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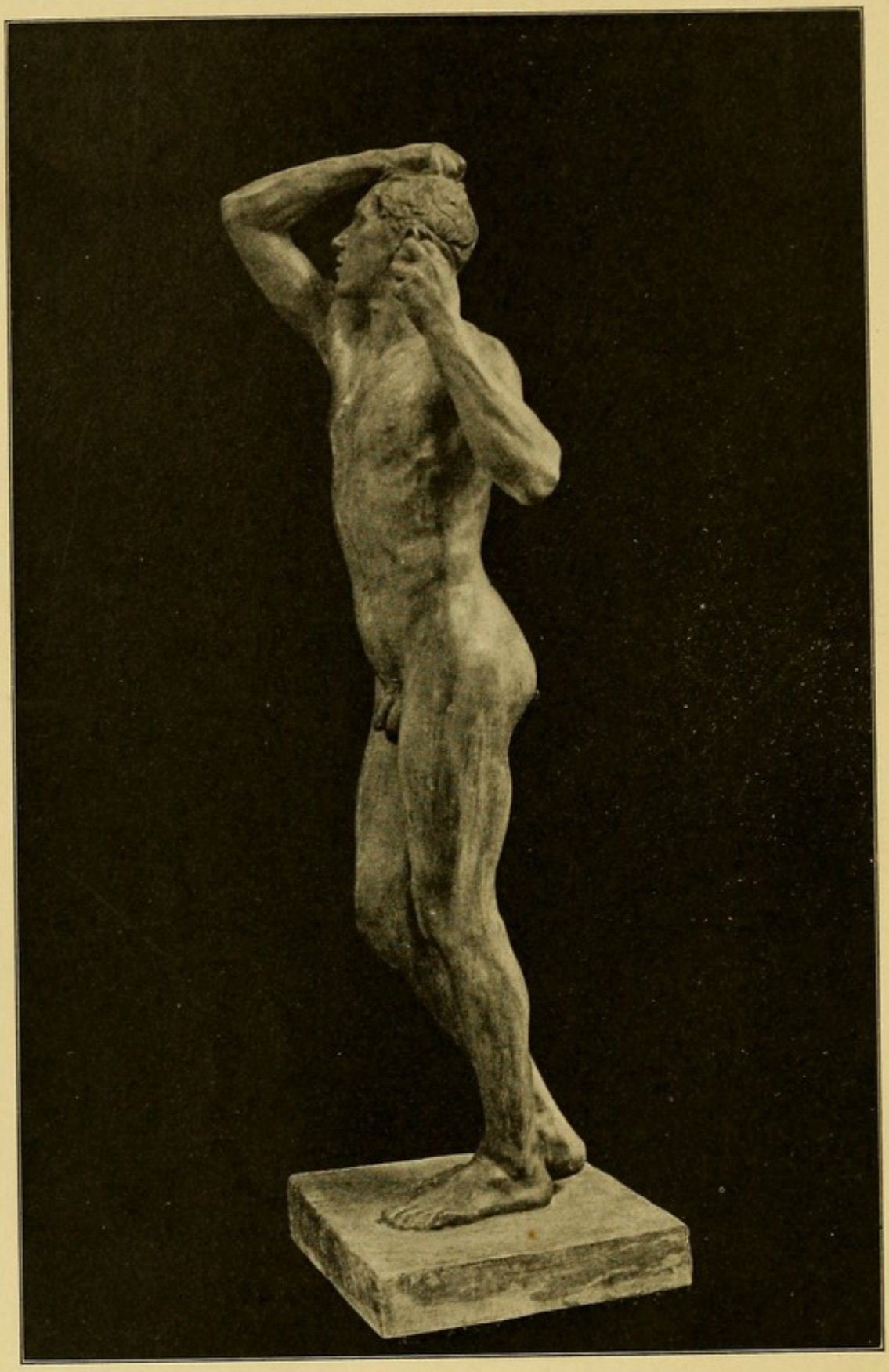
ORTHOPEDIC SURGERY
FOR
PRACTITIONERS



THE STRETCH BY RODIN, USUALLY CALLED "THE AGE OF BRONZE."
(New York Metropolitan Museum of Art.)

ORTHOPEDIC SURGERY

FOR

PRACTITIONERS

BY

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TO

CHARLES FAYETTE TAYLOR

PIONEER

"I look on that man as happy, who, when there is a question of success, looks into his work for a reply."—EMERSON.

"I will not follow where the path may lead, but I will go where there is no path, and I will leave a trail."—STRODE.

PREFACE

This book aims to give an outline of the essential facts in regard to deformities and crippling affections for daily use in general practice.

When one considers the large number of congenital, postural, traumatic, paralytic, rachitic, "rheumatoid," tuberculous, and other deforming affections in children and adults, it will be conceded that they comprise no inconsiderable part of the material which is presented to the practicing physician in the ordinary course of his work. It is he, oftener than the specialist, who has the privilege of detecting crippling affections in their incipiency, when the application of comparatively simple methods of treatment may save many from deformity or death.

A special effort has been made to present such methods as are at the command of any intelligent practitioner, and to eliminate irrelevant and useless matter.

The work is divided into general, special, and technical parts, as it is believed that this arrangement economizes space, emphasizes the importance of underlying causes, and is more convenient for reference. In the general part the underlying principles are discussed, and there are brief descriptions of the more important crippling affections. In the special part the principal de-

formities and crippling affections of each part of the body are taken up in the topographical order given in the table of contents; special attention has been paid to diagnosis, prevention, prognosis, and treatment. The theory and practice of splinting, in its broader sense, the mechanical control of motion and pressure for therapeutic purposes, are given in the third, or technical, part. When information is desired in connection with some special case, it is suggested that the appropriate section of the special part be read first, after which corresponding sections in the general and technical parts should be consulted.

It is not overstatement to say that as much pains has been taken with the illustrations as with the text. With few exceptions, the subjects were selected, posed, and photographed by the author especially for this volume. The skiagrams were taken by Dr. Albee, either at the Hospital for the Ruptured and Crippled or privately, the latter with Dr. Wisner R. Townsend's unusually complete installation.

The present work, containing the gist of twenty-five years of private and hospital experience in special practice, is constructed on foundations gained in close association with the late C. Fayette Taylor, than whom there never was a sounder or more inspiring teacher. The writer is also under special obligations to his friends Dr. Virgil P. Gibney, Dr. Wisner R. Townsend, Dr. Royal Whitman, and to the other members of the staff of the Hospital for the Ruptured and Crippled, and also to his colleagues at the Post-Graduate Hospital, for kind coöperation and valuable information and material.

There is scarcely a member of the American Orthopedic Association, native or foreign, to whom he does not owe a definite debt; particularly, however, to the late Dr. A. M. Phelps, to Mr. Robert Jones, and to the Boston orthopedic circle.

While it has not been thought practicable to insert detailed references to authorities, the books and monographs that have proved most helpful to the writer are listed at the end, with the hope that they may also prove useful to those who wish to pursue special topics further.

Modern orthopedic surgery has no prejudices for or against mechanical, gymnastic, or operative procedures as such, but uses each at the proper time and in its proper place. It has completely emancipated itself from its former rather narrow limits, and has made lately, and is still making, vast progress in the simplification and proper choice of methods; it is also making contributions of value to medical and surgical practice. It is this progressive, vital, modern orthopedic surgery that it has been our aim to present.

No specialty has more devoted, abler, or broader-minded workers, and in none is progress, both theoretical and practical, more evident. It owes an enormous debt to physicians, surgeons, and pathologists, the results of whose advanced investigations are being rapidly assimilated. If some of this indebtedness can be repaid by making the practical details of our art available in general practice, the aim of the work will be accomplished.

H. L. T.

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GENERAL PART

Orthopedic surgery is that branch of medical science which studies to prevent, alleviate, or correct the deformities and disabilities of the bodily framework.

In order to understand physical deformities a good working knowledge of anatomy, pathology, and general medicine, including neurology, is necessary, and for successful treatment one should know hygiene, elementary mechanical principles, corrective gymnastics, general therapeutics, and the principles and practice of surgery. In Germany, orthopedic surgery until recently has not paid special attention to underlying causes, but in this country it has long been recognized that bone and joint diseases produce a large proportion of deformities, and the tendency everywhere is to include their management as well as that of general and local conditions affecting bone stability and muscular power in the larger conception of orthopedic surgery. Some American clinics even assign fractures to the orthopedic department, as their successful management largely depends upon the correct application of mechanical principles and the manipulative dexterity which should distinguish the orthopedic surgeon.

HISTORY

The term orthopedic, from two Greek words, meaning *straight* and *a child*, was first used by Andry in his popu-

lar treatise published in French in 1741, and republished in English in 1743, and in German in 1744. Many authors before and since have described deformities and crippling affections and their treatment. Percival Pott published his discovery of the relation between destructive disease of the vertebræ and paraplegia in 1779, and early in the nineteenth century French, German, and English surgeons made important contributions to our knowledge of deformities, whose treatment received great impetus from the successful introduction of subcutaneous tenotomy by Strohmeyer in 1831. In America orthopedic surgery became an independent specialty through the labors of H. G. Davis, Louis A. Sayre, and C. Fayette Taylor, who, in the early sixties, placed the treatment of chronic joint and spinal diseases upon a sound basis by devising efficient, portative apparatus for continuous fixation and traction. In the last twenty years there has been a renascence and rapid expansion of this branch both in Europe and America. Aseptic surgery has made operative interference both for the removal of disease and the correction of deformity more generally applicable and more successful; at the same time the technic of forcible manipulation has been highly developed and its limits assigned. To these has been added the discovery of Roentgen, which reveals the size, position, and structure of the bones, and has made our work more exact and more satisfactory. Excellent work by surgeons and pathologists has been utilized, extending the scope of the specialty beyond its former rather narrow limits, and making possible its successful application to adults as well as children. The tendency and aim

of the best modern practice is toward radical results by simple methods.

CLASSIFICATION

Deformities may be divided into congenital and acquired, according as they develop before or after birth. The deformities due to injuries at birth form an intermediate group, usually classed with the acquired. Deformities may be primary or secondary, according as they are directly or indirectly due to injuries, pathological processes, general or local, or mechanical influences.

From the point of view of their pathogenesis deformities may be divided into two principal classes (Riedinger):

1. Load deformities, caused by yielding to pressure or superincumbent weight. The overloading may be traumatic, constitutional, static (habitual), or pathological (secondary). The critical factor is often the upright posture.

2. Contractures, caused by shortening of the tissues on one side of a joint. These also may be traumatic, constitutional, habitual, or pathological.

In simpler words, when the structural elements of a part are weakened or overloaded, that part may be pushed or pulled out of place.

Overgrowth, underdevelopment, wasting, and joint-looseness may also be considered with the deformities.

In reacting to a long-continued deforming force the skeleton behaves, so far as concerns its external form, like a plastic solid; it suffers condensation, expansion, and change of direction in various parts. Its internal struc-

ture, however, shows adaptation to change of stress (Wolff's law). In those parts where pressure is increased, the structure becomes stronger in its units and in its arrangement; in parts where pressure is diminished, the structure becomes weaker. Similar adaptive changes take place to a certain extent in the external form of the bone, as in the filling in of the concave side of a bow-leg. The soft parts also undergo structural adaptation to habitual postures.

CAUSATION

Congenital deformities may be due to primary defects or nutritional disturbances in the germ cells, injuries or diseases in utero, amniotic adhesions, uterine pressure from deficiency of liquor amnii, and other causes. The commonest congenital deformities are club-foot, the deformities of certain spastic palsies, congenital dislocation of the hip, and certain anomalies, deficiencies, and redundancies of the spine, trunk, and extremities.

