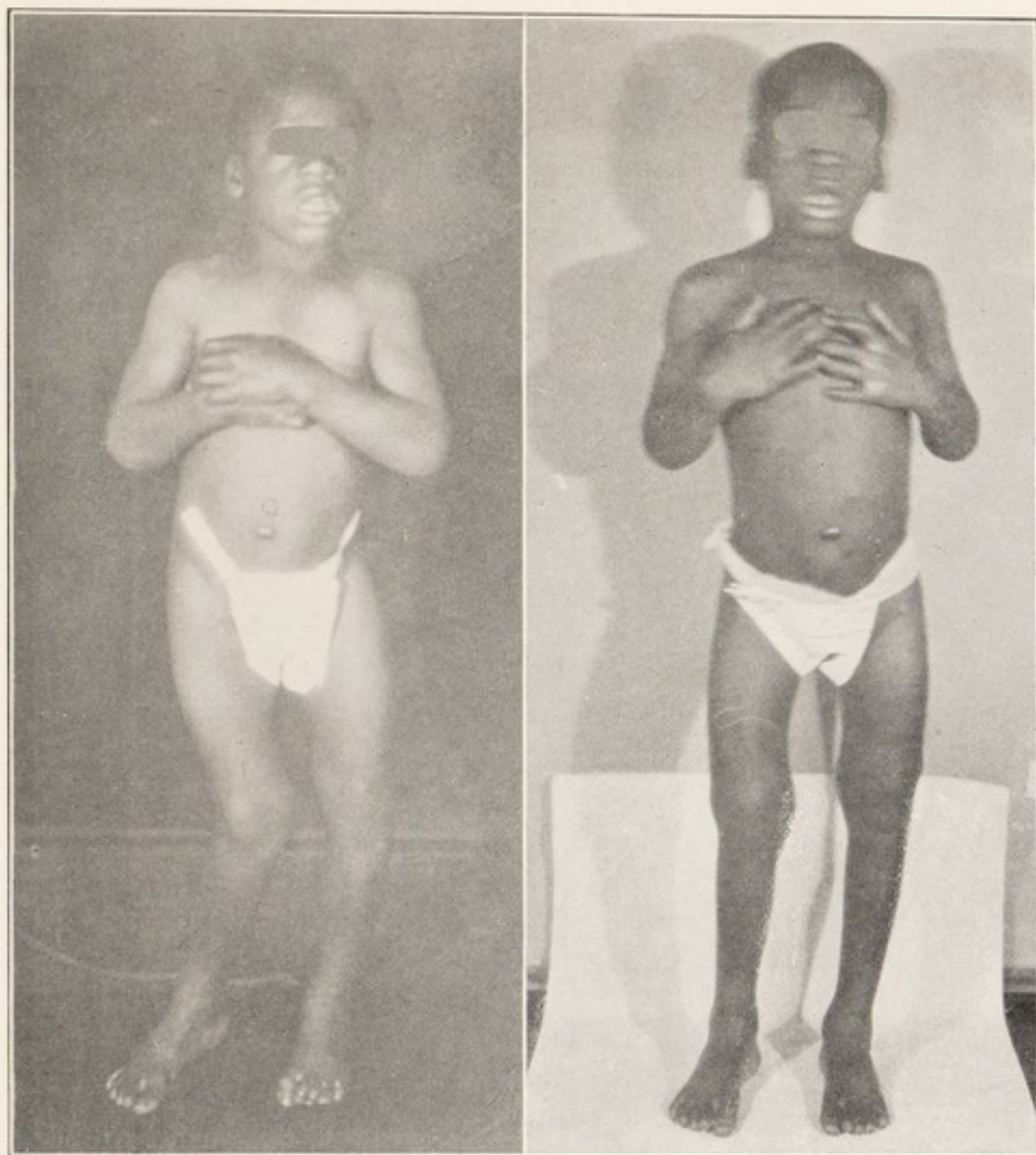


FIG. 136.—SAME AS FIGURE 135 AFTER OPERATION, SHOWING OSTEOTOMIES OF BOTH FEMURA, TIBIA AND FIBULÆ.

Late Rickets.—Late or latent rickets is a process with manifestations similar to rickets, occurring about adolescence or puberty. In many, there is a history of rickets in early childhood, which has apparently remained quiescent for years. The treatment is the same as in rickets.



A

B

FIG. 137-A.—PHOTOGRAPH SHOWING DEFORMITY FOLLOWING RICKETS; RIGHT GENU VALGUM, LEFT GENU VARUM.

FIG. 137-B.—SAME AS FIGURE 137-A, AFTER OPERATION.

Dyschondroplasia.—Dyschondroplasia is an affection of the bones occurring rarely in childhood, characterized by the development of bone into osteoid tissue, which is a mixture of bone and cartilage, with a diminution of lime salts. The epiphysis is not involved, and actual growth is apparently normal; there is, however, marked shortening in the bones due to longitudinal pressure on the softened bone structure, with consequent distortion. Fracture from slight trauma is common, but usually unites as readily as in fractures of normal bone. In children, the process may be local or

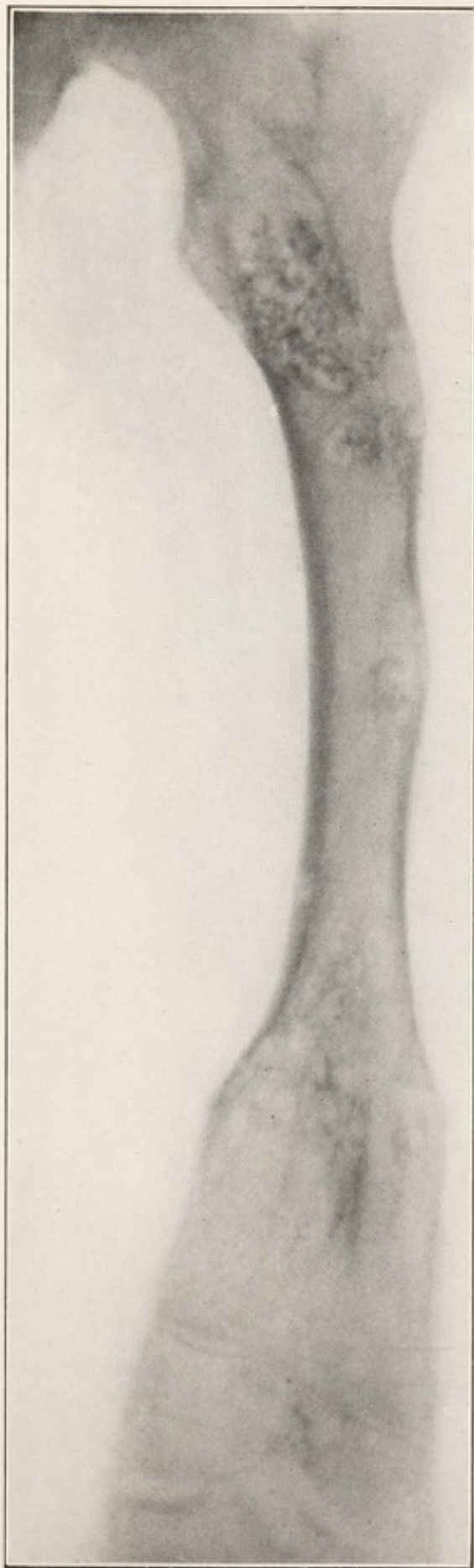


FIG. 138.—X-RAY SHOWING TYPICAL DYSCHONDROPLASIA OF FEMUR WITH METAPLASIA; ALSO INVOLVEMENT OF TIBIA.

diffuse throughout the skeleton. When diffuse, defective nutrition may be a factor, as observed recently in several European countries where children have been on a starvation diet; or there may be no apparent cause, in which case the condition is known as idiopathic. When local, one of the lower extremities may be involved. However, as other portions of the skeleton are normal, and the children are apparently healthy, the nutritional theory is untenable. The process usually subsides when full growth is obtained.

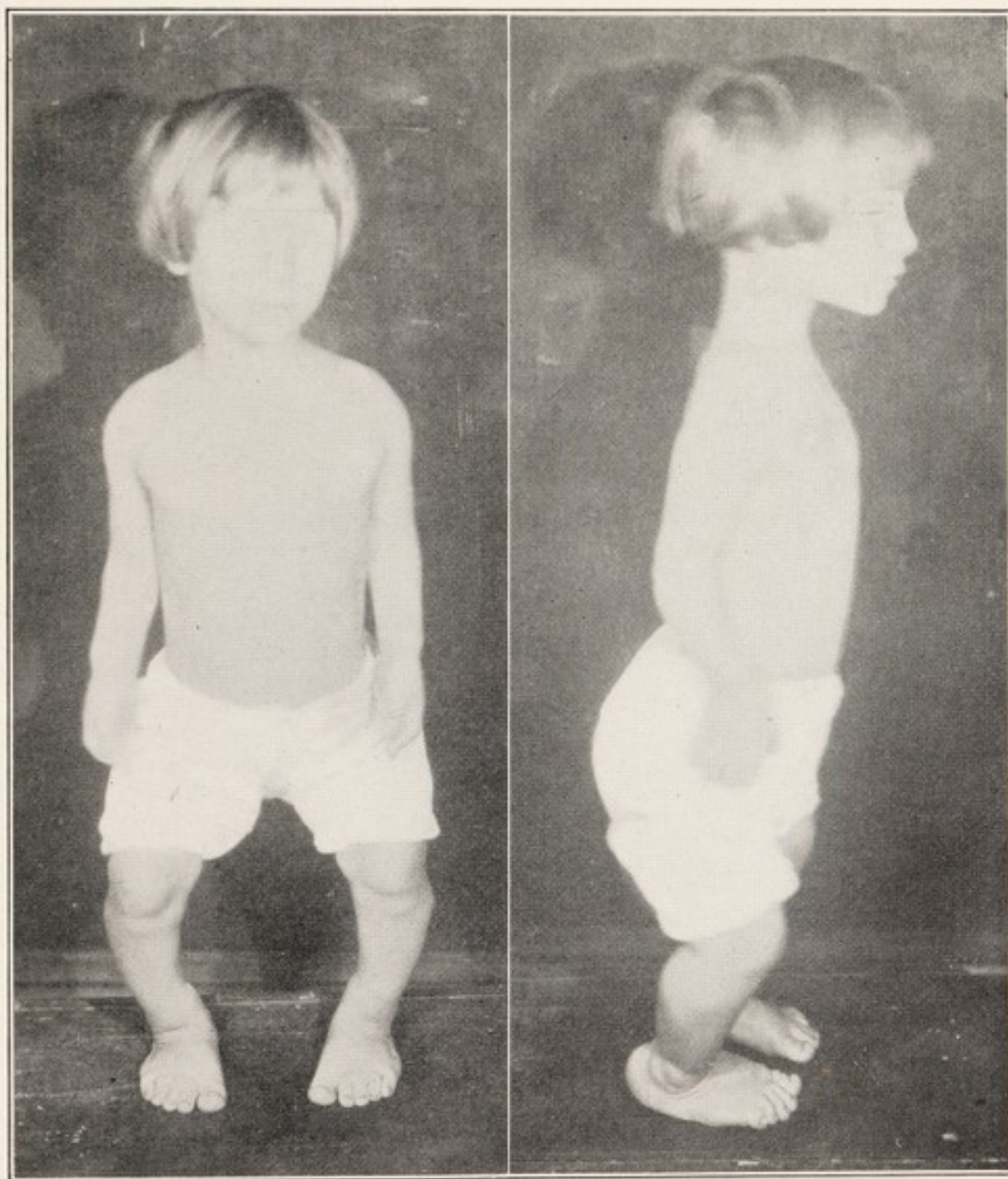
Prognosis and Treatment.—In the diffuse type, the prognosis is unfavorable, as there may be extensive distortion and deformity throughout the entire skeleton. No form of treatment has proved beneficial. Retentive apparatus should be employed for the prevention of deformity.

Scurvy.—Scurvy, or scorbutus, is caused in children by the lack of raw foods and may be observed in families of the highest class, especially in infants whose food has been thoroughly sterilized by heat.

As an orthopedic problem, scurvy is manifested by painful epiphyses and subperiosteal hemorrhages which cause lameness. On examination, the child shows other well-known manifestations, such as petechial hemorrhages of the mucous membranes and skin. The x-ray may demonstrate changes in the epiphyses somewhat similar to rickets. The treatment is entirely in the domain of the pediatrician and consists in the regulation of diet with sufficient raw food, as fruit juices, etc.

CONGENITAL DEFICIENCIES IN QUALITY OF BONE

In this class there is an inherent congenital abnormality of quality in osseous tissue, which may be apparent at birth or during early childhood. These affections are rare, but the knowledge of each is deemed advisable for the general practitioner.



A

B

FIG. 139-A.—PHOTOGRAPH OF CHILD, SHOWING DWARFISM AND TYPICAL DEFORMITIES OF CHONDRODYSPLASIA FETALIS, AGE TEN YEARS.

FIG. 139-B.—SAME AS FIGURE 139-A, LATERAL VIEW.

Fragilitas ossium.—Fragilitas ossium, idiopathic osteopsathyrosis, osteogenesis imperfecta, are the terms employed to describe an affection in which the bones fracture repeatedly from very slight injuries. Undoubtedly,

this condition is often observed in mild form, as many children are subject to repeated fractures. The etiology is obscure, though a history of the same affection may occasionally be obtained in the ancestry.

From the pathology, it would appear that the process of growth is not normal, osteogenesis, or bone production being too rapid. Normal bone is derived from bone-cells, whereas, in *fragilitas ossium*, bone apparently is produced directly from cartilage. These individuals are often of peculiar



FIG. 140.—X-RAY OF BONES OF LEGS, SHOWING CHANGES IN CHONDRODYSPLASIA FETALIS.

appearance, suggesting endocrine disturbance. The x-ray findings are rather indefinite, technical, and not of practical diagnostic importance.

The first symptom is a fracture from a very slight force, as turning in bed, and subsequently repeated fractures occur. Deformities are unavoidable and the individual usually becomes a hopeless invalid. The only treatment is the prevention of deformity by appropriate apparatus. Neither organotherapy nor any other remedy which has been suggested has a beneficial effect.

Hereditary Type.—There is also an hereditary type of brittle bone, which results in multiple fractures and is associated with an abnormal blue appearance of the sclera and deafness. The direct hereditary transmission differentiates this condition from osteogenesis imperfecta and osteopsathyrosis. The etiology is supposed to be due to a congenital hypoplasia of the

mesenchymal tissues. Fractures and dislocations may be caused from slight trauma. They unite promptly, but often result in shortening and deformity. The treatment of the fractures does not differ from that of a fracture in a normal individual. There is no known treatment of value for the underly-

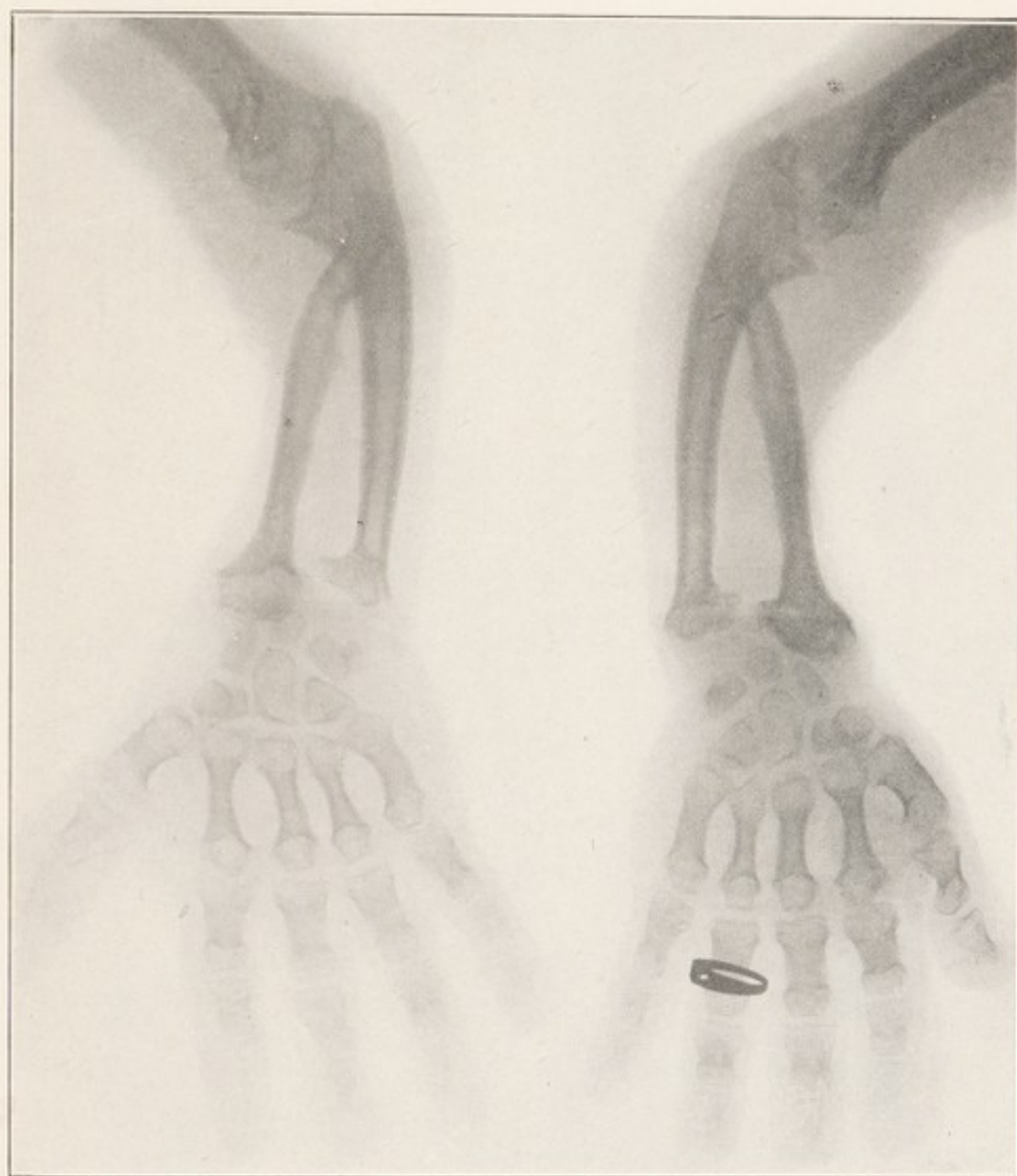


FIG. 141.—X-RAY OF BONES OF FOREARMS, SHOWING CHANGES IN CHONDRODYSPLASIA FETALIS.

ing condition; but, fortunately, fractures do not occur so frequently after adolescence.

Osteosclerosis.—Congenital osteosclerosis, or marble bones, is a congenital status of the bones, in which the x-ray demonstrates an increased density. The condition has been observed in father and son and therefore heredity is given as a factor. No cause is known. Destructive and proliferative changes in the joints occur in childhood, but the condition is of such rare occurrence as to deserve only mere mention.

Dyschondroplasia.—Dyschondroplasia, or multiple osteochondroma, is evidenced by the formation of hard, dense tumors in the region of the epiphyses, which may interfere with locomotion or cause pain by pressure. The condition may be hereditary. Removal by operative procedures of the enlarged process when causing symptoms by mechanical interference, is indicated; otherwise, no treatment is necessary. Dyschondroplasia is also manifested by the formation of osteoid tissue in the shaft of the bone (see p. 187).

Chondrodysplasia foetalis (Fetal Rickets).—This affection is apparent at birth and has been erroneously called fetal rickets, but it has been found that the process is a complex embryological condition and has no relation to rickets. The child is dwarfed, does not attain full growth; the head is square, the forehead prominent, and the body or trunk is out of proportion in length to the legs. The epiphyses show enlargement and there may be multiple deformities.

Apparatus for prevention of deformity is indicated, but is not very effective. No other measure is of value.

ENDOCRINE DISTURBANCES

Manifestations in the bones resulting from lack of balance of the endocrine glands may occur. The spine and joints may rarely be involved in such a process, which may permanently impair function and induce deformity. There are typical changes in the epiphysis of the cretin which are characteristic, and also in those with hypopituitarism. Organotherapy may be administered in the early stages, but when the process is advanced, no treatment is of any value.

NEOPLASMS OR BONE TUMORS

Tumors of or adjacent to bone in children may be classed as: (1) benign, which are those that do not recur locally after removal and have no tendency to metastasize; (2) locally recurrent, or those which often recur locally after apparent removal but do not metastasize; (3) malignant, those which not only recur locally, but metastasize to distant parts.

The benign tumors observed in children are: (a) osteochondroma, (b) chondroma, (c) giant-cell tumors.

Benign Tumors.—*Osteochondromata.*—Osteochondromata are also called exostoses and osteomata. They are usually composed of bone at their base, or origin from the bone, and cartilage at the periphery. This type of tumor occurs most frequently near the epiphyses at the lower extremity of the femur and upper extremity of the tibia. They arise from the bone by a broad base continuous with a slender neck, which terminates in a broad clubbed or cauliflower-like process. The growth is slow and there are no symptoms except those due to mechanical pressure or interference with

function of an adjacent joint. Large bursæ may develop over the tumor from constant muscle play and become filled with fluid. On palpation, the tumor can be outlined, if superficial. If there is mechanical irritation, ten-

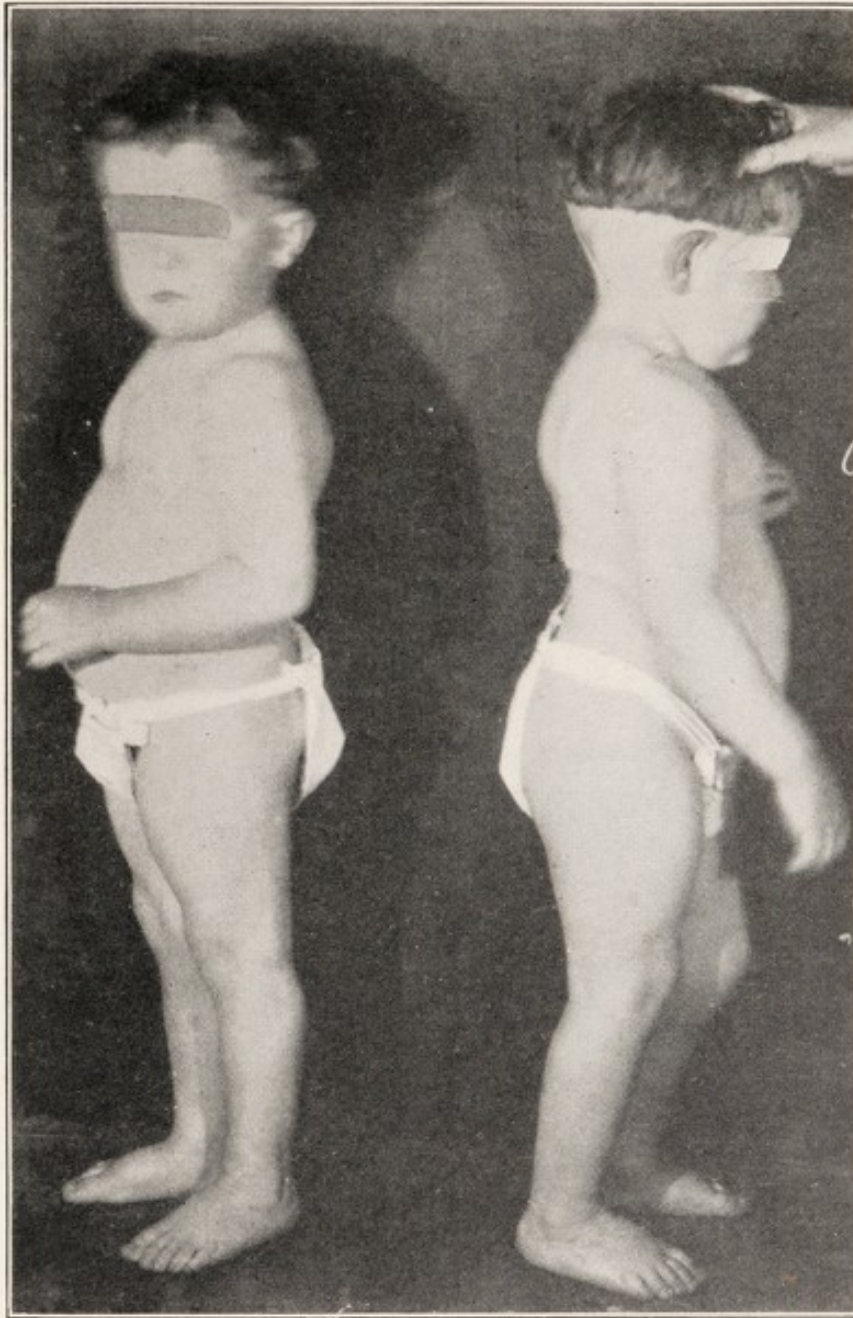


FIG. 142.—PHOTOGRAPH OF TWIN BOYS, SHOWING ENDOCRINE DISTURBANCES.

derness is present. The x-ray findings are characteristic, from which the diagnosis can be confirmed.

The treatment is excision from the base outward, including a small area of normal bone. Since malignant degeneration or metaplasia may rarely occur all tumors of this type should be removed unless multiple, as in dyschondroplasia.

Chondroma.—Chondromata, or tumors of cartilages, are rarely observed in children. They usually arise from the bone in the region of the epiphysis,

or in the central canal, as evidenced more often in the metatarsal, metacarpal and phalanges of the hands and feet.

Treatment consists of complete excision of the new growth without interfering with the continuity of the parent bone.

Giant-Cell Tumors.—Giant-cell tumors of bone are erroneously termed giant-cell sarcomata, but for the benefit of future progress in this field and

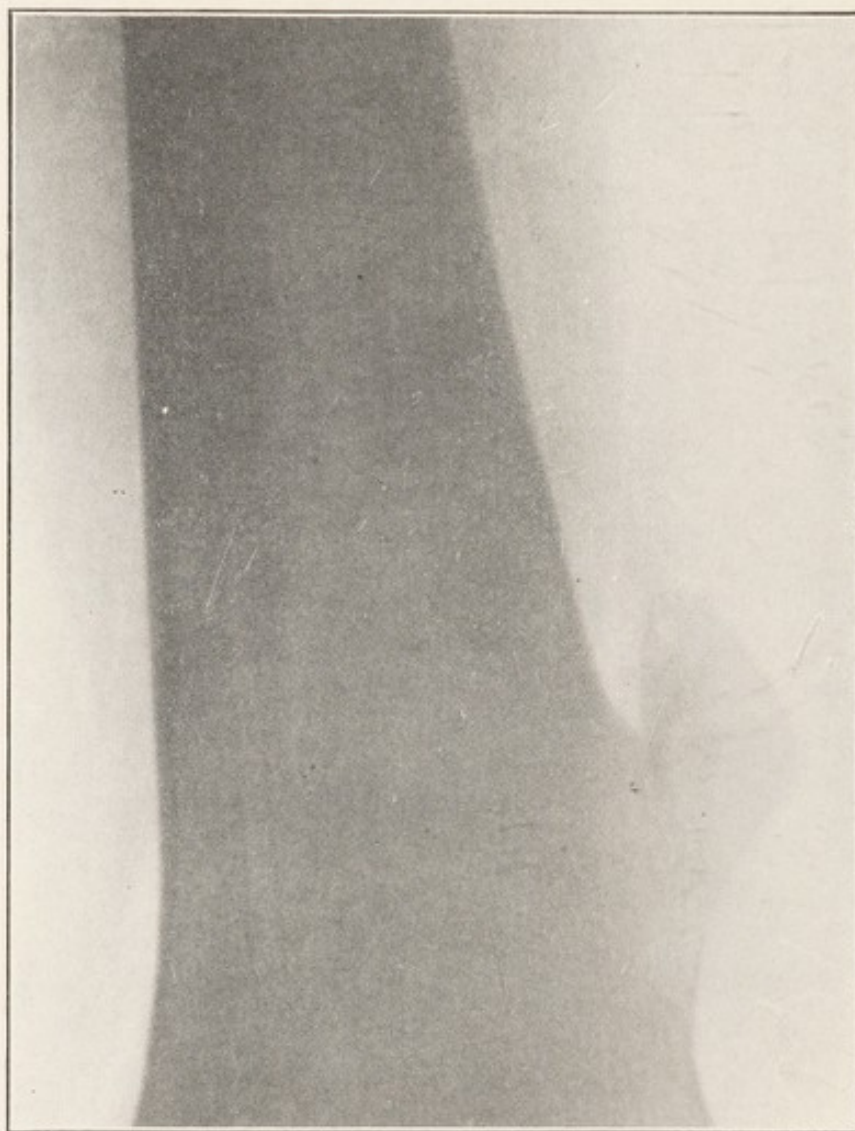
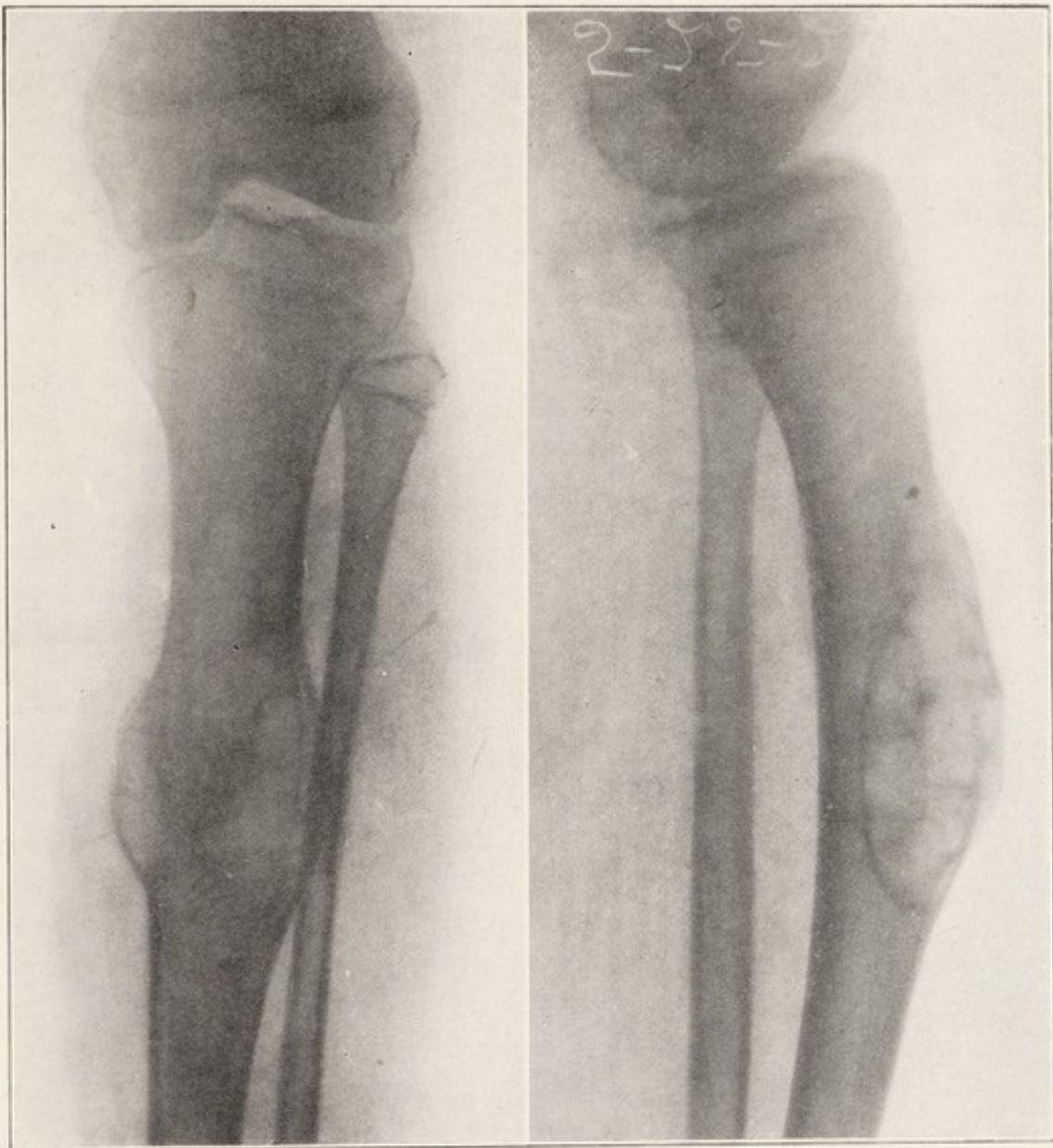


FIG. 143.—X-RAY OF OSTEOCHONDROMA OF LOWER END OF FEMUR, SHOWING TUMOR WITH PEDICLE.

for the conservation of extremities, the term "sarcoma" should be carefully avoided. There is a difference of opinion as to the nature of the pathological entity known as giant-cell tumor, as some authorities regard the lesion as a low-grade inflammatory process closely related to osteitis fibrosa cystica. However, the consensus of opinion is that the lesion is a new growth. Giant-cell tumor rarely occurs in young children, and is more often observed in late childhood or adolescence.

This type of tumor occurs practically always on the interior of an extremity of a bone as a central tumor. The symptoms are pain and slight

tenderness on pressure. A definite enlargement may be detected on palpation, but cannot be differentiated from the parent bone. In children, the x-ray shows a cavity or cyst within the bone adjacent to the joint. Rarely there may be a multilocular cystic appearance.



A

B

FIG. 144-A.—X-RAY SHOWING GIANT-CELL TUMOR OF TIBIA WITH MULTILOCULAR CYST, WITH EXPANSION OF BONE CORTEX.

FIG. 144-B.—SAME AS FIGURE 144-A, LATERAL VIEW.

Pathology.—The pathological process of giant-cell tumor is one of destruction, and unless arrested, may destroy an entire extremity of a bone. An incision into the tumor discloses the cavity filled with a red substance resembling currant jelly, which, on microscopical examination, is found to be cellular, similar to low-grade inflammatory tissue, with many giant-cells, from which the name is derived.

Diagnosis.—Differentiation cannot always be made from osteitis fibrosa cystica, nor is this essential, as the treatment of the two conditions is practically the same (see Osteitis fibrosa cystica, p. 142). The diagnosis is made by the clinical manifestations and the x-ray. According to Bloodgood¹ central lesions of bone occurring under fifteen years of age are benign, which fact is valuable evidence in reaching a diagnosis and also in preventing the erroneous diagnosis of malignancy which induces surgeons to perform unnecessary amputations.

Prognosis and Treatment.—When the diagnosis is made before there is extensive destruction, the results of efficient treatment are excellent. When the process is not arrested, there may be such an extensive dissolution of continuity of bone that permanent disability or amputation is inevitable. In the early stages, operative measures are indicated, which consist of opening the bony cavity and crushing in the wall so that small bony particles partially fill the cavity. Particles of bone should be removed from normal adjacent bone and placed in the operative area. Particles of bone may also be transplanted from elsewhere in the skeleton, as the tibia.

X-ray treatment may undoubtedly reduce the size of the tumor or arrest the process, but as the permanency of results so obtained is uncertain, operative procedures are advisable in the early stage. The x-ray should be employed in those with extensive destruction as a pre-operative and post-operative measure.

Recurrent Tumors.—Tumors of bone which recur locally are very rare in children. They are often composed of fibrous tissue cells and are called recurrent fibroma. Rarely, chondroma may recur. These tumors may occasionally undergo malignant degeneration or become malignant by metastasizing. The treatment is complete removal, followed by x-ray therapy. The probable cause of recurrence is the difficulty encountered in complete removal.

Malignant Tumors.—The nomenclature of malignant tumors of bone is so confusing that the general knowledge of the subject is vague and indefinite. In fact, there are over one hundred different combinations of cells by which various classifications are made, and in addition there are many clinical varieties. Such terms as myxoma, round-cell sarcoma, etc., are merely descriptive of a type of sarcoma—just as one would describe a man as being a red-headed man, but he would still be a man. All osteogenetic malignant tumors are sarcoma, but differ to some extent in degree of malignancy. However, much advance has been made in the knowledge of this subject by the Sarcoma Registry, and too much praise cannot be given their untiring and unselfish efforts. From a practical point of view, all osteogenetic malignant tumors may be considered under the general

¹ Joseph Colt Bloodgood, "Benign Giant-Cell Tumor," *Am. J. Surg.*, 1923, 37: 105.

term, osteogenetic sarcoma, of which only three types will be mentioned: (a) periosteal sarcoma, (b) endothelioma, (c) myeloma.

Periosteal Sarcoma.—In children, by far the most frequent malignant

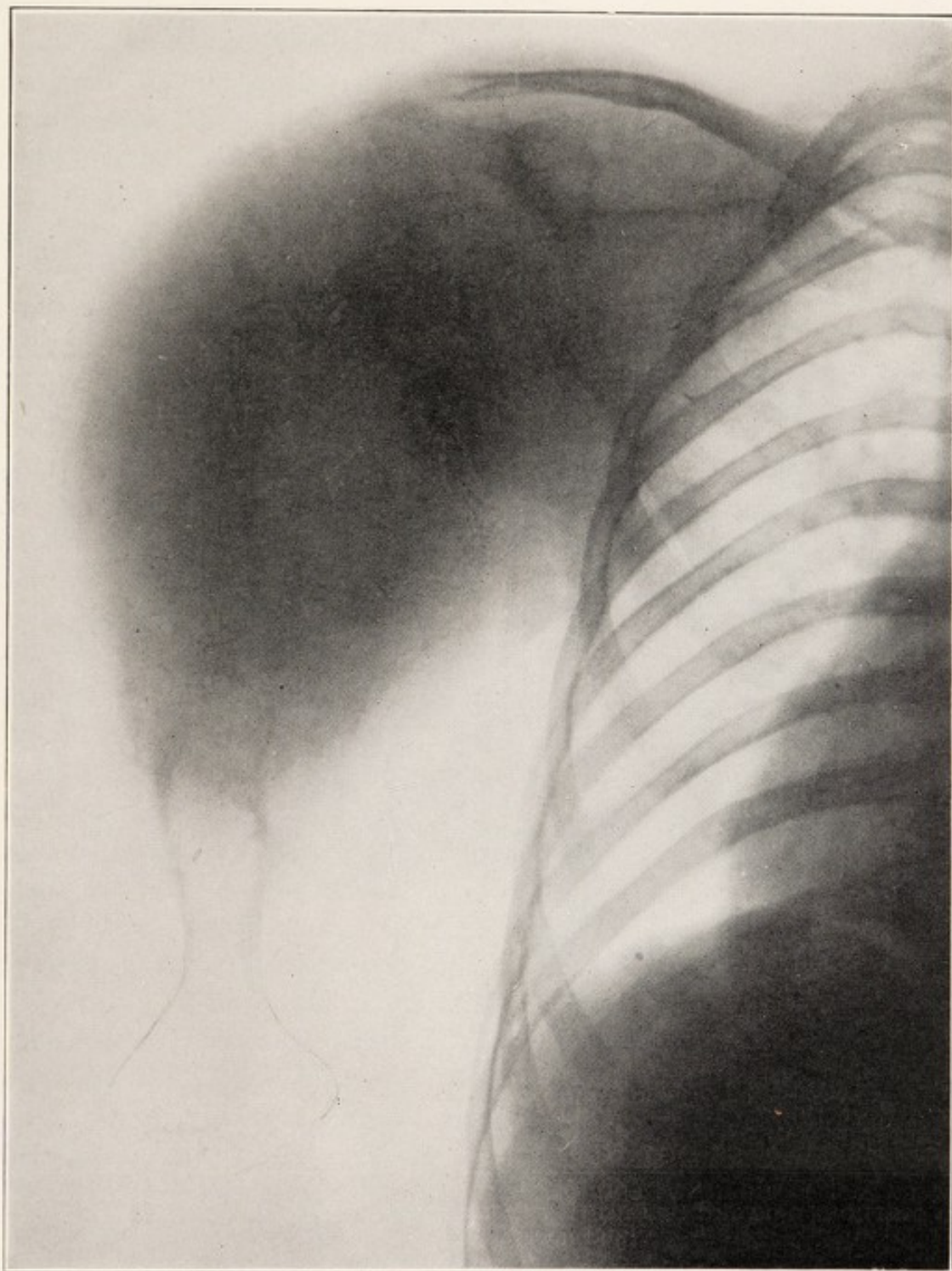


FIG. 145.—X-RAY OF OSTEOGENETIC SARCOMA OF HUMERUS, SHOWING COMPLETE OSTEO-
LYSIS OF SHAFT OF BONE.

bone tumor observed is periosteal sarcoma, a clinical type of osteogenetic tumor; endothelioma and myeloma are of such rare occurrence as to be negligible. In adults, carcinoma most frequently forms metastases to the bone, but carcinoma practically never occurs in children. Periosteal sar-

coma apparently arises from the periosteum and is characterized by osteogenesis, or bone production. Periosteal sarcoma in children occurs more frequently in the upper and lower thirds of the shaft of the long bones, though the middle third is not exempt. The lower third of the femur is more frequently affected, though any bone in the body may be involved.

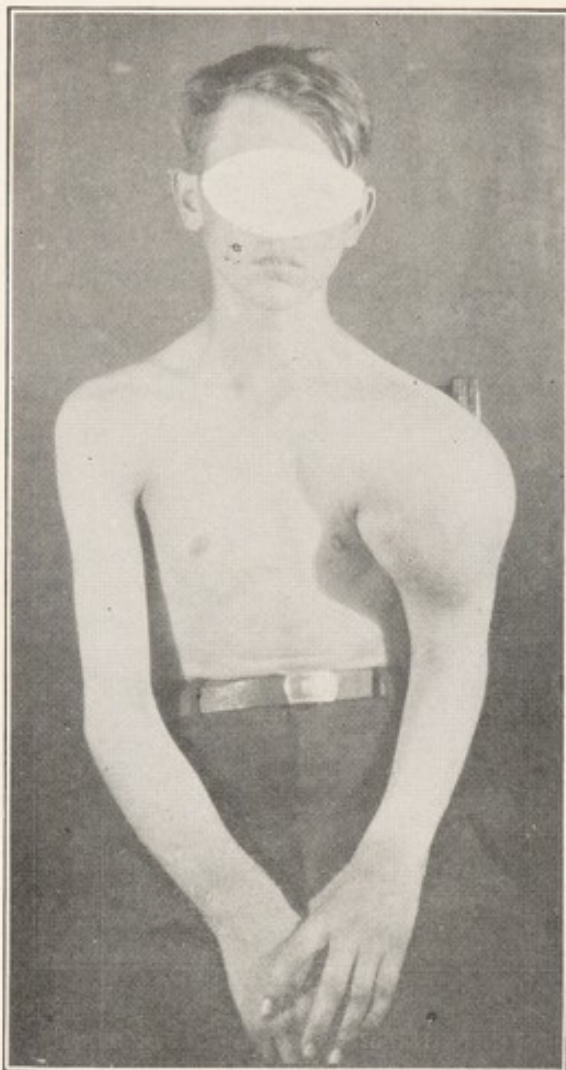


FIG. 146.—CASE OF OSTEOGENETIC SARCOMA OF HUMERUS OF WHICH X-RAY IS SHOWN IN FIGURE 145.

right angles from the shaft, from which the diagnosis can usually be made.