Birth deformities caused by head injuries, brachial plexus, or sterno-mastoid tears, and fractures of the long bones, are not infrequent. Injuries to nerves or centers often lead to characteristic palsies and contractures; injuries to muscles and bones, if untreated, may result in serious malpositions.

Acquired Deformities.—The large majority of children, however, are born without blemish, and most cripples acquire their deformity after birth through *weakness*, *injury*, or *disease*. These make possible displacement from pressure, the pull of gravity, or contraction.

1. Weakness from any cause, especially if combined

with poor hygiene, too much standing or sitting, monotonous occupations, and faulty postures, is a common cause of flat feet, round back, and lateral curvature of the spine. The supporting apparatus for one cause or another is inadequate to its function, and sags under the superincumbent weight. The weakness may be an expression of a general dyscrasia, or may be relative; inadequacy to the load.

2. Injuries resulting in inflammation or cicatricial contractions of the soft parts; sprains, fractures, and dislocations are frequent causes of temporary or permanent deformities, as are also the injuries inflicted by certain postures and occupations, and by improper dress, such as tight corsets, and short, narrow, or pointed shoes.

3. Most important of all in producing deformity are the changes produced by disease, affecting especially:

(*a*) The bones, cartilage, periosteum, and joints; as rickets, scurvy, chondrodystrophia, syphilis, osteomyelitis, Paget's disease, arthritis deformans, tuberculosis, and many other infectious, trophic disturbances, and new formations.

(*b*) The bursæ, tendon sheaths, tendons, and fibrous tissue; of which gonorrhœa is a frequent and often unsuspected cause. Dupuytren's finger deformity is due to fibrous contraction. Diseases of the muscles, as myositis acute and chronic, and myositis ossificans, often cause deformities and disabilities of considerable importance.

(*c*) The peripheral or central nervous system, producing stiff or flaccid palsies, or pseudo-palsies, often with great disability and deformity, and sometimes joint affections, as in Charcot's joint, and other arthropathies.

It will thus be seen that deformities and crippling affections may be studied from the standpoint of their causation, from that of the tissue affected, or from that of the part of the body involved. In the special part of this work each part of the body is passed in review and its principal deformities and deforming affections are briefly described. In order to save repetition and to emphasize the importance in many cases of general treatment directed to the underlying cause or pathological process, the principal crippling affections are hereinafter outlined.

CONGENITAL CRIPPLING AFFECTIONS

Local congenital affections, like congenital club-foot and congenital dislocation of the hip, are treated under appropriate sections in the special part.

The primary intrauterine diseases which seriously affect the skeleton are syphilis, myxedema, chondrodystrophia, and osteodystrophia. In addition nanism and gigantism, though not always congenital, may for convenience be considered here.

Nanism, or **microsomia,** is often due to some defect of nutrition, as cretinism, achondroplasia, or rickets. Micromelia may be accompanied by imperfect development of one or more of the long bones; if acquired, it may be due to imperfect use or imperfect nutrition from local paralysis, disease, or deformity. Slight differences in the length of the legs in otherwise normal children and adults, not otherwise easily explicable than as primary defects or as differences in the rate of growth, are not infrequent.

Gigantism.—When the whole skeleton is markedly larger than normal, the condition is known as gigantism, or macrosomia. Most marked gigantism is pathological; giants are usually weak and of poor endurance, often with

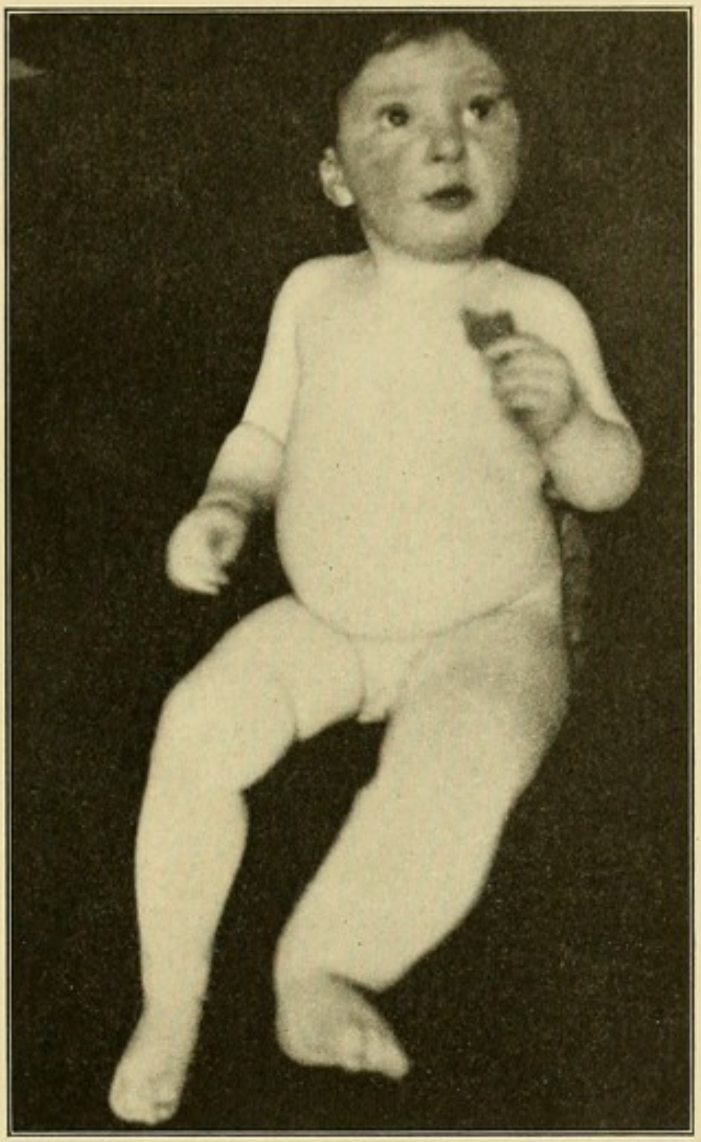


FIG. 1.—GIGANTISM OF LEFT LEG.
(Hospital for the Ruptured and Crippled.)

round back, lateral curvature, and other malformations. Many cases are supposed to be caused by nutritional changes due to affections of the pituitary body in the growing period. In adults similar conditions produce

acromegaly. Congenital macromelia affecting the lower extremity or a part of it is occasionally observed (Fig. 1). Sometimes a gigantic toe may require removal. Acquired macromelia may be due to blocked lymphatics, chronic osteomyelitis, and syphilis of the long bones. As in micromelia, a difference in length of the extremities may require additional height added to the sole of the shorter side, to level the pelvis and facilitate walking.

Congenital syphilis is treated in the same section as acquired.

Myxedema, or **cretinism,** is a disturbance of nutrition, which is often congenital, and is due to disease or deficiency of the thyroid gland, which lessens the supply of its internal secretion. The skin is dry and thick, and of a yellowish pallor, the hair is dry and brittle, the tongue, lips, and subcutaneous tissues are thickened. The intellect is dull and apathetic, and mental and bodily growth are much delayed. The bones are softer than normal, and round back and deformities of the thorax and limbs resembling rachitic deformities are not uncommon. The exhibition of the dried thyroid gland, beginning with a grain or two once or twice a day for infants, and increasing it under careful watching of the pulse, in nearly all cases effects marvelous improvement, and, if long enough continued, a complete disappearance of the symptoms. If the drug is withdrawn, the symptoms return.

Chondrodystrophia fetalis (*achondroplasia*) was formerly called fetal rickets, but is an entirely distinct disease, characterized by imperfect development of cartilage and of bone developed from cartilage. The epiphyses of the long bones fuse early, leading to retarded growth of the

extremities and dwarfing. The bridge of the nose is depressed, the head large, the trunk long, the arms and legs are very short and thick, and their growth extremely

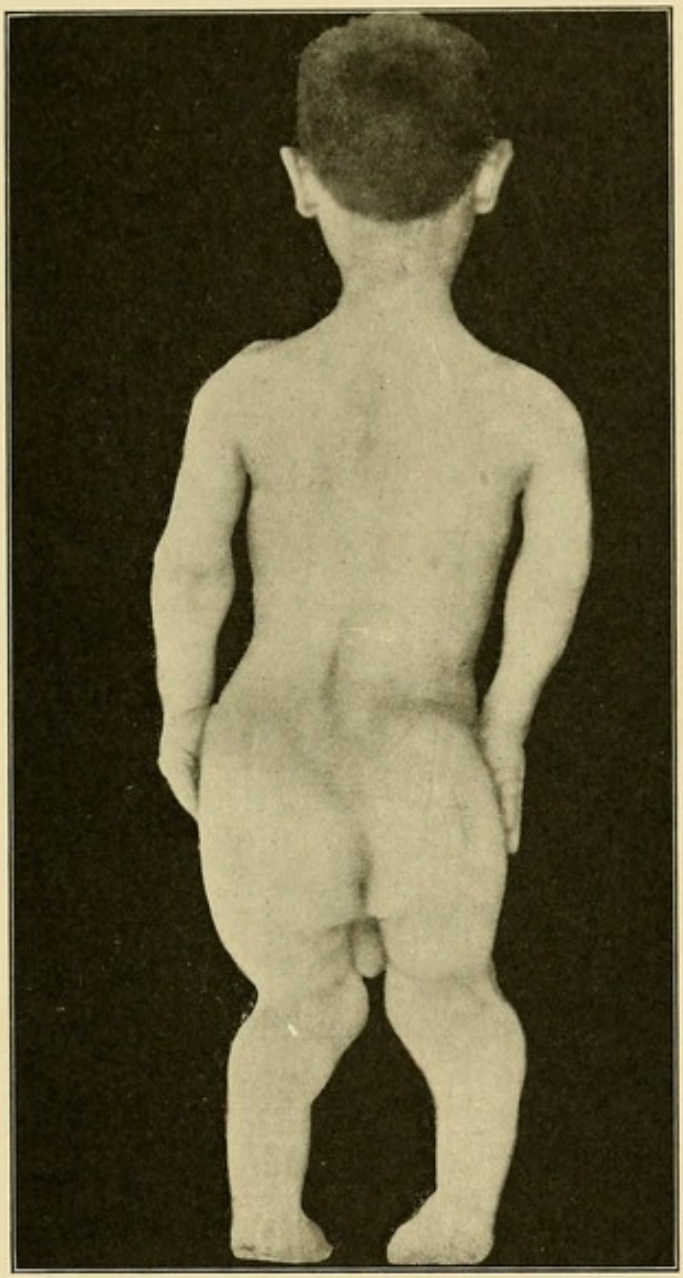


FIG. 2.—CHONDRODYSTROPHIC DWARF AGED FOURTEEN; HYPERTROPHIC FORM. Note shortness of extremities.

slow (Fig. 2). Curvatures of the long bones and round back are sometimes present. In certain cases the bony prominences about the joints are greatly hypertrophied,

making the joints very large, and interfering with motion; this stiffness may affect the spine. The cause is unknown and the treatment symptomatic.

Osteodystrophia fetalis [1] (*osteogenesis imperfecta, periosteal dysplasia, fragilitas ossium*).—This disease has also been called erroneously fetal rickets. "Osteogenesis imperfecta is a systemic bone disease, which . . . attacks the very young fetus, and . . . prevents or disturbs the normal development and calcification of osteoid tissue. Externally the disease manifests itself by defective development of the cranial vault and fragility of the bones of the entire skeleton" (Nathan).

The osteogenetic function of the periosteum is very defective, but the bones grow normally in length. Repeated fractures from trivial causes occur in infancy and childhood; these unite readily in four weeks. The cause of the disease is unknown and the treatment symptomatic. The child should be handled with great care to avoid fractures, and when these occur splints should be carefully adjusted to prevent deformity. These children learn to walk in time, and after puberty the bones become less brittle. There is no specific treatment of the process.

NUTRITIONAL DISORDERS

Marasmus is a disorder of infancy in which the body is insufficiently nourished. It is characterized by weakness and wasting, but is wanting in the specific characters of rickets. These children are late in holding up the head, sitting, standing, and walking, and often develop a round

[1] Term proposed by the writer.

back when seated, which resembles rachitic round back. When they begin to walk they may develop flat-foot and leg deformities. Children of delicate constitutions and defective development may develop weak feet and knock-knees, usually of light or moderate grade, without being either marantic or rachitic. The marantic cases should be kept off their feet, and, if necessary, prevented from sitting, until the diet has been regulated and the nutrition improved. Small doses of thyroid are said to be beneficial (Simpson). If deformity should still persist, it may require appropriate local management. In the case of delicate children a mild tonic regimen, with open-air life and abundant nourishment, should be provided. Comparatively mild local measures, such as special exercises, or the building up of the inner border of the shoes, will usually suffice for the deformity. See special part.

Rachitis, or rickets, the most frequent if not the most important crippling affection of infancy, is a disease of defective nutrition from faulty feeding, affecting all the tissues; it is no more a bone disease than syphilis is a disease of the skin. Rickets is very rife among the negroes, Italians, and Oriental Jews of New York, and exists among other elements of the population in proportion to the prevalence of errors of infant feeding, such as the feeding of cooked milk, condensed milk, artificial food, mother's milk of poor quality, due to illness, insufficient diet, too prolonged nursing (Fig. 3), or intercurrent pregnancy; or the feeding of substances unsuited to the child's age, such as the food from the family table, including tea, coffee, beer, and wine. A frequent error is the too free use of soup and cereals. The process in

the bone consists in an excessive production of cartilage with defective calcification; this is not affected by giving soluble calcium salts. The respiratory and intestinal

Fig. 3.—Rachitic Child of Two, Nursing. Note the large ankle bones.

tracts are prone to catarrh. The symptoms of rickets are enlargement of the juxta-epiphyseal regions, especially at the wrists and ankles, beading at the costochondral junction (rachitic rosary), Harrison's grooves

at the sides of the thorax, square forehead, large fontanelles, head sweating, delayed dentition, weakness, bowed back, delayed locomotion, and deformities, particularly of the lower extremities and dwarfing (Fig. 4). Rickets

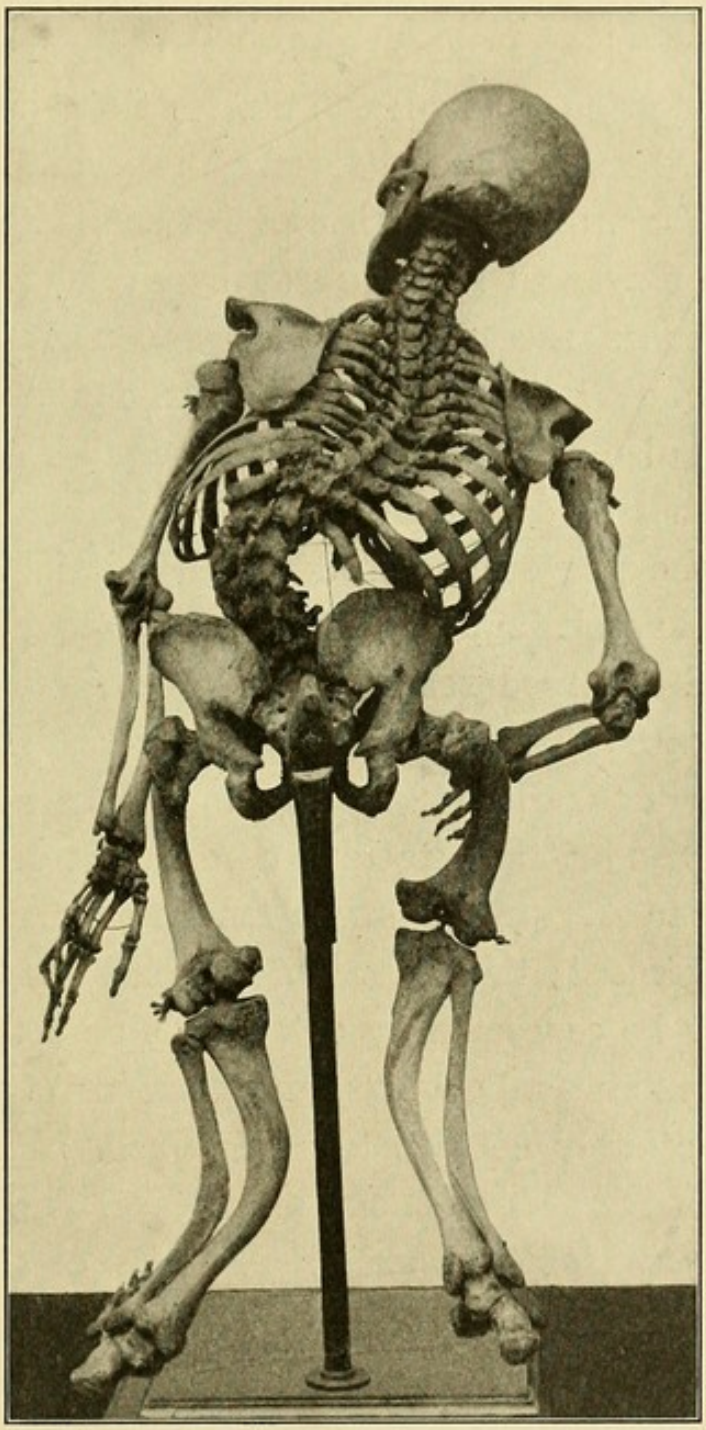


Fig. 4.—Skeleton of Rachitic Dwarf—Adult, Showing Multiple Deformities. (Royal College of Surgeons, London. Phelps.)

is a disease of infancy and early childhood; it usually begins in the first year, and seldom starts after the second. At the age when the baby should sit up, the flabby muscles and tissues allow the body to sag, and the back to curve backward; when the child begins to walk, the softened long bones bend under the superincumbent weight, giving rise to bow-legs, anterior tibial curves, and knock-knees, bending at the femoral neck, and other deformities (Figs. 57, 105, 106, and 165). Some of these deformities may also be produced by prolonged sitting. In severe cases the children may not walk until the fourth year or later, but the disease is usually self-limited, and also readily cured by proper feeding and the administration of digestible fat, either animal or vegetable. In the prevention of deformity, it is important that the child's sitting, standing, and walking should be limited, and enforced recumbency for weeks or months is sometimes necessary. The bones are soft during the active stage of the disease; after this they become abnormally hard and brittle. Rachitic deformities of moderate grade tend to disappear, but often require mechanical (brace) treatment; the severer deformities of the limbs may usually be corrected by osteoclasis or osteotomy.

The knock-knees, bow-legs, and coxæ varæ of adolescents are probably not due to "*adolescent rickets*," but, like their flat-feet, round-backs, and lateral curvatures, to an exaggeration of the normal plasticity of the tissues characteristic of the age of puberty. When to the lessened resistance of the tissues is added greatly increased loading, as in continuous sitting or standing, or the carrying of heavy packages, in the case of grocery

boys and others, the yielding of the tissues is easily understood.

"**Senile rickets**" is not rickets, but a disease characterized by hypertrophy of the skull and long bones, and bending of the latter; it was first clearly described by Paget. See Ostitis deformans.

Infantile scurvy was formerly described as "acute rickets," but has nothing to do with rickets, though the two diseases may coexist. It is an acute or subacute specific

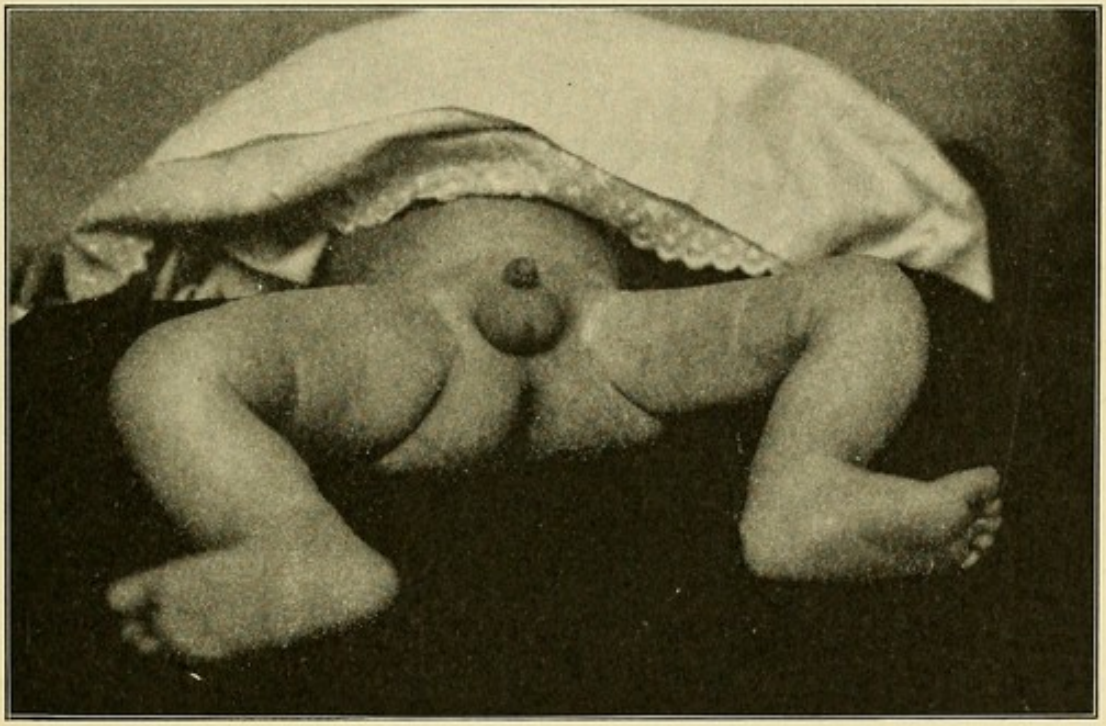


FIG. 5.—SCURVY FROM TWICE PASTEURIZED MILK; INFANT EIGHT MONTHS. Note posture of relaxation, and swelling of right thigh and both legs. Cure in three weeks on orange juice and fresh milk.

affection of nutrition, due to deficiency of raw or fresh food, and occurring in babies from six to eighteen months, and sometimes older. There are pains, especially in the legs, sometimes in the back, and on being handled; there are often tender spots and swellings near the joints, and the legs may move but little, sometimes

not at all (pseudo-paralysis, Fig. 5). The tenderness and swelling are due to effusions of blood under the periosteum. The child may have purplish spots on the skin, and there may be ulcerated and bleeding gums about the teeth; if teeth are not erupted, the gums are usually sound. In advanced cases the skin is of an unwholesome grayish color, the child refuses food, and often has some fever. There is little or no digestive or bowel disturbance. The child is fretful, observant, and anxious. When the artificial food or condensed milk is stopped and a suitable uncooked fresh milk mixture given, and the strained juice of one orange and a dessertspoonful to a tablespoonful of fresh meat juice administered daily, the symptoms usually disappear in a few days. When correctly diagnosed and treated, it is one of the most curable diseases known. Drugs are superfluous.