Diagnosis.—The diagnosis is made by the clinical manifestations and the x-ray, but rarely before the neoplasm is well advanced in growth. X-ray pictures should be made of all suspicious tumors in bone and interpreted by an expert roentgenologist. If the diagnosis is still in doubt, a specimen may be procured while the patient is under anesthesia, a frozen section examined and the decision then made as to the operative procedure. The diagnosis should be confirmed by tissue examination before amputation or radical operation. No pathologist can make a definite diagnosis in all cases from tissue examination alone.

Pathology.—As in all malignant tumors, the microscope demonstrates a riotous or disorganized arrangement of cells, which are rapidly proliferating, but the histopathology, the types of cells and their significance, is in the domain of the most expert pathologist and will not be considered further. Metastasis from bone to bone is rare, the lungs being the most frequent seat of secondary metastatic deposits. Trauma is probably a predisposing cause, as a definite history of injury is frequently obtained. There is much speculation as to the etiology of tumors, but few concrete facts.

Symptoms of Clinical Manifestations.—The onset is slow, the first symptom being enlargement of bone with pain and tenderness, which may increase rapidly. In the early stage, there may be no effect on the general health, but later, as metastasis occurs, there is a marked cachexia, with elevation of temperature.

X-Ray.—The x-ray demonstrates extensive proliferation of bone over the affected area, which radiates at

Prognosis.—In children, death is inevitable, though marked improvement may be observed for a time after excision or amputation. Possibly an earlier recognition might give opportunity for arrest and eradication of the tumor by surgery and x-ray. This can be accomplished only by an x-ray picture so soon as a bone lesion is recognized, and an expert interpretation of the roentgenogram.

Treatment.—Amputation offers slight, if any, hope, and therefore should not be performed unless the diagnosis is certain, for many limbs

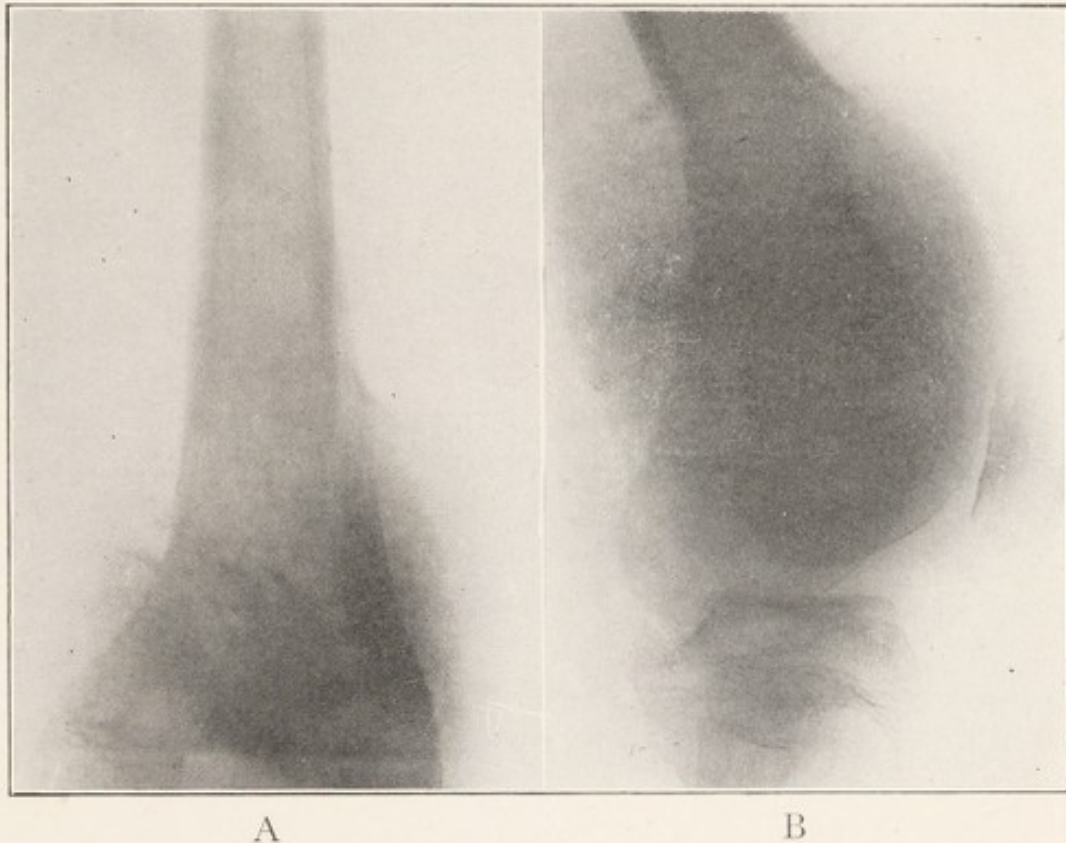


FIG. 147-A.—X-RAY OF PERIOSTEAL SARCOMA OF LOWER END OF FEMUR, ANTEROPOSTERIOR VIEW.

FIG. 147-B.—SAME AS FIGURE 147-A, LATERAL VIEW.

Note radiating bone striæ and pathological fracture.

have been needlessly sacrificed. Amputation after extensive invasion, or even metastasis, is often indicated for relief of pain. X-ray treatment retards but does not arrest the growth, and may possibly relieve pain to some extent.

Endothelioma.—Endothelioma is a bone tumor composed of a type of cell known to the pathologist as endothelium, and is also known as Ewing's tumor. The x-ray manifestations resemble osteomyelitis. There is general enlargement of the bone with pain and tenderness, and no elevation of temperature in the early stage.

The process is markedly retarded, but not arrested by x-ray treatment. Metastasis occurs as in osteogenetic sarcoma. This type of tumor is of

infrequent occurrence, but deserves mention. The termination is always fatal.

Myeloma.—Myeloma is a tumor originating in the marrow cavity from cells very similar to plasma cells, which may be either lymphoid or myeloid. The process in the bone is extensive, being usually diffuse throughout the entire skeleton. The x-ray may retard, but does not arrest the progress of the disease. Death is inevitable.

CHAPTER XII

AFFECTIONS OF THE SOFT TISSUES

In addition to the pathological processes in the bone and cartilage, deformity of joints may also be caused by pathological changes in the surrounding soft tissues. The tissues involved are the skin and subcutaneous tissue, the muscles and tendons and their sheaths, and the bursæ about the joints. The etiology, of course, varies greatly with the structures involved, as do the symptoms and treatment. Only the more common affections will be discussed.

SCAR CONTRACTURES

Deformities due to the contracture of scar tissue are of very frequent occurrence. Through a knowledge of the fundamental principles of joint mechanics and wound healing, many of these deformities can be prevented and milder ones which have formed can be corrected without operative procedures. The severer ones usually require some type of plastic operation.

Etiology.—The most common causes of scar contractures are: (1) burns, (2) lacerated wounds, and (3) infections.

1. *Burns.*—These are the most common cause of scar contracture involving the skin and superficial tissues. They may be caused by fire, scalding solutions, chemicals, electricity or excessive friction of the skin surface.

2. *Lacerated Wounds.*—Lacerated wounds, with direct loss or subsequent sloughing of the skin and superficial tissues, are second in the causation of scar contractures.

3. *Infections.*—Deep-seated abscesses located in such places as the axilla or popliteal space may produce sufficient scar tissue to form fixed contractures. Infections of the hand, particularly when involving the tendon sheaths or located under the palmar fascia, may cause sufficient stiffness and contracture of the fingers to impair permanently the function of the hand. Osteomyelitis involving superficial bones, as the tibia or skull, may produce extensive scars which are very painful and which ulcerate from the slightest trauma.

Location of Tissue Loss.—The location at which the loss of skin or soft parts occurs determines to a great extent the process of healing and the formation of subsequent contractures. If the loss of skin surface is small, or even of moderate degree, and located over the broad areas of the back, chest, abdomen or thighs, there is usually sufficient mobility of the

surrounding parts to allow the wound to heal satisfactorily. If the wound is extensive, healing can easily be promoted by small skin-grafts. When, however, the wound is near a joint, particularly on the flexor surface of such joints as the elbow, knee, wrist, fingers or ankle, contractures frequently occur. If the wound is located where contiguous skin surfaces are normally in opposition, as the axilla, adhesions between the surfaces of the chest and arm readily form. It is not uncommon, following extensive burns, to see the axilla obliterated and the arm adherent to the chest as far down as the elbow. Loss of skin over superficial tendons, such as those at the wrist or ankle, or over exposed bone, as the tibia or heel, causes wounds which are difficult to heal.

Depth of Tissue Loss.—The depth of the tissue loss also plays an important part in the formation of scar. Burns are classified into three types:

1. First-degree burns, when there is only a reddening of the skin surface. These heal without loss of the skin surface.
2. Second-degree burns, when there is blistering of the skin and loss of the superficial layers of the epithelium. The deeper layers of the skin with the papillæ are preserved and healing rapidly follows if the wound is kept clean and infection prevented.
3. Third-degree burns, when there is a loss of the entire thickness of the skin with varying amounts of the underlying soft parts. If the area is extensive, or if small and in an unfavorable location, skin-grafting of some type is usually necessary.

The same principles apply to loss of the full thickness of the skin from other causes.

Prevention of Contractures.—The formation of scar tissue with its subsequent contracture is nature's method of closing wounds. Ordinarily, it serves its purpose very well, but at times the location and extent of the wound make this contracture undesirable, if deformity is to be prevented and function preserved. Scar tissue begins to form in a granulating wound about the tenth day. The amount of scar which forms is largely dependent upon two factors: first, the extent and depth of the wound; second, the amount of infection which takes place in the underlying soft tissues.

Certain definite principles should be followed in order to prevent the formation of scar tissue:

1. Early removal of necrotic or sloughing tissue, and sterilization of the wound surface: This prepares the granulating surface for skin-grafting and prevents infection of the underlying soft tissue. Sterilization is best effected by continuous irrigation with Dakin's solution. Extensive burns are most successfully treated with medicated paraffin.
2. Secondary closure: If the loss of the skin is not too great, many

wounds can be sutured together after the surface has been thoroughly sterilized.

3. Skin-grafting: Covering the raw area of a wound by one of the various types of skin-grafts removes both the opportunity and the necessity for the formation of scar tissue. It should be employed as early as possible when scar tissue is undesirable.

4. Separation of contiguous surfaces: Granulating surfaces, if allowed to remain in contact, will rapidly become adherent. Surfaces such as those of the axilla should be kept well apart during the process of healing.

5. Splinting to prevent deformity: During the formation of a scar there is constant contraction, but once the scar tissue has fully developed, this drawing together ceases. Many contracture deformities can be prevented by proper splinting of the part during this formative period. It should be remembered, however, that the process of scar formation is often not complete for months after the wound has healed, and the utmost care must be used not to remove the splint too early. Certain well-recognized rules should be observed in regard to splinting.

(a) In infections or burns about the axilla, the arm should be kept well abducted.

(b) In wounds at the bend of the elbow, the arm should be kept in full extension.

(c) In wounds on the flexor surface of the wrist, the hand should be held in dorsiflexion. This can be done by a splint either on the back or front of the joint.

(d) With infections of the hand, the "position of function" should be maintained at all times. This position is slight dorsiflexion of the wrist, slight flexion, about 20 degrees, of the metacarpophalangeal joints, and abduction of the thumb to almost full extent. A hand with hyperextended metacarpophalangeal joints and a thumb drawn in against the palm is useless.

(e) Wounds on the flexor surface of the hip should be treated with extension and abduction.

(f) In infection or wounds around the popliteal space, the knee should be held in full extension. A posterior splint extending well up the thigh and down to the foot can be used until the wound is healed, when a walking brace with a knee cap may be substituted during the day and the splint re-applied at night. Many contractures occur because the use of a splint at night is overlooked.

(g) In wounds of the front of the ankle, the foot should be in plantar flexion; when the region of the tendo achillis is involved, the foot should be at a right angle.

Return of function will be hastened, the absorption of inflammatory tissue aided, and adhesions loosened by the early institution of motion to the

affected joints. This should be carefully directed and accompanied by massage and baking so soon as the infection has fully subsided.

Treatment.—The treatment of scar contractures is (1) mechanical and (2) operative. Contractures and deformities resulting from the formation of scar tissue may vary in severity from those very mild cases, which are quickly corrected by simple mechanical means, to the extremely resistant, which require extensive operative procedures. In many, a combination of both mechanical and operative treatment will give the best results.

Mechanical Treatment.—Whenever possible, joint deformities should be corrected gradually by splints before plastic operation on the overlying scar tissue is begun.

Experience has shown that many deformities can be completely and often permanently corrected by gradual stretching of the scar. This is particularly true in the larger joints, such as the hip and knee, where there is good leverage and where the weight of the limb itself helps the corrective process.

Forcible stretching of scar tissue under anesthesia is rarely ever advisable, and when attempted, only a moderate degree of force should be used. Usually, there is so much reaction in the soft tissues that there follows an increased amount of scar, resulting in further contracture. It must also be remembered that the bony structures composing the joint have, in all probability, undergone considerable atrophy from disuse, with accompanying softening, and serious injury by crushing of the articular surfaces may result from over strenuous manipulation. There are times, however, when careful manipulation is very helpful in stretching the joint capsules and breaking up light intra-articular adhesions. This should be followed by a splint holding the parts in the corrected position. Preliminary stretching also prevents undue tension on the soft parts following the plastic procedure and enables the operator to determine more accurately the amount of healthy skin necessary to be transplanted.

Operative Treatment.—The ideal operative treatment aims at the complete removal of all scar and its replacement by normal tissue. If the scar is not too extensive, this can usually be done, the dissection being continued until healthy tissue is exposed throughout the wound, the resulting raw area being covered by the appropriate type of skin-graft. When operating in and around scars, it should always be remembered that the vitality of scar tissue is very low, the blood supply poor, and that the slightest disturbance of nutrition will result in sloughing.

Transplantation of Skin.—In a large proportion of all scars removed, skin-grafting of some type must be used to cover the defect. Autografts are those removed from the same individual and should be used at all times, when possible. Isografts are those removed from other persons. As a rule, they are not satisfactory, most of them failing to "take," and

those which do take often gradually disintegrate. Satisfactory results have been obtained occasionally when the proper precautions were employed. The donor and recipient should be grouped, as in blood transfusions, or failure is certain to result. Zoögrafts are those transplanted from animals to human beings. Occasional successes have been reported, but it has been the experience of most operators that, even though an initial "take" is secured, the grafts are eventually absorbed.

Types of Grafts.—Reverdin Grafts (small, deep grafts, Davis).—These grafts are about 1 centimeter in diameter and consist of the epidermis and a small amount of the dermis. They are best removed under a local anesthetic by inserting the tip of a small needle into the epidermis, raising up a small cone, and removing it with a scalpel. The grafts are placed upon the area to be grafted about $\frac{1}{2}$ centimeter apart. On healthy granulating surfaces, almost 100 per cent of "takes" can be expected. This is a most useful and dependable method for covering even large areas where only the skin has been lost or where there is a sufficient amount of soft tissue beneath.

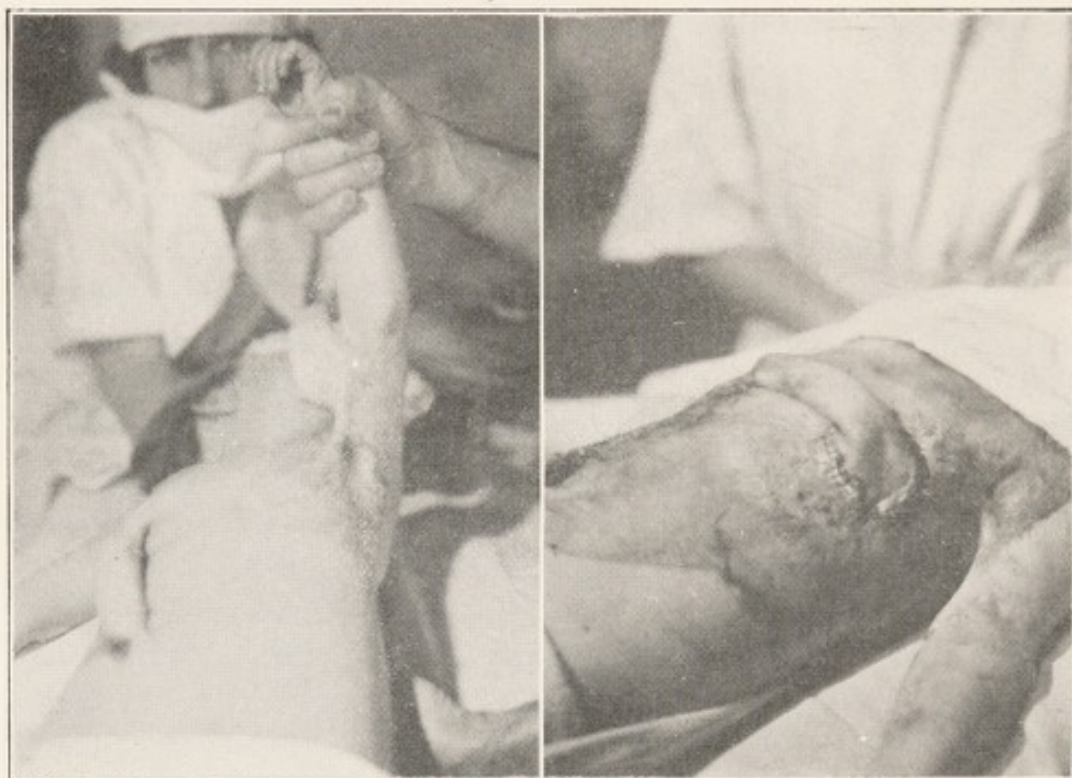
Ollier Thiersch Grafts.—These grafts are much larger, often being several inches in each dimension, but they include only the upper layer of the corium. They are particularly suitable for covering large fresh operative wounds where it is not necessary to supply any soft tissue.

Whole Thickness Grafts (Wolfe-Krause).—These include the whole thickness of the skin and a small amount of the underlying fat. They may be of almost any size desired, but an ellipse of about 2 by $\frac{3}{4}$ inches has proved most satisfactory. The fat is entirely removed by a scalpel before the graft is applied. The area to be grafted must be thoroughly aseptic and free from blood-clots. It may be a granulating area or a fresh wound. The advantage of these grafts is that they cover large areas without the formation of any scar and that they supply the whole skin thickness.

Pedunculated Skin Flaps.—Where it is necessary not only to cover a large skin defect, but also to supply enough healthy soft tissue to permit mobility and stretching, the pedunculated skin flap is the method of choice. This necessitates a two-stage operation, as the flap cannot be completely severed from its original site until it has become sufficiently attached in its new location to insure its blood supply. These flaps include the whole thickness of the skin and subcutaneous fat down to the fascia. If only a small flap 2 or 3 inches long is desired, it may be cut loose at one end, dissected up the desired length, and sutured directly into the area to be covered. After about ten days or two weeks, under a local anesthetic, the remaining pedicle may be gradually divided, cutting about one-third of the pedicle on succeeding days.

If a very large flap is to be used, it is better to leave it attached at both ends to prevent sloughing of the distal end, which often occurs when

there is only a single pedicle. The edges of the flap are sutured together immediately to form a tube, and are left for about two weeks to allow the development of an increased blood supply through the pedicles. One end is then cut loose and the flap transplanted in the usual manner. Variations of this technic may be used when the part to be covered can be brought directly under the flap and a primary suture effected, as in passing the hand under a flap from the abdomen.



A

B

FIG. 148-A.—PHOTOGRAPH OF CHILD WITH EXTENSION SCAR IN LEFT AXILLA.

A pedicled tube of skin from right abdomen and chest has been formed.

FIG. 148-B.—SAME AS FIGURE 148-A.

Second stage of operation, showing distal end of graft detached and sutured to new location on left chest.

It may at times be necessary to “step” the flap from one part of the body to another, allowing it to attach at one or more places before finally reaching its permanent location. A flap may thus be transferred from the thigh to the axilla.

Treatment of Special Deformities.—When operations are contemplated on bones or joints over which there is an adherent scar, it is usually advisable to remove this scar, filling the defect with normal skin, before the principal operation is done. In this way, failure due to sloughing of the scar and exposure of the operative field may be prevented.

Arm-Chest Adhesions.—When the axilla has been obliterated and the arm bound down to the chest by adhesions and scar, no mechanical stretching is of any benefit and operation offers the only hope of relief. If the skin

over the chest and back is not destroyed, flaps may be shifted from their locations after the arm has been freed and the scar tissue removed from the axilla. The essential point in the operation is to place sufficient healthy skin in the axilla to allow abduction of the arm. Where there is no normal skin in the vicinity of the axilla, a flap must be brought up from some other area.

Contractures of the Wrist, Hand or Fingers.—Disabling scars about the wrist are usually on the anterior surface and are accompanied by contractures and adhesions of the flexor tendons, resulting in flexion deformity of the wrist and fingers. If the scar is not too deep or extensive, a useful hand can often be secured by gradual extension on a splint, accompanied by massage and baking. A combination malleable cock-up splint with banjo attachment for traction on the fingers has been found most useful. The splint is applied in the position of deformity, the fingers gradually drawn out by attached rubber bands, and dorsiflexion of the wrist is then begun, bending the splint up each day as the deformity is corrected. Progress is often very slow due to swelling and pain throughout the hand. The splint may be removed each day for physiotherapy, if this is available. After the deformity is well corrected in both fingers and wrist, the finger extension may be gradually discontinued and active function encouraged, leaving the cock-up splint on the wrist. Support in the corrected position should be maintained until all tendency to recurrence has passed, this often being months after correction has been accomplished.

When the metacarpophalangeal joints are hyperextended and the thumb adducted against the palm, which so often follows infections of the hand, the same type of splint may be used, but the pull made to flex the fingers and abduct the thumb.

When the scar is too dense and adherent to permit stretching by mechanical means, a plastic operation with removal of the scar and transplantation of a pedicle flap will be necessary.

Removal of a wedge-shaped area from the carpal bones is occasionally



FIG. 149.—PHOTOGRAPH FOLLOWING OPERATION FOR SCAR CONTRACTURE OF AXILLA.

necessary to correct the flexion deformity when the condition has persisted for many years.

Scars of even moderate severity involving the palm of the hand and fingers usually require excision and transplantation of skin to insure sufficient mobility for good use of the hand. Simple excision is usually a failure, as the scars reform.

Scar Contractures Involving the Knee.—The deformity of the knee is usually a flexion contracture and is due to infection in the popliteal space



FIG. 150-A.—PHOTOGRAPH SHOWING SCAR CONTRACTURE ON DORSUM OF FOOT, FOLLOWING EXTENSIVE BURN, WITH TALIPES CALCANEUS DEFORMITY.

FIG. 150-B.—SAME AS FIGURE 150-A, AFTER OPERATION BY PEDICLED SKIN FLAP.

or burns involving the thigh and leg. Most of these affections can be corrected by mechanical means, as the leverage on the joint is great and the amount of surrounding soft tissue sufficient to allow considerable stretching. Correction is best secured by a specially designed extension apparatus (p. 60). Even very resistant deformities can be corrected in four to eight weeks' time. The Martin knee extension apparatus, which is incorporated into a cast, also secures excellent results.

A method that is slow but always available is the correction by successive plaster casts, which are cut at the knee and gradually wedged apart. Simple

traction on the leg, as by Buck's extension, rarely accomplishes the desired result. When correction cannot be obtained by apparatus alone, removal of the scar, tenotomies and fasciotomies of the contracted soft parts and transplantation of healthy skin must be done. Either method must be followed by careful after-treatment to prevent recurrence of the deformity. Walking braces extending well above the knee must be worn during the day and a straight posterior splint at night for several months.

Contractures about the Elbow.—The same principles apply here as to the knee, the apparatus being modified to suit the location.

Adherent Scars over the Tibia.—Adherent scars over the tibia are quite common following osteomyelitis, compound fractures, burns, and lacerations of the soft parts. These scars become firmly attached to the underlying bone, their nutrition is poor, and they are in a location which is constantly subject to injury. Slight trauma causes a slough and ulcer which is difficult to heal. The only satisfactory method of treatment is complete removal of the adherent scar and the shifting over of the adjacent normal skin. If normal skin on the same leg is not available, a pedunculated flap from the opposite thigh may be used instead. Shifting of the adjacent skin by the following method has been used in a large number of cases with excellent results.

The entire scar is dissected from the bone and the thickened bone over the front of the tibia is chiseled off. A second incision, usually about 2 inches to the inner side of the calf, is made parallel to the wound and the skin and subcutaneous fat dissected up, making a flap attached at both ends. This flap is displaced outward to cover the raw area over the tibia and sutured firmly to the lateral skin edge, completely covering the exposed bone. The raw area on the inside of the calf from which the flap was removed is allowed to heal by granulation or may be grafted with small, deep grafts.

Scars over the Heel and Ball of the Foot.—These are usually due to pressure sores or to traumatic injuries or burns. When painful enough to

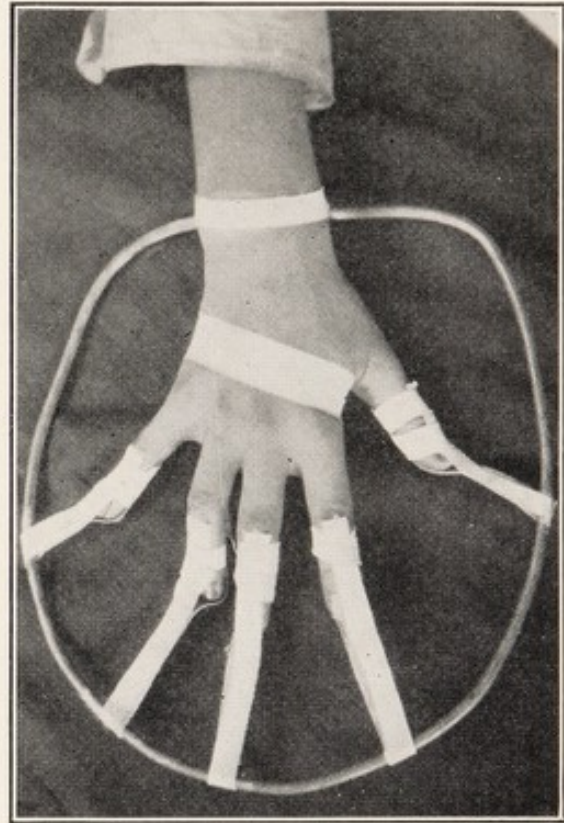


FIG. 151.—PHOTOGRAPH OF FINGERS EXTENDED BY BANJO TRACTION SPLINT TO PREVENT SCAR CONTRACTURE.

Also used in other affections of hand and fingers.



FIG. 152.—SERIES OF PHOTOGRAPHS SHOWING TECHNIC AND RESULT OF PLASTIC PROCEDURE (AS EMPLOYED BY THE AUTHOR'S COLLEAGUE, J. S. SPEED) FOR ULCER OF LEG FOLLOWING OSTEOMYELITIS.

interfere with walking, they should be excised and the defect filled with a pedicle graft.

MUSCLES

Trauma may cause rupture of a muscle, or the muscle may be involved in an acute or low-grade inflammatory reaction. Muscle tissue does not regenerate; consequently, when muscle fibers are destroyed, they are replaced by fibrous connective tissue, fat and, at times, bone. The contractile function of the muscle is thus diminished and as the fibrous tissue contracts, motion of the joint may be limited and deformity occur.

Rupture of Muscles.—Muscles may be ruptured by violent contractions, by sudden elongation of a contracted muscle, or by contusion of a contracted muscle. The muscles usually affected are the extensor brevis of the toes, the gastrocnemius, the plantaris, the tibialis posticus, the rectus femoris,

the biceps femoris, the adductors, the pectoralis major, the biceps cubiti, the deltoid, the trapezium, the sternomastoid, or the abdominal muscles.

Pathology.—The tear usually occurs at the attachment of the muscle belly to its tendon. It may be complete, partial, or fibrillar, in which only a few fibers are torn. A hematoma forms, which is gradually absorbed, and the gap replaced by scar tissue.

Symptoms.—During an unusually violent movement, the patient feels a sudden sharp pain, accompanied by the sensation of "something giving way" and, in some instances, by an audible snap. There is pain on movement, swelling, and ecchymosis at the point of rupture. A gap may be palpable in the muscle, and if the rupture is complete, the corresponding movement of the joint may be lost.

Diagnosis.—The diagnosis is made from the history and the symptoms. An x-ray may be necessary to exclude fracture.

Treatment.—The treatment is immobilization of the limb in a position to relax the muscle. In the incomplete variety, this may be all that is needed. If the rupture is complete, however, immediate suture is indicated, followed by immobilization and physiotherapy.

MYOSITIS

Inflammation of a muscle may occur during the course of an acute infectious disease, as typhoid fever or scarlet fever; or a low-grade inflammatory process may occur in tuberculosis and syphilis. The pathology and course of such affections do not differ materially from that of similar infections elsewhere in the body. The treatment is immobilization and the prevention of scar contracture deformities with appropriate measures for the eradication of the systemic infection.

There are, however, two forms of low-grade inflammatory processes in muscles which require special consideration. These are ischemic myositis and myositis ossificans.

Ischemic Myositis (Volkmann's Paralysis).—Ischemic myositis is a condition in which there is progressive degeneration and death of the muscles (necrobiosis), due to an obstruction of the arterial blood supply. The muscle tissue is replaced by fibrous tissue and characteristic paralysis and deformity result.

Etiology.—The paralysis usually involves the muscles of the forearm, but the leg may rarely be affected. It occurs most often between the ages of four and twelve years, following fractures in the region of the elbow. The great percentage undoubtedly occur as the result of constriction of the arm by splints that have been too tightly applied, or which have become too tight from subsequent swelling of the arm. However, deformity has been known to follow fracture of the arm when no dressing has been used

except a sling. Here, the cause has been assumed to be pressure of the fragments on the brachial artery, or the intense swelling of the extremity, which results in the skin and deep fascia becoming tense and compressing the underlying muscles. The damage occurs in a very short time. If the arterial flow is arrested for from three to six hours, myositis is practically certain to develop.

Pathology.—The greatest injury is sustained by the muscles on the flexor surface and ulnar side of the forearm. The nerves may also be affected, but the nerve symptoms are usually late and appear to be due more to constriction of the nerve by scar tissue than to the primary anemia. Following the edema and swelling, the muscles degenerate. Infiltration with small round cells occurs and the muscle is replaced by fibrous connective tissue. The muscles are matted together in a dense scar, and as contraction develops, the wrist and fingers become flexed.

Symptoms.—The symptoms during the stage of onset are intense pain, swelling, cyanosis or blanching of the finger tips, loss of motion and sensation. The cardinal symptoms of constriction, discussed in Chapter II, must always be kept in mind. If constriction has occurred and the splints are removed twenty-four hours later, the arm is edematous; the skin is covered with blebs and there may be areas of pressure necrosis at the point of greatest constriction (usually just below the elbow). The muscles feel hard and swollen. The child cannot move his fingers. Later, the typical deformity is a claw-hand. The elbow is flexed, the forearm pronated, the wrist flexed, the metacarpophalangeal joints extended, and the interphalangeal joints flexed. The thumb is usually adducted under the palm. The temperature of the hand is lower than that of its fellow. The skin is thin, shiny, and may show trophic lesions. Trophic ulcers occur usually at the tips of the fourth and fifth fingers. There may be diminished sensation.

The muscles of the flexor surface are hard and board-like in consistency and stand out prominently on attempts to straighten the wrist and fingers. Active motion in both flexion and extension is greatly diminished or entirely absent. Passive movement of the joints is usually normal; the fingers can be extended when the wrist is flexed, and the wrist can be extended when the fingers are flexed. This fact is made use of in correcting the deformity.

Diagnosis.—The diagnosis of ischemic paralysis is made from the history of onset associated with a fracture and from the characteristic symptoms and appearance. The board-like feel of the muscles is almost pathognomonic. Other conditions with which it might be confused are spastic paralysis, obstetrical paralysis and anterior poliomyelitis. Spastic paralysis and obstetrical paralysis are differentiated by the duration of the affection since birth. Anterior poliomyelitis is to be distinguished by the flaccid character of the paralysis.

Prognosis.—The prognosis is favorable when treatment is instituted early. The milder cases may be greatly benefited, but as a rule there is always permanent impairment of function.

Treatment.—*Preventive Treatment.*—The most important form of treatment is, of course, the preventive. Much caution is required in the use of circular dressings after trauma to the forearm of children. The fully flexed position universally used in the treatment of fractures about the elbow is particularly dangerous. The limb must be inspected frequently during the first forty-eight hours. If undue pain or other cardinal symptoms of constriction are present, the dressings must be removed, the arm massaged, the joints passively moved, and the dressings loosely re-applied. This treatment may be repeated every two hours, if necessary. If the manipulation is too painful, an anesthetic may be administered.

If it is thought that the arrest of circulation is due to pressure on the brachial artery, the fragments may be shifted blindly. If constriction is due to edema of the structures below the deep fascia, multiple incisions through the skin and deep fascia down to the muscles may relieve tension, and is indicated in rare instances.

Corrective Treatment.—The corrective treatment consists of gradual extension of the contracted structures. As has been mentioned, the distal joints can usually be straightened when the proximal ones are flexed. Metal splints are applied to hold the interphalangeal joints in extension while the metacarpophalangeal joints and wrist joint are flexed. The splints are changed daily and bent so that the metacarpophalangeal joints are gradually straightened. When the fingers become straight, the wrist is gradually extended in the same manner until it can be hyperextended. Physiotherapy is of great value and should include baking, hot-water baths, massage, and active and passive exercises. Surgical treatment offers little chance of improvement. The plastic lengthening of the muscles is perhaps the most rational procedure of the various operative methods which have been employed. Resection of a portion of the shafts of the radius and ulna has been advised but is rarely necessary.

Myositis ossificans.—Myositis ossificans is a low-grade inflammatory process characterized by the formation of bone in or in contact with a muscle. Three types are described: (1) the progressive; (2) the circumscribed; and (3) the traumatic.

Etiology.—The cause is not known. Various theories have been advanced to explain the condition, the most important of which are: (1) implantation of periosteum into a muscle; (2) escape of osteogenetic cells from the periosteum; (3) ossifying hematoma; and (4) metaplasia. Males are affected more frequently, and trauma plays an important part in almost every case. The progressive form usually begins in the muscles of the back

and steadily involves practically all the muscles of the body. Death occurs finally from interference with respiration.

In the circumscribed and traumatic forms, the bone production is limited to one muscle. The brachialis anticus muscle is most often affected. Other common sites are the quadriceps muscle, the adductors and the biceps brachii. Dislocation of the elbow is the most common predisposing factor.

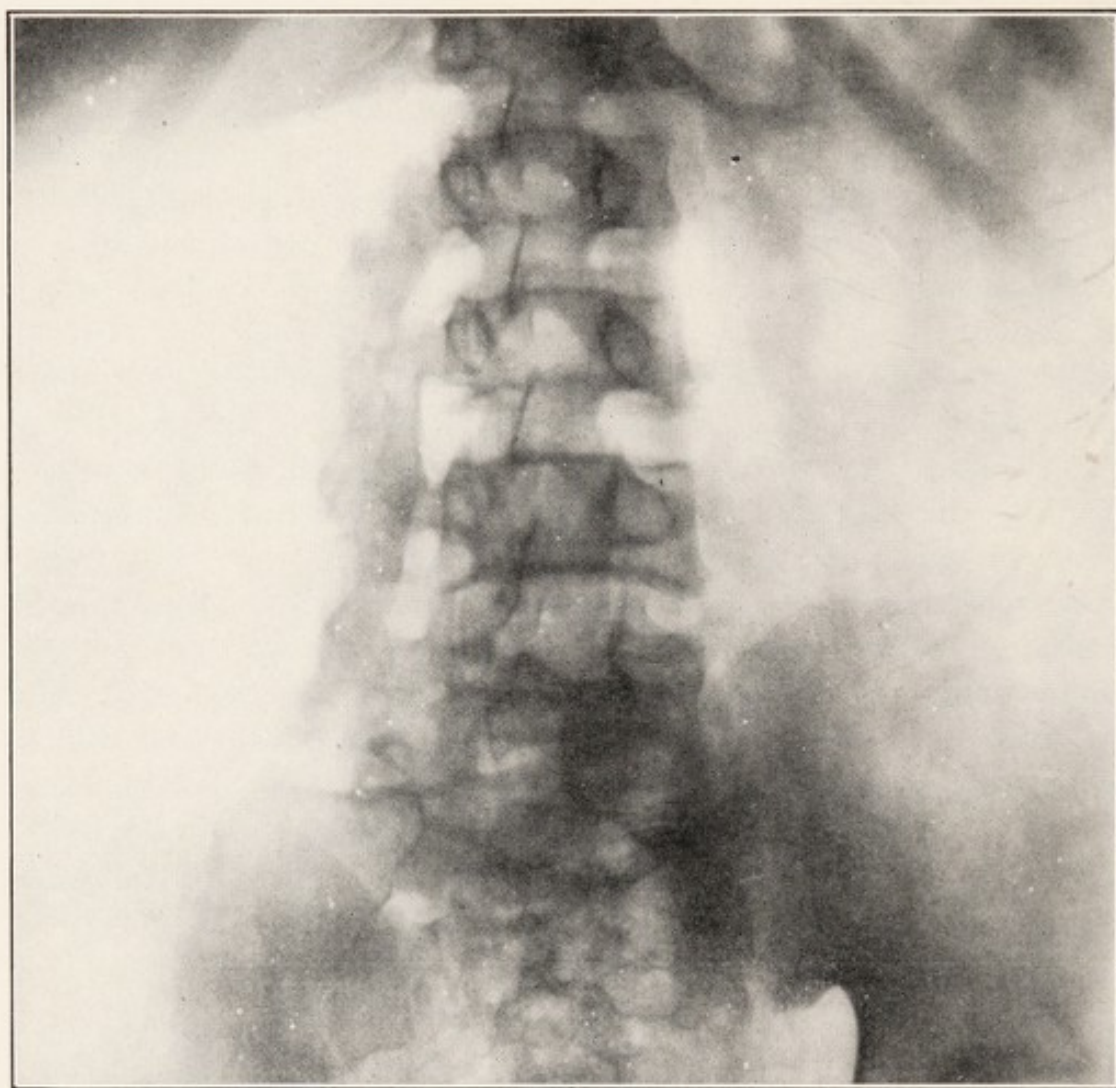


FIG. 153.—X-RAY SHOWING MYOSITIS OSSIFICANS IN LUMBAR MUSCLES FOLLOWING CONTUSIONS.

Note bridge of bone connecting transverse processes of lumbar vertebrae to the ilium.

Bone may also form in muscle following fractures, muscle contusions and muscle rupture.

Pathology.—The pathology in the different forms is essentially the same, varying only in distribution and degree. In the rare progressive form, as mentioned above, the process may be almost universal. In the circumscribed and traumatic type, the bone production is limited. The bone is found in the muscle tissue, in the tendon, muscle sheath, or along the fascial intermuscular planes. In the circumscribed form, the onset is slow, but in the traumatic form, the muscles may rapidly undergo ossification. Specimens removed at

operation show degeneration of the muscle fibers, replacement by fibrous tissue, cartilage cells and normal appearing bone. There may or may not be an attachment to the skeleton.

Symptoms.—The symptoms are those of interference with muscular function. The mass is palpable and gradually becomes larger and firmer. Pain is rarely a prominent symptom. The roentgenogram shows the mass in the muscle, which becomes gradually denser until it casts a shadow similar to normal bone. The entire process in traumatic myositis ossificans may occur in three months.

Diagnosis.—The diagnosis is made by the history of the injury, progressive limitation of motion in a joint, palpation of the bony mass, and the x-ray.

Treatment.—The treatment of the circumscribed lesions is purely surgical. As there is a strong tendency toward recurrence if the excision is not complete, it is wise to observe the tumor for a time and repeat the x-ray. When complete ossification has occurred, wide excision should be done. No treatment is of value in the progressive type.

TENDONS

Tendons, like muscles, may be ruptured or torn from their insertions by violent muscular contractions. The symptoms and treatment are identical with rupture of the muscles. Tendons may also be displaced from their anatomical positions. This is most frequently seen in the peroneal tendons.

Displacement of Peroneal Tendons.—The peroneal tendons may be displaced forward from their normal position behind the external malleolus. The cause may be traumatic, or due to congenital malformations of the groove in which the tendons lie. The dislocation is also seen in paralytic flat-foot. The displacement occurs when the foot is dorsiflexed and abducted. The symptoms are local swelling and ecchymosis.

The treatment consists of replacing the tendons in their groove and holding them in position by maintaining the foot in dorsiflexion and inversion. If recurrence follows, open operation may be necessary. An artificial groove can be constructed by turning up an osteoperiosteal flap from the fibula.

Tenosynovitis.—The tendon and its sheath may be involved in inflammatory processes. Because of their intimate association, the inflammation usually involves both coincidentally. Any of the classical types of inflammation may occur, as plastic, serous, purulent or proliferative. Tuberculosis is often the causative agent. Tenosynovitis occurs usually in the tendon sheaths of the wrist and ankle.

Pathology.—The tendon sheath is thickened. The synovial fluid is increased and may be normal in character, serous or purulent, depending

upon the nature of the infecting organism. In tuberculosis, rice-bodies are frequently found.

Symptoms.—The symptoms are swelling about the ankle or wrist joint, pain on motion, and impairment of function.

Diagnosis.—The diagnosis is easily made, but must be differentiated from arthritis and simple traumatic affections.

Treatment.—The treatment is rest by immobilization and aspiration or incision, if the symptoms become exaggerated.

Ganglion.—A ganglion is a cyst containing a clear, colloid material, developed from the synovial membrane of the tendon sheath or joint. Ganglia are situated generally on the dorsum of the wrist. They appear gradually and are usually associated with some slight strain, as practicing on the piano. The ganglion does not move with the tendon, but becomes tense on flexion of the wrist and fingers. The symptoms are usually mild, but may persist indefinitely.

The classical method of treatment, by breaking the ganglion with the corner of a book, is to be condemned. Aspiration of the colloid material followed by the injection of a few drops of tincture of iodine, phenol or mercurochrome, 1 per cent, may cause a slight inflammatory reaction and disappearance. If this is not successful, excision should be performed.

BURSÆ

A bursa is a sac enclosing a small amount of serous or synovial fluid designed by nature to prevent the ill effects of pressure, to facilitate gliding movements, and to diminish friction. Bursæ are usually located near joints and over bony prominences, and are subject to irritation by trauma and infection. As they are in close communication with the lymphatic system, they are frequently infected from distant foci. Bursæ react to irritation by an increase in the amount of serous fluid and by thickening the walls; this causes pain and swelling. There may be calcareous deposits formed after prolonged irritation. There are about one thousand bursæ described in the human body, but only the ones most frequently causing symptoms will be discussed. These are the one beneath the os calcis, the one about the tendo achillis, the prepatellar, the subacromial, and the one under the insertion of the pronator radii teres muscle. Like tenosynovitis, bursitis may be acute or chronic, serous or purulent, and may be due to tuberculosis or syphilis.

Calcaneobursitis.—Calcaneobursitis is an inflammation of the bursa beneath the os calcis, between the bone and the fatty tissue of the heel. The symptoms are pain and tenderness on pressure. If the condition is associated with flat-foot, the latter should also be treated. A felt or rubber heel pad will remove the jar of walking. In obstinate cases, the bursa may be excised through a lateral incision.

Achillobursitis.—Inflammation may occur within the bursa between the insertion of the tendo achillis and the overlying skin, or in the bursa between the tendon and the os calcis. The symptoms are pain and swelling about the back of the heel. The patient may walk on the toes to relax the tendon. The treatment is rest and removal of the counter of the shoe, as mentioned in the treatment of epiphysitis (p. 145). In more severe cases, drainage or excision may be necessary.

Prepatellar Bursitis (Housemaid's Knee).—Prepatellar bursitis is commonly due to excess kneeling. The symptoms are similar to those of bursitis elsewhere, and the diagnosis, as a rule, presents no difficulties. It must, however, be clearly differentiated from arthritis of the knee with effusion. The treatment in acute cases is strapping with adhesive tape. If there is much effusion, the sac may be aspirated. In persistent chronic cases, excision is the best method of treatment.

Subacromial Bursitis.—Subacromial bursitis is rare in childhood. It is manifested by swelling, pain and tenderness on the anterior aspect of the joint; motion of the shoulder is limited chiefly in abduction and internal rotation, as these movements compress the bursa under the acromion process. This sign is therefore of value in differentiating subacromial bursitis from arthritis of the shoulder joint. Calcareous deposits are more frequently observed in subacromial bursæ and adjacent tendons than in other bursæ. The treatment is conservative in the acute stage and surgical removal in the chronic stage.

Tennis Elbow.—Chronic bursitis of the elbow is frequently seen after repeated mild injuries, as in athletics. The symptoms are pain on the medial side of the elbow joint when using the arm, and tenderness over the insertion of the internal lateral ligament and the common tendon of the flexor and pronator muscles. The bursa over the head of the radius may be inflamed. This may be associated with tenderness and swelling over the insertion of the pronator radii teres into the radius, probably due to inflammation of a small bursa at this point. The treatment consists of rest, counterirritation and, later, massage.

CHAPTER XIII

AFFECTIONS OF THE NERVOUS SYSTEM

ANTERIOR POLIOMYELITIS

Anterior poliomyelitis, or infantile paralysis, is an acute infectious disease involving the cerebrospinal system and usually associated with peripheral paralysis. As in other infections of the central nervous system (meningitis), it may occur in epidemics or sporadically.

Etiology.—The etiological factor has not yet been proved. Anterior poliomyelitis may occur as a sequela of acute infections, as measles, whooping-cough, and during the clinical course of acute intestinal infections, and also sporadically and in epidemics, and it is probable that several organisms may induce the same pathological phenomena. Since the infection in the epidemic type can be induced in monkeys by the injection of a solution of infectious material from the central nervous system or elsewhere, which has been passed through filters sufficiently fine to retain all known bacteria visible through the microscope, it is believed that the causative agent is possibly ultramicroscopic and filtrable. No age is exempt, but the most frequent period of occurrence is from two to five years.

Pathology.—The infection apparently has a selective action for the motor cells of the anterior horn of the gray matter in the cervical and lumbar enlargements of the spinal cord; other portions of the central nervous system may be involved, though the posterior portion of the cord is seldom invaded. The muscles whose nerve-cells have been destroyed in the area of infection undergo metamorphosis until all muscular fibers may be substituted by fat. Some or all of the nerve-cells may be destroyed or only temporarily impaired; in those destroyed, no restoration to normal will occur; in those partially or slightly impaired, a return to normal or approach to normal may be expected.

Symptoms and Clinical Course.—There are a number of clinical varieties which may be enumerated, as follows: (1) abortive; (2) cerebral; (3) medullary; (4) meningitic; (5) spinal (the common type).

The abortive type is recognized only during epidemics. Fever is present for a number of days, but the condition subsides without paralysis. In the cerebral type, there are symptoms of an acute encephalitis. In the medullary form, the cardiac or respiratory centers may be involved, with death before diagnosis is made. This variety is also recognized only during

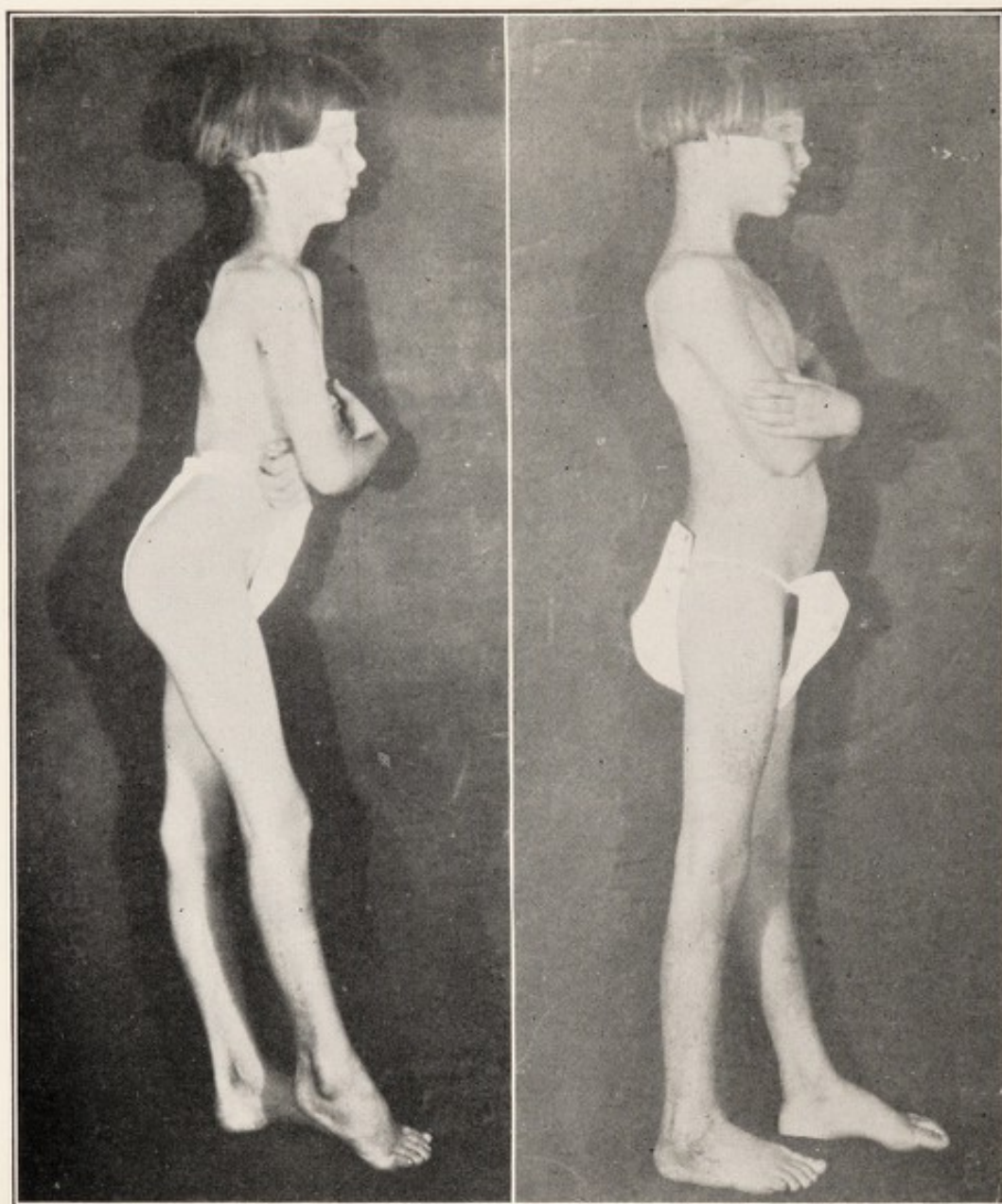
an epidemic. The meningitic type presents symptoms identical with cerebrospinal meningitis, which can only be differentiated by the examination of the spinal fluid. The cerebral, medullary, or meningitic types may be complicated by a peripheral paralysis. The spinal, or common, type occurs with such preponderant frequency that the other types above mentioned will not be further considered.

There are clinically four different stages: (1) acute, or febrile; (2) nervous; (3) resolution or functional improvement; (4) residual paralysis. In the first, or febrile stage, the onset is sudden, with a range in temperature in proportion to the intensity of the infection. In the epidemic form, the range is usually high, but (when probably due to some other type of infection, as measles, intestinal infection, etc.), there may be no elevation of temperature. It is generally conceded, however, that fever is always present, even if not detected. The fever persists from three to five days, during which time the child may be exceedingly nervous; or there may be no symptoms suggestive of involvement in the central nervous system. As these acute febrile symptoms subside, flaccid or loose paralysis in the extremities is apparent. In mild infections, the paralysis may be slight and may be passed unnoticed until walking is attempted, or months or years later, when deformity may ensue from deficient muscle balance. Spastic paralysis is rarely if ever observed as a sequela of anterior poliomyelitis.

The distribution of the paralysis in frequency of occurrence is: both lower extremities, one lower extremity, all four extremities and the spinal and abdominal muscles. The cranial nerves may be involved at times, and the speech center, as observed in one of the author's cases. There seems to be a selective action of the organism on those cells in the spinal cord which affect certain groups of muscles. The paralysis may be of any group, or part of group, or may involve the entire muscular system.

The nervous stage begins with the onset of paralysis, and may continue about six weeks, when all pain and nervous manifestations gradually disappear. The child is exceedingly nervous; any noise may cause irritation and the slightest jar may produce hysterical manifestations. There may also be photophobia. The stage of resolution or improvement is instituted as the nervous stage subsides, and there is a gradual return of muscular function. Muscle power is regained more rapidly for the first six months, and thereafter very slowly, becoming stationary in about eighteen months. The stage of residual paralysis is then instituted, and no further improvement may be expected. This stage is in reality a status, the result of a pathological condition, and does not represent an active pathological process. Deformity, which may be extensive, resulting from a lack of muscle balance, followed by contraction of the soft parts and structural distortions of bone, frequently complicates this stage. The more common deformities will be described, beginning with the foot.

The Foot.—Since the foot is the foundation on which the body is supported, and also the most dependent part, it is obviously more subject to strain and deformity, especially if weakened by paralysis. Equinus, varus, valgus, calcaneus, equinovarus, calcaneovalgus and equinovalgus, drop-foot



A

B

FIG. 154-A.—PHOTOGRAPH SHOWING EQUINUS DEFORMITY OF FOOT WITH LORDOSIS OF SPINE.

FIG. 154-B.—SAME AS FIGURE 154-A, AFTER OPERATION.

and flail-foot are the deformities most frequently observed. *Equinus* is caused by the paralysis of the anterior group of muscles in the leg, or the dorsal flexors, with active function in the posterior muscles of the leg, especially the gastrocnemius. The posterior muscles contract as muscle balance is lost, so that the patient walks on the ball of the foot (equinus). *Varus*, or turning in of the forefoot, ensues when the peroneals are paralyzed

and the tibials are active. Coincidentally, there develops an inward twist of the bone structure of the tarsus and contractions of the soft structures on the inner aspect of the foot. *Valgus*, or turning out of the forefoot, is produced when the tibials are paralyzed and the peroneals are active. This

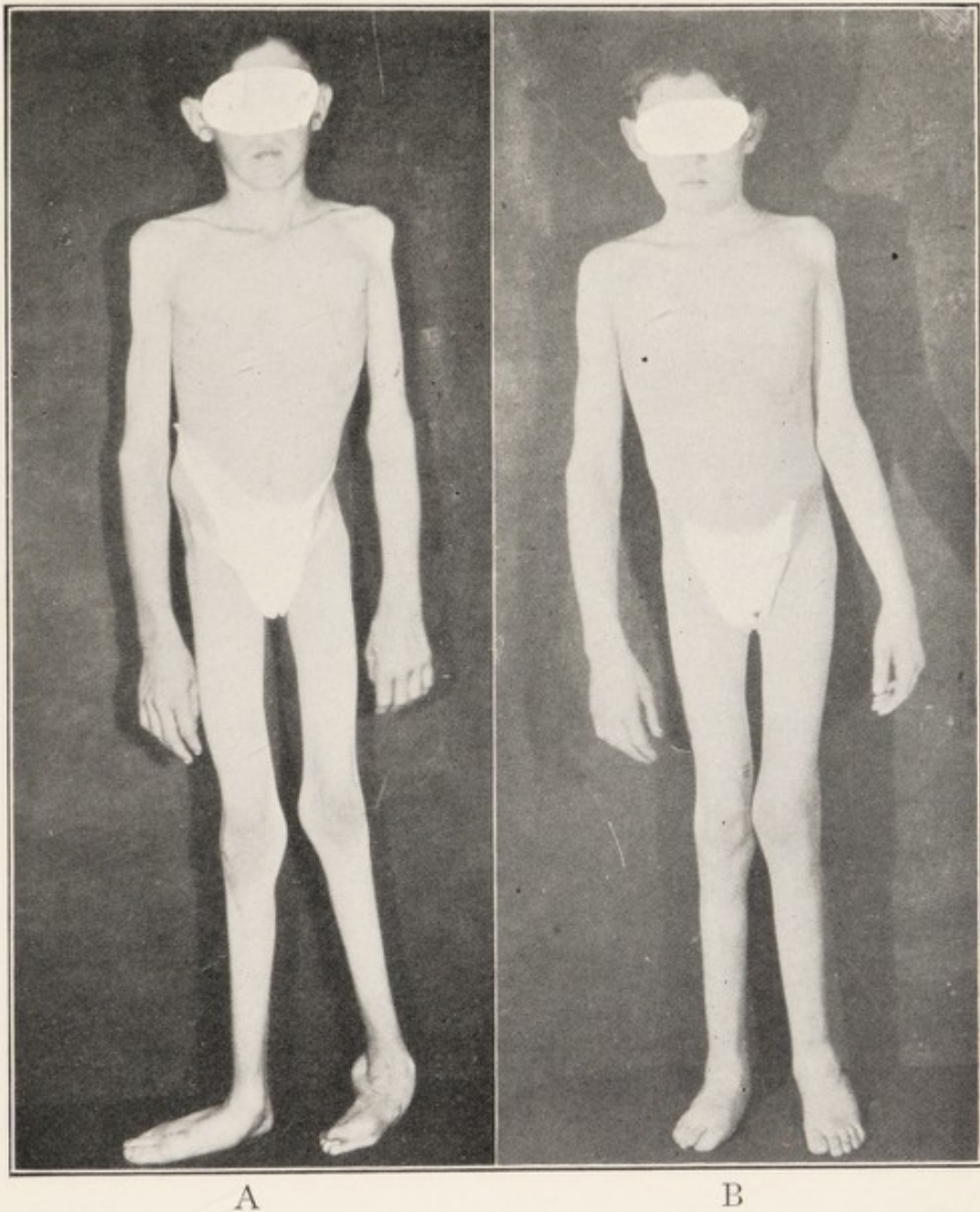


FIG. 155-A.—PHOTOGRAPH SHOWING PARALYTIC VARUS OF LEFT FOOT AND PARALYTIC VALGUS OF RIGHT.

FIG. 155-B.—SAME AS FIGURE 155-A, AFTER OPERATION.

obviously depresses the arch, and the condition may also be described as paralytic flat-foot. *Calcaneus*, or heel-walking, occurs when the posterior or calf muscles are paralyzed and the anterior group of the leg is active. In all these deformities, there is usually structural distortion of the bones.

There are also certain combinations of deformities, as equinovarus, calcaneovalgus and equinovalgus, which may become fixed from permanent

contraction of muscles and soft parts and distortion of the bones. *Equino-varus* is produced when there are paralyses of the anterior group of the leg and the peroneals, while the posterior group and tibials are active. These active muscles contract, pulling the foot into equinus and varus. *Calcaneo-valgus* is induced by paralysis of the posterior group and tibials with active

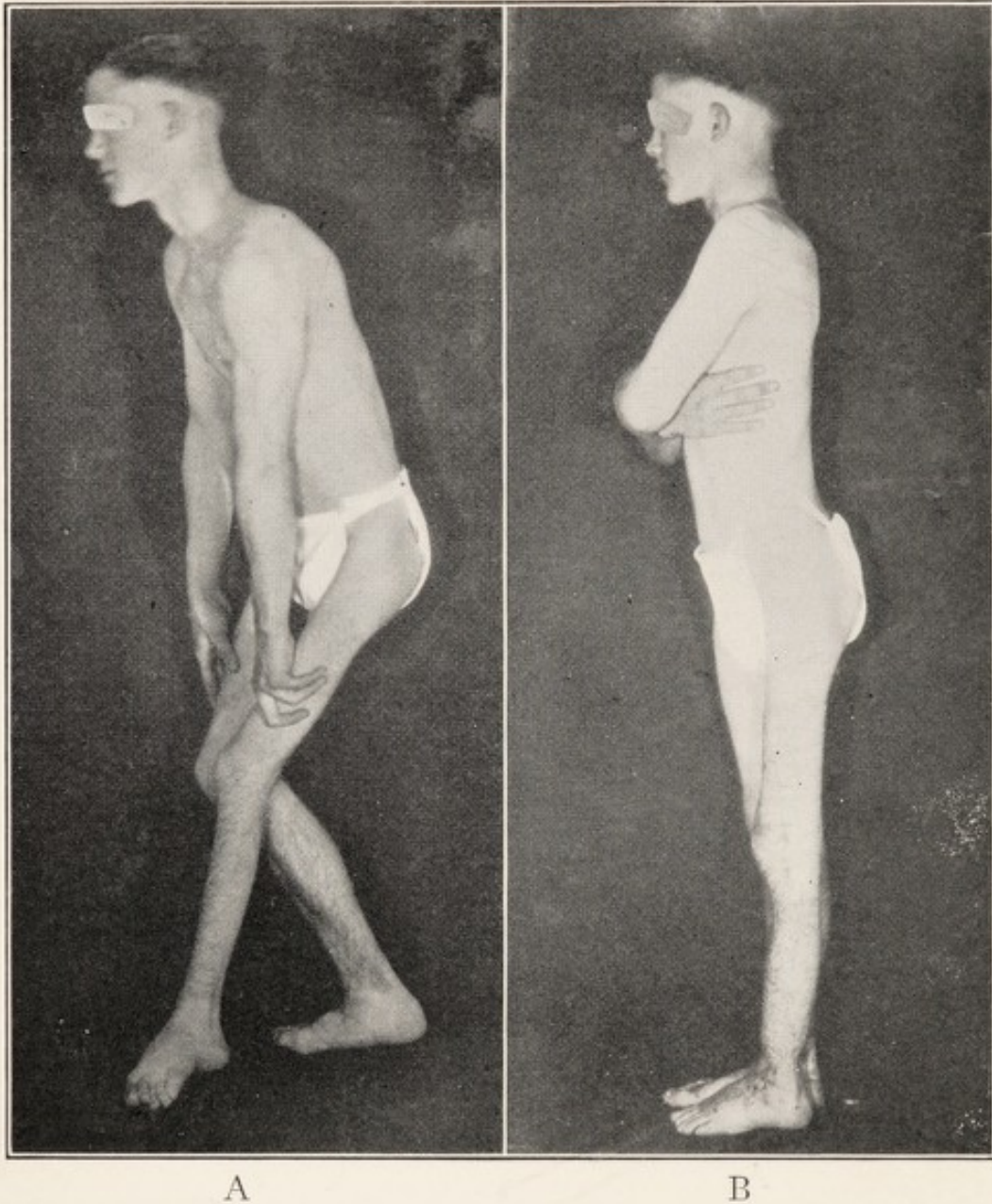
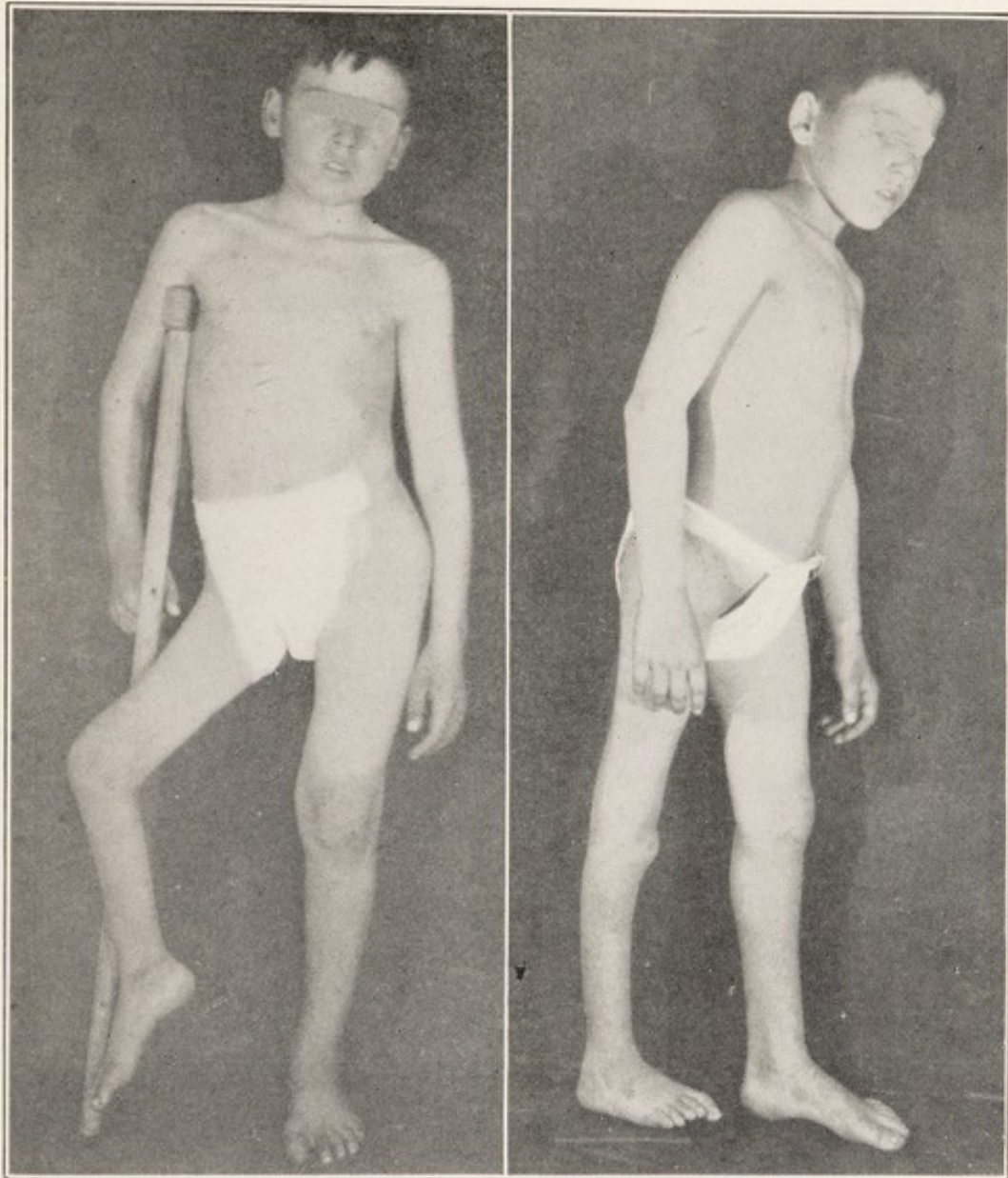


FIG. 156-A.—PHOTOGRAPH SHOWING
CALCANEVALGUS OF LEFT FOOT.

FIG. 156-B.—SAME AS FIGURE 156-A,
AFTER RECONSTRUCTION.

peroneals and anterior muscles of the leg. The latter become contracted from loss of muscle balance and pull the foot upward and outward. *Equinovalgus* may be caused by paralysis of the anterior group and tibials with active posterior muscles and peroneals, or may follow simple equinus without paralysis of the tibials by the foot being forced outward by weight-bearing in an effort to place the sole of the foot on a flat surface in walking.

Drop-foot occurs when the posterior muscles are active and the anterior muscles are paralyzed, but without contraction, even though a loss of muscle balance is present. When the leg is lifted from the ground in walking, the foot falls downward. Flail-foot, or "dangle-foot," results from paralysis



A

B

FIG. 157-A.—PHOTOGRAPH SHOWING FLEXION DEFORMITY OF KNEE.

FIG. 157-B.—SAME AS FIGURE 157-A, SHOWING CORRECTION OF FLEXION DEFORMITY OF KNEE.

Osteotomy of femur and drop-foot operation on foot.

of all muscles of the leg. A flail-foot is also a drop-foot, but a drop-foot is not necessarily a flail-foot. A description of deformities of the foot may also be found in the chapter on Congenital Anomalies.

The Knee.—Fixed flexion deformity may be produced by paralysis of the quadriceps. In addition, there may be associated external rotation and sub-

luxation of the tibia on the femur by a strong pull of the biceps femoris muscle on the head of the tibia, previously described in affections of the knee-joint (p. 59). Genu recurvatum, or exaggerated hyperextension, occurs when the hamstrings are paralyzed and the quadriceps is active. Genu recurvatum may also be a natural compensatory measure to fix the

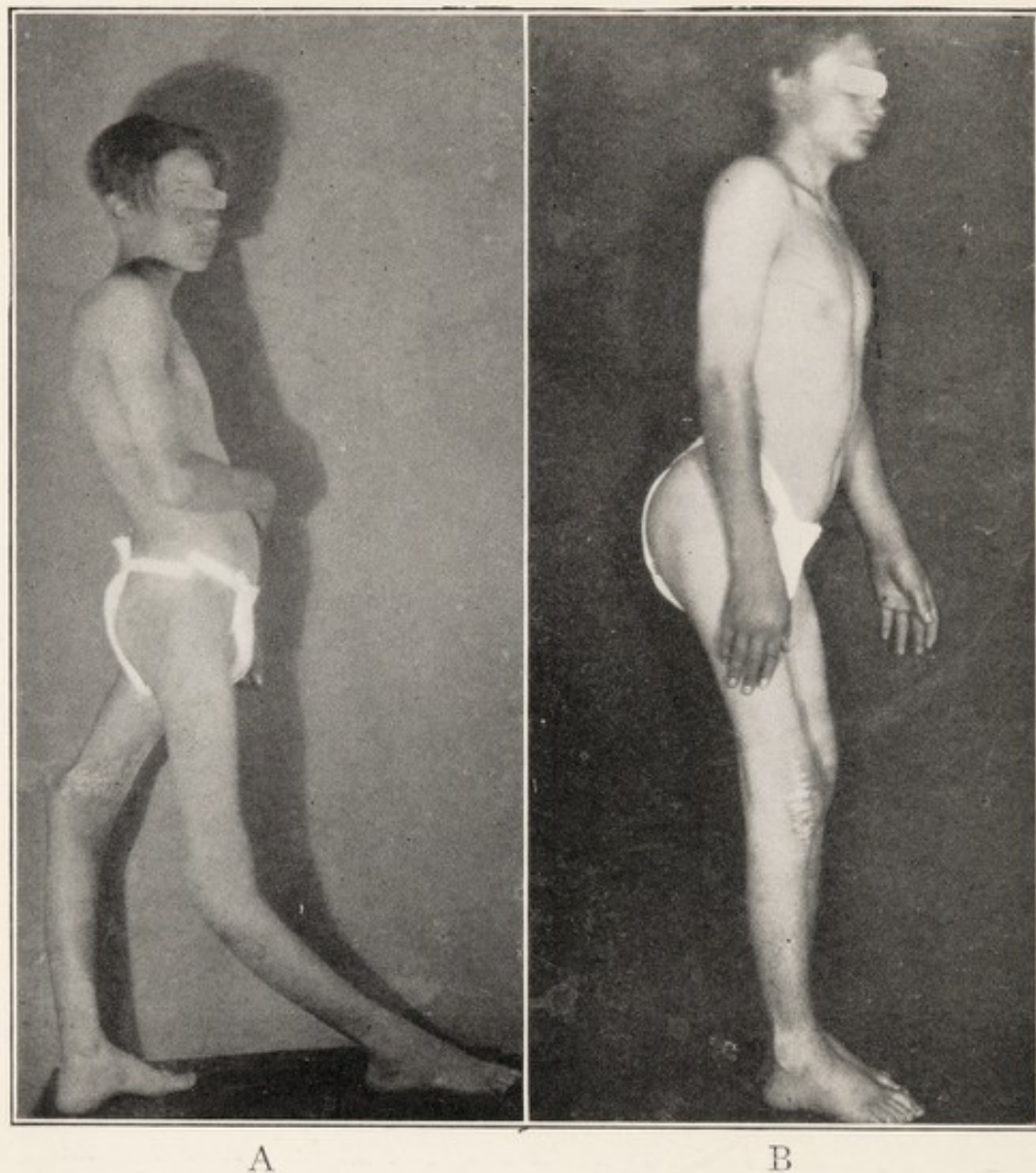


FIG. 158-A.—PHOTOGRAPH SHOWING BILATERAL GENU RECURVATUM.

FIG. 158-B.—SAME AS FIGURE 158-A, SHOWING CORRECTION OF BILATERAL GENU RECURVATUM AFTER AUTHOR'S OPERATION OF TRANSPLANTATION OF PATELLA TO TIBIA.

knee and enable standing and walking when all muscles of the thigh are paralyzed and a flail-foot exists.

The Hip.—The hip is more frequently fixed in flexion with abduction by contraction of the flexors and abductors, which may be so extreme that the thighs touch the chest when the spine is in normal position. Spontaneous dislocation of the hip is fairly common.

The Spine.—Slight or extreme structural rotary curvature of the spine, involving the entire trunk, may result from loss of muscle balance. The abdominal muscles may also be paralyzed, causing extreme visceroptosis.

The Shoulder.—In paralysis of the deltoid muscle of the shoulder, there is dislocation by gravity, which is often erroneously considered of traumatic origin. However, in traumatic dislocations, the shoulder cannot be reduced without considerable force, whereas, in paralytic dislocation, the head of the bone can be slipped in and out of place without discomfort.

The Elbow.—The elbow remains loose and flail, the problem being one of function and not deformity.

The Wrist.—The wrist may become flexed and subluxated, and the fingers extended at the metacarpophalangeal joint and flexed at the phalangeal, a peculiar type of claw-hand.

Deformities and dislocations are induced by the force of gravity and by natural attitudes, as sitting with the hips flexed and abducted, the knees flexed, and the feet in equinus.

Prognosis.—In the early stage, after paralysis has occurred, the return



FIG. 159.—X-RAY SHOWING FUSION PATELLA TO TIBIA IN AUTHOR'S OPERATION FOR GENU RECURVATUM.



FIG. 160.—PHOTOGRAPH SHOWING FLEXION CONTRACTURES OF HIPS AND KNEES WITH QUADRUPED LOCOMOTION.

of function depends upon the extent of destruction in the spinal cord. Muscles cannot be restored to action when their cell control in the spine has been destroyed, but in those muscles whose controlling cells are only impaired, there may be a restoration to normal. There is no method by which one can determine whether there has been destruction or only impairment. In the stage of residual paralysis, much may be accomplished; in fact,



FIG. 161.—SAME AS FIGURE 160, SHOWING CORRECTION OF DEFORMITY.

Child able to stand and walk with aid of braces.

there is very rarely observed any case which cannot be very materially improved by the institution of efficient measures. If a slight disability exists, as a twisted foot, very often approximately normal function may be restored. If only one limb is affected, crutches can usually be discarded, and often braces. If the patient walks on crutches, his limbs can be straightened and walking permitted with apparatus, or occasionally without apparatus. If the paralysis is extensive and the patient is confined to a rolling chair or walks on hands and knees, he can be placed on crutches with apparatus. In the upper extremity, much can often be accomplished to increase function by operations for stabilization and tendon transference.

Treatment.—During the acute and nervous stage, the child should be kept perfectly quiet; no treatment is necessary except to regulate muscle balance and prevent deformity. For the peripheral neuritis, when pain is severe, immersion of the child in a tub of tepid water may give relief. Recently, serum therapy, the value of which is *sub judice*, has been intro-

duced in an effort to arrest the progress of the infection. The administration of this serum is indicated as a possible beneficial agent and should be given when the diagnosis is made during the febrile stage or shortly thereafter. If any remedy is to arrest the process, it must be given at this stage; after paralysis occurs, no serum treatment is of the slightest benefit. Urotropin has been administered in the acute stage because of its known antiseptic effect on the spinal fluid.

The orthopedic treatment begins so soon as the paralysis is observed, and consists of the prevention of deformity with suitable apparatus, the same principles being applied as in affections of the joints. For example, if there is paralysis of the anterior group of the leg, the foot falls by gravity into the position of equinus, in which position it may become fixed. In order to prevent this fixed deformity, the foot is held at a right angle to the leg by a simple ankle splint or a bivalved plaster cast. This not only prevents deformity, but also gives the anterior group a better chance to recover. It has been found that overstretched muscles do not recover their tone and that relaxed muscles recover more rapidly. It is often demonstrated that an active muscle may apparently be paralyzed when overstretched. In fixed equinus, the anterior group may be feeble or apparently paralyzed until the foot, by severance of posterior structures, is placed at a right angle to the leg, relaxing the anterior group, when muscle power is often spontaneously regained and dorsiflexion of the foot in walking is possible.

The most useful position for the knee is in full extension. Flexion contractures, extreme hyperextension or rotary or lateral displacements should be prevented. The hips should be held straight and slightly adducted so as to prevent the common tendency to flexion and abduction. The spine can be most conveniently supported in the early stage on a Bradford frame, or if this is not obtainable, a plaster cast may be applied. The spine must be carefully observed until full growth is attained, as deformity may arise in later years, due to the increase in superincumbent weight by normal growth, and loss of muscle balance.

When the nervous stage has subsided, the third stage begins, which is called for convenience the stage of resolution or improvement, for in practically every case there is some spontaneous return of function. At this time, in addition to apparatus for the prevention of deformity, physiotherapy is indicated, which consists of massage, electricity and muscle training. The



FIG. 162.—METHOD OF PROGRESSION IN SEVERE CASE OF PARALYSIS, RESULTING FROM ANTERIOR POLIOMYELITIS WITH PARALYSIS AND DEFORMITY OF BOTH LOWER EXTREMITIES.

Patient unable to walk or crawl.

child has frequently forgotten the use of the affected muscles, even though the neuromuscular system has returned to normal function. Much harm may be done by ignorant and inexperienced individuals by the use of massage and electricity; consequently, physiotherapy should always be in the hands of an expert. If this is impossible, however, the mother or

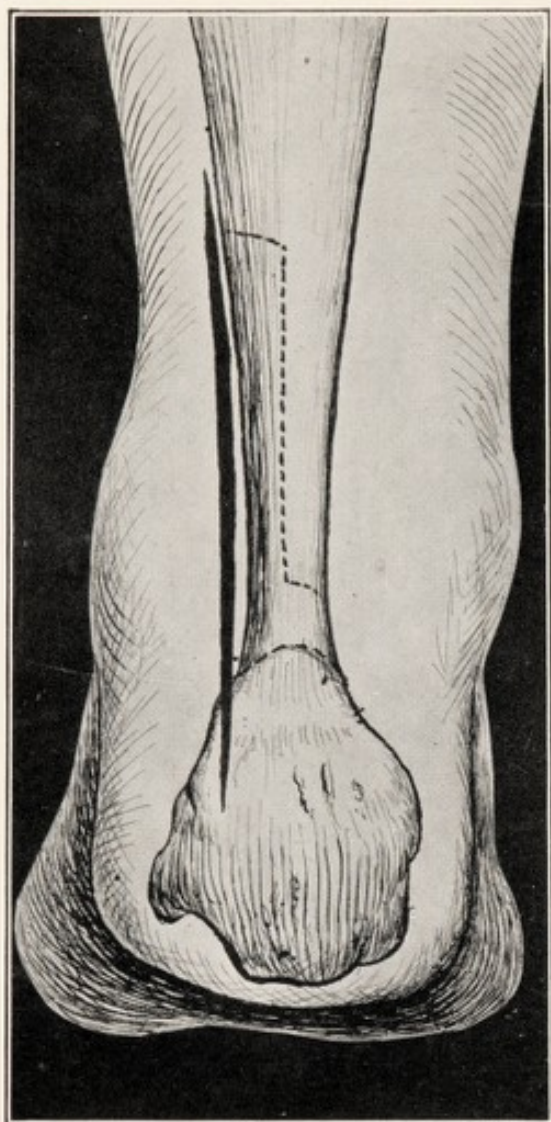


FIG. 163.—DRAWING SHOWING Z-SHAPED INCISION FOR LENGTHENING TENDO ACHILLIS.

attendant should spend sufficient time to acquire a knowledge of simple methods of muscle training and massage, and the proper use of electricity. Physiotherapy is of the greatest benefit during the first eight months.

When the lower extremities are involved, weight should not be borne on the affected limbs, as there is danger of overstretching weak and paralyzed muscles. It is, therefore, better to wait three to six months to determine the extent of return of function. It may be very difficult to keep the parents from permitting the child to walk because of the erroneous idea that exercise of the affected muscles alone will cause a restoration to normal. It is most important, however, that the muscles be kept in a state of relaxation, as overfatigue of paralyzed or partially paralyzed muscles tends to cause further deterioration.

When the residual stage of paralysis has been reached and no increase in function is apparent, further improvement in muscle power can often be developed, especially in those who have had no previous treatment. This is accomplished by re-education and muscle

training of the muscles which possess active motion, even though it be slight. However, if the paralysis is extensive, no approach of normal can be expected from treatment after the residual stage has occurred, which is about two years after the onset of the paralysis. At this time surgery is indicated, (1) to correct deformity, (2) to restore muscle power, and (3) to stabilize loose and relaxed joints.

Operations for the Correction of Deformity.—These consist in forcible correction, osteotomies for the correction of osseous deformity, and tenot-

omies, tenoplasties or fasciotomies, for lengthening contracted soft structures. Tendons are frequently lengthened by plastic measures. For example, the tendo achillis is severed with a Z-shaped incision which permits of lengthening (Fig. 163).

Operations for the Restoration of Muscle Power.—Operations for the restoration of muscle power consist of: (1) nerve anastomosis and (2) tendon transference. Nerve anastomosis consists in transferring portions of normal nerves into those supplying paralyzed muscles. This method has not proved satisfactory and is of historical interest only. Tendon transference is a valuable procedure, but should be employed only in selected cases and by those who have had specialized training and mastered this delicate procedure. While brilliant results have been obtained many failures have also occurred, probably due to the lack of correct technic. The tendon of an active muscle is transplanted to the point of insertion of a paralyzed muscle. The transplanted muscle must be of sufficient power to perform the function of the muscle whose action it assumes, and be correctly placed and arranged in the new position so that it will be capable of assuming the function of the replaced muscle or failure will result.

Operations for Stabilization.—These operations consist in arthrodesing or ankylosing certain loose and flail joints by operative methods to render the part stronger and more useful. There are certain more or less standardized operations which combine the three objectives: correction of deformity, stabilization, and restoration of function. No attempt will be made to mention all of these, but only a sufficient number to illustrate the purpose.

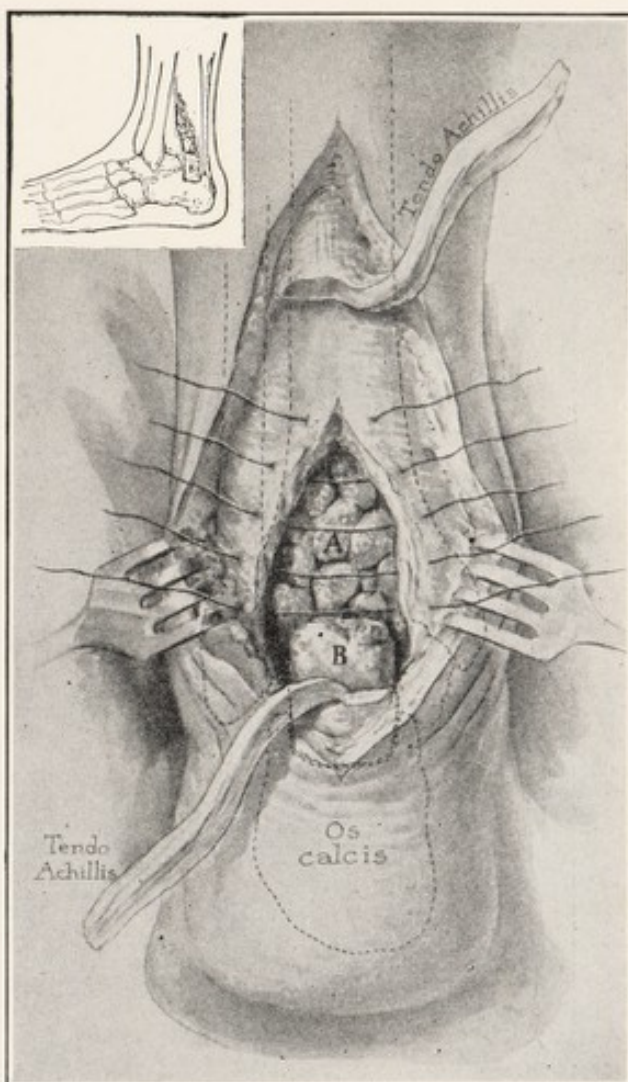


FIG. 164.—SCHEMATIC DRAWING SHOWING TECHNIC OF DROP-FOOT OPERATION, ILLUSTRATING THE TENDO ACHILLIS LENGTHENED BY Z-SHAPED INCISION AND MASS OF BONE CHIPS TRANSPLANTED TO UPPER SURFACE OF OS CALCIS.