Hemophilia and Purpura.—Bleeders not infrequently have effusions of blood into one or more joints after slight injury, and sometimes with no antecedent trauma; this may occur in early infancy, childhood, or early adult life. The effusion usually takes place rapidly, and there may be at first little pain, but if distention is great the pain may be severe. Tenderness, stiffness, and disability are less marked than one would expect from the pain and swelling. There may be considerable elevation of temperature at first. The leucocyte count is not increased; the withdrawal of sterile blood by the aspirator establishes the diagnosis. The knee is the joint most often first invaded, and both may be affected; other joints may be involved successively. In primary cases the symp-

toms may subside within a week, except the swelling and limitation of motion, which may remain longer. After repeated hemorrhages marked changes in and about the joint may result; these sometimes resemble those of arthritis deformans, and occasionally end in ankylosis. Subluxation, or lateral mobility at the knee, may occur from stretching of the capsule. Even in the recurrent cases the bone is not thickened, though it may seem so to palpation. The diagnosis is of critical importance, as several deaths from bleeding have occurred (two under König) after opening these joints under the mistaken diagnosis of tuberculosis. In making the diagnosis the history of the attack and the previous history should be carefully considered. The treatment is immobilization, with correction of deformity, and the administration of drugs to increase coagulability, such as gelatin, or chlorid, citrate or lactate of calcium gr. xx to xxx several times a day, or of thymus or suprarenal gland. The possibility of syphilis as a cause should be considered. Aspiration not only clears up the diagnosis, but may exert a favorable effect by relieving tension. A bleeder's joint should never be incised; though, according to Lobrazes and Weil, the subcutaneous or intravenous injection of 20 c.c. of fresh human, horse, or rabbit serum, or even antidiphtheritic serum, makes operations on hemophiles safe. The procedure may be repeated every three months as a curative measure.

True articular **gout** with deposits of urates is rare in America (Fig. 6). What usually passes for gout, whether in the joints or other structures, is either arthritis deformans or the result of infection or autointox-

ication. In articular gout the skiagraphic picture of the bones is not changed, unless urates are deposited

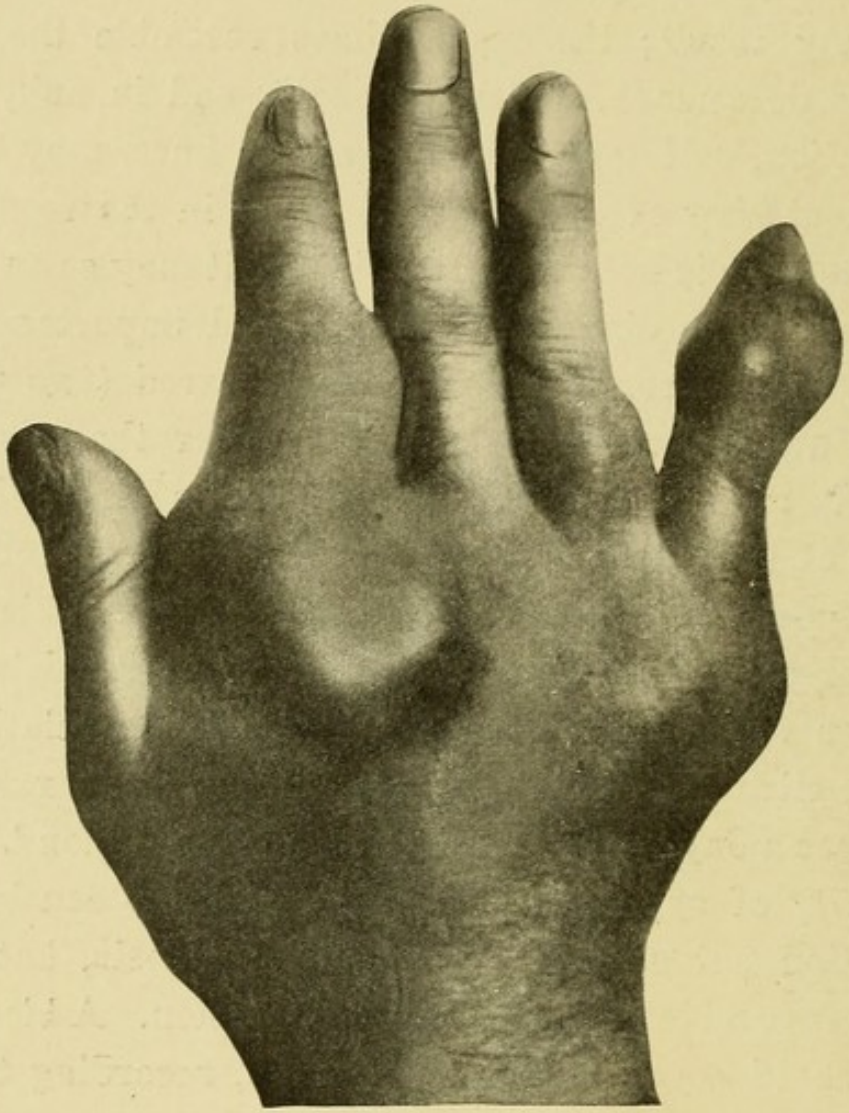


Fig. 6.—Gouty Hand. (After Fisk.)

in sufficient quantity to cause local absorption from pressure.

INFECTIONS OF BONES AND JOINTS

Syphilis.—Considering the wide prevalence of syphilis, the limited number of syphilitic bone and joint diseases seen in our large orthopedic clinics is rather remarkable.

The syphilitic baby of literature is a puny, wrinkled specimen, bearing certain stigmata; such babies present little

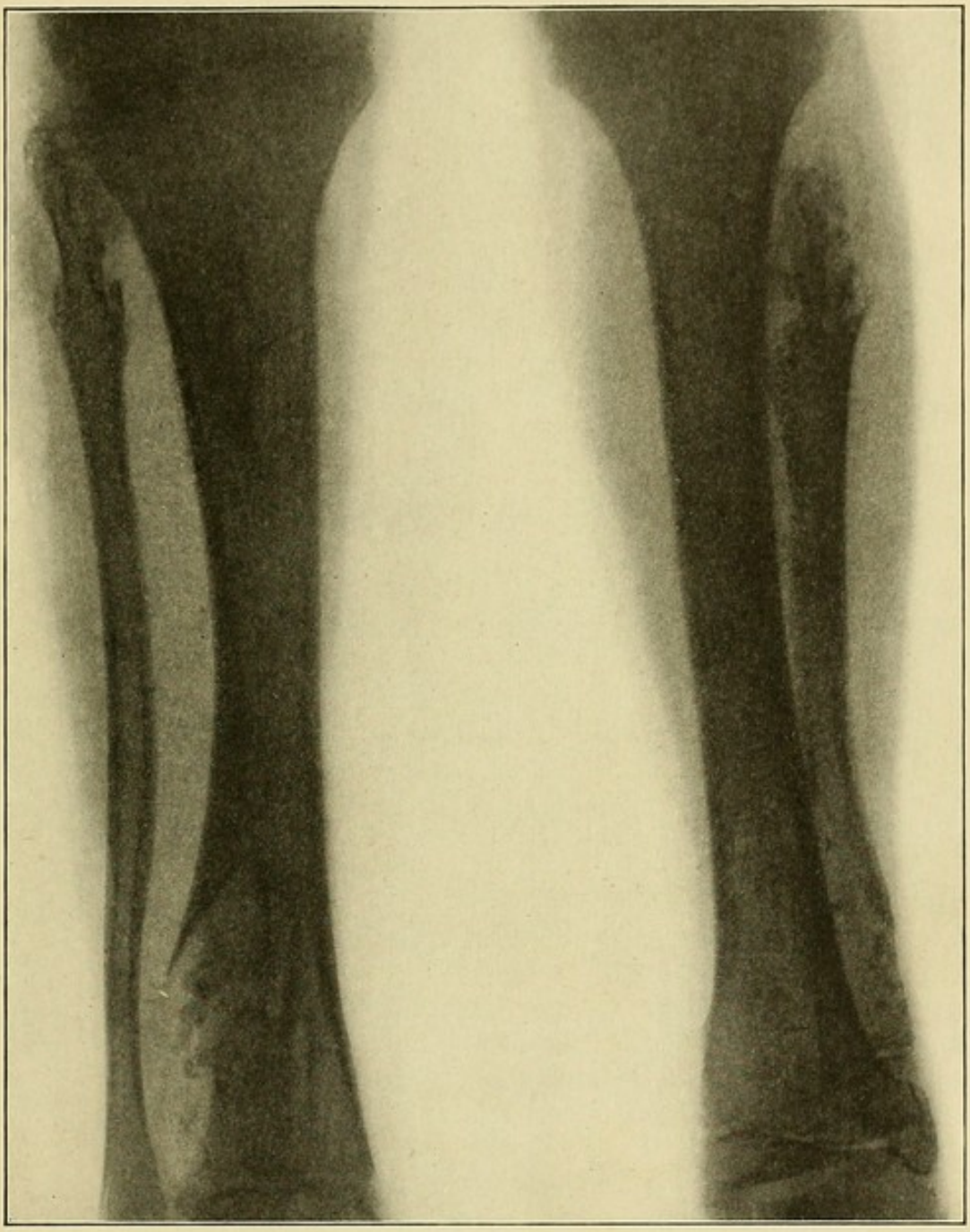


Fig. 7.—Osteochondritis, Two Years' Duration in a Boy of Eight; Inherited Syphilis. (Hospital for the Ruptured and Crippled.)

difficulty in diagnosis, but it should be borne in mind that some babies who afterwards develop characteristic lesions