INSERT: SCHEMATIC DRAWING SHOWING RESULT OF TRIPLE ARTHRODESIS AND DROP-FOOT OPERATION.

Note fusion of calcaneocuboid, astragalo-scaphoid and subastragalar joints and fusion of mass of bone on os calcis.

In any program for the reconstruction of a paralyzed extremity, due consideration must be given to the planning of surgical procedures along correct mechanical lines. The part must be considered as a whole and methods applicable to the individual case devised. For example, in fixed equinus, the patient may walk quite well by the tense heel cord holding the knee stable through the gastrocnemius muscle. If the cord is made too long, the foot may become flail and the knee unstable, thus rendering the extremity weaker, walking difficult, and the individual more disabled than before correction was attempted. Also, the position of the foot and its relation to other

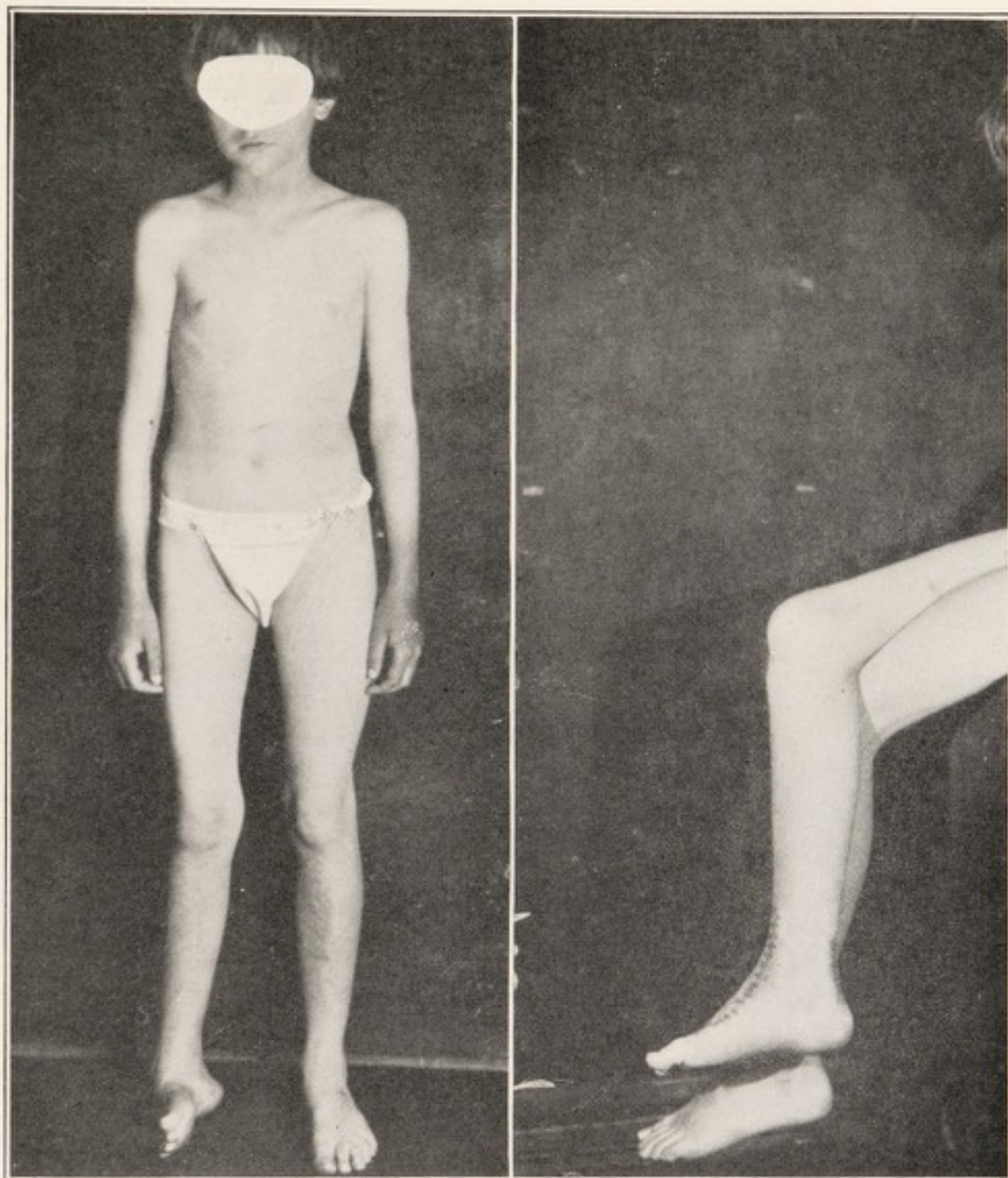


FIG. 165.—X-RAY OF FOOT FOLLOWING ARTHRODESIS OF ASTRAGALOSCAPHOID AND CALCANEOCUBOID JOINTS AND DROP-FOOT OPERATION.

parts must be considered. Operations which require the removal of bone for the purpose of fusion, stabilizing or reconstruction, are contra-indicated in very young children and should not be attempted until there has been sufficient osseous development; otherwise, failure will ensue. As a rule, eight years of age is about as early as these operations are indicated, except in special instances.

The Foot and Ankle.—The object of operative procedures on the ankle is to restore to the body a stable foundation, so that weight may be distributed on the sole of the foot. Deformity can be corrected in most cases of paralytic feet by excision and remodeling of three joints: the astragaloscaphoid, the calcaneocuboid, and the subastragalar. This process is known as triple arthrodesis, and corrects lateral deformity and instability, but does not correct the falling forward of the foot (drop-foot) when there is paralysis of the anterior muscles of the leg.

The author has devised an operation¹ for the correction of drop-foot which consists in making an incision into the posterior aspect of the ankle joint and transplanting a mass of spongy bone into the upper surface of the



A

B

FIG. 166-A.—PHOTOGRAPH SHOWING TALIPES EQUINOVARUS OF RIGHT FOOT.

FIG. 166-B.—SAME AS FIGURE 166-A, AFTER DROP-FOOT OPERATION.

Note foot blocked at right angle. Combined with tendon transplantation.

os calcis in close proximity to the ankle joint. This new bone lives, fuses with the os calcis, and forms a process which impinges upon the posterior

¹W. C. Campbell, "An Operation for the Correction of Drop-Foot," *J. Bone & Joint Surg.*, 1923, 5: 815; "End Results of Operation for Correction of Drop-Foot," *J. A. M. A.*, Dec. 19, 1925, 85: 192.

surface of the tibia and prevents plantar flexion. The method has been employed in over 150 cases during the past four years and has proved almost universally successful. The same procedure has also been used in all varieties of foot affections complicated by equinus or drop-foot. When combined with triple arthrodesis, it has the added advantage of stabilizing anteroposterior as well as lateral motion and also conserving the rocker motion of the ankle joint.

Astragalectomy, described by R. Whitman,² is a very valuable procedure in flail-foot and calcaneovalgus. The astragalus is excised and the foot



FIG. 167.—X-RAY OF FOOT FIVE YEARS AFTER ASTRAGALECTOMY.
Note backward displacement of foot on tibia.

displaced backward so that the weight of the body is placed over the center of the foot. Stabilizing operations on the feet may often be advantageously combined with tendon transference.

The Knee.—Severe deformities of the knee, as contractures with subluxation, should be corrected gradually by apparatus. If some degree of correction can thus be obtained before operation, much bone may be conserved. Tendon transference of the hamstring tendons into the quadriceps and patella in paralyzed quadriceps is a very valuable procedure. Even slight flexion materially weakens the knee, and osteotomy for correction is often done so that the weight may be borne on a perfectly straight knee, and walking thus facilitated. A mild degree of genu recurvatum is often of advantage, but if extreme genu recurvatum is present, the author trans-

² Royal Whitman, *Orthopedic Surgery*, 1917, Ed. 5, p. 840.

plants the patella into the upper extremity of the tibia to limit the forward motion of the leg at the knee.

The Hip.—In the hip, flexion with abduction is a very common and disabling deformity, and often prevents walking, especially if both hips are affected. Transference of the crest of the ilium is the operation employed by the author³ in this condition, and consists in chiseling loose the muscular attachment of the hip flexors to the anterosuperior spinous process of the ilium, and all of the abductor muscles attached to the crest, with a small portion of the crest. The entire mass is stripped downward and attached to the dorsum of the ilium at a point below, thus releasing the contracted muscles and correcting the deformity of extreme fixation and abduction. This operation enables patients who have been confined to a rolling chair to assume an upright posture and walk.

The Spine.—Paralytic scoliosis should be corrected as much as possible by the procedures described in the treatment of scoliosis (p. 260), after which the spine may be held in the corrected position by ankylosing operations, the principles of which are described in tuberculosis of the spine as the procedures of Albee and Hibbs.

The Upper Extremity.—*The Shoulder.*—Arthrodesis, or inducing bony ankylosis of the shoulder, is a very valuable procedure when the deltoid muscle is paralyzed and the scapula muscles are active. In this manner compensatory shoulder motion may be developed by the muscles of the scapula.

The Elbow.—Flail elbows with active flexors of the fingers may be greatly benefited by the ingenious procedure devised by Steindler⁴ which

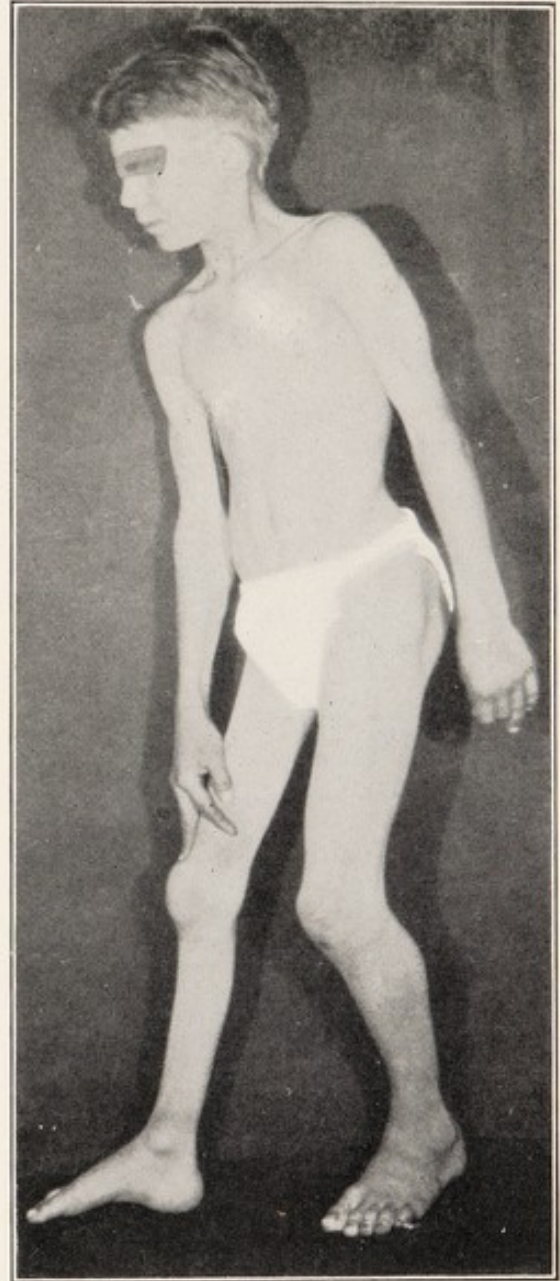


FIG. 168.—PHOTOGRAPH SHOWING METHOD OF PROGRESSION WITH WEAKENED QUADRICEPS.

³ W. C. Campbell, "Transference of the Crest of the Ilium for Flexion Contracture of the Hip," *Southern Med.*, 1923, 16: 289.

⁴ A. Steindler, *Operative Orthopedics*, 1925, p. 302.

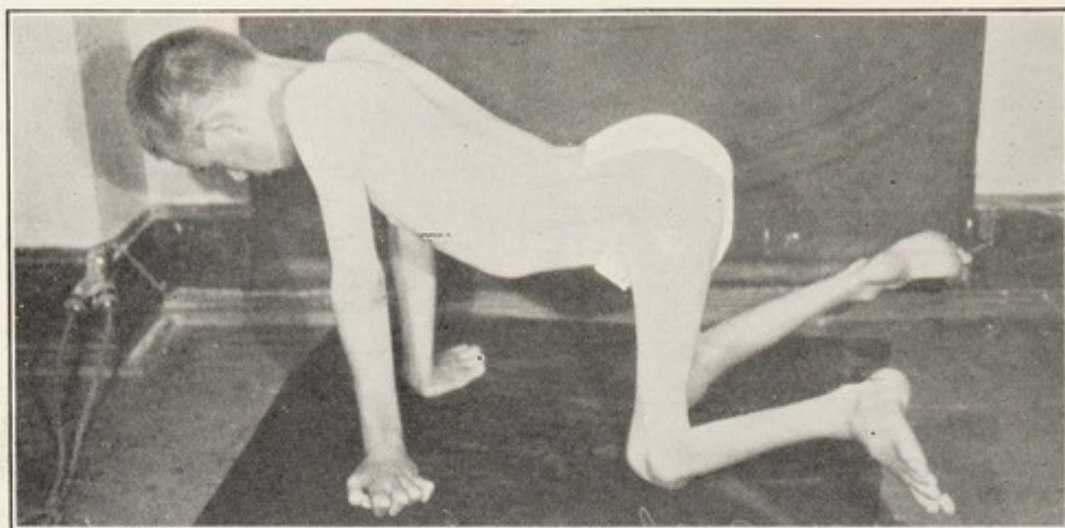


FIG. 169.—PHOTOGRAPH SHOWING FLEXION DEFORMITY OF HIP, CAUSING TYPICAL QUADRUPED.

consists in transferring the origins of the flexor muscles which are attached to the inner condyle of the humerus, with a portion of the condyle, and attaching them to the shaft of the humerus higher up. In this manner, the flexors of the wrist are also used to flex the elbow, and often considerable power is developed at the elbow.

The Wrist.—The wrist, if flail with no use of the fingers, is beyond



FIG. 170.—SAME AS FIGURE 169, AFTER CORRECTION OF FLEXION DEFORMITY OF HIP BY AUTHOR'S TRANSFERENCE OF CREST OF ILIUM.



FIG. 171.—SIMILAR TO FIGURE 169.

redemption; but if there are excellent flexors, the wrist may be arthrodesed in dorsiflexion and in this position will be restored to a measure of usefulness.

In selected cases, tendon transplantation is possibly more efficient in the

forearm than elsewhere, as weight-bearing is not required. Transplantation of the radial and ulnar flexors of the wrist is of special value. Dorsal flexion of the hand is thus restored and drop-wrist overcome.

Braces are used largely in the lower extremities, and may be indicated until there has been sufficient time to restore muscle tone to enable the patient



FIG. 172.—SIMILAR TO FIGURE 170.

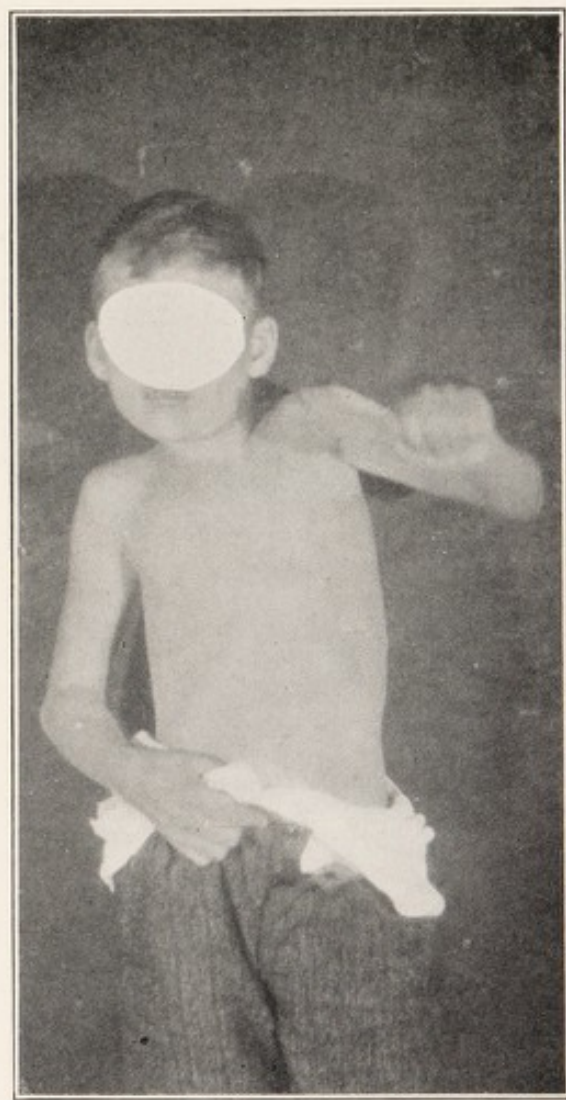


FIG. 173.—PHOTOGRAPH SHOWING AMOUNT OF ABDUCTION OF ARM FOLLOWING ARTHRODESIS OF SHOULDER IN ANTERIOR POLIOMYELITIS, WITH PARALYSIS OF DELTOID MUSCLE.

to walk; and also to prevent deformity. They should be constructed to conform to the limb, and regulate the range of motion in the joints. In the foot, if there is contraction of the heel cord and equinus, the joint at the ankle must be so constructed that plantar flexion will be prevented, but dorsiflexion will be free. If the converse is true, the joint is so constructed that dorsiflexion is prevented, and if the joint is practically flail, motion at the ankle can be restricted to a very limited range. At the knee, it may be

necessary to prevent motion by holding the knee perfectly stiff while walking, by a catch which can be loosened to permit flexion of the knee in the sitting posture. A stop-joint may at times be necessary to prevent over-extension or hyperextension. Also, a knee strap may be necessary in very weak knees to further stabilize the knee. The hip should often be held

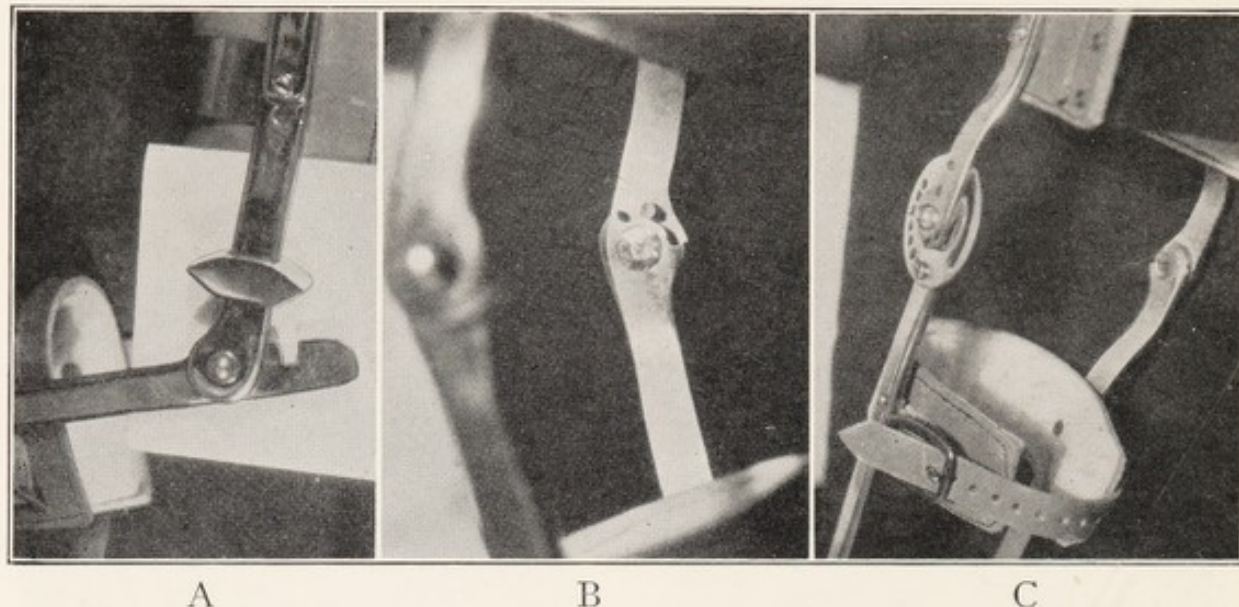


FIG. 174-A.—DETAIL OF JOINT AT KNEE, SHOWING CATCH TO LOCK KNEE IN EXTENSION.
FIG. 174-B.—DETAIL OF JOINT AT KNEE, SHOWING STOP-JOINT TO PREVENT HYPEREXTENSION.
FIG. 174-C.—DETAIL OF JOINT AT KNEE, SHOWING CONTROL DIAL TO REGULATE AMOUNT OF MOTION BY SET SCREW.

perfectly stiff until there is no likelihood of further contraction. This joint is most frequently neglected on account of the difficulty of sitting with the hip held in extension by a brace. Measurement for braces is described in Chapter II. Unless braces are intelligently constructed, they are so much weight added to an already defective member. The average commercial brace shop is devoid of any idea as to the necessary mechanical principles involved.

CHAPTER XIV

AFFECTIONS OF NERVOUS SYSTEM (*Continued*)

SPASTIC CEREBRAL PARALYSIS

(*Little's Disease*)

Spastic cerebral paralysis is an affection of the nervous system characterized by spasticity and incoördination of the muscles, due to a destructive lesion in the cortex of the brain. Depending upon the extent and location of the brain injury, it may involve one extremity, a monoplegia; both the arm and leg on one side, a hemiplegia; both legs, the arms being normal, a diplegia; or all four extremities, a quadriplegia. In the severer quadriplegias, the muscles of the face and trunk are usually also involved. The disease is quite prevalent, constituting 1 per cent of all the orthopedic cases seen in a large clinic.

Etiology.—The spasticity and loss of control of the muscles are due to disease or injury to the cortex of the brain, resulting in either a partial or complete destruction of the ganglionic cells in the motor area. With these control cells destroyed, the muscles are kept in a state of hyperexcitability or activity by the sensory impulses reaching them through the lower reflex arcs. The whole cortex of the brain may be, and often is, similarly involved, as is shown by the frequent impairment of the general mentality, which varies from normal in the mild cases to complete idiocy in the more severe types. The cases may be divided according to their cause into three groups.

1. *Prenatal, When Damage Occurs before Birth.*—Such cases are due to known inflammatory diseases, as polioencephalitis, to congenital malformations of the brain, or to primary degeneration of the motor cells, the exact nature of which is unknown. Spastic paralysis is apparently frequently associated with premature birth. It has been definitely proved that pyramidal motor tracts are not fully developed until the eighth month of fetal life; consequently, disturbance of development with loss of motor control might be expected in six- and seven-month babies. It is also possible, in fact, more probable that both the brain degeneration and the premature birth were part of and caused by the same undetermined cause.

2. *Natal or Birth Injuries.*—This group includes by far the larger percentage and is due either to intracranial hemorrhage, causing destruction of the brain cells, or direct laceration of the brain tissue. Recent investigations based on postmortem examinations and careful birth histories have

shown that intracranial hemorrhage in the newborn is much more common than has been previously thought. Slight hemorrhages occur in about 15 per cent, severe hemorrhage with cyanosis, convulsions and permanent brain injury in 2 per cent, and fatal hemorrhages in about 1 per cent of all deliveries.

Hemorrhages are caused by rupture of the cerebral vessels as the child's head is molded in its passage through the birth canal. They are, of course, more common in breech deliveries and difficult forceps extractions.

3. *Postnatal Causes.*—These are usually due to inflammatory processes or to rupture of a cerebral vessel, to trauma or disease. Hemiplegias occurring in connection with such diseases as measles, scarlet fever, diphtheria, encephalitis lethargica, and infections of the middle ear and mastoid are quite common. They usually occur in the first decade of life, when such diseases are most common. Primary vascular disease, such as arteriosclerosis associated with apoplexy in adults, is a very rare occurrence in children.

Congenital syphilis has previously been considered an important etiological factor, but neither clinical nor laboratory investigations have substantiated this theory. In a recent study of nearly two hundred cases from the records of the author and his colleague, J. S. Speed, in which blood Wassermanns were made, only 4 per cent were positive. In fifty consecutive cases, both the blood and spinal fluid were tested without encountering a single positive Wassermann.

Summarizing, it may be said that the most common cause is intracranial hemorrhage and that the majority of other cases occur in connection with the known infectious diseases of childhood.

Pathology.—Grossly, the brain shows a general atrophy, with shrinkage and sclerosis of the convolutions, or localized areas of softening and degeneration. Microscopically, the atrophied cortex shows an absence of ganglion cells and nerve fibers, which are replaced by gliosis.

Symptoms.—There is often a history of difficult labor, followed by cyanosis and convulsions. Many cases, however, give a normal birth history. The postnatal cases usually appear as a sudden paralysis involving one or both sides of the body, occurring during the course of some febrile disturbance or infectious disease. A spasticity of the affected muscles frequently develops, associated with an inability to control the movements of the extremities. The child is slow in sitting up, walking and talking. In the severer cases, the legs go into a spasmodic contracture on attempts to walk, the heels draw up, the knees flex, and the legs tend to cross, due to overaction of the thigh adductors. This is the typical "scissors gait," and may prevent standing or walking alone. In milder cases, particularly the hemiplegias, perhaps the only symptom will be a slight awkwardness in the use of the hand and a turning in of the toes, with a tendency to drag

the foot. These cases are often treated for disease of the hip and knee unless a careful examination is made. The reflexes are usually exaggerated.

There is often an impairment of mentality, the more severe cases being hopeless idiots, dribbling saliva, with expressionless faces and small, under-developed heads.

When the child is at rest or asleep, the spasticity disappears and the limbs assume their normal positions, but on any attempt at voluntary movement,

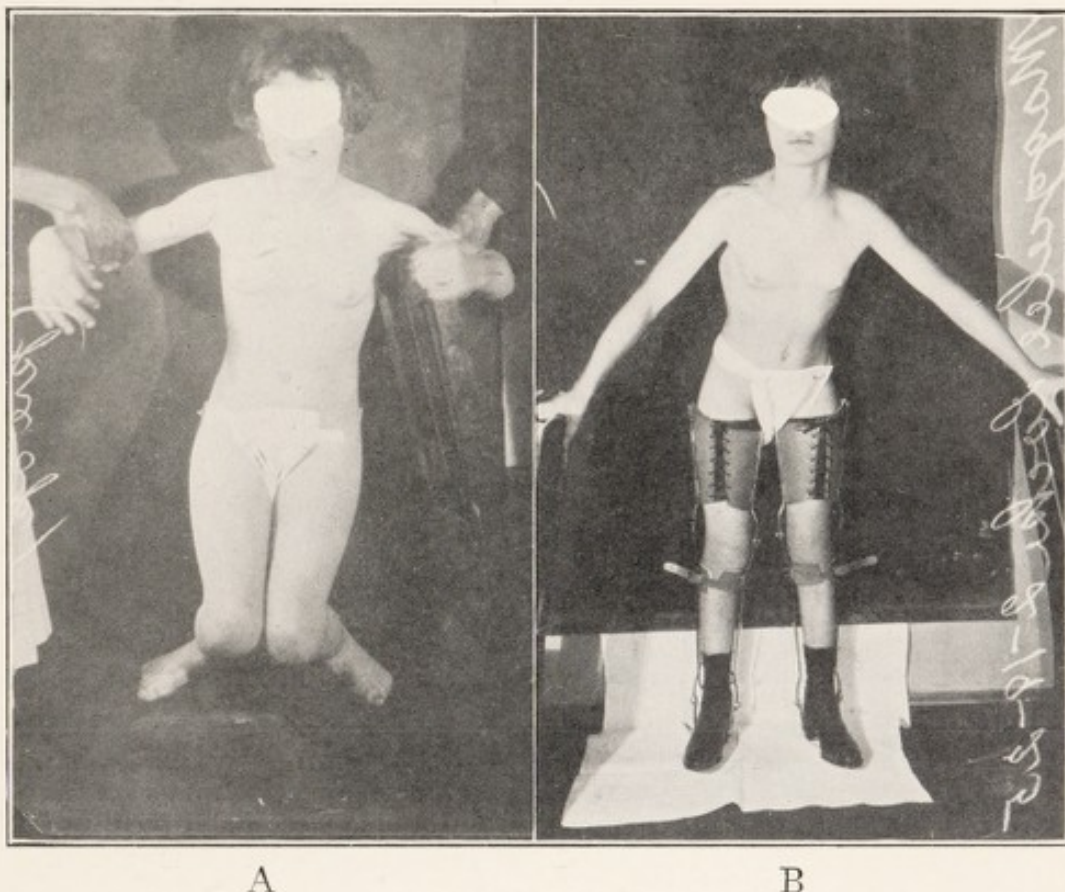


FIG. 175-A.—PHOTOGRAPH SHOWING SPASTIC PARALYSIS WITH ADDUCTION OF THIGHS, FLEXION OF KNEES AND CONTRACTURE OF TENDO ACHILLIS.

FIG. 175-B.—SAME AS FIGURE 175-A, AFTER STOFFEL OPERATION AND CORRECTION OF DEFORMITIES.

Child able to stand and walk with braces and crutches (operation by J. S. Speed).

such as walking, the spasmodic contractures reappear. In older children, fixed deformities develop, due to permanent shortening of the overactive muscle groups; the most common of these are the drawing up of the heels and flexion contractures of the knees. In cases of long standing, distortion of the bones of the foot and leg are often associated.

Differential Diagnosis.—Spastic cerebral paralysis is more often confused with anterior poliomyelitis, Mongolian idiocy, and lesions of the spinal cord, as lateral sclerosis and spina bifida.

In anterior poliomyelitis, the history of normal use of the limbs for several years, then of sudden flaccid paralysis of one or more extremities,

followed by a partial return of power in some muscle groups, with complete paralysis in others, is almost pathognomonic. The reflexes are abolished in infantile paralysis and hyperactive in spastic paralysis. The muscles are flaccid and atrophied in infantile paralysis, and rigid or spastic and well developed in spastic paralysis. The mentality is never impaired, and there is no incoördination or jerking of the extremities in infantile paralysis. Sensation is normal in both conditions. In Mongolian idiots, the facial expression is usually characteristic, the muscle tone is normal, there being no spasticity or hyperactive reflexes, and the control and use of the extremities is good.

Lateral sclerosis has much the same physical findings, but the history of a gradually progressive disease, coming on usually after the first decade, separates it from spastic paralysis, which is present at birth or appears soon afterward, and which tends to improve as the child grows older.

In spina bifida, if a meningocele is not present, the x-ray will show a defect in closure of the spinous processes of the vertebræ. Sensory disturbance is marked in spina bifida and absent in spastic paralysis.

The prognosis is good as to improvement, except in those with marked mental deficiency. Slight mental deficiency may be greatly improved by the relief of spasticity. In those with mild spasticity, normal restoration of function may often be secured.

Treatment.—The fundamental cause of the disease is a destruction of the motor ganglion cells in the cortex of the brain, and nothing can be done to correct this. However, the function of the extremities can be materially improved by correcting the spasmodic or fixed contractures which mechanically interfere with function. Certain muscle groups, such as the adductors of the thigh, the flexors of the knee and the calf muscles forming the tendo achillis, are more powerful than their antagonists. In conditions of general muscular spasticity, where voluntary control is lost, these muscle groups overcome their weaker antagonists, draw the limbs into positions of deformity and prevent walking.

Operations.—Various operative procedures have been employed to correct these deformities. The first operations consisted of myotomies and tenotomies on the overactive or contracted structures. These, by themselves, were followed by a high percentage of recurrences because the excessive nervous stimuli were not controlled. Foerster attempted to relieve this condition by sectioning the sensory nerve roots within the spinal canal as they emerged from the spinal cord. This operation has been abandoned because of the high operative mortality and the uncertainty of the results. Sharp for some time advocated decompression with the idea of relieving intracranial pressure, but, as was to be expected from a study of the true pathological condition of the brain, very little benefit was derived from the operation.

It gradually became apparent that the motor nerves offered the only logical point of attack, and in 1909, Stoffel¹ revolutionized the whole procedure by demonstrating the cable-like structure of the motor nerves. He showed that the cables to the various muscles could be identified and resected. This was a distinct advance, as it offered a direct and accurate method of cutting down the excessive motor stimuli.

An even more accurate method is to resect the desired amount of the branches to the muscles after they leave the parent trunk, just before they

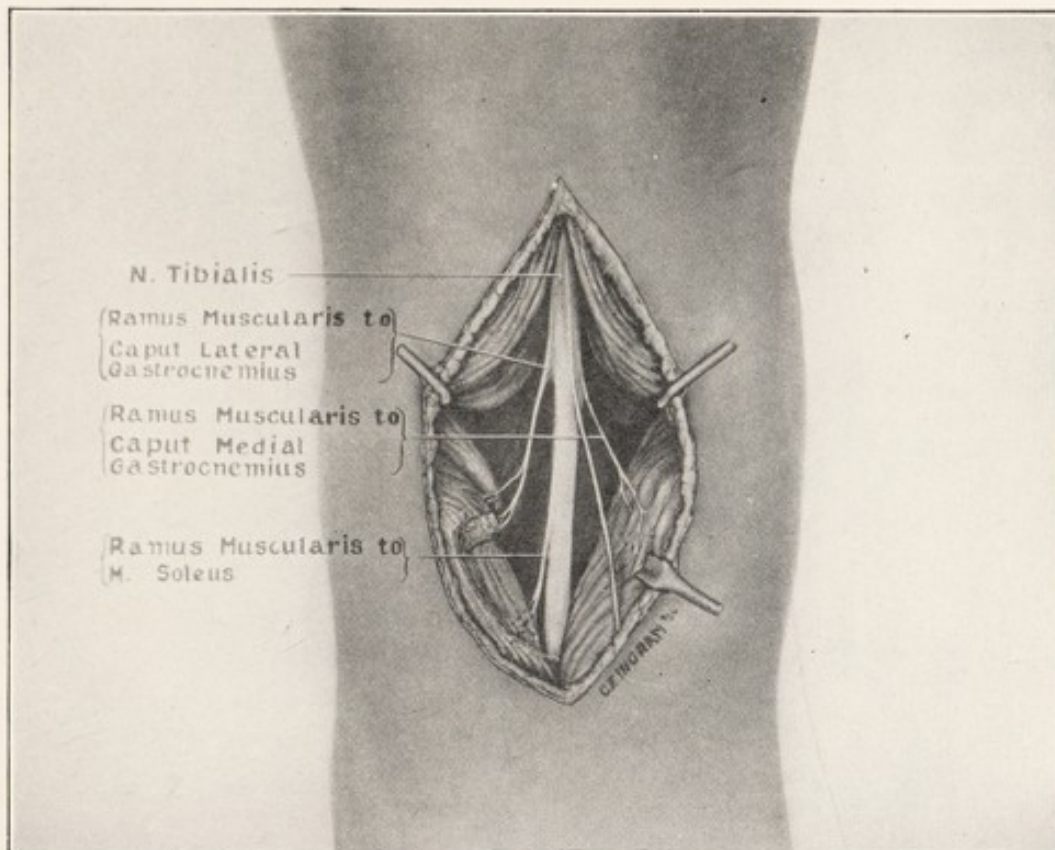


FIG. 176.—DRAWING SHOWING THE BRANCHES OF TIBIAL NERVE WHICH ARE RESECTED IN STOFFEL OPERATION TO RELIEVE SPASTIC CONTRACTURE OF FOOT.

enter the muscles. Only a portion of the motor nerve to a muscle is resected. Fortunately, practically all of the branches which it is desirable to resect are easily accessible and this procedure has been almost universally adopted.

The operation of resecting the sympathetic rami, as advocated by Royal and Hunter, while theoretically very attractive, has not proved to be reliable or of practical benefit. It has been used fairly extensively in this country with unsatisfactory results in nearly all cases.

Treatment to restore balance between the various muscle groups consists of: (1) resection of all or part of the motor nerve supply to the overactive groups; (2) muscle re-education and training, both before and after operation, to secure the best control of the muscles; (3) operations for the cor-

¹ Adolph Stoffel, "The Treatment of Spastic Contractures," *Am. J. Orthop. Surg.*, 1912-1913, 10: 611.

rection of osseous deformities and contractions of soft tissues, as described in infantile paralysis.

Surgical Treatment.—The operation of nerve resection is based on the principle that a muscle may be weakened to any desired extent by dividing all or part of its motor nerve supply, thus equalizing its strength with that of its antagonist and preventing spasmodic deformities. The operation, while technically somewhat difficult, is attended by very little surgical risk, as all of the nerves usually resected are easily accessible. The extent of nerve

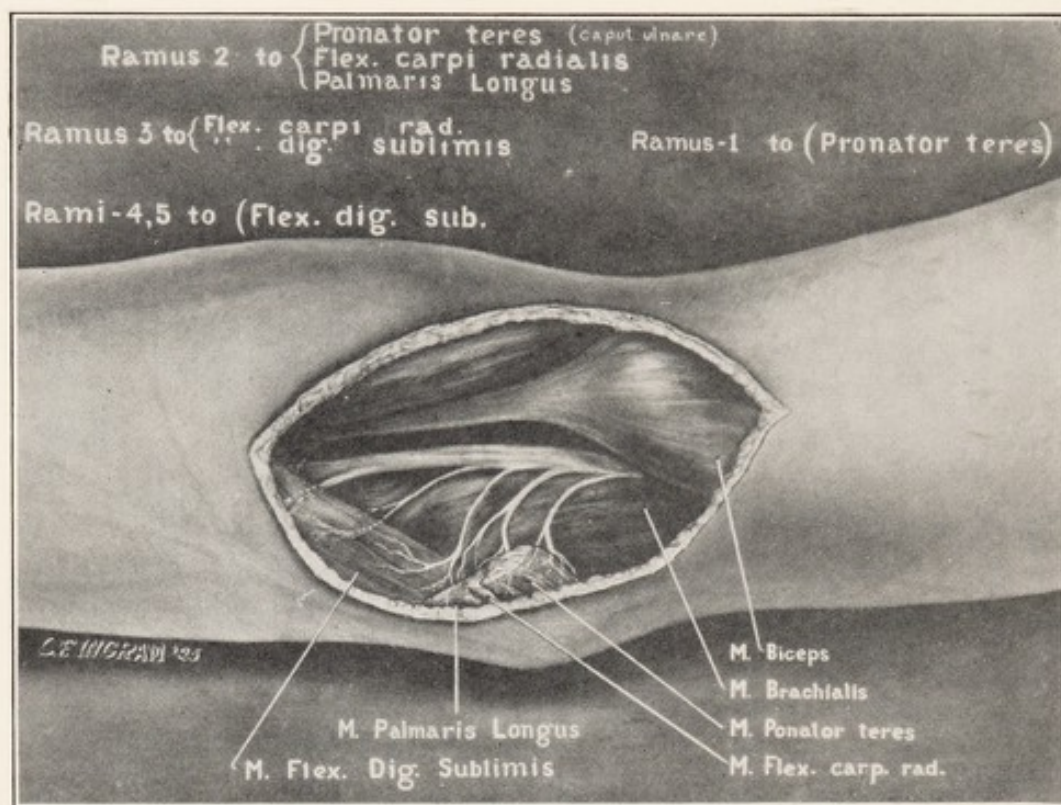


FIG. 177.—DRAWING SHOWING BRANCHES OF MEDIAN NERVE WHICH ARE RESECTED IN STOFFEL OPERATION TO RELIEVE SPASTIC CONTRACTURES OF HAND.

resection depends upon the spasticity of the muscles in each individual case. The nerves usually resected are, in the arm, the branches of the median nerve to the pronator radii teres muscle and flexor muscles of the wrist and fingers; in the leg, the branches of the obturator nerve supplying the adductor muscles of the thigh, the branches of the sciatic nerve to the hamstring muscles, and the branches of the tibial nerve to the calf muscles. The ideal age for operation is about five years, though marked improvement may be secured even in adults.

Fixed deformities must be corrected by orthopedic appliances or reconstruction operations on the bones and soft structures. Certain cases with marked impairment of mentality or extreme general muscular spasticity and incoördination are not suitable for operation.

The results in properly selected cases are very satisfactory. Many children who have never stood alone, and who moved about by crawling

on their hands and knees, are enabled to walk without support of any kind. Others who walked with the thighs crossed and the heels drawn up are restored to a much improved or almost normal gait. The results on the whole are better in the legs than in the arms, as the legs are less complicated and require less coördination.

Muscle Training.—Much benefit may be derived from muscle training both before and after operation. Gentle massage, followed by the constant repetition of the normal voluntary motions of the extremity are the fundamentals of this treatment. Electrical stimulation and vibration are contraindicated, as the muscles are already in a state of hyperexcitability and spasticity.

Medicinal treatment, such as the administration of certain glandular products, like pituitary and thyroid extracts, has proved of little value.

OBSTETRICAL PARALYSIS

(*Birth Paralysis*)

Obstetrical paralysis is a flaccid paralysis of the arm due to injury of the brachial plexus at birth and followed by a characteristic deformity of the extremity. Clinically, there are two groups: (1) those in whom the upper arm alone is affected, and (2) those in whom the entire arm and hand are paralyzed.

Etiology.—The injury is usually produced by tension on the brachial plexus in the course of a difficult labor. If the head and shoulders are separated during delivery, especially if the shoulder is depressed and the head bent toward the opposite side, the brachial plexus is stretched. Should the stretching force continue, the nerves are torn, hemorrhage occurs, and the injured nerves are replaced by scar tissue.

Pathology.—Paralysis may result from overstretching of the nerves, without tear. When this occurs, the paralysis is usually not permanent; or, the perineurium may be ruptured with hemorrhage into the perineural sheath. The nerve may be "frayed out" like a rope which has parted under excessive tension. The tearing practically always occurs from above downward. The fifth and sixth cervical nerves are most frequently injured. This accounts for the prevalence of the upper-arm type of paralysis. If the rupture is extensive enough to involve the seventh and eighth cervical and first dorsal nerves, the entire arm is paralyzed. Rarely, in breech presentations, the arms are carried above the head and the tear occurs in the reverse direction, from below upward. If the lower cords of the plexus are injured, the hand may be paralyzed but the muscles of the upper arm normal. The tear may occur in the nerve roots near the spinal cord, in or below the trunks of the plexus. The suprascapular nerve is almost universally injured.