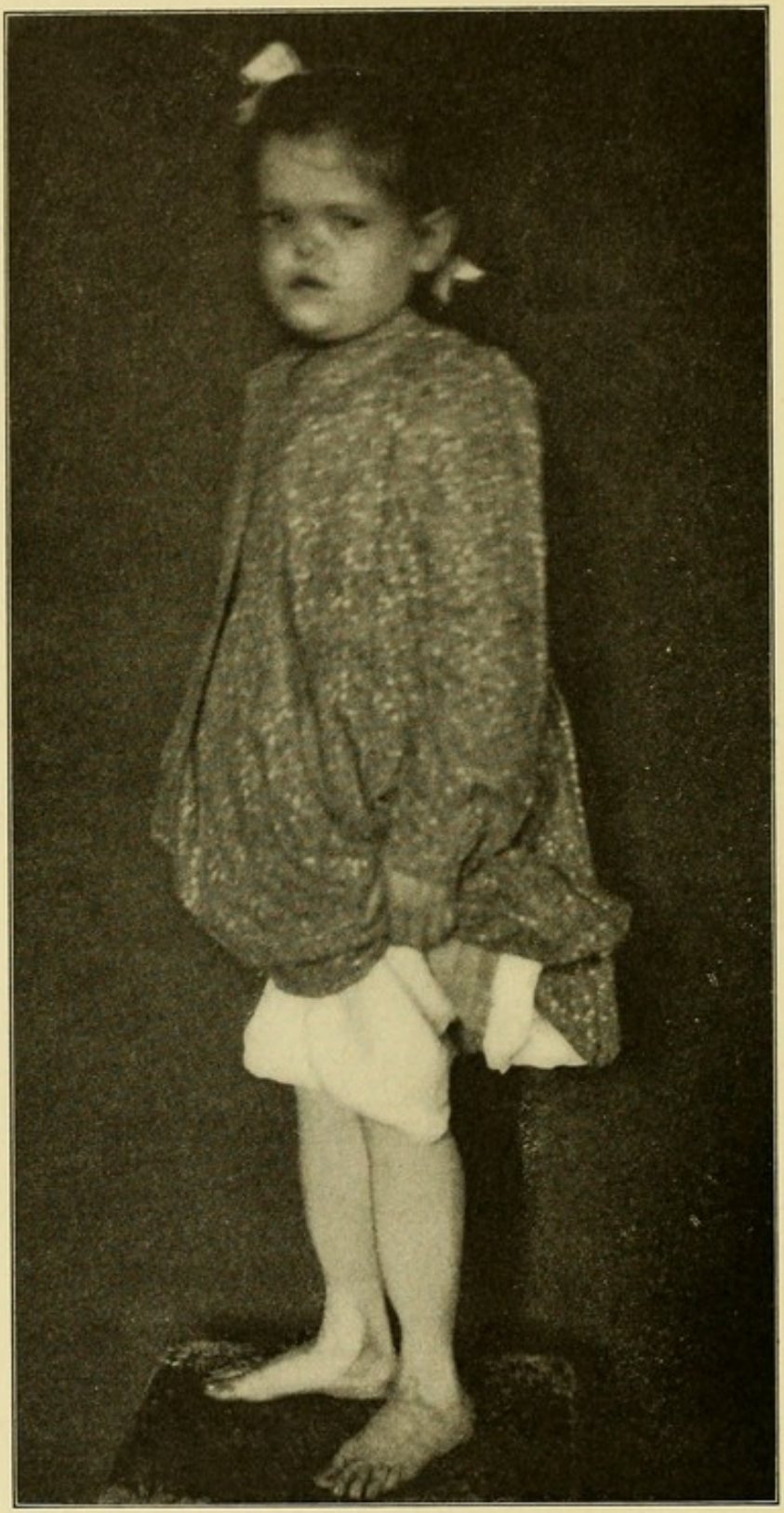


FIG. 8.—SYPHILITIC OSTEOPERIOSTITIS OF TIBIA; INHERITED.
Note fallen bridge of nose. (Hospital for the Ruptured and Crippled.)

are perfectly normal in appearance at birth and subsequently. Hereditary bone syphilis in infants often takes the form of an osteochondritis of an epiphysis, with pain, swelling, and sometimes effusion; the knee and elbow are specially vulnerable, and the affection is often polyarticular (Fig. 7); the process, if unchecked, may result in local destruction or epiphyseal separation. In older children a persistent unilateral or bilateral hydrops of the knee, a tardy manifestation of hereditary lues, may clear up on mixed treatment; such a condition may also be due to chronic tuberculous synovitis, but is then refractory to specific treatment. Hereditary or acquired bone lesions may be due to an osteoperiostitis (Figs. 8 and 9), with pain, tenderness, and overgrowth of bone in thickness and length, or to gummata involving bones and joints.

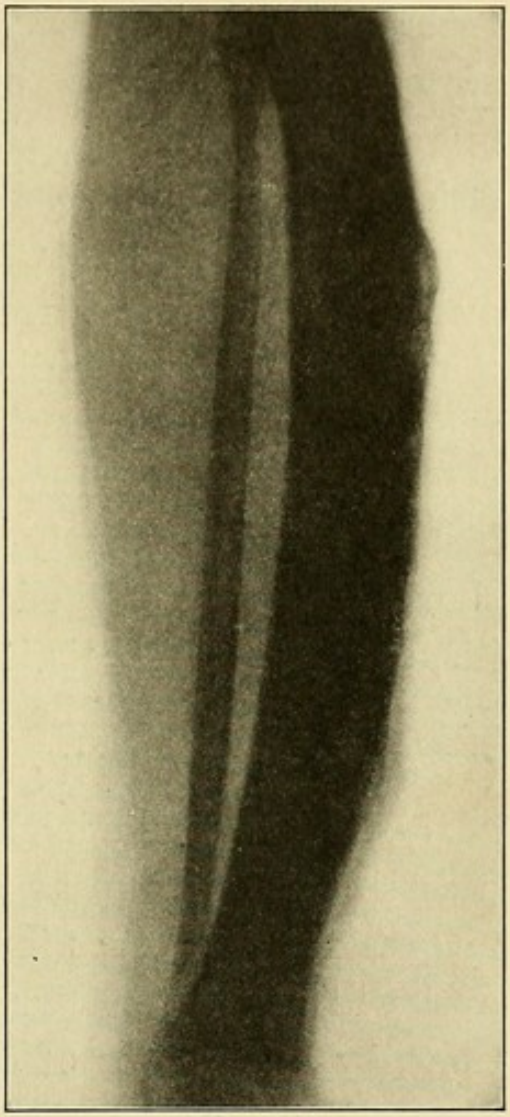


FIG. 9. — OSTEOPERIOSTITIS FROM INHERITED SYPHILIS IN A GIRL OF SEVEN. Notice the "bone blisters."

We occasionally see in children the elongated saber-like tibiæ resulting from a chronic specific osteoperiostitis (Fig. 180), and multiple bony swellings of unmistak-

able significance usually near joints. Phalangitis syphilitica is characterized by more thickening of the cortex and less tendency to involve the joint than phalangitis tuberculosa, which is much more frequent. We also see occasionally a bone or joint lesion whose character is revealed by the coexistence of some active specific lesion like a syphilitic testicle, or which may be suspicious from the history, and which improves or clears up on mercury or mixed treatment. It should be borne in mind that all lesions in syphilitics are not specific, especially when the syphilis is ancient, and also that with lesions evidently syphilitic either in a child or in an adult, the history may be entirely and truthfully negative. One should always be on the lookout for bone and joint syphilis, since the diagnosis is important, but such cases are not very common. The old-fashioned mixed treatment (Hydrargyri bichloridi gr. $\frac{1}{32}$, potassii iodidi gr. v, aquæ ad. ℥j, t. i. d. for an adult) has been most efficient and will occasionally clear up an obstinate or doubtful case like magic. In some cases inunctions of unguentum hydrargyri will act better. Babies may be treated by inunctions, by small doses of calomel, or by gray powder gr. ss.–gr. j., b. i. d.

Gonorrhea, on the other hand, is a very frequent cause of articular and periarticular inflammation, and even of ostitis and periostitis. The cause is usually overlooked, except in the form miscalled gonorrheal rheumatism. Joint infection occurs in over ten per cent of the cases, and may take place at any stage of the disease, even when latent in the seminal vesicles, prostate, or uterine adnexæ; endocarditis is also common. The mildest cases,

lasting only a few weeks, may be caused by the irritation of bacterial products; these form about one third of the cases. In others the pain is severe and may be agonizing, the effusion is great, and there is a tendency to the involvement of the bursæ, tendon sheaths, and periarticu-

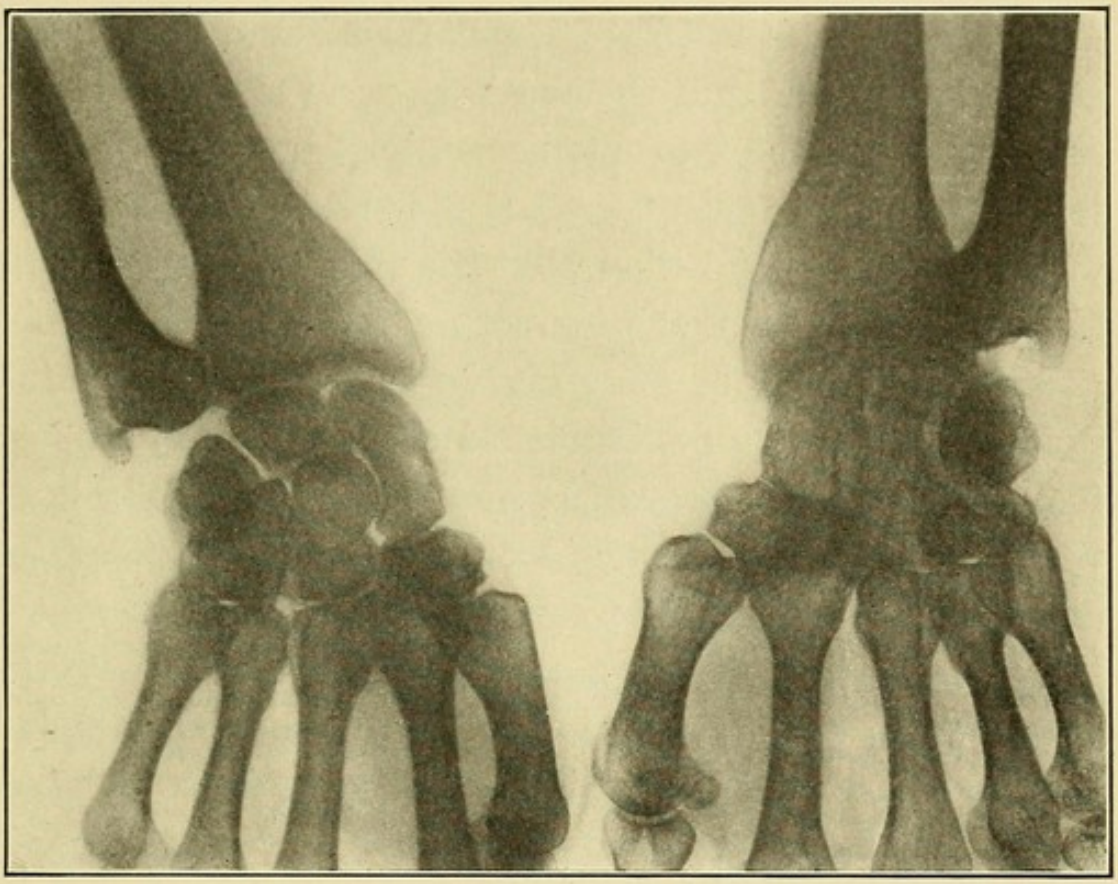


FIG. 10.—GONORRHEAL ARTHRITIS OF RIGHT WRIST IN ADULT.
Note atrophy, blurring of lines, and obliteration of joint spaces.

lar structures. The constitutional symptoms are moderate, and there is not much tendency to metastasis from the affected joints. According to Nathan, the infection is essentially acute, and involves either the bone or the joint primarily (Fig. 10). If a primary osteomyelitis, the X-ray reveals bone atrophy within a week, and the joint may become secondarily involved. The cases primarily

arthritic remain confined to the joint, and do not involve the bone secondarily. The cases which pass for chronic are said to be either cases of repeated infections, or else there is no active gonorrheal process, the irritation being kept up by repeated insults to deformed or defective parts. In nearly half the cases the trouble is monarticular, and in the polyarticular form fewer joints are affected than in acute rheumatism, and the tendency to skip from one joint to another is lacking. The larger joints are most frequently affected, particularly the knee, wrist, hip, ankle, and elbow, but the smaller joints do not always escape; even the temporo-maxillary articulation and the spine may be affected. In certain cases the disease can hardly be distinguished clinically or by X-ray from arthritis deformans. It should be remembered that when the blood is infected, local trauma predisposes to arthritic infection. The puerperium also is a time when the susceptibility of the patient is enhanced, and many joint and other affections which have passed for puerperal sepsis, are really due to gonorrhea, which may have been masked or latent. In spite of the feeble vitality of the gonococcus outside the body, the specific conjunctivitis and vaginitis is extremely contagious, especially in children and in hospitals, as pointed out by Holt. Vulvovaginitis should always be looked for and excluded from children's wards. In this form joint complications are extremely common, and usually serious. The serous effusions usually subside under bandaging and rest, but aspiration is occasionally necessary. Fibrinous exudation and periarticular involvement tend to limitation of motion, the formation of adhesions, and ankylosis; trac-

tion or splinting may be required in the active stages, and passive and active movements, and sometimes forcible correction, after recovery from the acute symptoms. It is usually possible to prevent deformity in early cases.

Many cases of stiff spine in young men are due to gonorrheal infection. Cases of flat or painful feet characterized by points of acute tenderness under, at the sides, or behind the heel, over the plantar fascia, or about the mid-tarsus, sometimes with enlargement of the os-calcis or boggy swelling about the heel, mid-foot, or fore-foot, and very resistant to shoe, strapping, and plate treatment, are often of gonorrheal origin. The formation of osteophytes under the os calcis, sometimes requiring excision, is not uncommon. Indeed, when a flat-foot is specially obstinate, particularly if unilateral, gonorrheal infection should always be considered.

Perhaps most important of all, and this we are only just beginning to appreciate, is the cure of the original point of infection, be it in the deep urethra, in the seminal vesicles, in the vagina, uterine adnexa, or elsewhere. Magical results are reported from attention to obscure sources of infection (Fuller). Encouraging reports are also given from the use of a bactericidal serum (Rogers).

After the subsidence of inflammation, deformities should be corrected, motion restored, and disabilities removed by appropriate orthopedic treatment.

Acute (pus) infection of bone and joints is not uncommon. The purulent epiphysitis and arthritis of infancy, affecting principally the hip, knee, or shoulder, may be an infection from the navel (phlebitis) or other source. If recognized early and treated by free incision, removal

of dead bone, when present, irrigation and drainage, the results are good. If neglected, a certain number of joints open spontaneously and recover, sometimes with extensive destruction of bone (Fig. 159); but many untreated cases succumb to sepsis.

Pus joints should be opened, irrigated, and drained, and during repair should be kept at rest in a splint.

Other forms of pus infection are acute, subacute, and chronic osteomyelitis.

Acute osteomyelitis is most frequent in early life, and is usually due to the staphylococcus aureus, though it is sometimes caused by streptococci, pneumococci, typhoid bacilli, and other organisms. Fatigue, exposure to cold and wet, trauma, and acute infectious disease are predisposing causes. Fractured bones, particularly compound fractures, may become involved in a local osteomyelitis. The usual location is near the ends of the long bones, outside of the epiphysis (metaphysis), and the process begins and spreads rapidly in the marrow, the bone becoming involved secondarily. When the bone is perforated, an abscess is formed which may elevate the periosteum; this is one cause of purulent periostitis. The formation of sequestra surrounded by thick and irregular bone (involucrum) is a characteristic end result (Fig. 11), but this does not always occur.

Symptoms.—The invasion is rapid and the constitutional symptoms are severe. Local pain and tenderness are intense, and if the bone is superficial, heat, redness, and swelling may soon be detected. The process may go on to the burrowing or rupture of an abscess (Fig. 12), or, if the pus does not perforate the bone, the toxemia

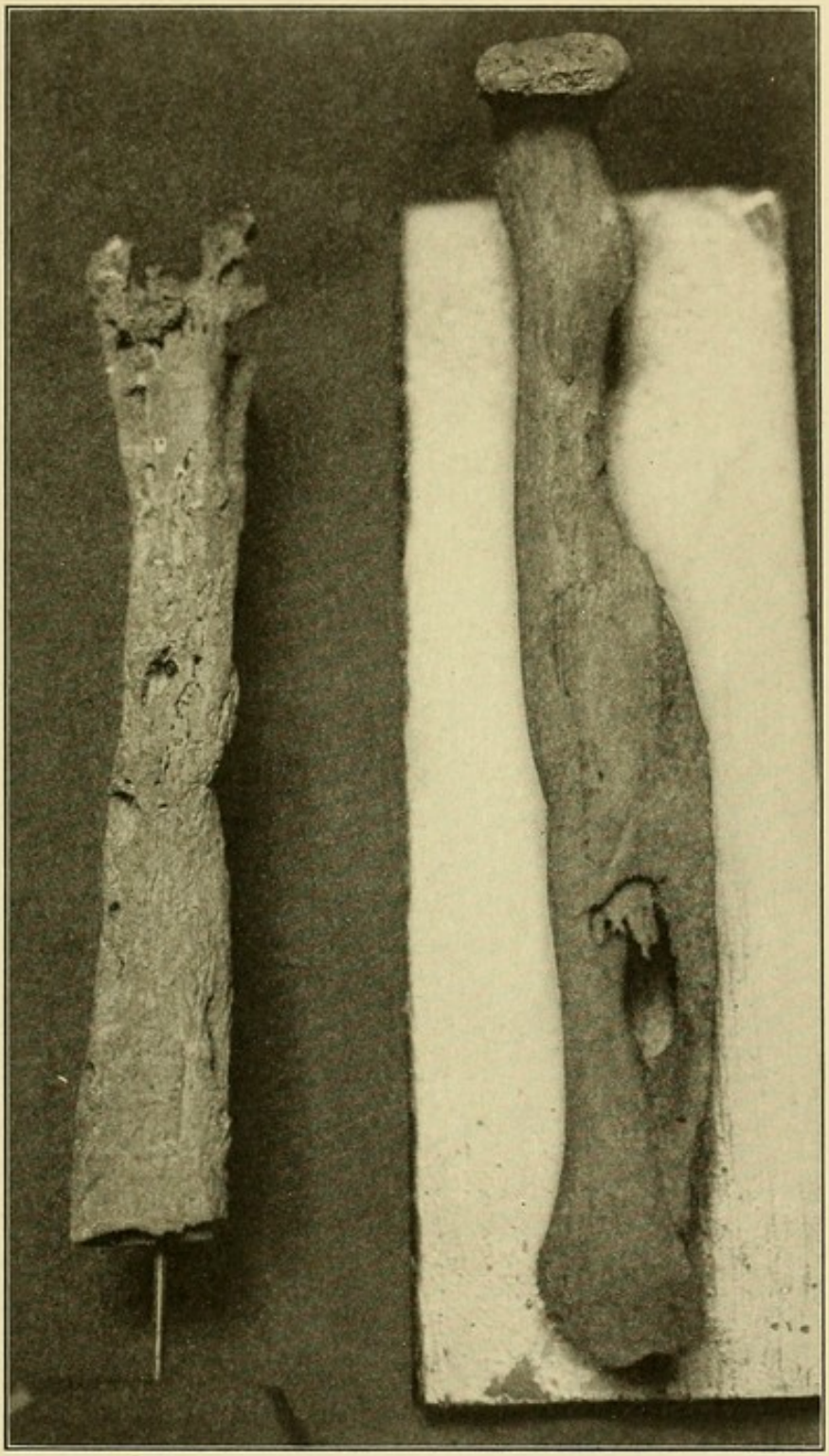


FIG. 11.—OSTEOMYELITIS OF TIBIA AT LEFT, OF FEMUR AT RIGHT. Both show a sequestrum, partially covered by a perforated involucrum. (Specimens from College of Physicians and Surgeons, New York.)

may increase and the patient may die in stupor or delirium. In some (subacute) cases the process goes on more slowly, with less urgent symptoms. In young chil-

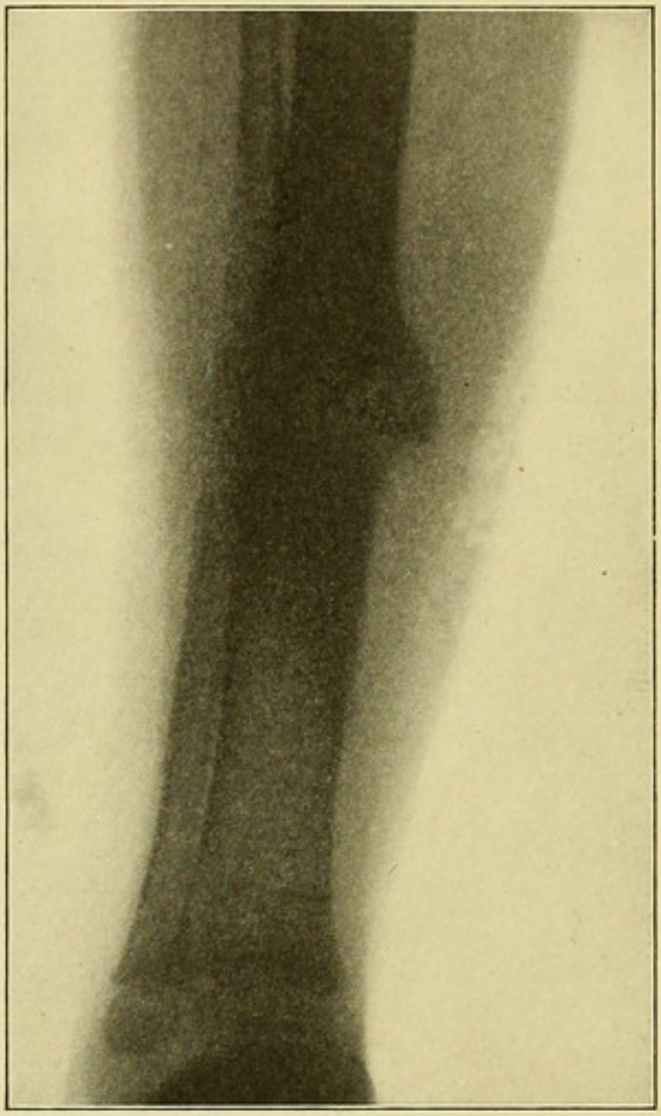


Fig. 12.—Circumscribed Osteomyelitis of Shaft of Tibia with Sequestrum and Sinus.

dren who do not localize pain well, a tender spot may often be found by systematic search.

Diagnosis.—Syphilitic and tuberculous bone and joint disease, typhoid fever, meningitis, acute rheumatism, and abscess of the soft parts are the affections most often confounded with acute osteomyelitis.

The PROGNOSIS in severe cases is very serious unless relief is promptly afforded; the patient may die of septicemia in a few days, or of pyemia, ulcerative endocarditis, or exhaustion later. Suppurative arthritis in a neighboring joint, or multiple foci, add to the gravity of the disease. Other cases progress more slowly to rupture or incision of the abscess, and a chronic suppurative process with sequestra, sinuses, and various deformities due to overgrowth, retarded growth, or destruction of bone, and involvement of neighboring joints. Many cases are saved by a timely operation.