Symptoms.—The symptoms depend entirely upon the location and extent of the nerve lesion. Immediately following birth, the arm lies close to the side and is inwardly rotated. The abductor muscles and the external rotators are paralyzed. Later, in untreated cases, the typical deformity in the

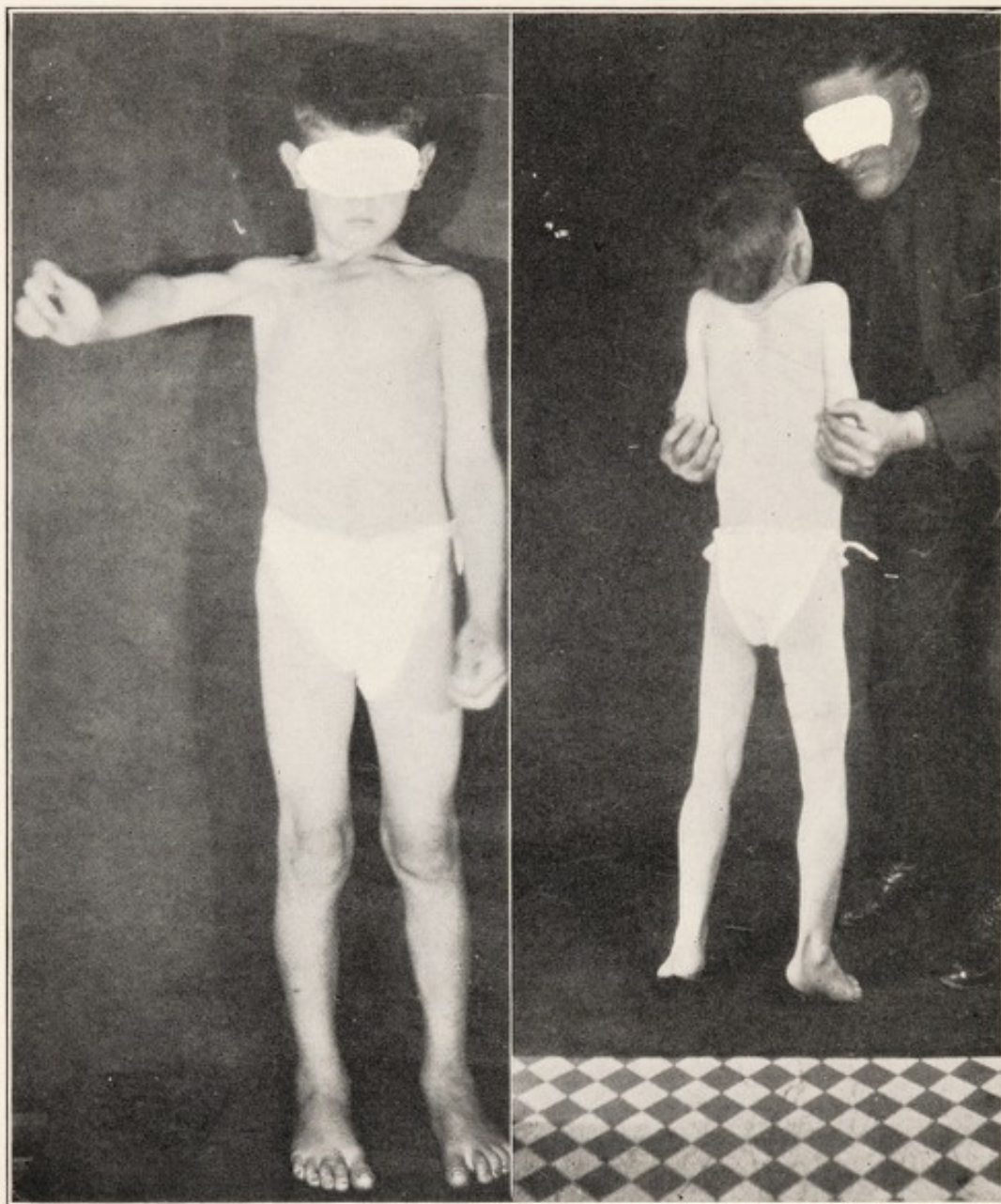


FIG. 178.—PHOTOGRAPH OF OBSTETRICAL PARALYSIS, UPPER-ARM TYPE, SHOWING LIMITED ABDUCTION AND EXTERNAL ROTATION OF ARM.

FIG. 179.—PHOTOGRAPH OF MUSCULAR DYSTROPHY, SHOWING PATIENT SLIDING THROUGH SHOULDERS.

upper-arm type results from unopposed contraction of the subscapularis, the latissimus dorsi, and the teres major muscles at the shoulders and the pronators of the forearm. The arm is held to the side and cannot be abducted. The elbow is extended, the forearm pronated, and the whole arm rotated inward. The child cannot put his hand to his mouth without raising the

elbow, nor put his hand on his head or behind his back. In paralysis of the whole-arm type, the hand is also affected. There is often an inequality of the pupils associated with the paralysis of the hand. The pupil on the affected side is smaller and the palpebral fissure is narrowed. The eye symptoms are caused by injury to the sympathetic nerves and are of value in prognosis, as they are seen only in the more severe cases. Sensory changes, of course, cannot be determined in the infant. In older children, sensation is rarely impaired. There is moderate atrophy of the arm, but not more than would be commensurate with disuse.

X-Ray Examination.—The x-ray shows lack of development of the bones of the arm. The scapula is elevated and the head of the humerus may be subluxated backward. The acromion process is bent downward more than normal.

Diagnosis.—The diagnosis should be made immediately after birth, and if the paralysis is noticed at this time, the diagnosis should be obvious; later, the differentiation may be more difficult. Obstetrical paralysis is differentiated from spastic paralysis by the weakness of the affected muscles and the diminished or normal reflexes. Anterior poliomyelitis may closely resemble obstetrical paralysis, but the history of an acute onset in a previously healthy child and the association of paralysis elsewhere in the body are usually sufficient to differentiate the two.

Prognosis.—The prognosis is good if the paralysis has been caused simply by overstretching of the nerves. The prognosis becomes unfavorable in proportion to the extent of the initial lesion. The decision as to the extent of the injury, however, cannot always be made immediately after birth. The prognosis is better in the upper-arm type than in the lower-arm type. As mentioned previously, inequality of the pupils is an especially unfavorable sign. Finally, the prognosis is better when the treatment is instituted early than after contractures have been allowed to develop.

Treatment.—The early treatment consists of rest of the part for three or four months with the limb in the most favorable position to prevent contractures of the muscles and ligaments. This position is abduction to 90 degrees with full outward rotation and extension, and is maintained by a simple splint to the body and arm. Massage and passive stretching of the paralyzed muscles are of value. So soon as the child is old enough, active exercises should be carried out.

The operative treatment consists in: (1) exploration of the plexus with suture of the injured nerves, and (2) operation to relieve contracture deformities.

Exploratory operations on the plexus are best deferred until the child is about one year of age. Little benefit can be expected from the operation, which, as a rule, is indicated only in the severe whole-arm type.

Sever² has devised an operation to correct the adduction and inward rotation of the arm by dividing the tendons of the pectoralis major and subscapularis muscles. This procedure is followed by immobilization in the corrected position and by active and passive exercises and massage.

PROGRESSIVE MUSCULAR ATROPHY

Progressive muscular atrophy is a disease characterized by degeneration of the motor nerve tracts, usually involving both upper and lower segments, but occasionally confined to one, most frequently the lower. Atrophy and wasting of the muscles are associated with and result from the nerve lesion.

Etiology.—The cause of the disease is unknown. It must still be classed in that group of so-called primary neurological degenerations in which the primary cause is undetermined. Hereditary influences apparently have little to do with the condition, although several cases have been reported in the same family.

Pathology.—The pathological process consists of a gradual degeneration of the motor ganglion cells in the anterior horns of the spinal cord and even in the cortex of the brain. The neurons composing the motor tracts, particularly the pyramidal tract, atrophy and are replaced by gliosis.

In the muscles, there is the typical atrophy and degeneration which accompanies any loss of motor nerve supply. Contrasted with gross lesions of the pyramidal tracts when there is immediate complete paralysis of all the muscles below the lesions, progressive muscular atrophy develops insidiously, involving first one group of muscles and then another. It most often begins in the small muscles of the hand, the muscles of the ball of the thumb, the interossei and lumbricales being first involved. Hollow depressions between the metacarpals are characteristic of the early stage of the disease. Rheumatoid pains and muscular twitching may precede the atrophy.

Symptoms and Clinical Course.—The muscles of the forearm, shoulder and trunk may next be affected; the lower extremities and face are attacked late. In the severer forms, the atrophy progresses until practically all the muscles of the body have disappeared and the patient is truly nothing but skin and bones. The living skeletons seen in side shows are usually victims of this disease. The patient gradually becomes bed-ridden, various deformities and contractures develop, depending upon which groups of muscles are most involved. Remissions may occur in which the patient will go for years without further progress of the disease, and a few cases have been reported in which the process was apparently permanently arrested.

² J. W. Sever, *A Text Book of Orthopedic Surgery*, The Macmillan Co., New York, 1925.

Fibrillary twitching of the muscles is a common symptom. Sensation is not impaired. Muscular weakness is slight at first but becomes extreme in the later stages, being in ratio to the atrophy. When the upper motor neurons are chiefly involved, there may be spasticity of the affected muscles.

Diagnosis.—Progressive muscular atrophy is a disease of adult life, usually coming on after the thirtieth year, without hereditary or other known cause. It occurs very rarely in children. It is characterized by a gradual muscular wasting, usually beginning in the hands and extending to the rest of the body. Fibrillary twitchings are common; there is no sensory disturbance, and the reflexes are increased.

Differential Diagnosis.—In the muscular dystrophies, the onset is usually in childhood. The majority of muscular atrophies originating before the twentieth year belong to the dystrophy group. Muscular hypertrophy, so common in the dystrophies, is never present in progressive muscular atrophy. Heredity is a marked factor in the dystrophies, and no signs of nerve degeneration can be found. In the terminal stages, the appearance of the two conditions may be much the same, but a careful history should easily distinguish them.

In anterior poliomyelitis, or infantile paralysis, there is a history of sudden acute onset of the paralysis, practically always in early childhood, with a gradual return of power in certain muscle groups. The reflexes are abolished and the muscles have lost their excitability. This is exactly the opposite from progressive central muscular atrophy.

The sensory changes in syringomyelia, when present, easily distinguish it, but when absent, the two conditions are very similar.

The various forms of neuritis usually involve only one side of the body or the muscles supplied by the same peripheral nerve on the two sides, such as wrist-drop in lead poisoning. Pain is also a more constant symptom in neuritis.

Treatment.—No treatment is of any permanent value in the majority of cases and the disease progresses to a fatal termination. Much can be done, however, to prevent deformities and to prolong the patient's ability to walk and to use the hands, by daily massage and the proper splinting of the legs to prevent contractures of the knees and feet. Splints may be worn only at night, allowing free use of the extremities during the day. If deformity has already occurred, the advisability of correction by operative or mechanical means should depend upon the rapidity of the process and the extent to which it has progressed. If the disease is arrested or progressing very slowly, any reasonable procedure is justifiable to prolong usefulness.

Medicinal treatment has little, if any, effect; mercury and iodids, or arsenic, in the form of Fowler's solution, may be tried.

MUSCULAR DYSTROPHY

Muscular dystrophy is a disease characterized by muscular wasting, either with or without a preceding hypertrophy, usually progressive in character, and due to degenerative changes in the muscles themselves, not secondary to known neurological disease. Pseudohypertrophic muscular paralysis is frequently discussed as a clinical entity, but in reality is a phase of muscular dystrophy.

Etiology.—No definite cause has been found. Heredity is an important element, the disease usually showing direct familial transmission, occurring in several generations in succession or in several members of the same family. However, 44 per cent of the cases reported in Erb's series occurred in individuals whose families show no record of the disease. Males are more often affected than females.

Pathology.—There is apparently an initial hypertrophy of the individual muscle fibers, soon followed by degenerative changes consisting of the loss of nuclei and deposition of fat and fibrous tissue, which gradually replaces the muscle fibers. During this stage, the muscles appear larger than normal, but are much weaker than muscles of normal size. Hypertrophic and degenerative changes are often found at the same time in different fibers of the same muscle. Atrophy of the fat and fibrous tissue next takes place and the muscles waste to below normal size. In some muscles, atrophy is the primary change, there being no initial hypertrophy.

Clinical Forms.—Although there is no sharp division between the various types, for convenience of clinical description, Erb has divided the cases into two groups: (1) those which occur in childhood; (2) those which occur in youth and early adult life. The first group is further subdivided into (*a*) hypertrophic type with pseudohypertrophy and with real hypertrophy; (*b*) atrophic type, with involvement of the face and without involvement of the face. The second group includes those cases occurring in young adults and the rare cases beginning after the age of twenty-five.

Symptoms and Clinical Course.—The symptoms usually appear in childhood, before the age of puberty. A clumsiness in walking, accompanied at times by an enlargement of the calf muscles, is first noticed. A careful examination will often reveal hypertrophy of the thigh and gluteal muscles, and of the deltoid and triceps about the shoulder. Sooner or later there is marked atrophy and wasting of the latissimus dorsi and pectoral muscles. This causes one of Erb's diagnostic signs: when the child is lifted with the hands under the arms, the shoulders are raised to the level of the ears and the patient appears to be sliding through the shoulders. In standing, the legs are apart, the shoulders thrown back, the spine curved forward and the abdomen protrudes. The gait is waddling and awkward.

On attempting to get up from the floor, the patient will "climb up his legs," first putting the hands on the feet, then on the knees, thighs and pelvis, and thus raise the trunk. The muscular weakness is often in marked contrast to the powerful appearance of the muscles. There are no sensory changes, and the neurological examination shows no abnormality.

The clinical course is usually slow, but steadily progressive; the wasting of one group of muscles follows another, either with or without previous hypertrophy. The patient gradually becomes so weak he cannot stand or sit alone. The previously enlarged muscle groups gradually shrink until they are completely atrophied.

Diagnosis.—The typical cases with enlarged calves, thighs and shoulders, weakness in marked contrast to the apparently overdeveloped muscles, and the loose shoulders and awkward, waddling gait, give a clinical picture in which the diagnosis is evident. A history of the disease beginning in childhood, with similar cases in the same or previous generations, can often be obtained.

During the later stages of the disease, when all the muscles are atrophied, or in the atypical cases, when atrophy of certain groups is the primary symptom, the diagnosis is often very difficult. In fact, it is believed that the muscular dystrophies, the progressive central muscular atrophies and the progressive neural muscular atrophies may be closely related.

Differential Diagnosis.—1. In atrophies due to cerebral lesions, the paralysis precedes the atrophy and there is no hypertrophic stage.

2. In the atrophies due to peripheral neuritis, the distribution usually corresponds to that of one or more peripheral nerves; in multiple neuritis, the paralysis is out of proportion to the atrophy and the history of onset is different.

3. In progressive central muscular atrophy, the disease usually begins in the small muscles of the hands, which are rarely, if ever, affected in the dystrophies. The central atrophies come on late in life and show little hereditary influence. Neurological changes, such as increased reflexes, spasticity and fibrillary twitchings in the muscles, are absent in the dystrophies.

Prognosis.—The final outlook is usually unfavorable, although, in some cases, the progress is remarkably slow. Stationary periods may occur and the patient go well into adult life before the muscular weakness seriously affects his activities.

Treatment.—No known treatment has any effect on the outcome of the disease. The progress may be delayed and the function of the muscles prolonged by massage and electrical stimulation. Contractures, particularly of the achillis tendon and the knee flexors, which occur late in the disease, may be prevented by splints which hold the feet at right angle and the knees extended.

HEREDITARY ATAXIA

(*Friedreich's Ataxia*)

Hereditary ataxia is a peculiar type of ataxia of distinct hereditary or familial occurrence. Several children in the same family may be affected. The onset is in childhood, about 90 per cent occurring before the fifteenth year and most of them before the tenth.

The disease is due to an extensive sclerosis or degeneration of the nerve fibers in both the sensory and motor tracts of the spinal cord, the dorsal and lateral tracts.

Symptoms.—The symptoms begin in the legs, but the ataxia differs from the ordinary types, as locomotor ataxia, in that the gait is swaying and irregular, like that of a drunken man, and there is not the characteristic "stamping" of a true tabes. Ataxia of the arms and hands is an early symptom and the athetoid movements are much like those in chorea. The hand will sway over an object for a moment and then pounce upon it. Choreiform movements of the face and head occur. Nystagmus, with constant twitching of the eyes from side to side, is a constant and characteristic symptom. Speech disturbance is also common, the patient talking in a slow, scanning manner. The expression of the face is dull, although the mentality is usually good. Deformities of the feet frequently develop, usually an equinovarus or club-foot type.

Sensory disturbances are absent. The deep reflexes are abolished early, this being one of the most constant and characteristic symptoms, and one which helps to differentiate this disease from chorea or spastic cerebral paralysis. The pupillary reflex to light is practically never affected, which helps to distinguish it from locomotor ataxia.

Diagnosis.—Four cardinal diagnostic points, which are practically always present, make the disease unmistakable: (1) a peculiar, incoördinated ataxia, involving the arms and legs, beginning in childhood, and often affecting several members of the same family; (2) nystagmus; (3) a slow, scanning speech; (4) loss of the deep tendon reflexes and the retention of the pupillary reflex to light.

Treatment.—The affection lasts for many years and is incurable. The equinovarus deformity of the feet can be corrected and its recurrence prevented by a stabilization operation and lengthening of the achillis tendon, followed by the use of braces, as in club-foot.

INJURIES TO THE PERIPHERAL NERVES

Injuries to the peripheral nerves in children are comparatively rare and usually occur as complications of some other injury. They occur most frequently with the following conditions:

1. **Fractures.**—Certain peripheral nerves lie in close proximity to the adjacent bony parts; injury to the bone also traumatizes or ruptures the nerve. Usually there is enough mobility to the nerve to allow it to slide aside and escape injury. In locations where the nerves are bound firmly to the bone, as the radial nerve in the musculospiral groove of the humerus, the ulnar nerve over the internal condyle of the humerus, and the anterior peroneal around the upper end of the fibula, they are frequently injured. Occasionally, when the nerve has escaped injury at the time of the fracture, it may later become compressed by the formation of callus or scar tissue. This may produce a painful neuritis, termed *causalgia*, or may result in partial or complete paralysis below the lesion.

2. **Injuries to the Soft Parts.**—Any of the peripheral nerves may be partially or completely severed in connection with cuts, lacerations or gunshot wounds of the soft parts. The most common sites are the nerves of the extremities, although the brachial or lumbar plexuses may occasionally be injured.

3. **Excessive Swelling or Constriction of an Extremity.**—This usually occurs in parts that have been immobilized in a splint or cast, or around which there is a tight circular bandage.

4. **Trauma or Excessive Stretching.**—The nerve trunks may be crushed by direct trauma or ruptured by extreme tension upon them. Obstetrical paralysis, due to rupture of certain parts of the brachial plexus through excessive traction during childbirth, is an example of this type. Similar injuries may be caused by the arm being caught in a revolving belt or wheel, or by heavy objects falling across the shoulder.

Types of Nerve Injuries.—The types of nerve injuries are: (1) single trauma with edema; (2) hematoma within a nerve sheath; (3) compression by scar or callus; (4) partial severance; (5) complete severance; (6) tumors involving the peripheral nerves (extremely rare in children); (7) toxic or inflammatory neuritis (seen in lead poisoning, diphtheria, etc.).

Diagnosis.—As a general rule, the symptoms of nerve injury are so well marked and so definite that no difficulty is experienced in determining its presence. However, many nerve injuries go unnoticed because of the fact that all attention is centered on the primary injury. The observance of a few simple rules when the patient is first examined may save much embarrassment later.

1. In all fractures of the humerus involving the middle and lower thirds, or in lacerated wounds over this area, it should be carefully determined whether or not the patient can extend the wrist and fingers. Inability to do this means an injury to the musculospiral nerve.

2. In extensive fractures about the elbow, particularly those around the internal condyle, the sensation of the little and ring fingers should be tested. Numbness indicates an injury to the ulnar nerve.

3. In all cuts across the flexor surface of the wrist, the sensation over both the ulnar and radial sides of the hand and fingers should be noted. Roughly, the median nerve supplies sensation to the radial or thumb side, and the ulnar to the little finger side of the hand. All of the small muscles of the hand are supplied by these two nerves through branches which are given off below the wrist. If the patient can fully separate and approximate the fingers and can accurately touch the tips of the four fingers to that of the thumb, there is, in all probability, no motor nerve injury. Fractures about the wrist rarely cause nerve injury.

4. In fractures of the upper end of the tibia and fibula, particularly when associated with crushing or twisting of the knee, the patient should be requested to dorsiflex his foot. If this is impossible, the muscles on the anterior and outer side of the leg supplied by the common peroneal nerve are paralyzed.

Symptoms.—The symptoms upon which the diagnosis of nerve injury may be made are as follows:

1. Motor paralysis: loss of motion in the muscles supplied by the nerve below the lesion.

2. Sensory paralysis: Sensation consists of a number of different sensibilities, any one or all of which may be lost. Usually, in sensory paralysis due to lesions of the peripheral nerves, all types of feeling are lost or impaired, depending upon the location and completeness of the injury. The important sensations to be tested for are subjective sensations—how the part feels to the patient, including pain, numbness and tingling. Touch is best tested for by passing a bit of cotton or soft cloth over the skin. Hard pressure will give deep joint and muscle sensations and confuse the picture. Pain is tested for by pricking with a sharp-pointed instrument, and compared in intensity with the opposite side. Temperature sense is the ability to distinguish the difference between hot and cold; small glass tubes of hot and cold water are a convenient means of making this test. Joint sense is tested for by passively moving the joint while the patient has his eyes closed. This is a deep sensation in tendons and muscles, and usually retained unless all the peripheral nerves are involved or the lesion is in the spinal cord. When the position of part of the extremity is moved, the patient should be able to appreciate the new position.

3. Trophic changes: When the nerve supply has been lost, there is a disturbance of both the circulation and nutrition of the affected part. This is evidenced by a slight cyanosis and coldness; by excessive perspiration; by a glossy and tight appearance of the skin. Small blisters frequently form, which may exfoliate, leaving ulcers which are very difficult to heal.

4. Contractures: Due to the disturbance of nutrition and to the loss of function, the muscles undergo atrophy, contracture of the tendons develops, the bones become atrophic, and the joints become stiffened. In the

hand, this results in the typical "claw-hand," with the metacarpophalangeal joints hyperextended, the fingers flexed, and the thumb drawn against the palm.

Treatment.—1. *Conservative.*—Many nerve lesions are only temporary in their effects and recover spontaneously, if given the opportunity. It is often difficult or impossible to tell whether a nerve has been divided or simply bruised. For this reason, unless it is obvious that the nerve has been severed, conservative treatment should be given a thorough trial before operation is advised. Simple contusions, hematomata, partial severance, and the toxic or inflammatory types should be treated conservatively. When there is doubt as to the extent of the lesion, similar treatment should be tried for three or four months and, if, at the end of this time there is no return of sensation or muscle reaction, exploration should be advised.

During the period of conservative treatment, proper splints should be employed to prevent overstretching of the paralyzed muscles by their active antagonists, or by the force of gravity. The hand should be in dorsiflexion on a cock-up splint, with the metacarpophalangeal joints flexed. The knee should be held in extension and the foot at a right angle by night and walking braces by day.

Physiotherapy in the form of massage, electrical stimulation of the paralyzed muscles, and active and passive motion should be employed.

2. *Operative.*—When the symptoms of extreme pain or gradually increasing motor and sensory paralysis make it certain that a nerve is being compressed by scar tissue or callus, freeing of the nerve by open operation offers the only hope of relief. The nerve should be freed at the point of pressure and for a good distance both above and below, in order that it may be transplanted into a new bed of healthy soft tissue. If the nerve has not been badly damaged, there is usually prompt relief of pain and early return of function. When the scar tissue has invaded the nerve trunk, causalgia may persist indefinitely.

Complete Nerve Severance.—When a nerve is seen to be divided in a recent open wound, suture should be performed at once, even though infection is anticipated. Suture prevents retraction of the nerve ends and troublesome shortening, which make later operations so difficult. Primary union or healing, with only slight infection, may occur, and the nerve is then in the most favorable condition for regeneration. When a nerve is severed, all the fibers of the distal segment undergo degeneration and never resume their function; they act only as a scaffold along which the axis cylinders from the proximal segment may grow. All regeneration then comes through an outgrowth of fibers from above, and anything which hinders this delays or prevents regeneration. Separation of the divided ends, interposition of scar tissue, and the formation of neuromata on the proximal fragment are the usual obstacles.

After three or four months of conservative treatment, if there has been no return of motion or sensation, it is reasonable to assume that the nerve has either been completely divided or that so much scar tissue has formed that regeneration is not possible. Exploration should then be done and the

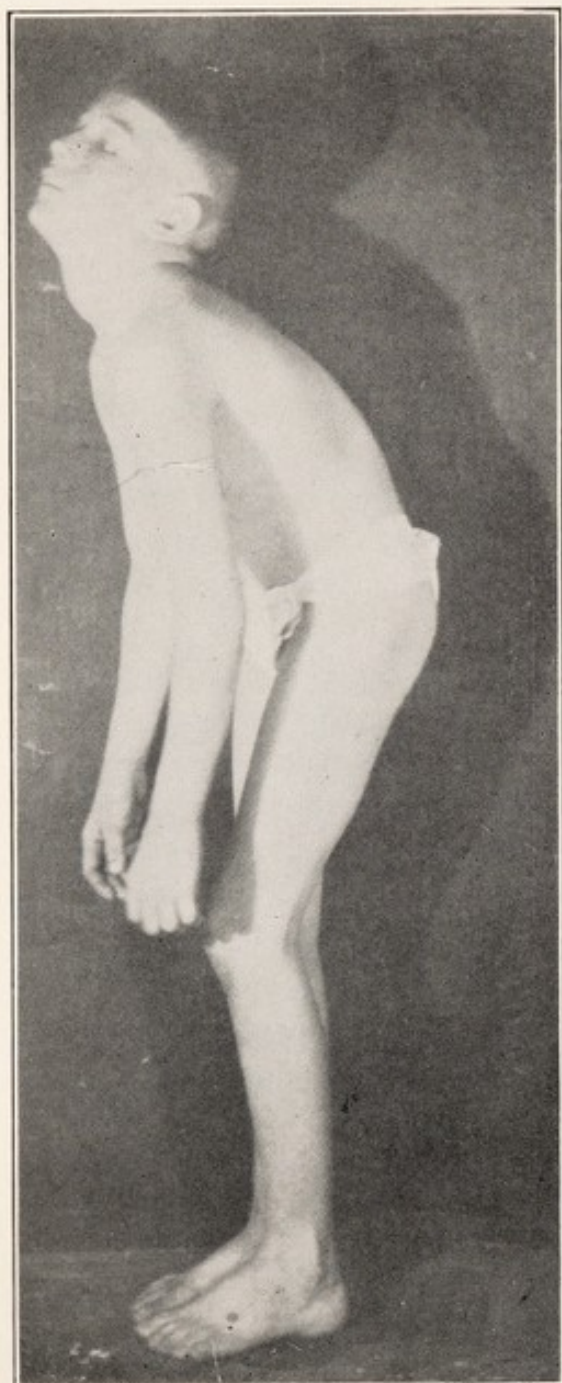


FIG. 180.—PHOTOGRAPH OF HYSTERICAL PARALYSIS.

nerve sutured together, care being taken to remove all neuromata and scar tissue from the nerve ends. Reformation after nerve suture is very slow, at least six months being required. Many cases do not show definite return of motion for over a year, but there is often an improvement in the nutrition and sensation of the part before this time. Successful results in nerve sutures vary somewhat with the nerve involved, but on the average, about 60 per cent are satisfactory. Some very remarkable recoveries are obtained, complete function being restored. The percentage of good results is sufficiently high to justify the operation in all cases. The longer the period between injury and suture, the less favorable is the prognosis. Return of function is rarely observed in cases of complete nerve severance existing for two years. Physiotherapy should, of course, be combined with the operative treatment.

HYSTERICAL PARALYSIS

Hysterical paralysis is a rare affection, usually seen in girls about the age of puberty. The paralysis occurs suddenly, especially after some emotional shock, and may persist for variable periods of time, from a few

hours to many weeks or months. The spine, the upper or lower extremities may be affected. The symptoms are characteristic in that the lesion always involves a functional group of muscles, without regard for anatomic structure. The paralysis may be spastic or flaccid in type, but usually differs from organic

lesions in certain important details, as abnormal posture of the part, loss of reflexes, presence of abnormal reflexes, etc. Hysterical anesthesia is usually of the stocking or glove type.

The diagnosis may at times be difficult, but with close observation the physician will usually find some detail which will not fit into the picture of a genuine organic affection. The advance of the affection in response to suggestion by the physician is a valuable diagnostic point.

The treatment is entirely suggestive, and the paralysis may disappear as rapidly as it came.

CHAPTER XV

STATIC DEFORMITIES

Static deformities are those which are induced by improper distribution of the weight of the body on its bony framework. As the bones of the spine and the lower extremities are the only portions of the human skeleton concerned with weight-bearing, static deformities naturally occur only in these regions. They comprise the largest group of cases with which the orthopedic surgeon has to deal. Many static affections begin in childhood, but are not noticed until adolescence, or may cause no symptoms before early adult life. However, if they are discovered early and properly treated, correction may often be obtained and much disability prevented in later life. The body weight of the young child is light and occupation plays an insignificant rôle. But as the weight increases and occupations are assumed which require prolonged sitting or standing in faulty attitudes, any static deformity may become exaggerated.

The static deformities which are commonly seen in children are weak and pronated feet, knock-knee, bow-leg, scoliosis, round shoulders and hollow-back. Such conditions as metatarsalgia, hallux valgus, hallux varus, hammer-toe, and claw-toe are seldom seen in childhood as a result of static conditions, but may occur following paralysis or scar contracture of the soft tissues.

DEFORMITIES OF THE FEET

Structure and Function of the Normal Foot.—The normal foot is described as having two arches—a transverse and a longitudinal. The transverse arch is said to be formed by the inferior surfaces of the heads of the metatarsal bones. In reality, however, there is no transverse arch during weight-bearing, as is quite apparent from an examination of the ball of the normal foot. The longitudinal arch is divided into a lateral and a medial portion; the lateral consists of the os calcis, the cuboid and the lateral two metatarsal bones; the medial is formed by the astragalus, the scaphoid, the three cuneiform bones and the medial three metatarsal bones. When the normal child stands, the entire plantar surface of the heel, the outer border of the sole and the plantar surface under the heads of all the metatarsal bones and toes should be in contact with the floor. The inner two-thirds of the sole of the foot is slightly elevated from the floor, the highest part of the arch being at the scaphoid bone. The medial border

of the foot is also slightly concave, so that when the feet are placed together, there is an interval between them opposite the scaphoid bones.

The weight should be evenly distributed on the two feet and the line of weight-bearing should pass through the crest of the tibia, the center of the astragalus and into the foot in line with the second toe. The movements of the foot, as described in Chapter I, are flexion, extension, abduction, adduction, eversion and inversion.

The Weak Foot (Pes planus, Flat-Foot).—Deformity.—When the foot gives way beneath the superincumbent weight, the typical deformity is an outward displacement of the foot upon the leg. The line of weight-bearing now falls medial to the line through the second toe, and in severe cases, even medial to the inner border of the foot. The foot is abducted and everted. The inner portion of the longitudinal arch is forced downward. The medial border of the foot becomes convex, instead of concave. The foot rolls inward and downward, the fore-foot is abducted and the internal malleolus stands out prominently. A rotation of the leg inward on the foot also takes place. This results in stretching of the internal lateral ligaments of the foot and ankle, and a contraction of the tendo achillis and the structures on the outer side of the foot, so that adduction and inversion may be impossible.

Symptoms.—The symptoms, as a rule, in the young child, are mild. The parents will usually say that the child is awkward or clumsy, or that he runs his shoes over on the inner side. There is rarely any pain. In older children, when the body weight is greater and the activities of the child are increasing, pain is more often complained of, and in some cases, may be disabling. The pain is usually located on the inner side of the foot and ankle.

Examination.—The examination should consist of a careful inspection of the foot in walking and standing, noting the distribution of the weight, the general contour of the feet, and the condition of the arches. Active and passive movements are tested in flexion, extension, abduction, adduction, eversion and inversion. Special note should be made of limited motion in adduction and inversion. Muscle power should be tested to differentiate



FIG. 181.—PHOTOGRAPH OF WEAK OR FLAT-FOOT, SHOWING DEPRESSION OF LONGITUDINAL ARCH.

from a paralytic condition. Points of tenderness may be located about the astragaloscaphoid joint, the internal malleolus, under the os calcis, or in the sole of the foot. The examination of shoes that have been worn for some time is of value in demonstrating the tendency to run over the heels and counters to the inner side.

Diagnosis.—The diagnosis is made by the symptoms and examination. As the foot is the most dependent part of the body, circulation is slower than in other portions of the body. The foot is frequently the seat of various infections, such as acute infectious arthritis and low-grade arthritis, and is also most frequently involved in paralytic conditions. Therefore, pain in the foot may be due to other causes than flat-foot, even though flat-foot is present. This must be constantly borne in mind in any routine examination of the feet. In adults, infectious arthritis is far more frequently the cause of pain than static deformities, whereas in children the reverse is true.

The x-ray examination is usually negative, but in some cases it may show associated arthritic changes.

Treatment.—The treatment of weak feet may be divided into: (1) treatment by exercises and physiotherapy, (2) treatment by supports, including proper shoes, and (3) operative treatment; or a combination of all three may be necessary in order to restore the affected foot to normal. In every case, however, the extent of permanent function regained depends entirely upon muscular development, which can only be accomplished by continuous exercises of the feet, faithfully carried out over a long period of time. Exercise, physiotherapy, etc., must be carried out indefinitely.

1. Exercises and Physiotherapy.—Exercises may be taken either with or without weight-bearing. In the more severe types of pronated feet, it is wise to begin with the exercises without weight-bearing and to gradually work up to those performed with weight-bearing. The exercises without weight-bearing are for the toes, such as flexion and extension, and for the foot, as follows: the foot is first strongly plantar flexed, the forefoot is then adducted and inverted and, finally, dorsiflexed. In the exercises with weight-bearing, the patient stands with the feet together. At the count of one, he rises on the toes; at two, he adducts and inverts the foot; at three, he resumes position two; and at four, he goes back to the starting position. Exercises should be carried out at home twice a day, but will not be persisted in unless under the direct supervision of the family physician.

Practically all patients with weak feet need to be taught how to stand and walk properly. Exercises in corrective walking should be practiced with the foot adducted and its inner border elevated. In making each step, the weight should be borne on the heel and outer border of the sole. As the opposite foot is brought forward, the weight shifts inward on the heads of the metatarsal bones and the heel is raised. The final act in each step is a propulsive force given by the great toe. Walking exercises along a

double inclined plane may be of value by compelling the foot to assume the proper inverted position.

Alternating hot and cold foot baths stimulate the circulation, and massage is of value in restoring tone to the weakened muscles.

2. Supports.—The application of a comfortable and efficient foot-strapping is one of the best methods of treatment and should be done in all except the very mild cases. The strapping also acts in the nature of a therapeutic test; if the condition is purely a static one, proper strapping will usually give immediate relief. If the strapping does not give relief, it is often found that there is some other cause of the pain, such as arthritis, and a careful search for possible foci of infection should be made.

The technic of applying a foot-strapping is as follows: The foot and leg should be shaved. The patient is instructed to hold the foot at a right angle with the leg and strongly inverted. It may be necessary to have the foot held in this position by an assistant, or the patient may help maintain it by a sling of bandage about the forepart of the foot. Zinc oxid adhesive plaster is used in two-inch width strips. The first strip begins just above the lateral malleolus, passes under the heel and up the inside of the leg as high as the level of the tibial tubercle. This is pulled tightly and held until it adheres to the skin. The first strip may be reënforced by another strip placed slightly anterior to and overlapping it. The second strip begins at the outer side of the foot, passes under the arch, up over the astragaloscapoid joint, across the dorsum of the ankle to the outer side of the leg, and spirals about the leg one complete turn, ending at the level of the tibial tubercle. A few circular strips are then placed about the leg to hold the long strips in place. This strapping should be left on for four or six days and should be renewed as often as necessary until all pain has disappeared. The period of strapping varies, of course, with the individual case.

When this point is reached, it becomes necessary to prescribe some form of permanent support. In mild cases, arch supports are applied without preliminary strapping; when pain is severe, the symptoms are first relieved

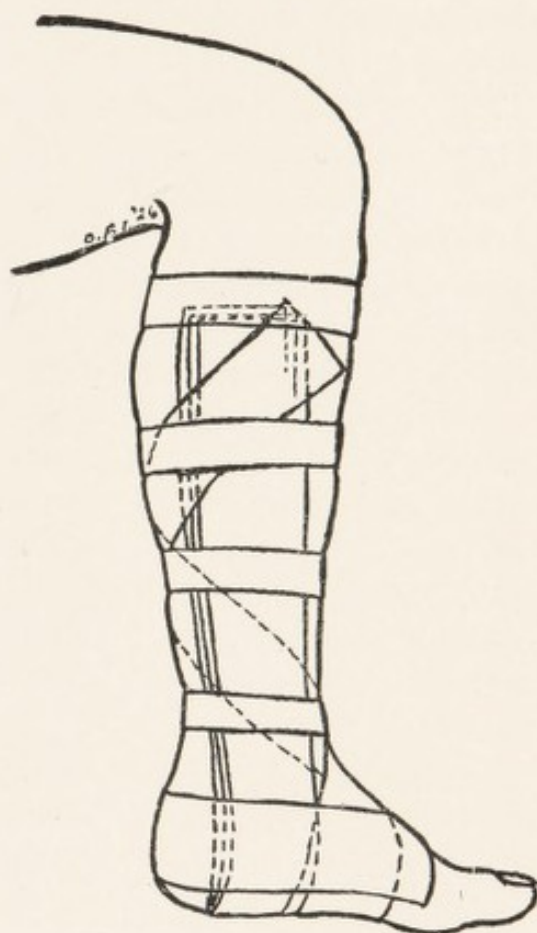


FIG. 182.—DRAWING SHOWING METHOD OF STRAPPING FOR PES PLANUS.

by strapping, and arch supports then applied. Arch supports must conform to the foot, of course, and must support, to be of any real value. They must therefore be made over a plaster-of-Paris mold of the foot. Arch supports may be made of steel, Monel metal, or alloys of various kinds. The author prefers and has for many years used a support made from leather and reënforced with cork. This type of support is resilient and permits muscle play, whereas, rigid steel supports do not. However, steel supports are often absolutely necessary where there is extensive deformity. Metal plates which embrace the heel, as devised by Roberts, are often satisfactory for young children.

The question of proper shoes is a less difficult one to solve in children than in adults, as in the former we do not have to compromise so much for style. Generally speaking, laced shoes are to be preferred. They should be sufficiently long, the inner border should be straight and the width ample to avoid crowding of the toes. Elevation of the inner border of the heel and sole one-fourth to three-eighths of an inch may be all the treatment necessary in the young child and is often advisable in older children.

3. Operations.—Various operative procedures are employed, but only the three most generally used will be discussed. Operations are indicated only in the very resistant cases and are to be advised in practically the same order named for cases of correspondingly resistant deformity: (1) manipulation of the foot under anesthesia and the application of a plaster-of-Paris cast in the inverted position; (2) section of the peroneal tendons, as advised by Sir Robert Jones, followed by manipulation and casts; (3) transplantation of the tibialis anticus muscle to the scaphoid bone; (4) arthrodesis of the astragaloscaphoid joint. In many cases when coöperation is absolutely impossible and satisfactory results from other forms of treatment cannot be obtained, we should resort more frequently to operative measures in flat-foot. No child should be permitted to suffer, and if the deformity cannot be corrected by simple measures, surgery should be employed.

Knock-knee and bow-leg are usually the combined result of rickets and static force, and have been discussed in the section on rickets (p. 182).

SCOLIOSIS

Scoliosis, or lateral curvature of the spine, is the fixed deformity of side-bending associated with rotation of the vertebræ. The normal movements of the spine have been discussed in the chapter on Orthopedic Examinations. They are flexion, extension, side-bending and rotation. The latter two are, however, always associated and occur simultaneously. There can be no rotation without a certain amount of side-bending, and, likewise, there can be no side-bending without rotation. This has been well shown by the experiments of Lovett and others. The rotatory twist in scoliosis may



FIG. 183.—CONGENITAL ANOMALY OF SPINE WITH ABSENCE OF PART OF SEVENTH AND EIGHTH DORSAL VERTEBRÆ AND THE SEVENTH AND EIGHTH RIBS ON LEFT SIDE.

be compared to that produced by grasping the ends of a malleable rod and twisting in opposite directions.

Etiology.—The etiology of scoliosis is obscure. The most generally accepted theory is that the weight of the upper part of the body, being directed obliquely on an unstable spine, causes the deviation from the midline. The spine, being made up of many segments superimposed one upon another, is freely movable in flexion, extension, side-bending and rotation, and in



FIG. 184.—PHOTOGRAPH SHOWING PARALYTIC SCOLIOSIS.

scoliosis, each segment is rotated by the twisting force. Any faulty attitude habitually assumed by the growing child will result in the weight being unevenly distributed, and this is frequently a potential factor in the etiology of scoliosis.

The predisposing factors are varied. In a group of 100 cases of scoliosis observed by the author and his colleague, Joseph I. Mitchell, 60 were of the idiopathic or static type. Nineteen followed anterior poliomyelitis, 11 had congenital anomalies of the bones of the spine, 3 followed empyema, 3 were associated with destructive process in the bodies of the vertebrae, 3 were seen in cases of spastic paralysis, and 1 followed rickets. Scoliosis may also be associated with other congenital deformities, such as torticollis and congenital elevation of the scapula.

Females are much oftener affected than males, and this is especially marked in the static type of the de-

formity. In a study of 100 cases of all types, 68 per cent were females and 32 per cent were males. But in the 60 cases of the static group, 80 per cent were females and only 20 per cent were males. The average age at which deformity was observed was twelve years. It is probable, however, that the onset is usually much earlier, as the deformity is, as a rule, well established when the physician is consulted. At this time developmental factors are active. The reproductive and entire organism of the body is changing from childhood to girlhood. Softening of the bone may also occur at this time, as well as inflammatory changes in the epiphyses of the bodies of the vertebrae (p. 114).

Scoliosis occurs in anterior poliomyelitis in about 30 per cent of old cases. It is caused by paralysis of the spinal or abdominal muscles on one or both sides, and is often associated with paralysis of one arm, or with shortening of one leg, due to trophic changes.