TREATMENT.—Operative interference to provide ample drainage of the medulla is urgently needed in the acute cases. At the operation the periosteum may be found elevated from the whitish bare bone by creamy pus. If dots of pus are seen coming from osteal vessels, or if fat globules float on the pus, this is proof of suppuration inside the bone. At this operation the periosteum should be divided and separated and the whitish, bare bone chiseled away so as to freely expose the diseased medulla throughout its extent; obviously diseased or infected tissues should be removed, but the medullary cavity should not be too vigorously scraped, as it is important to preserve both the periosteum and endosteum, from which new bone is developed. Many surgeons lay great stress upon swabbing out with various antiseptic solutions, such as pure carbolic acid, followed by alcohol, or tincture of iodine; but it is doubtful if they are better than mild cleansing solutions. In the milder cases it is sometimes well to close the wound up, and occasionally readhesion

of the periosteum and primary healing take place. It is usually safer to pack the bone with gauze for twenty-four hours, and then to provide wick drainage down to, but not into, the bone for a shorter or longer time, as may be necessary (McCurdy); this favors healing by granulation, and a considerable number of such cases heal, if they do not become reinfected. Often a mild infection ensues, and an involucrum of ossifying tissue is formed around a sequestrum. This will become sufficiently developed in three or four months, when it should be split and opened for the removal of dead bone; the cavity is then scraped and cleansed. If only part of the thickness of the shaft is removed, the involucrum may be turned into the cavity and nailed. If the whole circumference of the shaft is removed, the involucrum may be folded and stitched together to obliterate the cavity (Nichols). The involucrum should only be treated in this manner when it is fairly certain that all diseased tissue has been removed. In very extensive cases nearly or quite the whole shaft may have to be removed subperiosteally, but this should not be done unless it is evident that the shaft is dead. Complete regeneration of the shaft of a long bone from the periosteum has often been observed. In cases where the bone focus is small and well defined it is often well after scraping and cleansing the cavity to fill it with Mosetig-Moorhof's bone wax,[1] which serves as a scaffold for the granulations, and is gradually absorbed. When

[1] Sixty parts iodoform, forty parts each of spermaceti and oil of sesame; the two latter are melted together, the iodoform added and the mixture heated to 150° on a water bath an hour; it is then cooled to 120° and poured into the cavity at that temperature; or it may be allowed to become semisolid and may be pressed into the cavity; it becomes solid at the body temperature.

this is used the operation wound may be closed, though it frequently breaks down.

In the after treatment plaster-of-Paris splints, with windows or brackets, or wire splints, should be used, and the patient kept in bed until healing is well advanced. Ample supplies of fresh air day and night and a generous diet facilitate repair. If bone regeneration is insufficient, osteoplasty or bone-grafting may be indicated. The process of repair often lasts many months.

Chronic Osteomyelitis.—Osteomyelitis may be exceedingly chronic, may be multiple, and even symmetrical in location, and may simulate rheumatism. The X-ray will often clear up the diagnosis, and enable the surgeon to remove the diseased focus.

Infectious Arthritis.—The ordinary pus microbes are not the only ones that may cause a joint, or even a pus infection. All the acute infectious diseases, such as pneumonia, influenza, measles, scarlatina, typhoid fever (Fig. 13), and the rest, are capable of exciting bone and joint inflammation, sometimes with the formation of pus. These arthritides, excited by the toxins or bacteria of the acute infectious diseases, have often passed for rheumatism or for a tuberculous infection, but should be sharply distinguished from both. The term infectious arthritis, proposed by Goldthwait, is a convenient one to separate these cases in practice. When a joint infection occurs during or soon after an acute infectious disease, the possibility of a specific irritation and infection should be considered, and, when possible, the fluids or tissues examined bacteriologically. It should be remembered, however, that the resistance of the individual cells and of the

system is weakened after such diseases, making easier the local proliferation of pus germs, which are always

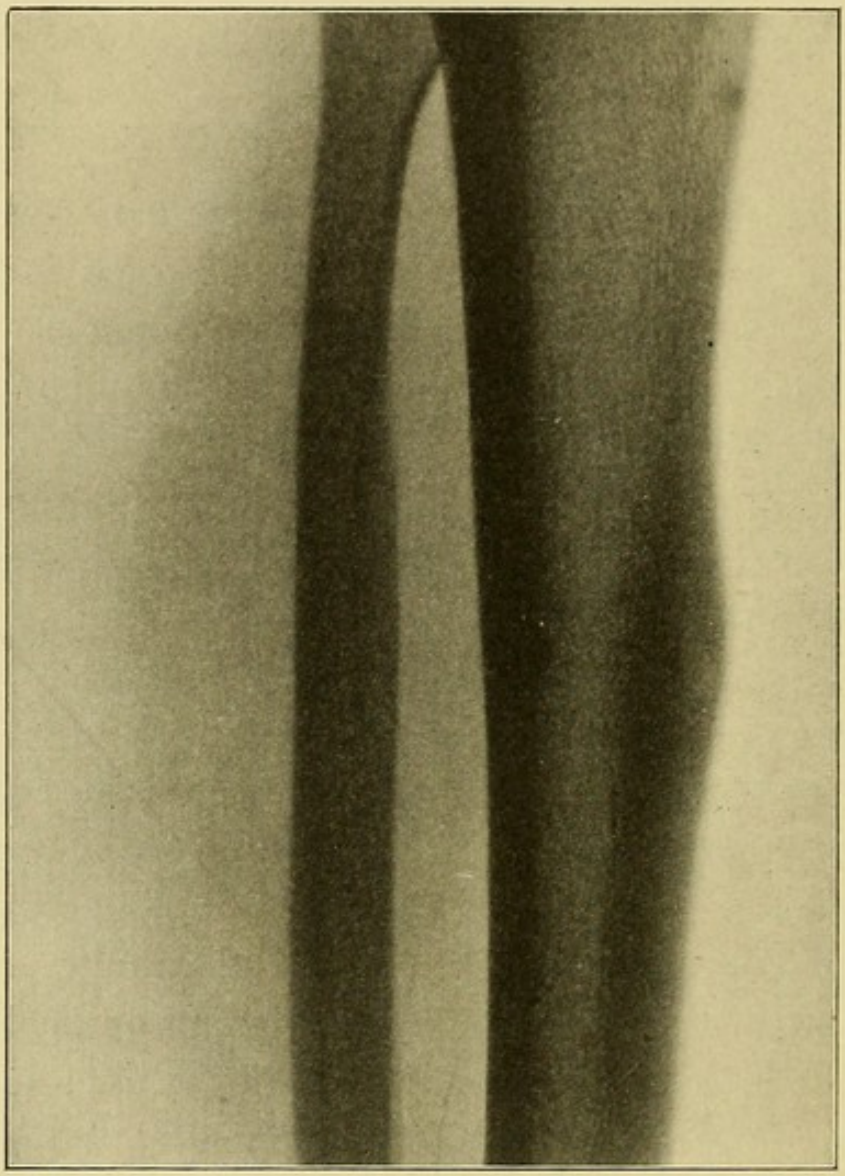


FIG. 13.—OSTITIS OF THE TIBIA WITH SMALL ABSCESS, NINETEEN MONTHS AFTER BEING HIT BY BASEBALL, SOME MONTHS AFTER TYPHOID FEVER. Boy of eighteen.

present. This is also true of tuberculous infection, which often occurs after whooping cough, measles, and other depressing diseases.

Tuberculosis.—After all is said, the large majority of chronic joint diseases, particularly in children, are tuber-

culous. There are many hip, knee, and ankle diseases, but the typical and usual one is tuberculous.

Pathological Anatomy.—The tuberculous process in bones and joints is due to the proliferation of the tubercle bacillus, which excites a granulation of low vitality destructive to adjacent bone, but with a definite tendency

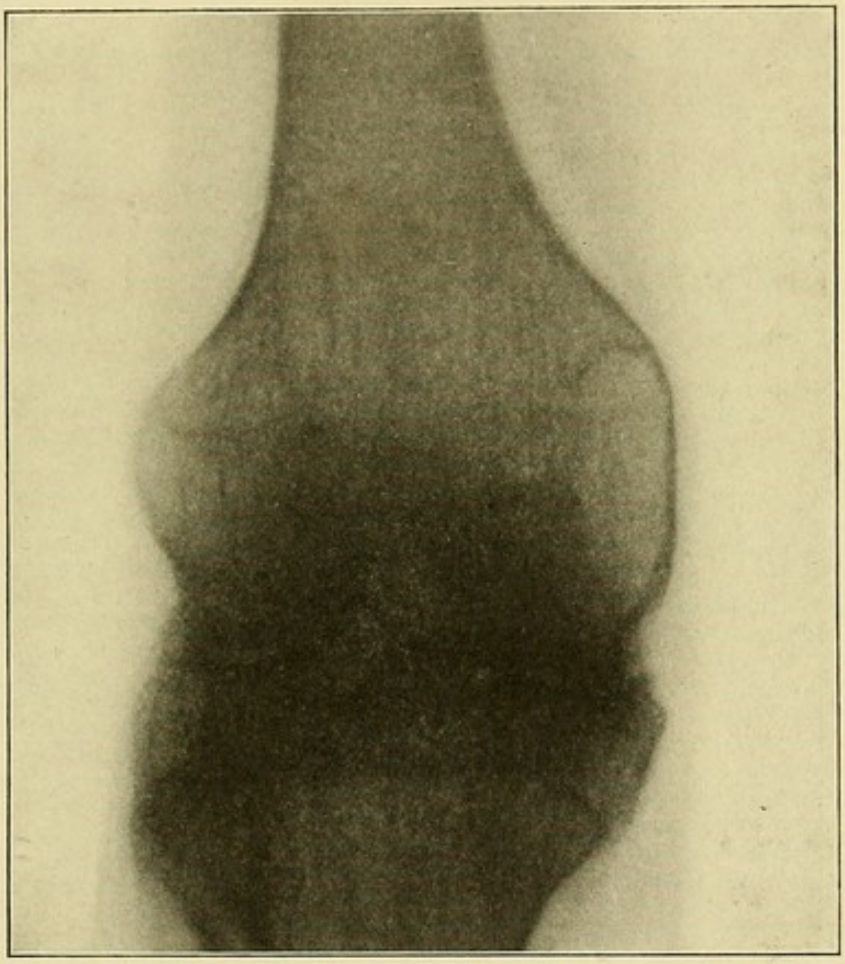


Fig. 14.—Tuberculous Focus in Left Internal Condyle (Reversed) in Woman of Twenty-four. Symptoms at times for fifteen years following a fall. Knee flexed and stiff, tender spot over internal condyle. Note large bullet-shaped focus, absence of joint space, and atrophy of bone.

to heal by encapsulation, calcification, or cicatrization. The tuberculous infection of bones and joints is usually secondary to glandular, or other, involvement (König),

though in most cases clinically the disease seems solitary. The infecting material is usually carried by the blood current, and commonly lodges in the very vascular epiphyses of the young. Here it may assume the form