True scoliosis, however, does not, as a rule, follow inequality in the length of the legs. It is not uncommon to find an individual with one-half or even three-fourths inch shortening on one side, but many cases with extreme scoliosis have no inequality. Many cases with extreme inequality in length of the legs, as in infantile paralysis, where there may be 4 or 5 inches' shortening, have no fixed deformity of the spine. There is a tilting of the pelvis when the patient stands and a compensatory lateral curve of the spine, which disappears when the patient sits or lies down.

The congenital anomalies of the spine which predispose to scoliosis are an extra cervical or lumbar rib, a portion of a supernumerary vertebra, large transverse processes of the fifth lumbar vertebra, which may be sacralized, and spina bifida.

Deformity.—The scoliotic attitude is one of the normal positions of the spine. It becomes pathological only when there are changes which prevent the resumption of the normal attitude or the diametrically opposed attitude.

Given a case of scoliosis convex to the right, beginning at the upper dorsal and terminating at the lower dorsal regions, with the apex about the sixth dorsal segment, the spine is bent sideways to the left and the vertebræ are rotated to the right. The greatest amount of rotation occurs at the sixth dorsal segment, and the adjacent regions have correspondingly less rotation until the normal plane is reached. The spinous processes deviate from the midline in a curve convex to the right. They, being superficial, are the landmarks by which the surgeon detects the condition. It must be remembered, however, that the sagittal plane of the entire vertebræ is rotated to the right, and therefore the bodies are even farther displaced to the right

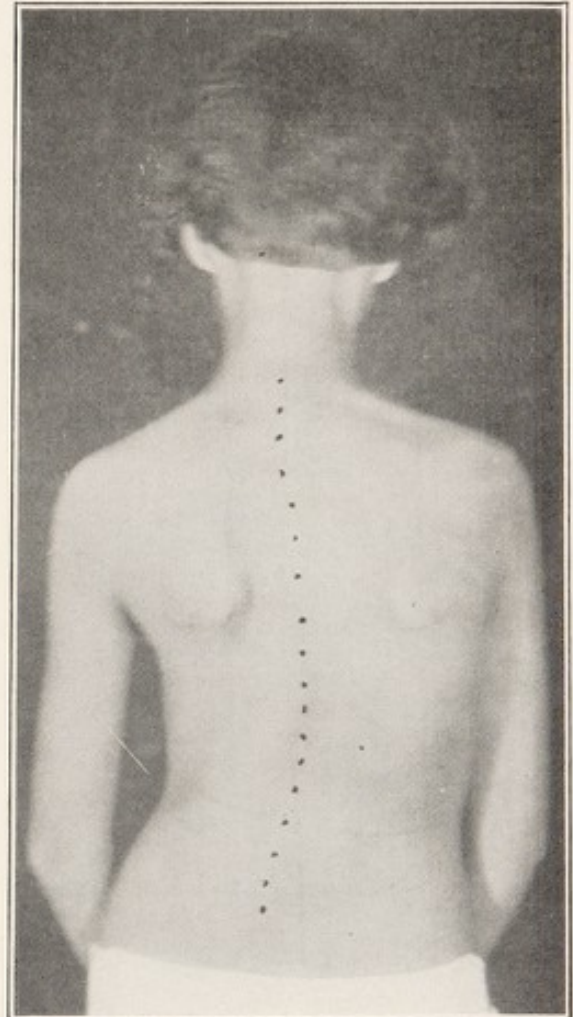


FIG. 185.—PHOTOGRAPH SHOWING SCOLIOSIS OF STATIC TYPE, RIGHT DORSAL, LEFT LUMBAR.

Note elevation of right shoulder, prominence of left hip and increased angle between left arm and body.

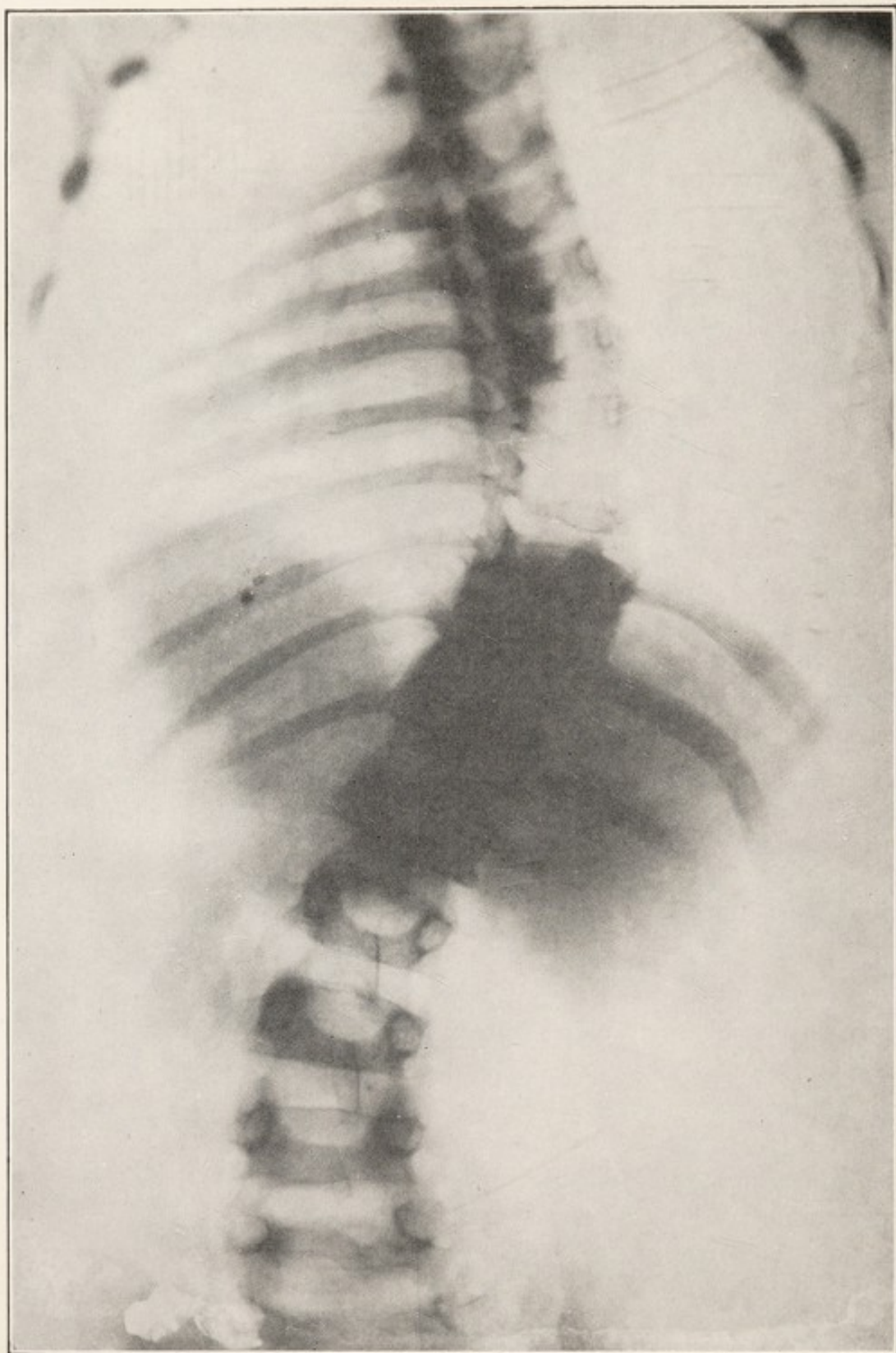


FIG. 186.—X-RAY OF SCOLIOSIS, RIGHT DORSAL, LEFT LUMBAR, SHOWING ROTATION OF BODIES OF VERTEBRÆ.

than the spinous processes. There may be compensatory curves above or below the primary curve. These are similar to the first, but are in the opposite direction. When this condition has been present for a period of time, the muscles and ligaments on the concave side of the spine become contracted and those on the convex side are stretched. This leads to degenerative changes and fibrosis of the muscles of both sides and will ultimately prevent reduction. The vertebræ themselves become distorted, in accordance with Wolff's law, and the bodies assume wedge-shaped and lozenge-shaped dimensions. The laminæ, pedicles and processes are also distorted. The intervertebral disks are compressed and atrophied. The ribs, following the rotation of the vertebræ, are distorted. The thoracic cavity is diminished in size and the viscera are compressed or displaced.

Symptoms.—The deformity is the chief symptom. It is usually first noticed during the period of adolescence and may be coincident with a time of rapid growth. A frequent complaint is that one shoulder is higher or that one hip is larger than the other. In the case of girls, this is often first noticed by the dressmaker. The children, in many instances, are less robust than their brothers and sisters; they tire easily, complain of back-ache on exertion and pain in the chest.

Examination.—The points to be noted in the routine examination of the spine have been brought out in Chapter I. The special points to be noted in a case of scoliosis are the location and degree of the lateral curves and the amount of rotation of the vertebræ. When the thoracic vertebræ are rotated, the ribs become prominent on one side posteriorly and on the opposite side anteriorly. The shoulder on the convex side is usually higher. Any tilting of the pelvis should be noted and the length of the legs should be compared. The strength of the spinal muscles should be tested. Motion of the spine in the direction opposed to the deformity is usually limited. The amount of correction obtained by voluntary effort should be noted and also the improvement by forward bending and by suspension.

A record should be made of the curvature before treatment is begun. This may be done by a tracing of the curve of a lead tape bent to correspond to the deformity. A roentgenogram of the entire spine should always be made and is probably the best record available.

X-Ray Examination.—The x-ray in the early stage shows the curvature with narrowing of one side of the intervertebral spaces. In cases of long standing, there may be marked wedging of the vertebræ and associated torsion of the pedicles, laminæ and processes. In many, the roentgenogram shows a pathological process in the bone which may resemble, to some extent, the epiphysitis of coxa vara, discussed under epiphysitis of the spine (p. 114). The purely destructive lesions, such as tuberculosis, osteomyelitis and syphilis of the spine, are readily differentiated by the x-ray from the

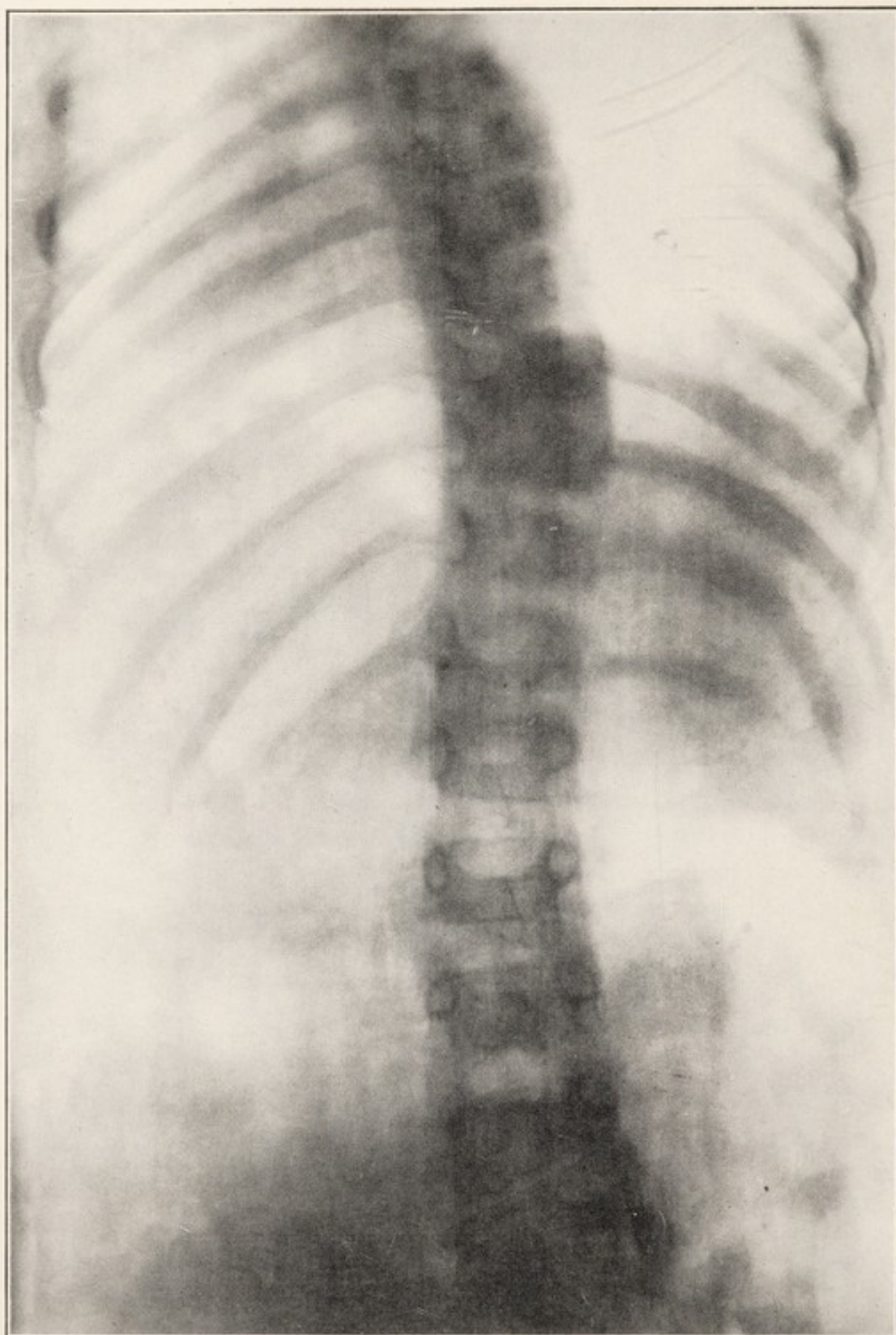


FIG. 187.—SAME AS FIGURE 185, AFTER CORRECTION BY TURNBUCKLE CAST.
Note straightening in both dorsal and lumbar areas, also decrease in rotation of bodies of vertebræ.

excessive amount of destruction. As destructive lesions usually involve the bodies of the vertebræ, the resulting deformity is a kyphosis, and rarely a lateral distortion.

Diagnosis.—The diagnosis of scoliosis is evident by inspection of the spine and rarely will be confused with other lesions. The differentiation from tuberculosis is perhaps the most important. It is made by the greater severity of pain in tuberculosis, with muscle spasm and rigidity of the spine. As previously mentioned, the deformity in tuberculosis is usually a kyphosis. The x-ray is also an aid in differentiation by showing the erosion of the adjacent surfaces of the vertebræ.

Prognosis.—The prognosis for improvement is favorable in most cases, but deformity often progresses regardless of every form of treatment. When the deformity is well advanced, normal symmetry of the body can never be restored, but if the condition is recognized early, appropriate treatment may arrest the process and prevent severe deformity, or in many cases the spine may be held practically straight.

Treatment.—The treatment of scoliosis consists of: (1) gymnasium exercises to develop certain muscles, and physiotherapy; (2) correction by casts or apparatus; and (3) operative treatment. However, all these measures must often be combined in a given case.

Gymnasium and Physiotherapy.—The purpose of gymnasium treatment is to stretch the contracted structures and to strengthen the stretched muscles. Daily suspension by the Sayre head traction apparatus, or having the patient suspend himself by the hands, is of value. Active exercises, especially those which bend the spine toward the corrected position, are indicated, as well as breathing exercises. All active exercise is best done in front of a large mirror. Massage to the muscles of the back, and general tonic



FIG. 188.—PHOTOGRAPH OF SCOLIOSIS BEING CORRECTED BY TURNBUCKLE CAST.

measures to build up the natural resistance of the body are useful. In addition, the patient should spend a part of each day in the recumbent position.

Corrective Treatment.—Corrective treatment in its simplest form is by recumbency on a Bradford frame with traction to the head and feet. Side traction over the points of greatest deformity may be added. A plaster-of-Paris cast may be applied with the patient suspended or placed in the best possible position in an apparatus such as the Abbott frame. Windows may



FIG. 189.—PHOTOGRAPH OF PLASTER-OF-PARIS CAST MODEL OF BODY, CUT AND CORRECTED TO DESIRED DEGREE, TO BE USED IN MANUFACTURE OF LEATHER CORSET.

be cut in the cast, through which successive layers of felt padding may be drawn to press on the convexity of the curves.

There are numerous methods of treatment, but one of the most satisfactory in suitable cases is with the turnbuckle cast, as described by Lovett¹ and Brewster. This cast is applied in the following manner: The patient is suspended. The bony prominences are well padded and a snugly fitting plaster-of-Paris cast is applied. If the curve is in the lower dorsal or lumbar region, it is well to include the thigh on the concave side. The cast is allowed to set, and is then cut down the center front and removed. At the point of greatest deformity, it is cut across transversely. An ordinary garden-gate hinge is fastened on the convex side and two turnbuckles are fastened to the concave side. Straps and buckles are applied down the

front. When complete, the cast is replaced on the patient. The turnbuckles are tightened a few times each day and the deformity is gradually corrected. If necessary, a second and a third cast may be applied in the same manner until the maximum amount of correction is obtained.

Retentive Appliances.—In the milder cases and in the more severe ones after correction has been accomplished, it is necessary to maintain the correction by some form of spinal brace. Several types of spinal braces have been illustrated in the chapter devoted to apparatus. The brace here described, devised by my colleague, Joseph I. Mitchell, has been built on the same principle as the turnbuckle cast. A plaster-of-Paris model is made

¹ R. W. Lovett and A. H. Brewster, "Treatment of Scoliosis by a Different Method from that Usually Employed," *J. Bone & Joint Surg.*, 1924, 6: 847.

of the patient, extending from the groin and including the shoulders. This is removed immediately, and when thoroughly dry, is cut across transversely at the point of greatest deformity. The segments are then separated on the concave side to the same degree that the turnbuckle cast has been separated. A few more turns of plaster bandage hold the model in the corrected position. The form is then filled with plaster cream and a torso of the patient in the corrected position is secured. Over this torso, a leather corset is made and this is reinforced with steel strips. This gives a comfortable brace, which maintains correction and is easily removable for bathing and exercises.

Operative Treatment.—The operative treatment consists of fusion of the spine after the deformity has been corrected as completely as possible by the other methods. It is especially indicated in paralytic scoliosis. The type of operation may be either a Hibb's fusion operation or an Albee bone-graft; or an osteoperiosteal graft may be used.

The treatment of scoliosis is a highly technical procedure, requiring the services of an expert. The average general surgeon is neither competent nor equipped to undertake this work. The general practitioner can coöperate with the specialist, but he should not attempt to treat such conditions alone unless he has had special training, not only in orthopedics, but in this particular field. Emphasis must always be placed upon the importance of early diagnosis, and the immediate institution of efficient treatment, by which serious deformity can usually be arrested.



FIG. 190.—PHOTOGRAPH OF LEATHER CORSET REINFORCED WITH STEEL, TO BE USED AFTER MAXIMUM CORRECTION HAS BEEN OBTAINED IN TREATMENT OF SCOLIOSIS.

ROUND SHOULDERS; HOLLOW-BACK

Round shoulders and hollow-back, like scoliosis, are most frequently seen in girls about the age of puberty. The symptoms, as a rule, are negligible, except for the posture. However, the patients are generally below par physically.

In the round-shoulder type, the dorsal region of the spine is stooped and rounded; the normal kyphos is increased. The cervical spine may also be rounded forward. The scapulæ are prominent; the lumbar lordosis may be increased. In the hollow-back type, there is an exaggeration of lumbar lordosis.

Examination may show other associated static conditions, such as flat-feet. The x-ray in the lateral view shows a narrowing of the intervertebral spaces, which may closely resemble low-grade spondylitis. The intervertebral spaces are narrowed and the bodies of the vertebræ may be compressed. This is probably due to a form of epiphysitis (p. 114), and is also mentioned in connection with scoliosis (p. 262) as a predisposing factor.

Diagnosis.—The diagnosis is usually obvious on inspection, and must be differentiated only from tuberculosis. This differentiation is made by the angular character of the kyphosis in tuberculosis, in which one spinous process is unusually prominent. In round shoulders, the kyphos is rounded and there is no definite "knuckle." Pain is rarely present in round shoulders, and when present, is not severe. In tuberculosis, pain is the earliest symptom, is constant, and gradually increases in severity.

Prognosis and Treatment.—The prognosis depends upon the early recognition of the affection. With the prompt institution of efficient treatment, much subsequent deformity may be prevented.

The treatment is to build up the general health by rest, tonics and out-of-door exercise. Deep-breathing exercises and exercises to strengthen the spinal muscles are of value. In those cases in which the deformity is progressive, a light form of spinal brace may be indicated. In the severe cases, corrective measures may be necessary, such as traction to head and feet on a curved Bradford frame, or gradual correction in a modification of the turnbuckle cast, as used in scoliosis.

SPONDYLOLISTHESIS

Spondylolisthesis, while not, strictly speaking, a static condition, is best discussed in connection with the other static affections. It is the slipping forward of the fifth lumbar vertebra on the sacrum. It may occur in childhood, but is more often seen in early adult life.

Etiology.—Spondylolisthesis may be divided into two groups, the traumatic and the congenital. However, as pointed out by Kleinberg, it is probable that in all cases there is a predisposing element, such as a developmental anomaly, and a direct cause, as trauma. The developmental anomalies which might predispose to spondylolisthesis are: enlarged transverse processes, increase in the normal obliquity of the lumbosacral joint, anomalies of the articular processes, lack of fusion between the superior and

inferior articular processes, and congenital weakness of the spinous ligaments.

The trauma, as a rule, is of such a nature as to cause forced flexion of the spine. In examining the skeleton, it is easily demonstrated that, with the fifth lumbar vertebra intact, the spine must first be strongly flexed in



FIG. 191.—DRAWING FROM AN X-RAY OF SPONDYLOLISTHESIS.

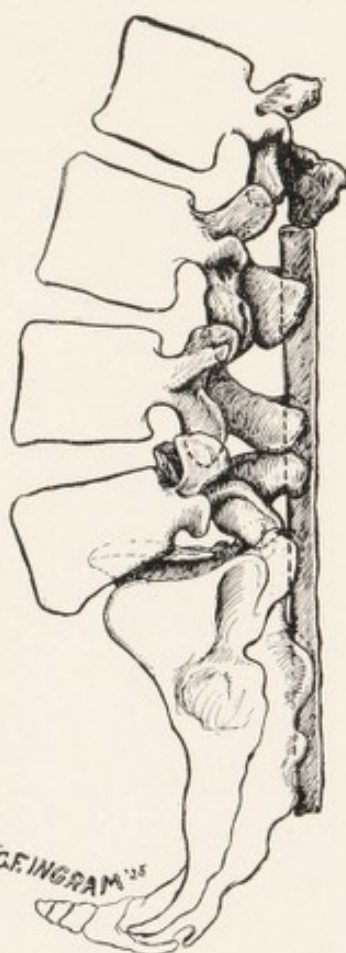


FIG. 192.—SAME AS FIGURE 191, SHOWING METHOD OF FIXATION WITH ALBEE BONE-GRAFT.

order to disengage its articular processes from those of the sacrum before a spondylolisthesis can occur.

Symptoms.—The symptoms are chiefly stiffness and soreness in the lower spine and pain radiating about the iliac crest and down the legs. Pain may be aggravated by exertion, prolonged standing or walking, jarring, lifting or stooping. Pain on forward bending is the most common and characteristic symptom.

Examination.—The objective findings are increase of the lumbar lordosis, and a prominence of the sacrum, with a depression immediately above it. This is more apparent on palpation than on inspection. The pelvis appears to be more horizontal than normal; the anterior superior spines of the ilia are prominent, and the costal margin is closer to the iliac crest. The spine is limited in motion in all directions, but especially on forward

bending. Tenderness may be present over the lumbosacral or sacro-iliac joints. There may be motor and sensory paralysis in one or both legs. Kernig's sign may be positive.

The roentgenogram is typical and pathognomonic of the condition. Stereoscopic plates of the anteroposterior view are to be recommended, as well as a good lateral picture. On examination of the anteroposterior roentgenogram in the stereoscope, one's first impression is the increase of the lumbar lordosis. The bodies of the upper lumbar vertebræ are quadrilateral in shape. As a rule, the upper four lumbar vertebræ are clearly seen. The body of the fifth lumbar vertebra is seen superimposed upon the shadow of the sacrum. The oval outline of the body is seen, with the spinal foramen open above it. The spinous process may be the most superior portion of the vertebra. In the lateral view, the bodies of the upper four lumbar vertebræ are seen placed one upon the other, their anterior surfaces forming an unbroken line, slightly convex anteriorly. The fifth lumbar vertebra is displaced forward and downward on the sacrum.

Treatment.—The treatment of spondylolisthesis is supportive, either by means of a spinal brace or by a fusion operation on the spine.

VISCEROPTOSIS

Visceroptosis is a sagging of the abdominal viscera often associated with static deformities of the spine, as round shoulders and hollow-back. Normal posture is described in Chapter I. The intestinal tract is most frequently affected, but one or both kidneys may also be displaced. Weakness of the abdominal muscles is a predisposing cause, and exaggerated cases are sometimes seen following infantile paralysis.

The symptoms are referable to the organs displaced and usually consist of digestive disturbances, constipation, flatulence and pain. The diagnosis may be made from the symptoms but, as a rule, fluoroscopic or x-ray examination following a barium meal is required for confirmation.

All types of cases, particularly the paralytic, may be benefited by the application of properly fitted abdominal supports, and close attention to the restoration of normal body posture.

CHAPTER XVI

CONGENITAL ANOMALIES

Congenital anomalies and deformities are those of prenatal origin, the cause of which is largely speculative. The theory of prenatal suggestion through fright or mental impressions is a superstitious invention of the ignorant which has been passed from generation to generation, but cannot



FIG. 193.—PHOTOGRAPH OF CONGENITAL EQUINOVARUS ASSOCIATED WITH CONSTRICTING BANDS ABOUT LEG AND HYPERTROPHY OF GREAT TOES.



FIG. 194.—PHOTOGRAPH SHOWING INTRA-UTERINE AMPUTATION OF FOREARM ON RIGHT AND CONGENITAL ABSENCE OF ULNA ON LEFT.

be substantiated by scientific facts. However, as this theory has been accepted for centuries, there are still members of the medical profession who regard prenatal influence as a factor. There also exists in the mind of the laity the fallacious impression that syphilis in some ancestor is responsible

for deformities in children. The Wassermann test is positive in about the same percentage in children with congenital deformities as in any other group, and syphilitic stigmata are not observed more frequently.



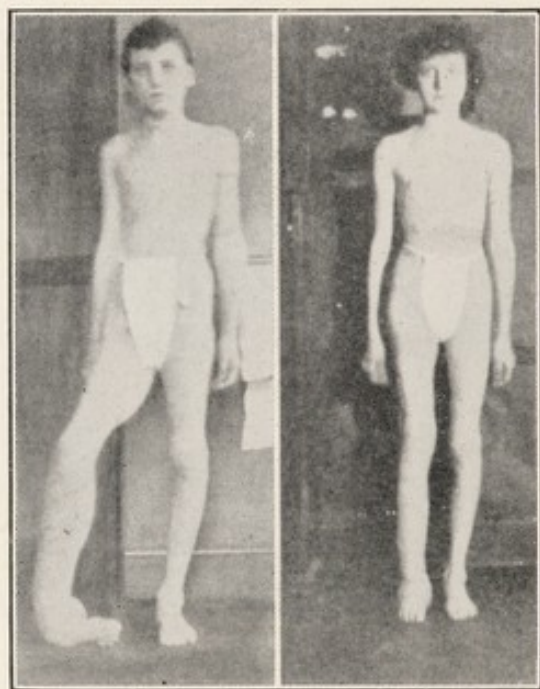
FIG. 195.—X-RAY SHOWING CONGENITAL ANOMALY OF FIFTH FINGER, LEFT HAND, WITH ATROPHY OF TERMINAL TWO PHALANGES.

Errors of development may arise from an inherent abnormality in a germ cell which does not possess the normal selective action in reproducing the normal part. Errors of development may also be due to an inherent peculiarity, weakness or disorganization, as evidenced by the transmission of certain anomalies through several generations. Anomalies may also be due to constrictures and distortions from amniotic bands, as evidenced by circular constrictures about the extremities, often associated with congenital anomalies. Position *in utero*

may possibly be a contributing factor.

Congenital anomalies are varied and numerous, but only those of common interest will be considered. For convenience in description, congenital anomalies may be classified as follows: (1) atrophic, (2) hypertrophic, (3) those with numerical variation, and (4) those with deformities, or distortions of normal structures. However, all these conditions may be more or less associated in the same individual. There seems at times to be a lack of organization in growth, which is manifested by these abnormalities.

Atrophy may be local or general. General atrophy is evident in dwarfism. There may be local atrophy of a finger, toe or extremity, without defect in the component parts. Hemiatrophy, or unilateral asymmetry, is deficiency in growth of one lateral half of the body, so that when full growth is attained, the face on one side is much smaller and the extremities much shorter. No treatment is of any practical value, except to compensate by prosthetic appliances.



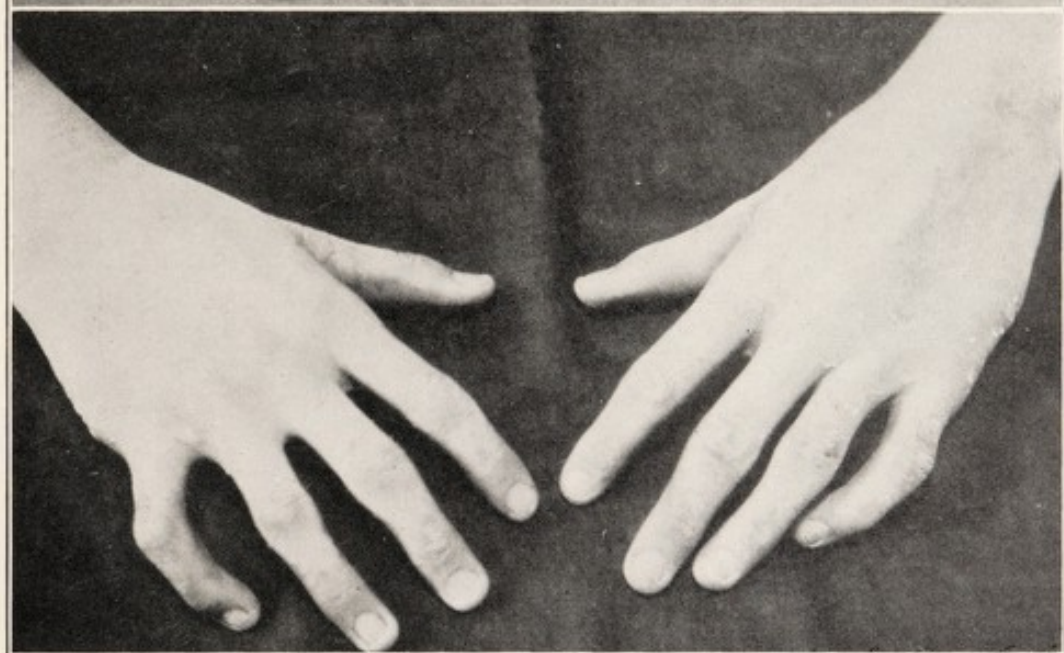
A

B

FIGS. 196-A AND B.—CONGENITAL HYPERTROPHY OF LEG BEFORE AND AFTER EXCISION OF REDUNDANT TISSUE AND STABILIZATION OF FOOT.

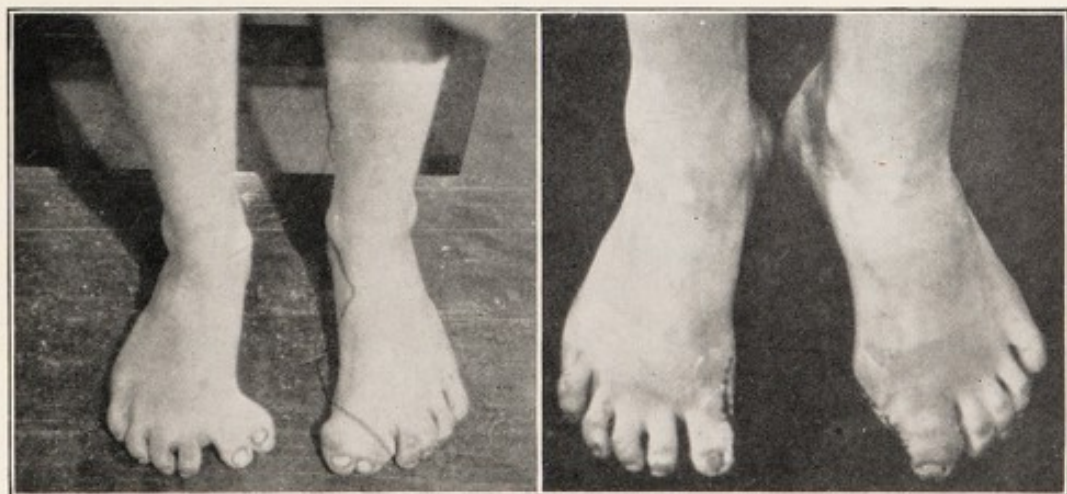


A

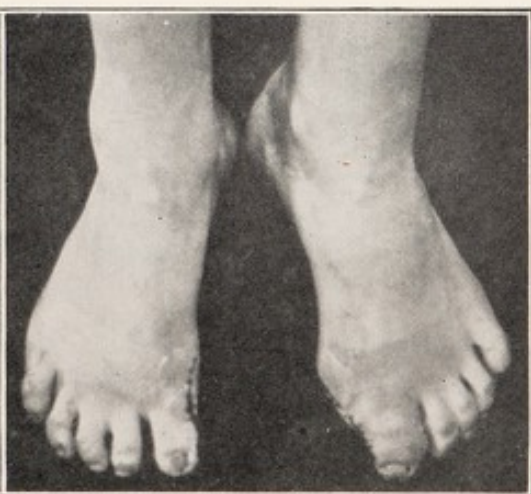


B

FIG. 197-A.—PHOTOGRAPH OF HANDS, SHOWING SIXTH FINGER ON EACH HAND.
FIG. 197-B.—SAME AS FIGURE 197-A, AFTER REMOVAL OF SUPERNUMERARY FINGERS.



A



B

FIG. 198-A.—PHOTOGRAPH OF FEET, SHOWING ADDITIONAL GREAT TOE ON EACH FOOT.
FIG. 198-B.—SAME AS FIGURE 198-A, AFTER REMOVAL OF SUPERNUMERARY TOES.

Hypertrophy may be diffuse in oversized individuals, but is of no special significance; or there may be a local hypertrophy of one part, as a finger, toe or hand, or an entire extremity may be involved until it becomes three or four times normal size. This may be due apparently to rapid proliferation



FIG. 199.—X-RAY OF HAND, SHOWING SIXTH FINGER ARTICULATING BY RUDIMENTARY SIXTH METACARPAL TO FIFTH METACARPAL.
Same patient as in Figures 197-A and 197-B.

of embryonic tissue, or tissue which has not fully matured, and is in a measure related to tumors. Hypertrophy may also be caused by actual neoplasms. Neurofibromata may induce a condition which closely resembles, or, in reality, is, congenital hypertrophy.¹

There are also distortions of hypertrophied parts, particularly if the affected part is a lower extremity. Amputation may at times

¹ "Congenital Hypertrophy," *Surg., Gyn. & Obst.*, May, 1923, p. 699.

be indicated, but much can often be accomplished by excision of hypertrophied tissue and reconstruction operations on bone (Fig. 196).

Numerical variation is an increase or decrease in the normal number of anatomical parts. There is often observed complete absence of a part,



FIG. 200.—X-RAY OF FOOT, SHOWING RUDIMENTARY METATARSAL BONE ATTACHED TO FIRST METATARSAL BONE AND COMPLETE DUPLICATION OF GREAT TOES.

Same patient as in Figures 197-A and 197-B.

as congenital amputation of a limb, or there may be partial absence; or there may be supernumeration, or increase in number. There may be absence of one of the phalanges of the toes or fingers, or of the metatarsal or metacarpal bones.

In the leg, the entire tibia may be absent; this is of frequent occurrence and produces a characteristic distortion. The foot is usually clubbed and folded against the inner aspect of the leg. The fibula becomes markedly hypertrophic and bowed outward, and at the upper extremity is displaced upward; the leg may also be folded against the inner aspect of the thigh. The leg below the knee is much shorter than normal and may be a mere appendage. The only treatment for such conditions is surgical, which consists in shifting the fibula by a two-stage operation to articulate with the knee and ankle. Compensatory hypertrophy of the fibula then occurs, but the limb is always much shorter and an approach to normal is never to be expected. Prosthetic apparatus is always necessary. Absence of the fibula is not so disabling as the absence of the tibia, because the entire knee-joint and a greater portion of the ankle is present. Congenital absence of a bone is always associated with contracted muscles and soft structures. In the thigh, there may be partial or complete absence of the femur with the leg attached as an appendage at the hip. In such cases, only prosthetic appliances are of benefit; surgery offers very little hope of improvement.



FIG. 201.—PHOTOGRAPH OF CHILD WITH BILATERAL CONGENITAL ABSENCE OF FIBULA WITH EXTREME TALIPES VALGUS.

seventh cervical, the so-called cervical rib, which may cause serious pressure symptoms in young adults, though never in children, as the process is composed largely of cartilage. Also, the transverse process of the fifth lumbar is often enlarged and may in later life press upon the wing of the sacrum and possibly cause low back pains. Scoliosis is often associated with anomalies of the spine, or is caused by them, as the superincumbent weight increases.

In the upper extremities, congenital absence of the radius is more frequent. The hand is deviated outward, the so-called club-hand. The ulna is

consists in shifting the fibula by a two-stage operation to articulate with the knee and ankle. Compensatory hypertrophy of the fibula then occurs, but the limb is always much shorter and an approach to normal is never to be expected. Prosthetic apparatus is always necessary. Absence of the fibula is not so disabling as the absence of the tibia, because the entire knee-joint and a greater portion of the ankle is present. Congenital absence of a bone is always associated with contracted muscles and soft structures. In the thigh, there may be partial or complete absence of the femur with the leg attached as an appendage at the hip. In such cases, only prosthetic appliances are of benefit; surgery offers very little hope of improvement.

Congenital absence of an entire vertebra or part of a vertebra may be observed in the spine (Fig. 183), or there may be supernumerary vertebrae, as six lumbar vertebrae. Again, there may be a hypertrophy of certain processes, as the transverse process of the

bowed inward and the radial muscles shortened; supernumerary digits are often associated, or there is an absence of thumb or fingers. Congenital absence of the ulna is exceedingly rare and the deformity is the opposite of that observed in congenital absence of the radius. The extremity is ma-



A

B

FIG. 202-A.—X-RAY OF FIGURE 201, SHOWING BILATERAL CONGENITAL ABSENCE OF FIBULA, WITH EXTREME TALIPES VALGUS AND COMPENSATORY HYPERTROPHY OF TIBIA, ANTEROPOSTERIOR VIEW.

FIG. 202-B.—SAME AS FIGURE 202-A, LATERAL VIEW.

terially shortened. No treatment is of any value until the child is two years of age, when operative procedures along the same principles described in the absence of the tibia are carried out. The final result is a much shortened and defective member.

Deformities or distortions of normal structures are deformations or distortions of a member that has all its component parts, and are probably

more common than atrophy, hypertrophy, or deficiency. For example, in congenital club-foot all the bones and soft structures of the foot are present, but are distorted. These conditions may be due to deficiencies or contractions of the soft parts from position *in utero*. Heredity plays a part, but many deformities are observed in healthy parents from whom no family history of former occurrence can be obtained. However, people are often sensitive regarding congenital anomalies, and their reticence may have prevented such knowledge from passing to their descendants. Congenital anomalies may also be due to deficient growth or overgrowth of an epiphysis. The description of congenital deformities will begin with the feet.

DEFORMITIES OF THE FEET

Congenital deformities of the feet are called talipes, and may be classed as equinus, calcaneus, varus, valgus, and the combined forms, as calcaneovarum and calcaneovalgus, etc.

Congenital Club-Foot (Talipes).—The most common deformity occurring in the feet is congenital equinovarus, or club-foot, also termed reel-



A

B

FIG. 203-A.—PHOTOGRAPH SHOWING BILATERAL CONGENITAL CLUB-FOOT IN INFANCY.

FIG. 203-B.—PHOTOGRAPH SHOWING CORRECTION OF BILATERAL CONGENITAL CLUB-FOOT BY PLASTER-OF-PARIS CAST.

Note window cut out to prevent pressure on dorsum of foot.

foot. As in other congenital anomalies, congenital equinovarus may be single or double. As the term implies, the forefoot is turned in and is known as varus; the heel is drawn upward so as to fix the foot in plantar flexion, or equinus. The bones of the tarsus are distorted, being twisted inward so that the outer side of the foot is prominent and overdeveloped; the inner is concave, compressed, or underdeveloped. The small bones of

the tarsus are distorted to conform to this position, which becomes more pronounced and fixed as age advances. The leg is often twisted or rotated inward from the knee down to conform to the position of the foot. When walking begins, the weight is borne on the outer aspect, or dorsum of the foot, which adds pressure to increase and fix the deformity. Walking often develops large bursæ on the dorsum of the foot, which may become inflamed in older children or adults. There is marked atrophy of the leg in untreated cases.

Diagnosis.—The diagnosis of this condition is apparent at birth and requires no differentiation, but later in life there may be a close resemblance to acquired equinovarus (paralytic or traumatic). In both, there is atrophy of the leg. In paralytic club-foot, there is usually a history of normal members at birth and, after birth, a definite onset. In some children, however, especially orphans, no history is available, when differentiation must be made by the determination of muscle power. In congenital equinovarus, there is voluntary action in all muscles, though there is weakness in the dorsal flexors and peroneals from overstretching, and in the posterior muscles of the leg and tibials from inactivity. In paralytic equinovarus there is definite paralysis and usually associated evidence of paralysis elsewhere in the affected limbs or other portions of the body. Also, paralytic club-foot is not so frequently bilateral as congenital. In acquired equinovarus from other cause, there is a history of definite injury of muscle or nerve severance, or, rarely, a burn may cause destruction of muscles or nerves with characteristic deformity. In addition, in lesions of the central nervous system, as in spina bifida and such affections as muscular dystrophy, progressive muscular atrophy, or so-called chronic anterior poliomyelitis (a confusing term), there may be equinovarus or other distortions of the feet, but differentiation can always be made by the characteristic symptoms of the central lesion.

Prognosis.—The prognosis in congenital equinovarus or club-foot is excellent if treatment is instituted early. In early childhood, the deformity can be corrected; normal function should be secured in every case, but slight atrophy of the calf muscles may persist throughout life, as denoted by the decrease in circumference of the leg and, to some extent, the thigh on the affected side. This may be quite noticeable, though in no way interfere with the activity of the individual. Growth is not arrested and length is rarely appreciably affected. In middle and late childhood, or at any age after fixed structural changes occur in the bones, the foot can be made perfectly straight, so that walking on the sole is permitted; but there is greater arrest in development, and appreciable deficiency in length may be apparent. Also, walking on the affected side is never normal and is of the flat-sole type. There may be a slight limp, but if no actual limp, the normal resiliency or elasticity in gait is lost. In bilateral equinovarus, the gait is a peculiar waddle, which is quite characteristic. However, the deformity can be

corrected, regardless of age, though the earlier this is accomplished, the more nearly perfect will be the restoration of function.

In those rare instances when equinovarus is apparently due to an irregularity in epiphyseal growth, deformity may repeatedly recur after operative procedures, but finally correction can be maintained permanently. Recurrence of deformity is so common from inefficient reduction and inefficient retention after reduction, that a general impression prevails among the laity that correction of this deformity is impossible.

Treatment.—The treatment indicated depends upon the age and resistance of the deformity. The treatment in congenital equinovarus of mild degree should be instituted at the end of two weeks; prior to this time, the mother or child obviously should not be disturbed, although there is no contra-indication to the beginning of treatment on the first day. In very mild deformities, when no bony deformity exists and when the foot may be passively held straight, correction may often be accomplished by simple passive movements. The forefoot is grasped between the fingers of one hand while the other hand fixes the tiny heel. With the midtarsal region as a fulcrum, the forefoot is turned outward. When varus disappears and the forefoot can be held in the overcorrected position, the forefoot is forced gently in the direction of dorsiflexion. This procedure should be carried out three or four times daily for five or ten minutes for a period of three to six months, or until the foot remains in the normal position and does not assume the position of equinovarus when relaxed. In addition to the corrective movements, the foot should be held in the overcorrected position by a simple apparatus. In a vast majority, there is structural deformity of the bones and fixed contractures of soft structures, and full correction cannot be made by passive motion. These require retention apparatus and more complicated treatment, which may be deferred until the child is one month of age, if it is not convenient to the mother to begin at an earlier time.

Methods of Treatment.—There are many methods by which congenital equinovarus may be corrected, but only the routine procedures of the author will be described, as an illustration of the general principles involved by all methods.

At one month of age, two methods may be instituted: (1) gradual correction by successive plaster casts; (2) operation, or forcible correction under anesthesia. The type of treatment selected depends entirely upon the social and financial status of the family. The first method requires about six weeks to two months of constant observation and repeated changes of cast, and therefore may entail considerable expense or otherwise work a hardship upon a mother with a large family, if not living in a vicinity where such treatment can be secured. The second method requires only a few days, when the mother and child may return to their home to be observed only at varying intervals.

Correction can be accomplished by successive plaster casts in the following manner: A snug bandage of outing cloth, about 2 inches in width, is applied from the toes to the groin. The knee is flexed at a right angle, while firm pressure is made to overcome as much varus as possible, after which a plaster cast is applied from toes to groin. When the plaster has consolidated, the cast is trimmed out over the toes so that each toe is distinctly visible at its tip. The cast should extend on the inner aspect to the tip of the great toe. Each week, or as often as every five days, a new cast should be applied in the same manner, forcibly correcting the varus, or the turning in of the forefoot. When the varus is overcorrected, but not before, upward pressure is made on the forefoot to gradually dorsiflex the foot and to stretch the heel cord and the posterior structures of the ankle joint, thus correcting the equinus. When varus and equinus are overcorrected and the foot is held in valgus, calcaneus and dorsal flexion, a cast is applied, to be changed at intervals of one month for a period of two to four months, or until the foot remains in the overcorrected position. At this time, passive motion is instituted, as above described, and the foot is placed in a simple retention brace, which is continued until the child is able to walk. When walking is begun, a simple club-foot brace is applied, which limits plantar flexion and also varus; or, in many cases, the shoe is simply elevated about one-fourth of an inch on the outer aspect. If there is the slightest tendency to the relapse of deformity, retention splints should be worn at night and during rest periods in the daytime. As relapse is apt to occur in congenital club-foot, the patient should be observed at intervals until at least two years of age.

Correction of equinovarus can be accomplished just as satisfactorily in a much shorter length of time by a very simple operation. The child is given just enough ether to prevent kicking and to relieve pain; complete narcosis is never required. The foot is grasped with both hands, placing both thumbs over the dorsum of the tarsus, when the forefoot can be forced into valgus, after which the equinus or plantar flexion is slowly forced into a dorsal flexion, thus overcorrecting the deformity. If the tendo achillis



FIG. 204.—PHOTOGRAPH OF RETENTION SPLINT USED FOR CLUB-FOOT AFTER CORRECTION BY SUCCESSIVE CASTS.

is resistant, a subcutaneous tenotomy may be required. A small knife, known as a tenotome, is inserted under the skin from without inward, so as to avoid injury to the posterior tibial artery and nerve, and the tendo



A

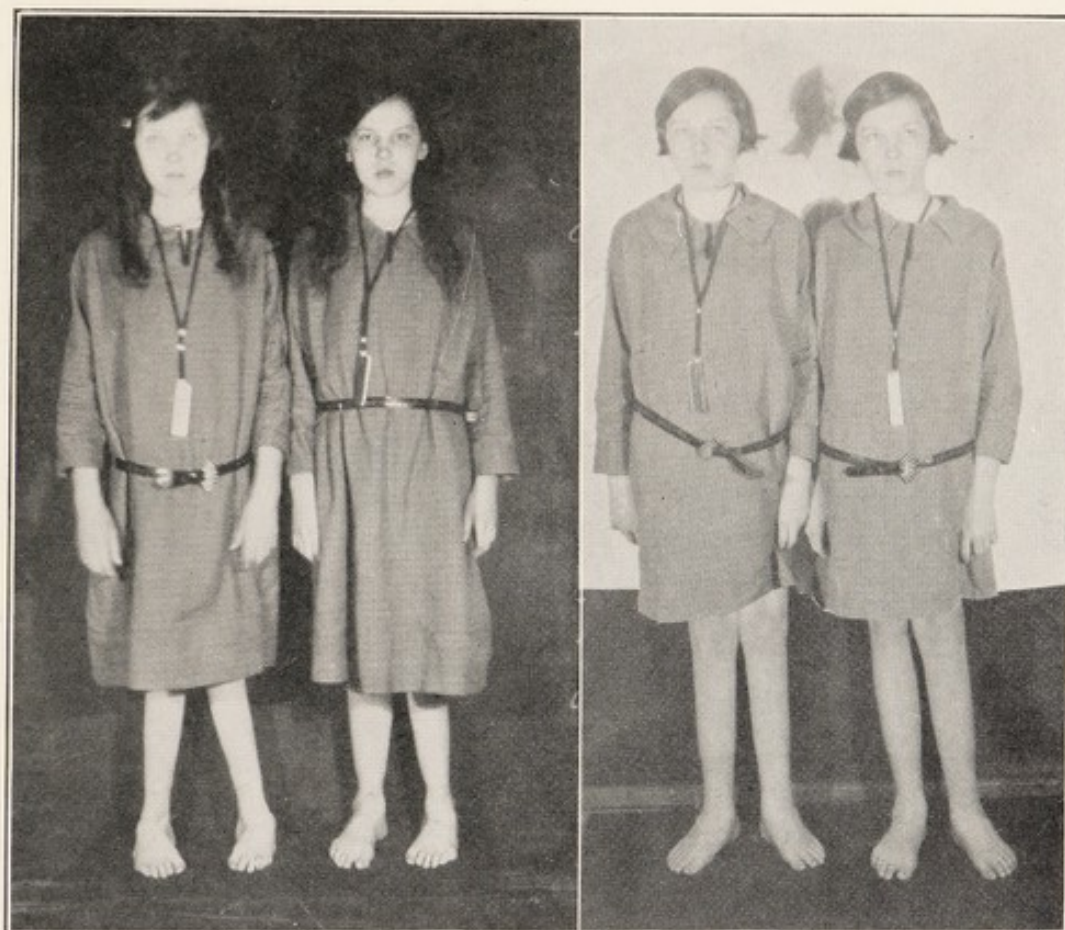
B

FIG. 205-A.—PHOTOGRAPH SHOWING BILATERAL CONGENITAL CLUB-FOOT IN CHILD, AGE EIGHTEEN MONTHS.

FIG. 205-B.—SAME AS FIGURE 205-A, AFTER CORRECTION BY MANIPULATION.

achillis is seyered. When this is accomplished, there is a definite snap and the foot can be forced into dorsal flexion. A plaster cast is then applied, extending from toes to groin, with the knee flexed at a right angle. The cast is applied in this position, for casts extending to any point below the knee often slip downward over the foot, permitting inefficient retention

and the foot to assume the original position. Unusual care must be exercised to avoid irritation or necrosis from pressure. The toes must be carefully watched, especially as to color and motion for the first twenty-four hours. Opium in the form of paregoric, in doses of five to ten drops every three hours, may be required at intervals, when necessary; if an excessive amount is required, the casts should be bivalved for inspection or re-applied, for there is a possibility of undue pressure at some unexpected point. The first



A

B

FIG. 206-A.—PHOTOGRAPH SHOWING BILATERAL CONGENITAL CLUB-FOOT IN TWINS, AGE TEN YEARS.

FIG. 206-B.—SAME AS FIGURE 206-A, AFTER SURGICAL CORRECTION.

cast is removed at the end of one month, and then at monthly intervals for about three months, when the after-treatment is the same as when successive casts are employed.

In those observed after the first year or during early childhood, forcible correction and tenotomy, as described, are indicated, but a wedge-shaped wooden block, advocated by Lorenz, or the Thomas wrench, which is a modification of the ordinary monkey wrench, is required to force the foot from varus to valgus. The after-treatment is the same as heretofore described, except that often intervals of two months may elapse before the casts are changed. Passive movements of the feet are employed by the

mother when the casts are discarded. In middle childhood, from the age of five to ten years, correction may be accomplished in many by successive forcible manipulations under anesthesia with application of plaster casts.

In the relapsed and more severe deformities, open operative procedures are often required, which consist of reconstructing the shape of the tarsal bones, and especially the subastragalar region, thus correcting varus. The tendo achillis and posterior capsule of the ankle joint are then made longer by plastic procedures and the equinus and plantar flexion are corrected. After operation, the foot is retained in the corrected position by a bivalved plaster cast for a period of eight weeks, when a simple club-foot brace is applied to be worn for six months; or in many, elevation of the outer aspect of the sole of the shoe may be sufficient. After the foot is corrected by any method, there may be pronounced in-toeing when walking, which is caused by an inward rotation of the leg. This may often be corrected by education, but if resistant, correction should be made by a simple osteotomy of the tibia in the upper third; the fibula can be manually fractured and the leg rotated outward, placing the foot and knee in normal relation.

Varus.—Simple varus of the forefoot without equinus is rare, but can be corrected, as described under club-foot (p. 283). However, it is unusually resistant to treatment and requires very close observation for at least two years after treatment is discontinued.

Congenital Valgus or Calcaneovalgus (Congenital Flat-Foot).—This anomaly is congenital flat-foot and is of very common occurrence. In exaggerated cases at birth the dorsum of the foot approximates the leg, but can usually be passively held in the normal position. Structural osseous changes are rarely observed. In those in whom the anterior group of muscles of the leg and peroneals are resistant, correction can be accomplished by successive plaster casts. In a vast majority, this deformity can be corrected by a simple splint made of ordinary galvanized iron or aluminum to conform to the sole and inner aspect of the leg. The foot and leg are held to the splint with the foot in overcorrection or adduction, by simple muslin bandages, which the mother can apply. The mother is also taught to plantar flex and adduct the foot by passive motion three or four times a day. Correction is usually accomplished in a few months, and there is no tendency to recurrence. When the child begins to walk, routine treatment for flat-foot, or pes planus, may be required, as described on p. 257.

Congenital Equinus.—Congenital equinus is a rare anomaly, in which there is a contraction of the heel cord and posterior structures of the leg, holding the foot in plantar flexion. When walking is instituted, weight is borne on the ball of the foot and the arch is usually elevated into cavus, or abnormally high arch. Unless corrected early, there is extensive compensatory shortening of the extremity on the affected side. In infancy, correction can be accomplished by successive casts gradually forcing the foot

into dorsal flexion, as in the second stage of the treatment for equinovarus. Also, the tendo achillis may be severed by subcutaneous tenotomy, after which a cast is applied holding the foot in dorsiflexion. In older children, the tendo achillis should be lengthened by the Z plastic method, and if the longitudinal arch of the foot is too high and cavus exists, the contracted structures on the sole of the foot must be severed. Usually, this can be accomplished subcutaneously, but the tendo achillis should be severed only by open operation, as there is a possibility of extensive retraction with loss of power to the posterior group of muscles. The after-treatment is on the same principles as congenital equinovarus.

DEFORMITIES OF THE KNEE

Genu recurvatum.—The most common congenital abnormality in the knee is genu recurvatum, or hyperextension of the knee. The leg is bent forward instead of backward. This may also be considered a forward displacement of the leg on the femur. In those in whom the anterior

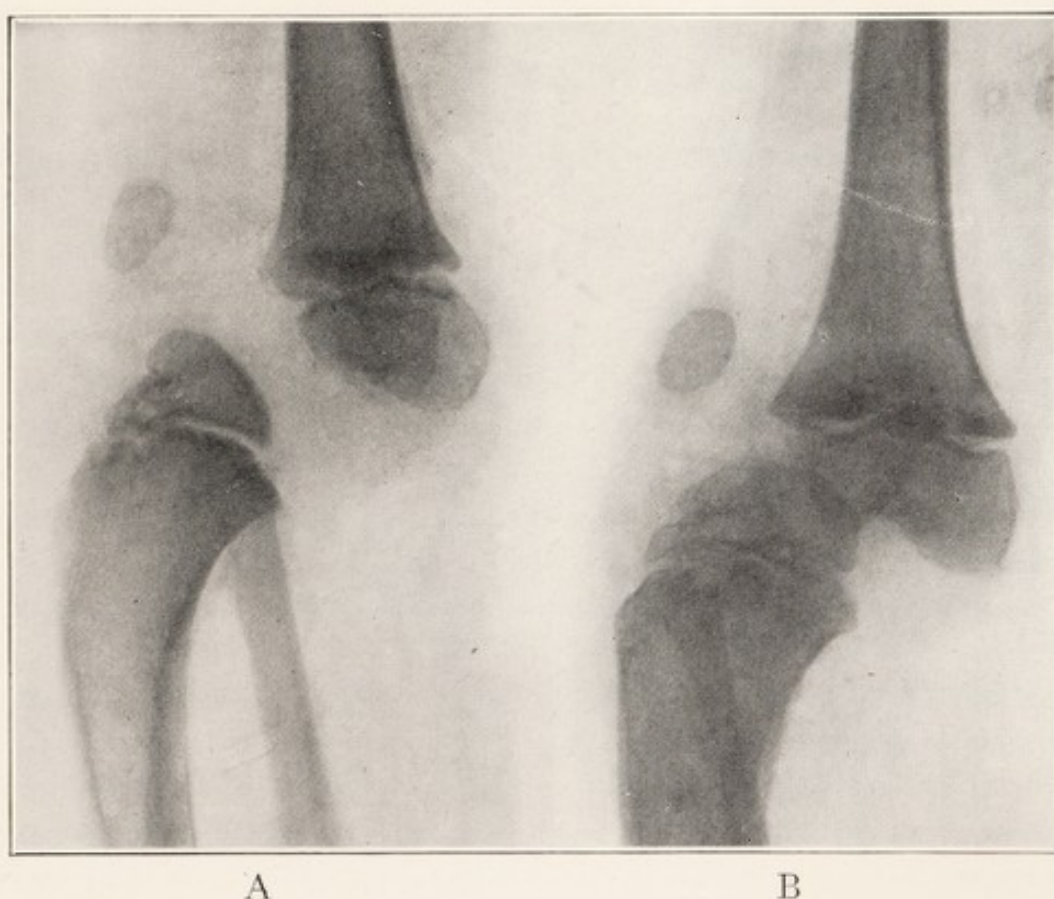


FIG. 207-A.—X-RAY SHOWING CONGENITAL DISLOCATION OF KNEE, LATERAL VIEW.

FIG. 207-B.—SAME AS FIGURE 207-A, ANTEROPOSTERIOR VIEW.

muscles composing the quadriceps are materially shortened, the deformity may be resistant, requiring operative measures when the child is about two years of age. In many, correction may be obtained by a simple malleable

posterior splint of sheet metal. The knee is flexed as much as possible when the splint is applied. Every week the knee is flexed and the splint bent to conform to the increased flexion, until the knee is held in right angle flexion for one month, or longer if there is a tendency to recur. This very simple measure will often correct a very disabling deformity.

Malformation and Rotary Displacements of Knee.—The tibia may be rotated on the femur so that the surfaces of the femur and the tibia do not articulate normally, and motion is mechanically blocked or limited. Often several degrees may be present, but the motion is from side to side instead of anteroposterior. There may also be malformation of articular surfaces, which limits motion. This condition may be of multiple distribution, occurring in practically all of the joints of the body, and has been called by Stern² *arthrogryposis multiplex congenita*. Absence of patella and other congenital anomalies, as equinovarus, are often associated. Physiotherapy may be of great benefit in increasing the range of motion in the joints if instituted early in infancy. In later childhood, surgery is the only treatment from which relative improvement may be expected.

DEFORMITIES OF THE HIP

Congenital Dislocation.—Congenital dislocation of the hip, congenital coxa vara, and other rare anomalies and deficiencies may be observed in the hip, but only congenital dislocation is of material importance. These dislocations occur more frequently in girls than boys, and may be single or double. As in other congenital anomalies, there is much speculation as to the origin. Increased flexion *in utero*, a purely mechanical condition, and developmental factors, of which there is often evidence from the association with other congenital deformities, are regarded as probable causes. The statement has often been made that injury at birth may produce congenital dislocation of the hips, but this is positively untrue, or of exceedingly rare occurrence. Fracture of the femur or pelvis would ensue before a hip would dislocate.

In congenital dislocation of the hip, the head is out of the acetabulum and is irregular in shape, being often conical instead of globular; the neck is often twisted, and coxa vara is common. The acetabulum is shallow, flat and triangular in shape and filled with more or less cartilage and fibrous tissue. The capsule is contracted about the acetabulum and also the head, with constriction between the head of the femur and the acetabulum, forming the so-called hour-glass contraction. When dislocations are of long standing, shallow "false" acetabula, with which the head of the femur articulates, are often formed on the dorsum of the ilium. This joint may remain intact

² Walter G. Stern, "Arthrogryposis Multiplex Congenita," *Tr. Am. M. Ass.* (Orthopedic Sec.), 1923, p. 66.

for some time, but gradually slips out of position and a new "false" acetabulum is formed on the ilium. This may be repeated until there are several sockets on the surface of the ilium. Rarely, however, there is a deep socket formed and the patient in this manner develops a fairly functional joint, and might be said to make a partial spontaneous recovery.

Symptoms and Clinical Manifestations.—The clinical manifestations are somewhat different in single and double dislocations of the hip. When one hip is dislocated, usually no abnormality is detected until the child begins to walk, when a slight limp is noticed, which becomes progressively more apparent. The limp is of a peculiar elasticity, as the trochanter ascends when weight is placed on the dislocated hip. In early childhood, no pain or local tenderness is present. On examination, motion may be somewhat increased above normal in all directions, but is never limited in any direction. Mensuration will demonstrate a definite decrease in length on the affected side, and the trochanter higher than on the normal side, as indicated by relation to Nélaton's line (a line drawn from the anterosuperior spinous process of the ilium to the center of the tuberosity of the ischium). On palpation over the center of Poupert's ligament and the femoral artery, a definite lack of resistance can be detected when compared to the normal hip.

In bilateral dislocations of the hip, there is a peculiar elastic waddle when the child first begins to walk. The width of the perineum is increased. As both hips are posterior to their normal position, there is a compensatory lordosis in the lumbar spine—a definite sway-back; otherwise, the manifestations are similar to those of single dislocations.

As age advances, the trochanter, with the head and neck of the femur, ascends, making the limp more apparent in unilateral dislocation and the difference in length of the two limbs greater. In bilateral dislocation, the gait becomes an exaggerated elastic waddle, which is so unusual as to be a source of derision from others and a pathetic embarrassment to the patient. Symptoms of pain and disability also appear in single and double dislocations as age advances, as there is no support for the upper extremity of the femur except muscle and fibrous tissue. In rare instances, a new acetabulum may be developed on the dorsum of the ilium (described under



FIG. 208.—DRAWING OF CONGENITAL DISLOCATION OF HIP, ILLUSTRATING LENGTHENING OF LIGAMENTUM TERES AND HOUR-GLASS CONTRACTION OF JOINT CAPSULE.

pathological anatomy as false acetabula). There is always a degree of disability, though in some it may be slight.

Diagnosis.—The diagnosis can always be made by the symptoms, but should be confirmed by the x-ray. Paralytic dislocation may resemble congenital dislocation but shows pronounced atrophy in the neck of the femur, with coxa valga and definite muscular weakness or paralysis. Traumatic dislocations give a history of severe trauma, and the x-ray demonstrates a normal head and neck of the femur and acetabulum; also,

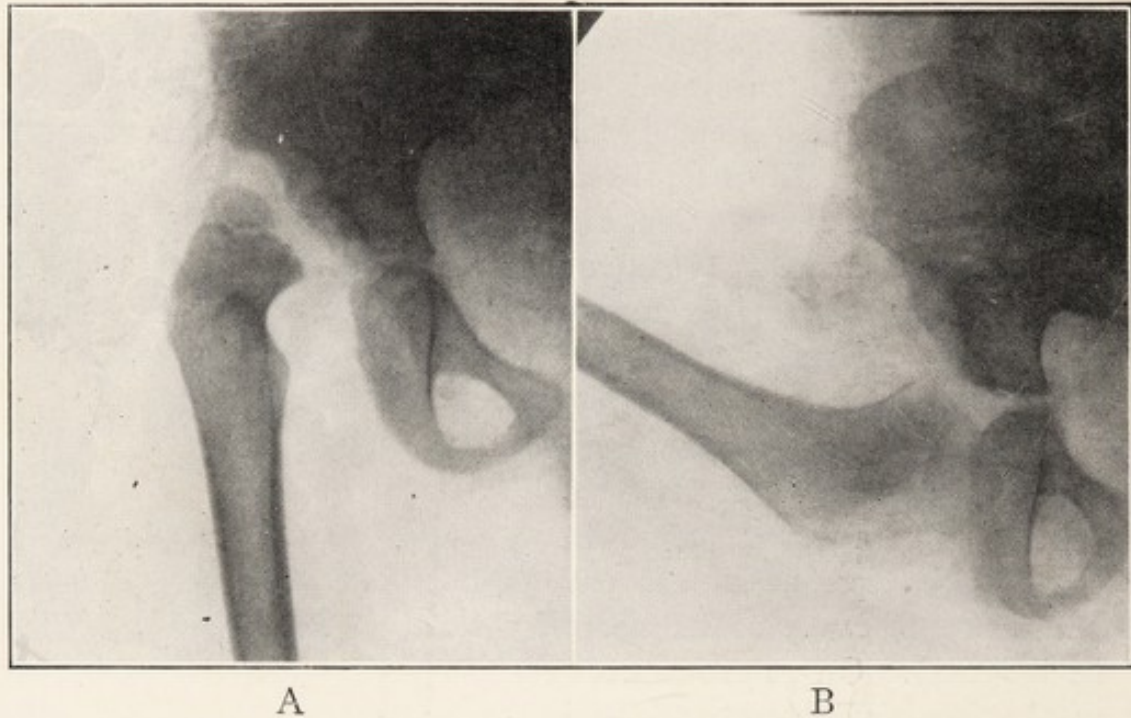


FIG. 209-A.—X-RAY OF CONGENITAL DISLOCATION OF LEFT HIP, SHOWING DEFICIENCY OF RIM OF ACETABULUM AND FORMATION OF FALSE ACETABULUM.

FIG. 209-B.—SAME AS FIGURE 209-A, AFTER REDUCTION AND FIXATION IN FULL ABDUCTION.

there is usually adduction contracture with limited motion in the hip-joint. The only condition which may present almost identical symptoms is a dislocation of the hip following acute infectious arthritis, or some low-grade painless process, as syphilis. In these conditions, differentiation can be made by the x-ray, which shows marked destructive changes in the roof of the acetabulum. The roof may have entirely disappeared, permitting the hip to ascend from the pressure of weight-bearing. Such affections as tuberculosis of the hip, coxa plana, coxa vara and infectious arthritis present both subjective and objective symptoms which are significant of the lesion in question.

The x-ray, in congenital dislocation, demonstrates the pathological anatomy above described: the head of the femur dislocated, with anomalous contour, and the acetabulum flat, but with no destructive process present.

Prognosis.—The prognosis depends entirely upon the time the diagnosis

is made and the age of the patient when reduction is attempted. If reduction is made at the proper age, without undue trauma, a normal hip-joint, with normal function, may be expected. It is therefore obvious that an early diagnosis is of the utmost importance. The preferable age for reduction is from two to four years. As age advances, the head, the neck of the femur and the acetabulum become more abnormal and reduction is increasingly difficult. For the same reason, the possibility of securing good function, even after reduction, is also diminished. Anatomical reduction with good function may be secured as late as eight or ten years, or older, but the percentage of successes is far less than in early childhood. It is

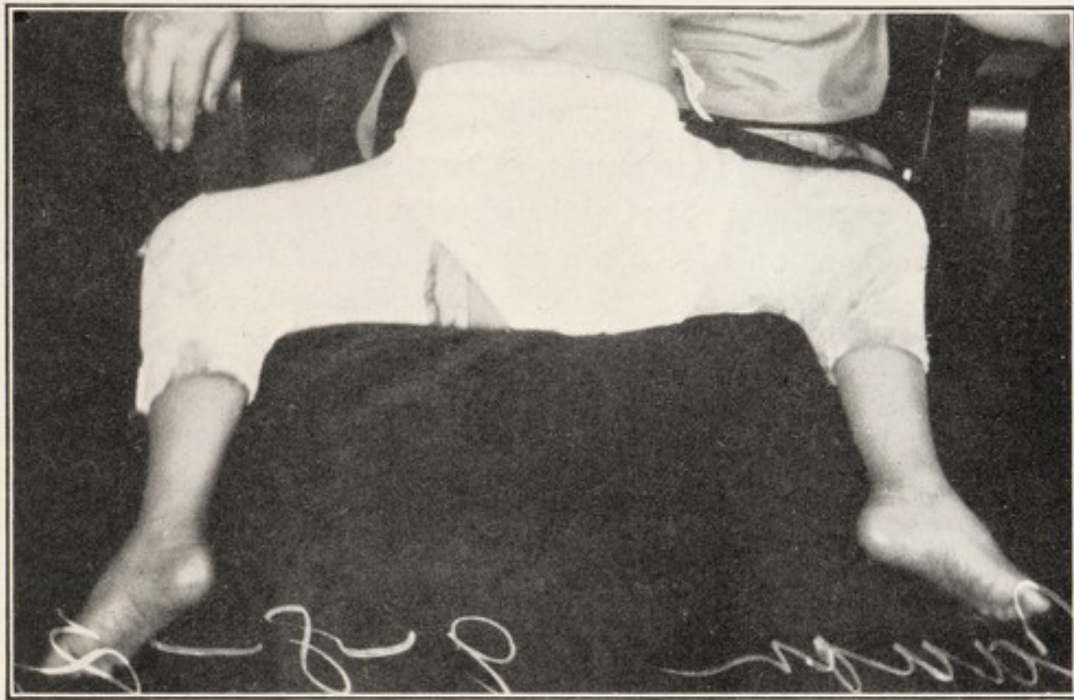


FIG. 210.—PHOTOGRAPH OF BILATERAL CONGENITAL DISLOCATION OF HIPS AFTER REDUCTION, SHOWING PLASTER-OF-PARIS CAST FROM PELVIS TO BELOW KNEES, LORENZ POSITION.

the duty of the attending physician to make these conditions plain to the parents and to urge proper procedures at the most propitious time. In many, the reduction of congenital dislocation of the hip is not difficult, but in the hands of a novice, there may be irreparable damage. In single dislocations, the prognosis is, of course, better than in the bilateral form.

Treatment.—The method of reduction chosen depends upon the operator. After reduction, the hip is placed in a plaster-of-Paris spica cast in that position in which reduction can be maintained most effectively, and a sufficient time allowed to elapse for the development of the acetabulum to such an extent that the head will be retained. This usually requires from six to eight months, after which physiotherapy is often a valuable adjuvant in the restoration of function. In older children, above the age of eight, and in some instances below this age, depending upon the development of the individual, reduction may rarely be accomplished without undue force.

If too much trauma is necessary, open operation is preferable. In many, even open reduction may be accomplished only by too much tension on the soft parts, and under such circumstances should not be attempted. In those in whom an early diagnosis is not made and reduction is not possible, much relief of pain and disability, as well as improvement in function, may often be secured by open operation and the formation of a new acetabulum on the dorsum of the ilium on a line with the normal acetabulum. This procedure may be carried out in adults as well as in older children. If beyond the age when reduction can be safely accomplished, permanent disability must be expected in every case.

ANOMALIES OF THE SPINE

Congenital anomalies of the spine are not uncommon, as deficiencies in the number of vertebræ, supernumerary vertebræ, partial supernumerary vertebræ and hypertrophy of normal processes. Variations are prone to occur about the junction of the different regions of the spine. Cervical ribs may be rudimentary or complete; they usually give no trouble during childhood, but cause symptoms by pressure on the brachial plexus or large vessels at the root of the neck in early adult life. Spinal anomalies may be associated with fusion of one or more ribs. There may be six instead of five lumbar vertebræ. The transverse processes of the fifth lumbar vertebra may be enlarged and encroach upon the wing of the sacrum, and may also cause symptoms in later life. Spina bifida, due to lack of fusion of the spinous processes, may occur, and may be of the occult variety or associated with meningocele and nerve symptoms.

In the cervical spine, there is often a congenital deformity which may be only postural, but is often associated with bone structural deformity.

TORTICOLLIS

Torticollis is described as congenital and acquired. The acquired type has been described as a manifestation of such conditions as tuberculosis and infected glands of the neck. The congenital type, or wry-neck, like other congenital deformities, is caused by errors in development or position *in utero*. Rarely, myositis of the sternocleidomastoid muscle from birth injury with hematoma may cause torticollis, which, in reality, is not congenital but acquired.

Congenital torticollis is the contracture of the sternocleidomastoid muscle *in utero*. At the birth the head deviates toward the side of the contracted muscle and the chin toward the opposite side. In a large number, the muscle only is contracted, but not infrequently there may be associated structural deformity in the cervical vertebræ and also congenital anomalies. When

torticollis is of long standing, there is asymmetrical development of the face. The side on which the sternomastoid muscle is contracted is usually very much atrophied, the degree of atrophy being increased in proportion to the duration of the deformity.

Diagnosis.—The diagnosis of torticollis is made from the history and clinical manifestations, though differentiation from the acquired type is often necessary. Congenital torticollis is frequently associated with scoliosis of the entire spine, which, however, is not often exaggerated (asymmetry). The diagnosis of congenital torticollis is usually apparent, as there are no local symptoms; acquired torticollis may require differentiation in those in whom there is no available history. In tuberculosis of the cervical vertebræ, there is torticollis, but all the muscles of the neck are in a state of spasm and there are other local symptoms. If of long duration, the x-ray will also define a tuberculous process. Traumatic torticollis, or an infectious process of the neck, as in tuberculosis of the cervical glands, presents definite local symptoms and manifestations. In ocular or aural affections, with defective vision and hearing, the head may be held to one side, but can usually be corrected by force or under anesthesia. Hysterical torticollis is not uncommon, but can usually be differentiated by the nervous status of the child.

Prognosis and Treatment.—

The treatment of congenital torticollis should be instituted early—on the day of birth, if possible. This treatment consists in manipulating the head against contracture of the sternomastoid muscle: for example, if the right sternomastoid is contracted, the occiput and chin are grasped with the hands and the chin rotated to the right and the occiput to the left. This should be carried out three or four times a day for three to five months, gradually increasing the time of manipulation at each treatment. In bed, the infant should be placed on the side to which the occiput rotates; no pillow should be used. An ordinary brick, suitably covered and placed against the occiput on the side to which the occiput deviates, will hold the head partially straight when the infant is on its



FIG. 211.—PHOTOGRAPH OF CONGENITAL TORTICOLLIS, SHOWING DEVIATION OF HEAD TOWARD AFFECTED SIDE AND CHIN TOWARD OPPOSITE SIDE.

back. By these simple means, a large percentage can be corrected during the first year. In those of longer duration, an operation by an expert, with efficient after-treatment, is required, which consists in severance of the sternomastoid muscle and overcorrecting the deformity by placing in the position of torticollis in the opposite direction. The overcorrected position must be maintained by apparatus for several weeks, and in some instances, for several months. Head traction at night and manipulation of the head and neck, as described, should be carried out for some time after the apparatus has been discarded. Asymmetry of the face disappears entirely when correction is obtained in early childhood and improves to a marked degree when correction is made later. Should structural deformity and congenital anomalies exist, full correction may be impossible, but with efficient treatment, marked improvement may be expected in the majority.

INDEX

- Abbott frame, scoliosis and, 268
- Abortive poliomyelitis, 218
- Abscess, psoas, acute infectious arthritis and, 60
 - acute infectious spondylitis and, 62
 - hip-joint tuberculosis differentiated from, 82
 - treatment of, 66
 - spinal tuberculosis complicated by, 88
 - tuberculous, treatment of, 76
- Achillobursitis, orthopedic management of, 217
- Active motion, orthopedic examination by, 8
 - sacro-iliac joint and, 21
 - spine and, 23
 - Willems', acute infectious arthritis and, 55
- Acute anterior poliomyelitis, clinical course of, 218
 - etiology of, 218
 - Little's disease differentiated from, 239
 - operative measures for correction of deformity, 228
 - orthopedic management of, 218
 - pathology of, 218
 - prognosis of, 225
 - progressive muscular atrophy differentiated from, 247
 - symptoms of, 218
 - treatment of, 226
- Acute infectious arthritis, ankle manifestations encountered in, 58
 - clinical course of, 51
 - diagnosis of, 52
 - elbow and, 67
 - etiology of, 50
 - foot management in, 58
 - hand and, 67
 - hip-joint and, 60
 - joint tuberculosis differentiated from, 71
 - knee and, 59
 - laboratory and x-ray observations in, 52
 - pathology of, 50
 - physiotherapy and, 57
- Acute infectious arthritis, prognosis of, 54
 - psoas abscess and, 60
 - shoulder joint and, 66
 - surgery and, 53, 55
 - symptoms of, 51
 - treatment of, 54
 - wrist and, 67
- Acute infectious osteomyelitis, diagnosis of, 131
 - etiology of, 128
 - local manifestations of, 129
 - pathology of, 128
 - prognosis of, 133
 - symptoms of, 129
 - treatment of, 135
 - x-ray and, 130
- Acute infectious spondylitis, diagnosis of, 64
 - prognosis of, 64
 - psoas abscess and, 62
 - symptoms of, 62
 - treatment of, 66
 - tuberculosis of spine differentiated from, 91
 - x-ray findings in, 64
- Acute traumatic arthritis, pathology of, 118
- Acute traumatic spondylitis, treatment of, 122
- Adhesions, arm-chest, treatment of, 206
- Albee bone graft, scoliosis and, 269
 - spinal tuberculosis and, 93, 94
- Alpine light, coxa plana and, 110
- Ancient dislocations, 177
- Ankle, acute infectious arthritis of, 58
 - acute traumatic arthritis of, 118
 - braces for, 28
 - inspection of, 12
 - orthopedic examination of, 12
 - plaster-of-Paris supports for, 27
 - poliomyelitis affecting, orthopedic measures for, 230
 - splinting of, 27
 - sprain of, 118
 - tuberculosis of, diagnosis of, 76
 - treatment of, 78

- Ankylosis, acute infectious arthritis and,
51, 54, 56
— hip-joint, 17
— tuberculosis and, 70, 83
Anomalies, congenital, anomalies of spine,
292
— — classification of, 274
— — deformities of feet, 280
— — deformities of hip, 288
— — deformities of knee, 287
— — etiology of, 274
— — orthopedic management of, 49, 273
— — torticollis, 292
Anterior poliomyelitis, acute, clinical
course of, 218
— — etiology of, 218
— — Little's disease differentiated from,
239
— — operative measures for correction of
deformity, 228
— — orthopedic management of, 218
— — pathology of, 218
— — prognosis of, 225
— — progressive muscular atrophy differ-
entiated from, 247
— — scoliosis and, 263
— — symptoms of, 218
— — treatment of, 226
— — Volkmann's paralysis differentiated
from, 212
Apparatus, orthopedic, 26
— — Calot jacket, 41
— — general considerations, 26
— — head and neck, 39
— — low-grade joint affections and, 72
— — measurement of braces, 46
— — Sayre suspension, 39
— — symptoms of constriction, 44
— — time element in use of, 1
Arch, fallen, supports for, 259
— — osteoporosis and, 18
Arm-chest adhesions, treatment of, 206
Arsphenamin, bone and joint syphilis and,
102
Arthritis, acute infectious, ankle mani-
festations encountered in, 58
— — clinical course of, 51
— — diagnosis of, 52
— — elbow and, 67
— — etiology of, 50
— — foot management in, 58
— — hand and, 67
— — hip-joint and, 60
— — joint-tuberculosis differentiated from,
71
Arthritis, acute infectious, knee and, 59
— — laboratory and x-ray observations
in, 52
— — pathology of, 50
— — physiotherapy and, 57
— — prognosis of, 54
— — psoas abscess and, 60
— — shoulder joint and, 66
— — surgery and, 53, 55
— — symptoms of, 51
— — treatment of, 54
— — wrist and, 67
— acute traumatic, pathology of, 118
— chronic infectious, clinical course of,
103
— — diagnosis of, 104
— — etiology of, 102
— — pathology of, 103
— — prognosis of, 105
— — symptoms of, 103
— — treatment of, 105
— — types of, 103
— — x-ray and, 104
— chronic traumatic, character of, 123
— subacute traumatic, characteristics of,
123
— tuberculous, 68
Arthritis deformans, clinical course of,
106
— treatment of, 107
Arthrodesis, age affecting justification
of, 1
— flat-foot and, 260
— poliomyelitis affecting shoulder and,
235
Arthroplasty, elbow dislocation and, 178
Aspiration, acute infectious arthritis and,
55, 58, 59
— orthopedic examination by, 8
Astragalectomy, 232
Ataxia, Friedreich's, orthopedic manage-
ment of, 250
— hereditary, orthopedic management of,
250
Atrophy, bone, 181
— congenital, orthopedics and, 274
— progressive muscular, clinical course
of, 246
— — diagnosis of, 247
— — etiology of, 246
— — muscular dystrophy differentiated
from, 247
— — pathology of, 246
— — symptoms of, 246
— — treatment of, 247

- Auscultation, orthopedic examination by, 8
- Autogenous vaccines, chronic infectious arthritis and, 105
- Bandages, orthopedic, plaster-of-Paris, 26
- Basket-weave adhesive bandage, 120
- Bed-pans, Bradford frame and use of, 38
- Benign bone tumors, Bloodgood's, 196
- chondroma, 193
- osteochondroma, 192
- Birth injuries, congenital fractures differentiated from, 175
- Little's disease and, 237
- Birth paralysis, 243
- Blood, dyscrasias of, orthopedic considerations of, 125
- Bloodgood's benign giant-celled bone tumor, 196
- Bone, acute affections of, osteomyelitis, 128
- affections of, orthopedic, 48
- atrophy of, 181
- brittleness of, 190
- changes shown by x-ray of, 10
- character of early, 1
- congenital deficiencies in quality of, 189
- cyst of, 142
- endocrine disturbances of, 192
- hereditary deficiency of, 190
- low-grade affections of, epiphysitis of extra-articular epiphyses, 144
- — Garré's sclerosing osteomyelitis, 139
- — osteitis fibrosa cystica, 142
- — syphilis, 136
- — tuberculosis, 136
- marble, 191
- neoplasms of, 192, 200
- nutritional disorders of, osteomalacia, 187
- — rickets, 182, 187
- — scurvy, 188
- syphilis of, destructive stage of, 138
- — diagnosis of, 139
- — Garré's sclerosing osteomyelitis and, 139
- — osteochondritis form of, 137
- — osteomyelitis form of, 138
- — periosteal stage of, 137
- — prognosis of, 139
- — symptoms of, 136
- — treatment of, 139
- Bone, syphilis of, Wassermann test and, 101
- traumatic affections of, 147
- — dislocations, 177
- — epiphyseal separations, 166
- — fractures, 147
- — malunited fractures, 169
- — osteitis, 181
- — osteoporosis, 181
- — ununited fractures, 174
- tuberculosis of, 136
- tumors of, 192, 200
- x-ray examination of, 9
- Bone-grafts, age of child and, 176
- congenital fractures and, 176
- massive, ununited fractures and, 174
- Bow-leg, pathology of, 183
- rickets causing, 182
- treatment of, 185
- Brace, orthopedic, Bradford's abduction, 110, 113
- — knee, 33
- — measurement of, 46
- — plaster-of-Paris, 28
- — poliomyelitis and, 235
- — spinal, 42
- Bradford abduction brace, coxa plana and, 110
- coxa vara and, 113
- Bradford frame, acute traumatic spondylitis and, 122
- bed-pans and, 38
- emergency use of, 40
- hip-joint and, 34, 37
- rickets and, 182
- scoliosis and, 268
- spinal tuberculosis and, 92
- spine and, 37, 92
- tuberculosis of hip and, 84
- Brisement forcé, acute infectious arthritis and, 57
- Brittle bone, 190
- Buck's extension, description of, 29
- hip-joint dislocations and, 179
- hip sprain and, 120
- spinal tuberculosis and, 92
- tuberculosis of hip and, 83
- tuberculosis of knee and, 80
- Burns, scar contractures following, 201
- Bursæ, affections of, orthopedic management of, 49, 216
- Bursitis, prepatellar, orthopedic management of, 217
- subacromial, orthopedic management of, 217

- Calcaneobursitis, orthopedic management of, 216
 Calcaneovalgus, congenital, treatment of, 286
 Callus, peripheral nerve injury and, 251
 Calot jacket, 41
 Calvé's disease, tuberculosis of joints differentiated from, 71, 83
 Campbell-Mitchner knee splint, 60
 Casts, orthopedic, plaster-of-Paris, 36
 Cerebral paralysis, spastic, diagnosis of, 239
 — etiology of, 237
 — pathology of, 238
 — symptoms of, 238
 — treatment of, 240
 Cerebral poliomyelitis, 218
 Chondrodysplasia foetalis, 192
 Chondroma, joints and, 126
 — treatment of, 193
 Chorea, Friedreich's ataxia resembling, 250
 Chronic infectious arthritis, clinical course of, 103
 — diagnosis of, 104
 — etiology of, 102
 — pathology of, 103
 — prognosis of, 105
 — symptoms of, 103
 — treatment of, 105
 — types of, 103
 — x-ray and, 104
 Chronic infectious spondylitis, symptoms of, 104
 Chronic traumatic arthritis, characteristics of, 123
 Clavicle, fracture of, diagnosis of, 165
 — frequency of, 161
 — prognosis of, 165
 — symptoms of, 164
 — treatment of, 165
 — x-ray examination of, 165
 Claw-toes, acute infectious arthritis causing, 58
 Club-foot, congenital, description of, 280
 — diagnosis of, 281
 — prognosis of, 281
 — treatment of, 282
 Club-hand, congenital, 278
 — peripheral nerve injury and, 253
 Cod-liver oil, joint tuberculosis and, 72
 Colles' fracture, rarity in young children, 151
 Compensatory lumbar lordosis, 17, 19
 Congenital anomalies, anomalies of spine, 292
 — classification of, 274
 — deformities of feet, 280
 — deformities of hip, 288
 — deformities of knee, 287
 — etiology of, 274
 — orthopedic management and, 49, 274
 — torticollis, 292
 Congenital atrophy, orthopedics and, 274
 Congenital bone deficiencies, chondrodysplasia foetalis, 192
 — dyschondroplasia, 192
 — fragilitas ossium, 189
 — osteosclerosis, 191
 Congenital calcaneovalgus, treatment of, 286
 Congenital club-foot, description of, 280
 — diagnosis of, 281
 — prognosis of, 281
 — treatment of, 282
 Congenital hypertrophy, 274
 Congenital equinus, treatment of, 286
 Congenital flat-foot, treatment of, 286
 Congenital fractures, 175
 Congenital hip dislocation, 288
 Congenital laxity, knee showing, 13
 Congenital osteosclerosis, 191
 Congenital syphilis, bones and joints and, 98
 — splastic cerebral paralysis and, 238
 Congenital valgus, treatment of, 286
 Constriction, bandage, symptoms of, 44
 Contracture, scar, etiology of, 201
 — factors determining extent of, 201
 — prevention of, 202
 — treatment of, 204
 — Volkmann's, orthopedic management of, 211
 Coxa plana, diagnosis of, 110
 — etiology of, 108
 — prognosis of, 110
 — symptoms of, 109
 — treatment of, 110
 — tuberculosis of joints differentiated from, 71, 83
 — x-ray examination, 110
 Coxa valga, etiology of, 114
 Coxa vara, diagnosis of, 113
 — epiphyseal separation causing, 168
 — etiology of, 111
 — pathology of, 111
 — prognosis of, 113
 — rickets causing, 182

- Coxa vara, symptoms of, 112
 — treatment of, 113
 — tuberculosis of joints differentiated from, 83
 — x-ray and, 111
 Crepitation, orthopedic significance of, knee and, 13
 Crutches, measurement for, 28
 Cyst, bone, 142
 Cystic osteitis fibrosa, 142
- Dakin's solution, scar prevention and, 202
 Dangle-foot, 223
 Davis' skin-grafts, scar contractures and, 205
 Deformities, foot, congenital, 280
 — — congenital club-foot, 280
 — — orthopedic management of, 256
 — — talipes, 280
 — hip-joint, congenital dislocation of, 288
 — knee, genu recurvatum, 287
 — — malformation and rotary displacements of, 288
 — spinal, hollow-back, 269
 — — round shoulders, 269
 — — scoliosis, 260
 — — spondylolisthesis, 270
 — static, hollow-back, 269
 — — orthopedic management of, 256
 — — round shoulders, 269
 — — scoliosis, 260
 — — spondylolisthesis, 270
 — — visceroptosis, 272
 — — weak foot, 257
 Delanginere bone-graft, ununited fractures and, 175
 Diphtheria, peripheral nerve injury and, 251
 Dislocation, ancient and recent, 177
 — hip-joint, congenital, 288
 — spontaneous hip, 224
 Drop-foot, operation for, 231
 Dyschondroplasia, orthopedic considerations, 192
 Dyscrasias, blood, joints and, 125
 Dystrophy, muscular, clinical forms of, 248
 — — diagnosis of, 249
 — — etiology of, 248
 — — pathology of, 248
 — — prognosis of, 249
 — — progressive muscular atrophy differentiated from, 247, 249
- Dystrophy, muscular, symptoms of, 248
 — — treatment of, 249
- Edema, peripheral nerve injury and, 251
 Elbow, acute infectious arthritis of, 67
 — acute traumatic arthritis of, 122
 — dislocations of, ancient and recent, 178
 — fixation of, 44
 — fracture of, 156
 — — peripheral nerve injury and, 251
 — malunited fractures of, 171
 — poliomyelitis and, 225, 233
 — scar contractures of, 209
 — sprain of, 122
 — tennis, orthopedic management of, 217
 — tuberculosis of, management of, 95
 Endocrines, bone disturbances and, 192
 Endothelioma, Ewing's, 199
 Epiphyseal enlargement, rickets causing, 182
 Epiphyseal separations, 166
 Epiphysitis, extra-articular, generalized, 146
 — — Köhler's disease and, 145
 — — os calcis and, 144
 — — Osgood-Schlatter's disease and, 146
 — — scaphoid and, 145
 — — tibial tubercle and, 146
 — tuberculosis of joints differentiated from, 71
 — tuberculosis of spine differentiated from, 91
 Equinovarus, description of, 280
 — diagnosis of, 281
 — prognosis of, 281
 — treatment of, 282, 286
 Ewing's endothelioma, 199
 Extra-articular epiphysitis, orthopedic considerations of, 144, 146
- Fallen arch, supports for, 259
 Fallen viscera, orthopedic considerations of, 272
 Fascia, affections of, orthopedic, 49
 Femur, birth fractures of, 150
 — congenital anomalies of, 278
 — fracture of shaft of, 149
 — malunited fractures of, 170
 Fetal rickets, 192
 Fibroma, joints and, 126
 — recurrent bone, 196
 Fibrous osteitis cystica, 142
 Fibula, congenital anomalies of, 278

- Fibula, fracture of, peripheral nerve injury and, 252
- Fingers, scar contractures of, 207
- Flail-foot, 223
- Flat-foot, congenital, treatment of, 286
- deformity in, 257
 - diagnosis of, 258
 - examination of, 257
 - symptoms of, 257
 - treatment of, 258
- Foot, acute infectious arthritis of, 58
- congenital anomalies of, 278
 - deformities of, 280
 - — orthopedic management of, 256
 - — talipes, 280
 - flat, deformity in, 257
 - — diagnosis of, 258
 - — examination of, 257
 - — symptoms of, 257
 - — treatment of, 258
 - inspection of, 12
 - normal, structure and function of, 256
 - orthopedic examination of, 12
 - poliomyelitis and, 220, 230
 - scar contractures of, 209
 - tuberculosis of, diagnosis of, 76
 - — treatment of, 78
 - weak, deformity in, 257
 - — diagnosis of, 258
 - — examination of, 257
 - — symptoms of, 257
 - — treatment of, 258
 - x-ray of normal, 2
- Forearm, fracture of, 151
- Formalin, acute infectious arthritis and, 55
- tuberculous abscess and, 76
- Fracture, birth, 175
- clavicle, 161
 - congenital, 175
 - elbow, 156
 - femur, 149
 - forearm, 151
 - fragilitas ossium and, 191
 - general considerations of, 147
 - humerus, 156, 158
 - malunited, 169
 - osteitis fibrosa cystica and, 143
 - osteomalacia and, 187
 - peripheral nerve injuries and, 251
 - spine, 151
 - — tuberculosis of spine differentiated from, 91
 - ununited, 174
 - x-ray and, 147
- Fragilitas ossium, 49, 189
- Friction fremitus, knee showing, 13
- Friedreich's ataxia, orthopedic management of, 250
- Ganglia, treatment of, 215
- Garré's sclerosing osteomyelitis, diagnosis of, 141
- local manifestations of, 139
 - pathology of, 139
 - prognosis of, 141
 - symptoms of, 139
 - treatment of, 141
- Generalized extra-articular epiphysitis, 146
- Gentian violet, acute infectious arthritis and, 55
- Genu recurvatum, description of, 224
- orthopedic management of, 287
- Genu valgum, definition of, 185
- epiphyseal separation causing, 166
 - rickets causing, 182
 - treatment of, 185
 - tuberculosis causing, 78
- Genu varum, definition of, 183
- rickets causing, 182
 - treatment of, 185
- Giant-celled bone tumors, diagnosis of, 196
- occurrence of, 194
 - pathology of, 195
 - treatment of, 196
- Gibney adhesive sprain dressing, 119
- Gonococcus, acute infectious arthritis and, 50
- Grafts, bone, age of child and, 176
- — homogeneous, congenital fractures and, 176
 - — massive, congenital fractures and, 177
 - — ununited fractures and, 174
 - skin, scar prevention and, 203
 - — scar treatment by, 204
 - — types of, 205
- Hand, acute infectious arthritis of, 67
- scar contractures of, 207
- Harrison's groove, rickets and, 182
- Head, orthopedic apparatus for, 39
- Heel, scar contractures of, 209
- Heliotherapy, chronic infectious arthritis and, 106
- coxa plana and, 110

- Heliotherapy, foot and ankle tuberculosis and, 76
 — joint tuberculosis and, 72
 — rickets and, 182
 Hematoma, peripheral nerve injury and, 251
 Hemorrhage, petechial, scurvy causing, 188
 Henderson shoulder splint, 43
 Hereditary ataxia, orthopedic management of, 250
 Hereditary bone deficiency, fragilitas ossium, 190
 Hibbs' boneplasty, spinal tuberculosis and, 94
 Hibbs' fusion operation, scoliosis and, 269
 Hip-joint, acute infectious arthritis and, 60
 — acute traumatic arthritis of, 120
 — ankylosis of, 17
 — Bradford frame and, 34
 — compensatory lumbar lordosis of, 17, 19
 — deformities of, congenital dislocation of, 288
 — dislocations of, 178
 — inspection of, 15
 — measurements in examination of, 18
 — Nélaton's line and examination of, 18
 — orthopedic apparatus for, 34
 — orthopedic examination of, 15
 — palpation of, 16
 — passive motion in examination of, 16
 — poliomyelitis affecting, operative measures for, 233
 — poliomyelitis and, 224
 — sprain of, 120
 — Thomas splint for, 37
 — Trendelenburg's sign, 16
 — tuberculosis of, diagnosis of, 82
 — — pathology of, 81
 — — prognosis of, 83
 — — symptoms of, 82
 — — treatment of, 83
 — x-ray examination of, 18
 History card, orthopedic, 5, 7
 Hollow-back, orthopedic management of, 269
 Homogeneous bone-grafts, congenital fractures and, 176
 Housemaid's knee, orthopedic management of, 217
 Humerus, fracture of, 156
 — — malunited, 170, 172
 — — peripheral nerve injury and, 251
 — — shaft, 158
 Humerus, fracture of, supracondylar, 156
 Hypertrophy, congenital bone, orthopedic considerations of, 274
 Hysteria, tuberculosis of spine differentiated from, 91
 Hysterical paralysis, orthopedic considerations of, 254
 Hysterical torticollis, diagnosis of, 293
 Idiocy, Mongolian, Little's disease differentiated from, 240
 Ilium, transplant of crest of, tuberculosis of hip and, 84
 Infection, bone, acute, 128
 — — low-grade, 136
 — — susceptibility of children to, 3
 — joint, low-grade, 68, 98
 — scar contractures following, 201
 Infectious arthritis, acute, ankle manifestations encountered in, 58
 — — clinical course of, 51
 — — diagnosis of, 52
 — — elbow and, 67
 — — etiology of, 50
 — — foot management in, 58
 — — hand and, 67
 — — hip-joint and, 60
 — — joint tuberculosis differentiated from, 71
 — — knee and, 59
 — — laboratory and x-ray observations in, 52
 — — pathology of, 50
 — — physiotherapy and, 57
 — — prognosis of, 54
 — — psoas abscess and, 60
 — — shoulder joint and, 66
 — — surgery and, 53, 55
 — — symptoms of, 51
 — — treatment of, 54
 — — wrist and, 67
 — chronic, clinical course of, 103
 — — diagnosis of, 104
 — — etiology of, 102
 — — pathology of, 103
 — — prognosis of, 105
 — — symptoms of, 103
 — — treatment of, 105
 — — types of, 103
 — — x-ray and, 104
 Infectious osteomyelitis, acute, diagnosis of, 131
 — — etiology of, 128

- Infectious osteomyelitis, acute, local
 manifestations of, 129
 — pathology of, 128
 — prognosis of, 133
 — symptoms of, 129
 — treatment of, 135
 — x-ray and, 130
- Infectious spondylitis, acute, diagnosis
 of, 64
 — prognosis of, 64
 — psoas abscess and, 62
 — symptoms of, 62
 — treatment, 66
 — tuberculosis of spine differentiated
 from, 91
 — x-ray findings in, 64
 — chronic, symptoms of, 104
- Infraction, metatarsal, 107
- Involucrum, definition of, 129
- Iodids, joint tuberculosis and, 72
 — syphilis of bones and joints and, 102
- Ischemic myositis, diagnosis of, 212
 — etiology of, 211
 — pathology of, 212
 — prognosis of, 213
 — symptoms of, 212
 — treatment of, 213
- Jackets, orthopedic, plaster-of-Paris, 40
- Joints, acute affections of, 50
 — infectious arthritis, 50
 — infectious spondylitis, 62
 — affections of, orthopedic, 47
 — blood dyscrasias and, 125
 — low-grade affections of, 68, 98
 — ankle tuberculosis, 76
 — arthritis deformans, 106
 — chronic infectious arthritis, 102
 — coxa plana, 108
 — coxa valga, 114
 — coxa vara, 111
 — elbow tuberculosis, 95
 — foot tuberculosis, 76
 — hip tuberculosis, 81
 — knee tuberculosis, 78
 — Köhler's disease, 107
 — Legg's disease, 108
 — osteochondritis, 107, 114
 — Perthes' disease, 108
 — Pott's disease, 85
 — shoulder tuberculosis, 95
 — spinal tuberculosis, 85
 — Still's disease, 106
 — syphilis, 98
- Joints, low-grade affections of, tuberculo-
 sis, 68, 85
 — upper extremity tuberculosis, 95
 — wrist tuberculosis, 96
 — malignant tumors of, 126
 — neoplasms affecting, 125
 — syphilis of, concomitant infections in,
 101
 — diagnosis of, 101
 — pathology of, 98
 — prognosis of, 102
 — symptoms of, 99
 — treatment of, 102
 — types of, 99
 — Wassermann test in, 101
 — x-ray examination of, 100
 — traumatic affections of, 118
 — acute arthritis, 118
 — blood dyscrasias, 125
 — malignant tumors, 126
 — neoplasms, 125
 — subacute arthritis, 123
 — tumors, 125
 — tumors affecting, 125
 — x-ray examination of, 9
- Jones' splint, 44
- Knee, acute infectious arthritis and, 59
 — acute traumatic arthritis of, 119
 — braces for, 33
 — Buck's extension and, 29
 — Campbell-Mitchner splint for flexion-
 deformity of, 60
 — congenital laxity of, 13
 — crepitation in, 13
 — deformities of, genu recurvatum, 287
 — malformation and rotary displace-
 ments of, 288
 — examination of, 12
 — friction fremitus in, 13
 — "housemaid's," orthopedic management
 of, 217
 — hyperextension of, 287
 — inspection of, 12
 — malformation of, 288
 — orthopedic examination of, 12
 — orthopedic management of, plaster-of-
 Paris and, 29
 — poliomyelitis involving, 223
 — operative measures for, 232
 — rotary displacements of, 288
 — scar contractures of, 208
 — sprain of, 119
 — subacute traumatic arthritis of, 123

- Knee, Thomas splint for, 30
 — tuberculosis of, prognosis of, 79
 — — symptoms of, 78
 — — treatment of, 80
 — x-ray of, 14
 Knock-knee, pathology of, 185
 — rickets causing, 182
 — treatment of, 185
 — tuberculosis causing, 78
 Köhler's disease, definition of, 107
 — joint tuberculosis differentiated from, 77
 — symptoms and treatment of, 145
 Krause skin-grafts, scar contractures and, 205
 Kümmell's disease, osteochondritis and, 115
 — tuberculosis of spine differentiated from, 91
 Kyphosis, acute infectious spondylitis and, 62
 — Bradford frame and, 38
 — definition of, 22
 — destructive lesions causing, 267
 — rickets causing, 182
 — round shoulders and, 270
 — spinal tuberculosis and, 87

 Lacerated wounds, scar contractures following, 201
 Latent bone rickets, 187
 Lateral sclerosis, Little's disease differentiated from, 240
 Laxity, congenital, knee showing, 13
 Lead poisoning, peripheral nerve injury and, 251
 Leg, congenital anomalies of, 278
 Legg's disease, diagnosis, 110
 — etiology of, 108
 — prognosis of, 110
 — symptoms of, 109
 — treatment of, 110
 — tuberculosis of joints differentiated from, 71, 83
 — x-ray examination, 110
 Ligaments, affections of, orthopedic, 49
 — knee, testing of, 13
 Lipoma, joints and, 126
 Little's disease, etiology of, 237
 Locomotor ataxia, Friedreich's ataxia differentiated from, 250
 Lordosis, compensatory lumbar, 17, 19
 — definition of, 22
 Lordosis, spinal tuberculosis and, 88
 Low-grade joint affections, orthopedic management of, 68, 98

 Malignant bone tumors, endothelioma, 199
 — myeloma, 200
 — nomenclature of, 196
 — periosteal sarcoma, 197
 Malunion, orthopedic considerations of, 169
 Malunited fractures, 169
 Marble bones, 191
 Martin knee extension, 208
 Massive bone-graft, ununited fractures and, 174
 Medullary poliomyelitis, 218
 Meningitic poliomyelitis, 218
 Meningitis, tuberculous, hip-joint tuberculosis and, 82
 — — prognosis of, 71
 Meningococcus, acute infectious arthritis and, 50
 Mensuration, hip examination and, 18
 — orthopedic examination and, 8
 Mercurochrome, acute infectious arthritis and, 55
 Mercury, syphilis of bones and joints and, 102
 Mercury quartz light, value of, 75
 Methylene-blue, acute infectious arthritis and, 55
 Mongolian idiocy, Little's disease differentiated from, 240
 Multiple osteochondroma, 192
 Muscle, affections of, orthopedic, 49, 210
 — inflammation of, 211
 — rupture of, 210
 Muscular atrophy, progressive, clinical course of, 246
 — — diagnosis of, 247
 — — etiology of, 246
 — — muscular dystrophy differentiated from, 247
 — — pathology of, 246
 — — symptoms of, 246
 — — treatment of, 247
 Muscular dystrophy, clinical forms of, 248
 — diagnosis of, 249
 — etiology of, 248
 — pathology of, 248
 — prognosis of, 249

- Muscular dystrophy, progressive muscular atrophy differentiated from, 247, 249
 — symptoms of, 248
 — treatment of, 249
 Myeloma, 200
 Myositis, ischemic, diagnosis of, 212
 — etiology of, 211
 — pathology of, 212
 — prognosis of, 213
 — symptoms of, 212
 — treatment of, 213
 Myositis ossificans, etiology of, 213
 — pathology of, 214
 — sprain of elbow causing, 122
 — treatment of, 215
 — types of, 213
- Neck, orthopedic apparatus for, 39
 — wry, orthopedic management of, 292
 Nélaton's line, hip examination and, 18
 Neo-arsphenamin, syphilis of bones and joints and, 102
 Neoplasms, bone, benign, 192
 — chondroma, 193
 — endothelioma, 199
 — malignant, 196
 — myeloma, 200
 — osteochondroma, 192
 — periosteal sarcoma, 197
 — recurrent, 196
 — joint, types of, 125
 Nerves, peripheral, injuries to, 250
 Nervous system, affections of, anterior poliomyelitis, 218
 — birth paralysis, 243
 — Friedreich's ataxia, 250
 — hereditary ataxia, 250
 — hysterical paralysis, 254
 — Little's disease, 237
 — muscular dystrophy, 248
 — obstetrical paralysis, 243
 — orthopedic, 49
 — peripheral nerve injuries, 250
 — progressive muscular atrophy, 246
 — spastic cerebral paralysis, 237
 — orthopedic management of affections of, 218, 237
 Neuritis, peripheral nerve injury and, 251
 Non-union, orthopedic management of, 174
 Nutrition, bone disorders and, 182
- Nutritional bone disorders, osteomalacia, 187
 — rickets, 182, 187
 — scurvy, 188
 Nystagmus, Friedreich's ataxia and, 250
- Obstetrical paralysis, diagnosis of, 245
 — etiology of, 243
 — pathology of, 243
 — peripheral nerve injuries and, 251
 — symptoms of, 244
 — treatment of, 245
 Ollier-Thiersch skin-grafts, scar contractions and, 205
 Orthopedics, acute joint affections in, 50
 — affections encountered in, classification of, 47
 — apparatus used in, 26
 — bone affections and, 128, 147, 182
 — congenital anomalies and, 273
 — derivation of the word, 1
 — examinations in, 5, 7
 — ankle, 12
 — foot and ankle, 12
 — hip, 15
 — knee, 12
 — sacro-iliac joint and, 20
 — spine and, 22
 — upper extremity, 25
 — history taking in, 5
 — low-grade joint affections and, 68, 72, 85, 98
 — nervous system affections and, 218, 237
 — soft tissue affections and, 201, 210
 — static deformities and, 256
 — traumatic joint affections and, 118
 Os calcis, epiphysitis of, 144
 Osgood-Schlatter's disease, symptoms and treatment of, 146
 Ossifying myositis, 213
 Osteitis, traumatic, 181
 — tuberculosis of spine differentiated from, 91
 Osteitis fibrosa, foot and ankle tuberculosis differentiated from, 77
 Osteitis fibrosa cystica, occurrence of, 142
 — treatment of, 143
 Osteochondritis, intra-articular, 107
 — spinal, 114
 — syphilitic, 137
 Osteochondritis juvenilis, tuberculosis of joints differentiated from, 71

- Osteochondroma, joints and, 126
 — multiple, 192
 — treatment of, 192
 Osteogenesis imperfecta, fragilitas os-
 sium differentiated from, 190
 Osteogenetic sarcoma, types of, 197
 Osteoma, joints and, 126
 Osteomalacia, orthopedic management of,
 187
 — osteitis fibrosa cystica and, 143
 Osteomyelitis, acute infectious, diagnosis
 of, 131
 — — etiology of, 128
 — — foot and ankle tuberculosis differ-
 entiated from, 76
 — — local manifestations of, 129
 — — pathology of, 128
 — — prognosis of, 133
 — — symptoms of, 129
 — — treatment of, 135
 — — tuberculosis of joints differentiated
 from, 71
 — — x-ray and, 130
 — Garre's sclerosing, diagnosis of, 141
 — — local manifestations of, 139
 — — pathology of, 139
 — — prognosis of, 141
 — — symptoms of, 139
 — — treatment of, 141
 — syphilitic, 138
 Osteoporosis, 181
 Osteopsathyrosis, fragilitas ossium differ-
 entiated from, 190
 Osteosclerosis, congenital, 191
 Osteotomy, coxa vara treated by, 114
- Palpation, orthopedic examination by, 8
 — sacro-iliac joint, 20
 — spine, 23
 Paralysis, birth, 243
 — hysterical, orthopedic consideration of,
 254
 — obstetrical, diagnosis of, 245
 — — etiology of, 243
 — — pathology of, 243
 — — peripheral nerve injuries and, 251
 — — symptoms of, 244
 — — treatment of, 245
 — poliomyelitis and, 219
 — spastic cerebral, diagnosis of, 239
 — — etiology of, 237
 — — pathology of, 238
 — — symptoms of, 238
 — — treatment of, 240
- Paralysis, spinal tuberculosis complicated
 by, 89, 94
 — Volkmann's, diagnosis of, 212
 — — etiology of, 211
 — — orthopedic management of, 211
 — — pathology of, 212
 — — prognosis of, 213
 — — symptoms of, 212
 — — treatment of, 213
 Passive motion, hip examined by, 16
 — orthopedic examination by, 8
 — sacro-iliac joint and, 21
 — spine and, 23
 Pedunculated skin flaps, scar contractions
 and, 205
 Periosteal sarcoma, diagnosis of, 198
 — frequency of, 197
 — pathology of, 198
 — prognosis of, 199
 — symptoms of, 198
 — treatment of, 199
 — x-ray demonstration of, 198
 Periosteum, syphilis of joints affecting,
 100
 Periostitis, acute, 128
 — syphilitic, 137
 — traumatic, 181
 Peripheral nerves, injuries to, 250
 Peroneal tendons, displacement of, 215
 Perthes' disease, diagnosis of, 110
 — etiology of, 108
 — prognosis of, 110
 — symptoms of, 109
 — treatment of, 110
 — tuberculosis of joints differentiated
 from, 71, 83
 — x-ray examination, 110
 Pertussis, acute infectious arthritis and,
 50
 Pes calcaneovalgus, 222
 Pes calcaneus, 221
 Pes equinovagis, 222
 Pes equinovarus, 222
 Pes equinus, poliomyelitis and, 220
 Pes planus, deformity in, 257
 — diagnosis of, 258
 — examination of, 257
 — symptoms of, 257
 — treatment of, 258
 Pes valgus, 221
 Pes varus, 220
 Petechial hemorrhages, scurvy causing,
 188
 Physiotherapy, acute infectious arthritis
 and, 57

- Pigeon-breast, rickets causing, 182
 Pirquet test, joint tuberculosis and, 71
 Plaster-of-Paris, ankle tuberculosis and, 78
 — bandages, 26
 — braces measured with aid of, 46
 — Calot jacket of, 41
 — orthopedic use of, 26
 — pressure symptoms from, 45
 — reënforcements of, 36
 — regional application of, 27
 — — ankle, 27
 — — elbow fixation by, 43
 — — femur, 150
 — — flat-foot and, 260
 — — forearm fractures and, 154
 — — knee, 29
 — — sacro-iliac joint, 37
 — — shoulder, 43
 — scoliosis and, 268
 — types of jackets made from, 40
 Pneumococcus, acute infectious arthritis and, 50
 Pneumonia, acute infectious arthritis and, 50
 Poliomyelitis, acute anterior, clinical course of, 218
 — — etiology of, 218
 — — Little's disease differentiated from, 239
 — — operative measures for correction of deformity, 228
 — — orthopedic management of, 218
 — — pathology of, 218
 — — prognosis of, 225
 — — progressive muscular atrophy differentiated from, 247, 249
 — — scoliosis and, 263
 — — symptoms of, 218
 — — treatment of, 226
 — — Volkmann's paralysis differentiated from, 212
 Polyarthrititis, diagnosis of, 104
 — syphilitic, manifestations of, 100
 Posture, determination of, 6
 — defective, orthopedic affections caused by, 49
 — weight-bearing line and, 6
 Potassium iodid, syphilis of bones and joints and, 102
 Pott's disease, complications of, 88
 — diagnosis of, 91
 — prognosis of, 92
 — symptoms of, 85
 — treatment of, 92
 Pott's disease, x-ray examination in, 90
 Prenatal deformities, orthopedic consideration of, 273
 Prepatellar bursitis, orthopedic management of, 217
 Progressive muscular atrophy, clinical course of, 246
 — diagnosis of, 247
 — etiology of, 246
 — muscular dystrophy differentiated from, 247
 — pathology of, 246
 — symptoms of, 246
 — treatment of, 247
 Psoas abscess, acute infectious arthritis and, 60
 — acute infectious spondylitis and, 62
 — hip-joint tuberculosis differentiated from, 82
 — treatment of, 66
 Psoas contracture, diagnosis of, 64
 Radium, joint neoplasms and, 126
 Radius, congenital absence of, 278
 Recent dislocations, 177
 Recurrent bone tumors, 196
 Reverdin's skin-grafts, scar contractures and, 205
 Rickets, bone pathology in, 182
 — fetal, 192
 — latent, 187
 — tuberculosis of spine differentiated from, 91
 Rollier's heliotherapy, joint tuberculosis and, 72
 Round shoulders, orthopedic management of, 269
 Rupture, muscle, 210
 Sacro-iliac joint, orthopedic examination of, 20
 — plaster-of-Paris and, 37
 — traumatic injuries of, 120
 Salicylates, acute infectious arthritis and, 55
 — chronic infectious arthritis and, 105
 Sarcoma, osteogenetic, types of, 197
 — periosteal, diagnosis of, 198
 — — frequency of, 197
 — — pathology of, 198
 — — prognosis of, 199
 — — symptoms of, 198
 — — treatment of, 199
 — — x-ray demonstration of, 198

- Sayre adhesive dressing, application of, 166
- clavicular fracture and, 165
- Sayre head traction, scoliosis and, 267
- Sayre suspension apparatus, 39
- Scanning speech, Friedreich's ataxia and, 250
- Scaphoid, epiphysitis of, 144
- Köhler's disease of, 145
 - — joint tuberculosis differentiated from, 77
 - osteitis of, 145
- Scapula, motion of, 25
- Scar contractures, etiology of, 201
- factors determining extent of, 201
 - peripheral nerve injury and, 251
 - prevention of, 202
 - treatment of, 204
 - Volkmann's, 212
- Scarlet fever, acute infectious arthritis and, 50
- Sciatic scoliosis, 122
- Scissors gait, spastic cerebral paralysis causing, 238
- Sclerosing osteomyelitis, Garre's, diagnosis of, 141
- — local manifestations of, 139
 - — pathology of, 139
 - — prognosis of, 141
 - — symptoms of, 139
 - — treatment of, 141
- Scoliosis, definition of, 22, 260
- deformity in, 263
 - diagnosis of, 267
 - etiology of, 262
 - examination of, 265
 - factors predisposing to, 262
 - lateral, Little's disease differentiated from, 240
 - orthopedic management of, 260
 - prognosis of, 267
 - rickets causing, 182
 - sciatic, 122
 - sex influencing incidence of, 262
 - spinal anomalies and, 278
 - symptoms of, 265
 - torticollis and, 293
 - treatment of, 267
 - x-ray examination of, 265
- Scorbutus, 188
- Scurvy, orthopedic phases of, 188
- Separation, epiphyseal, 166
- Sequestrum, definition of, 129
- Sever's operation, obstetrical paralysis and, 246
- Shoulder joint, acute infectious arthritis and, 66
- fixation of, 43
 - orthopedic examination of, 25
 - poliomyelitis and, 225
 - — operative measures for, 233
 - tuberculosis of, management of, 95
- Skin, affections of, orthopedic, 49
- scar contractures following loss of, 201
 - — pedunculated flaps and, 205
- Skin-grafts, scar prevention and, 203
- scar treatment and, 204
 - types of, 205
- Soft tissue, affections of, orthopedic management of, 201
- peripheral nerve injuries affecting, 251
- Soutter operations, tuberculosis of hip and, 84
- Spastic cerebral paralysis, diagnosis of, 239
- etiology of, 237
 - pathology of, 238
 - symptoms of, 238
 - treatment of, 240
- Speech, scanning, Friedreich's ataxia and, 250
- Spina bifida, Little's disease differentiated from, 240
- Spina ventosa, symptoms of, 76
- Spine, active motion of, 24
- apparatus for treatment of, 37
 - application of cast to, 41
 - congenital anomalies of, 292
 - deformities of, hollow-back, 269
 - — round shoulders, 269
 - — scoliosis, 260
 - — spondylolisthesis, 270
 - fixation of, 41
 - fracture of, 151
 - orthopedic examination of, 22
 - osteochondritis of, 114
 - passive motion of, 23
 - physiological curves of, 6, 22
 - poliomyelitis affecting, operative measures for, 233
 - poliomyelitis and, 218, 225
 - range of motion of, 20
 - routine examination of, 23
 - tuberculosis of, Albee bone-graft operation in, 93, 94
 - — complications of, 88
 - — deformity in, 87, 270
 - — diagnosis of, 91
 - — Hibbs' boneplasty and, 94

- Spine, tuberculosis of, prognosis of, 92
 — symptoms of, 85
 — Taylor brace in, 93
 — treatment of, 92
 — x-ray examination for, 90
 — typhoid, 62
 Spinal braces, 42
 Splenomegaly, Still's disease and, 52
 Splints, elbow, 44
 — peripheral nerve injuries and, 251
 — scar prevention and, 203
 — shoulder, 43
 — spine, 41
 — traction humerus, 43
 — Volkmann's paralysis and, 211
 — wrist, 44
 Spondylitis, acute infectious, diagnosis of, 64
 — prognosis of, 64
 — psoas abscess and, 62
 — symptoms of, 62
 — treatment of, 66
 — tuberculosis of spine differentiated from, 91
 — x-ray findings in, 64
 — acute traumatic, treatment of, 122
 — chronic infectious, symptoms of, 104
 Spondylolisthesis, etiology of, 270
 — examination of, 271
 — symptoms of, 271
 — treatment of, 272
 Sprain, ankle, 118
 — elbow, 122
 — hip, 120
 — knee, 119
 — sacro-iliac joint, 120
 Staphylococcus, acute infectious arthritis and, 50
 Static affections, orthopedic, 49
 Static deformities, hollow-back, 269
 — orthopedic management of, 256
 — round shoulders, 269
 — scoliosis, 260
 — spondylolisthesis, 270
 — visceroptosis, 272
 — weak foot, 257
 Still's disease, clinical course of, 106
 — infectious arthritis resembling, 52
 — polyarthritis and, 105
 — treatment of, 107
 Stoffel operation, Little's disease and, 241
 Streptococcus, acute infectious arthritis and, 50
 Subacromial bursitis, orthopedic management of, 217
 Subacute traumatic arthritis, characteristics of, 123
 Sunlight, "canned," 75
 Sunshine, joint tuberculosis and, 72
 Supracondylar fracture, humerus and, 156
 Synovitis, syphilitic, 98
 Syphilis, bone, destructive stage of, 138
 — diagnosis of, 139
 — Garre's sclerosing osteomyelitis and, 139
 — gumma formation in, 98
 — osteochondritic form of, 137
 — osteomyelitic form of, 138
 — periosteal stage of, 137
 — prognosis of, 139
 — symptoms of, 136
 — treatment of, 139
 — Wassermann test and, 101
 — bone and joint, tuberculosis of joints differentiated from, 71
 — congenital, bones and joints and, 98
 — spastic cerebral paralysis and, 238
 — joint, concomitant infections in, 101
 — diagnosis of, 101
 — hip-joint tuberculosis differentiated from, 82
 — pathology of, 98
 — prognosis of, 102
 — symptoms of, 99
 — treatment of, 102
 — types of, 99
 — Wassermann test in, 101
 — x-ray examination of, 100
 Syringomyelia, progressive muscular atrophy differentiated from, 247
 Tabes dorsalis, Friedreich's ataxia differentiated from, 250
 Talipes, description of, 280
 — diagnosis of, 281
 — orthopedic considerations of, 280
 — prognosis of, 281
 — treatment of, 282
 Tarsectomy, acute infectious arthritis necessitating, 58
 Taylor brace, spinal tuberculosis and, 93
 Taylor spinal brace, 42
 Tendons, affections of, orthopedic management of, 49, 215
 — peroneal, displacement of, 215

- Tennis elbow, orthopedic management of, 217
- Tenosynovitis, orthopedic management of, 215
- Thermotherapy, acute infectious arthritis and, 55
- Thiersch skin-grafts, scar contractures and, 205
- Thomas caliper brace, tuberculosis of knee and, 80
- Thomas splint, 30
- application of, 33
 - coxa plana and, 110
 - description of, 32
 - femur fractures and, 150
 - hip-joint and, 37
 - knee and, 31
 - measurement for, 32
 - tuberculosis of hip and, 84
 - tuberculosis of knee and, 80
- Tibia, congenital anomalies of, 278
- epiphysitis of tubercle of, 146
 - fracture of, peripheral nerve injury and, 252
 - scar contractures over, 209
 - subluxation of, tuberculosis causing, 79, 80
- Tonsils, chronic infectious arthritis and, 105
- Torticollis, congenital, orthopedic considerations of, 292
- Traction humerus splint, 43
- Transplantation, skin, scar treatment and, 204
- Trauma, birth, Little's disease and, 237
- Traumatic arthritis, acute pathology of, 118
- chronic, character of, 123
 - subacute, characteristics of, 123
- Traumatic bone affections, dislocations, 177
- epiphyseal separations, 166
 - fractures, 147
 - clavicle, 161
 - elbow, 156
 - femur, 149
 - forearm, 151
 - humerus, 156
 - spine, 151
 - malunited fractures, 169
 - osteitis, 181
 - osteoporosis, 181
 - ununited fractures, 174
- Traumatic spondylitis, acute, treatment of, 122
- Trendelenburg's hip-muscles sign, 16
- Tuberculin, joint tuberculosis diagnosed by, 71
- Tuberculosis, ankle, diagnosis of, 76
- syphilis differentiated from, 76
 - bone, osteomyelitis differentiated from, 133
 - symptoms and treatment of, 136
 - elbow, management of, 95
 - foot, diagnosis of, 76
 - syphilis differentiated from, 76
 - hip, coxa plana differentiated from, 110
 - diagnosis of, 82
 - pathology of, 81
 - prognosis of, 83
 - psoas abscess differentiated from, 82
 - symptoms of, 82
 - treatment of, 83
 - joint, abscess complicating, 76
 - clinical course of, 70
 - complications affecting prognosis of, 72
 - diagnosis of, 70
 - differential, 71
 - etiology of, 68
 - heliotherapy and, 72
 - occurrence, 69
 - pathology of, 69
 - prognosis of, 71
 - surgical treatment of, 75
 - symptoms of, 70
 - treatment of, 72
 - surgical, 75
 - x-ray examination of, 70
 - knee, genu valgum caused by, 78
 - prognosis of, 79
 - symptoms of, 78
 - treatment of, 80
 - relative frequency as a factor in orthopedic affections, 50
 - shoulder, management of, 95
 - spine, Albee bone-graft operation in, 93, 94
 - complications of, 88
 - deformity in, 87, 270
 - diagnosis of, 91
 - Hibbs' boneplasty and, 94
 - prognosis of, 92
 - symptoms of, 85
 - Taylor brace in, 93
 - treatment of, 92
 - x-ray examination for, 90
 - upper extremity joint, 95

- Tuberculosis, wrist, management of, 96
 Tuberculous arthritis, 68
 Tuberculous meningitis, hip-joint tuberculosis and, 82
 — prognosis of, 71
 Tumors, bone, benign, 192
 — — chondroma, 193
 — — endothelioma, 199
 — — malignant, 196
 — — myeloma, 200
 — — osteochondroma, 192
 — — periosteal sarcoma, 197
 — — recurrent, 196
 — joint, types of, 125
 Turnbuckle cast, scoliosis and, 268
 Typhoid fever, acute infectious arthritis and, 50
- Ultraviolet rays, rickets and, 182
 Ununited fractures, 174
 Upper extremity, orthopedic examination of, 25
 — poliomyelitis affecting, operative measures for, 233
 — tuberculosis of joints of, 95
 Urotropin, poliomyelitis and, 226
- Vaccines, autogenous, chronic infectious arthritis and, 105
 Valgus, congenital, treatment of, 286
 Varus, treatment of, 286
 Vertebrae, acute infection of, 62
 — congenital anomalies of, 278
 — spondylolisthesis of, 270
 Visceroptosis, orthopedic considerations of, 272
 — poliomyelitis causing, 225
 Volkmann's paralysis, diagnosis of, 212
 — etiology of, 211
 — pathology of, 212
 — prognosis of, 213
 — symptoms of, 212
 — treatment of, 213
 Von Pirquet test, joint tuberculosis and, 71
- Wassermann test, bone and joint syphilis and, 71, 101, 139
 Weak foot, deformity in, 257
 — diagnosis of, 258
 — examination of, 257
 — symptoms of, 257
 — treatment of, 258
- Whitman's reduction of epiphyseal separation of femur, 168
 Whooping-cough, acute infectious arthritis and, 50
 Willems' active motion, acute infectious arthritis and, 55
 Wolfe-Krause skin-grafts, scar contractures and, 205
 Wounds, lacerated, scar contractures following, 201
 Wrist, acute infectious arthritis of, 67
 — fixation of, 44
 — nerve injury and trauma of, 252
 — poliomyelitis affecting, 225
 — — operative measures for, 234
 — scar contractures of, 207
 — tuberculosis of, management of, 96
 — Volkmann's contracture of, 212
 Wry-neck, diagnosis of, 293
 — orthopedic management of, 292
 — treatment of, 293
- Xanthoma, joints and, 126
 X-ray, acute infectious arthritis and, 52
 — acute infectious osteomyelitis and, 130
 — acute infectious spondylitis and, 64
 — atrophy of bone shown by, 181
 — chronic infectious arthritis and, 104
 — clavicular fractures and, 165
 — congenital dislocation of hip and, 290
 — coxa plana and, 110
 — coxa vara and, 111
 — flat-foot and, 258
 — foot and ankle and, 12
 — Garre's sclerosing osteomyelitis and, 141
 — heliotherapy results in joint tuberculosis shown by, 74
 — hip examination by, 18
 — joint tuberculosis and, 70
 — knee and, 14
 — Legg's disease and, 110
 — normal foot, 2
 — obstetrical paralysis and, 245
 — orthopedic examination by, 9
 — osteitis fibrosa cystica and, 143
 — osteoporosis and, 181
 — periosteal sarcoma demonstrated by, 198
 — Perthes' disease and, 110
 — Pott's disease and, 90
 — psoas abscess and hip-joint tuberculosis differentiated by, 82

X-ray, rickets in bone and, 182
— sacro-iliac injuries and, 120
— scoliosis demonstrated by, 265
— spinal tuberculosis and, 90
— Still's disease and, 106

X-ray, syphilis of joints and, 100
— syphilitic osteomyelitis and, 138
"Z" plastic operation, acute infectious arthritis and, 58

(1)