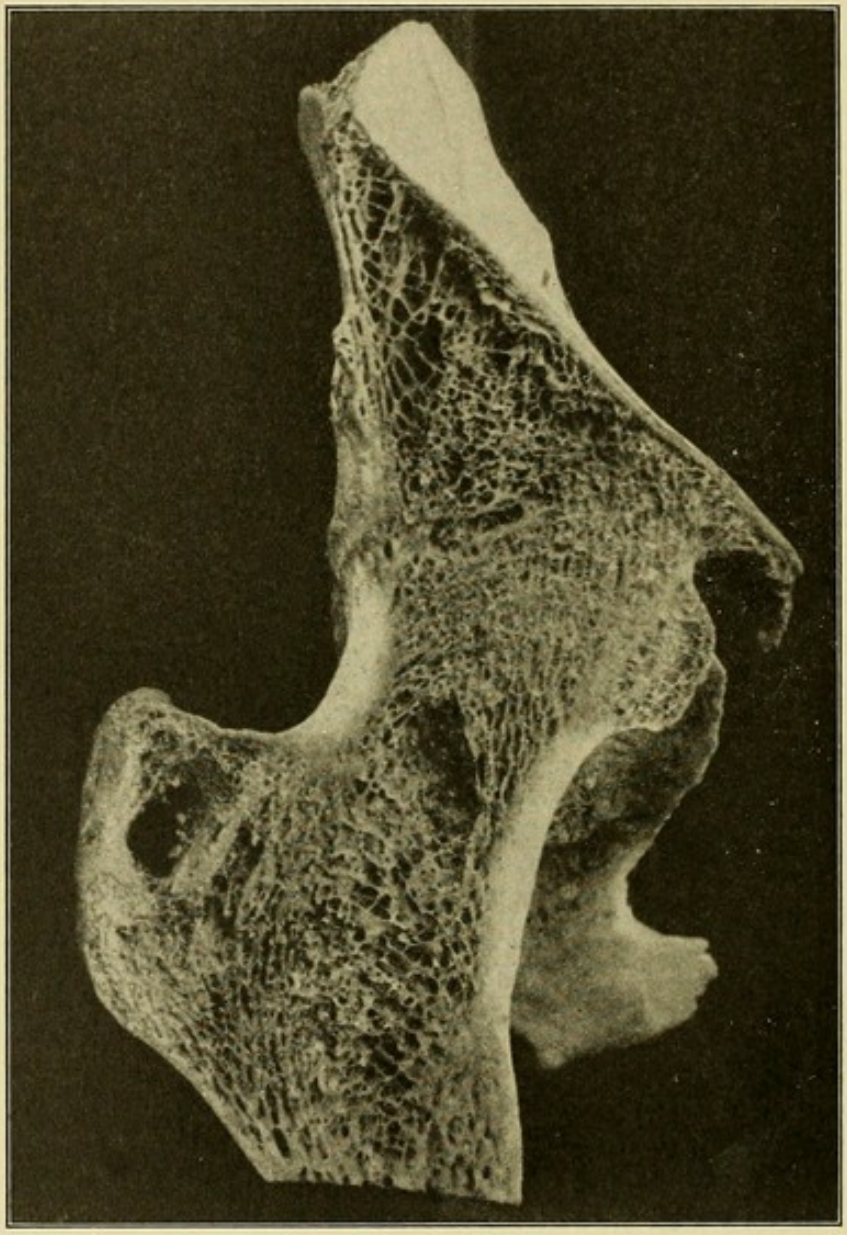


FIG. 15.—BONY ANKYLOSIS FOLLOWING TUBERCULOSIS OF THE HIP.
(Royal College of Surgeons, London. Phelps.)

of one or more small, rounded foci (Fig. 14), of a wedge-shaped infarct, extending to the joint surface, or of a

diffuse infiltration. Small foci may cicatrize, or break outward, but usually erode into and infect the neighboring joint. The process often ends in bone destruction with deformity and stiffness, sometimes in true bony ankylosis (Fig. 15). Small sequestra, cheesy masses, or collections of ichor [1] may be formed. In certain cases the infection is primarily synovial, with production of serum, fibrin (rarely sterile pus), and pulpy degeneration; in such cases the cartilage may resist infection and keep itself and the bone intact (Nathan); in others the cartilage and bone are eroded by the organization of deposits of fibrin. Rarely the tuberculous process is localized in the shaft of a long bone. The diseased and swollen phalanges (spina ventosæ), formerly considered syphilitic, are, in the vast majority of cases, tuberculous. Phalangitis tuberculosa is characterized by thinning, expansion, and destruction of bone and early involvement of neighboring joints (Fig. 16).

The danger of infecting others from a tuberculous joint is remote and probably negligible. It has seemed to the writer that there was marked antagonism between active rickets and joint tuberculosis, since, while both are common in early childhood, their coincidence is rare.

Etiology.—Too much emphasis should not be placed on the personal or family history, which is often unreliable, and is never decisive. It is true that bone tuberculosis very often occurs in delicate children of tuberculous antecedents, prone to catarrhal, digestive, and glandular

[1] The term ichor, suggested by A. Rose, is used to designate the thin fluid with flocculi and débris, which often comes from tuberculous foci but is in no strict sense pus.

troubles, formerly called scrofulous; but such constitutions are quite as apt to come from alcoholic or neurotic parentage, and may result from a vicious environment. In a word, the absence of tuberculosis in the family by

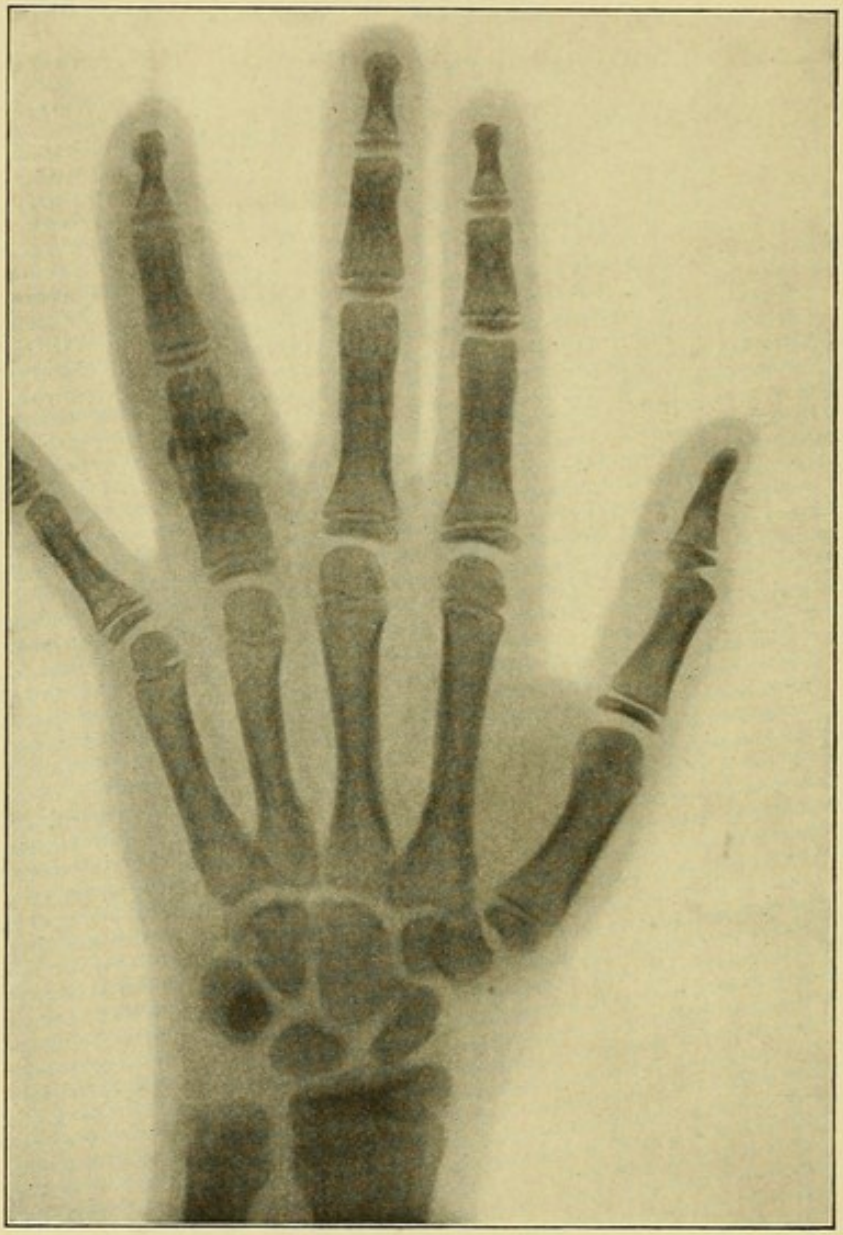


Fig. 16.—Tuberculous Phalangitis; Three Months' Duration; Cure after Curettage by Albee.

no means protects the child from infection, nor should a tuberculous family history cause one to diagnose a present joint affection as tuberculous. The history is one

factor in the case, often a minor one, and to be at all complete it must include information as to alcoholism and neuroses, and possibly syphilis, and especially as to exposure to tuberculous infection in the dwelling, whether from a relative or other person. Trauma may or may not be an exciting cause, and may in particular determine, or more probably unmask, the localization of the destructive process. A trauma of moderate severity is more apt to have this effect than a severer injury, which causes a local reaction unfavorable to the growth of the bacilli. In many cases of joint tuberculosis all history of trauma is absent; but the disease often follows measles, whooping cough, and other acute infectious diseases.

Symptoms.—The invasion is usually insidious, and the symptoms for several months may be obscure and intermittent; pain may be absent in the beginning, and occasionally through the course of the disease. The most important symptoms are the characteristic postures, and disabilities, reflex spasm of the muscles controlling the affected joint, the rounded fusiform swellings without acute symptoms, in superficial joints, and the tendency to the formation of ichor pockets [1] (cold abscesses). There is practically no fever, unless secondary pus infection has taken place.

The diagnosis can usually be made from the symptoms and course of the affection; in doubtful cases the chances are in favor of tuberculosis on account of its frequency, especially in children. It is important to distinguish pus

[1] Term proposed by the writer for the collections of serum and débris so common in connection with tuberculous bones and joints, and which are to be sharply distinguished from true suppuration.

and other infections, infantile scurvy, hemorrhagic joints, syphilis, injuries, and that large and vague category often denominated "rheumatic," or "rheumatoid." In spite of the fact that rheumatism is almost unknown in infancy, and rare in early childhood, the commonest error is to consider a tuberculous joint rheumatic. The results of such mistakes are often disastrous. Skiagraphy, the tuberculin test, and aspiration may aid in diagnosis.

Tuberculin in Diagnosis (Ogilvy).—Injections of tuberculin for diagnostic purposes have been employed during the past eighteen years. A hypodermatic injection of five tenths of a milligram of Koch's old tuberculin was usually given. An elevation of from one to three degrees of temperature, accompanied by a general feeling of malaise, indicates a positive reaction.

Of Koch's new tuberculin (T. R.), one tenth of a milligram is a sufficiently large dose. This preparation, with the smaller dosage, has eliminated some of the objectionable results previously experienced. The advantage of this method is that in localized tuberculosis we have a perceptible reaction in the area of disease. The reaction is at its height in from twelve to fourteen hours, and passes away in about twenty-four hours.

Vaccination Test.—Von Pirquet's method consists in scarifying the skin through a drop of Koch's old tuberculin. Two small areas about three inches apart are so vaccinated. The skin between these two areas is simply scarified; no dressing need be applied. The reaction begins in from ten to fifteen hours, and lasts a week or more. The faintest reaction is easily detected by com-

parison with the control spot. Von Pirquet especially recommends this method for young children.

The Eye Test.—The Calmette ophthalmo-tuberculin reaction has, with Von Pirquet's method, attracted much attention during the past year. One minim of the 1 to 100 sterile, saline solution of the alcoholic precipitate of Koch's old tuberculin is dropped into one eye. At the end of three to four hours a mild conjunctivitis is noticed. The reaction continues, and becomes gradually more intense, in some instances resulting in a purulent conjunctivitis, with a slight burning sensation.

The reaction reaches its most acute stage in about eighteen hours and passes off in twenty-four hours. Occasionally a mild conjunctivitis may remain for several days. This method should not be used when an inflammatory affection of the eye is present.

The Inunction Method.—Moro recommends rubbing into the skin of the chest or abdomen an ointment of Koch's old tuberculin, 5 c.c., with anhydrous wool fat, 5 grams.

A piece about the size of a pea is rubbed into the skin for half a minute, over an area of about the size of the palm of the hand. In from twenty-four to forty-eight hours small papules appear, which usually vanish at the end of a week. No harmful reactions have followed this method. There are apparent errors both positive and negative in all these reactions.

The PROGNOSIS in tuberculous joint affections in children is distinctly good under rational treatment; the large majority recover with useful limbs.

The untreated and improperly treated cases, however,

either go from bad to worse, and finally die of acute tuberculosis, tuberculous meningitis, sepsis, waxy viscera (Fig. 17), exhaustion, or intercurrent diseases, or recover with crippling deformities and impaired constitutions.

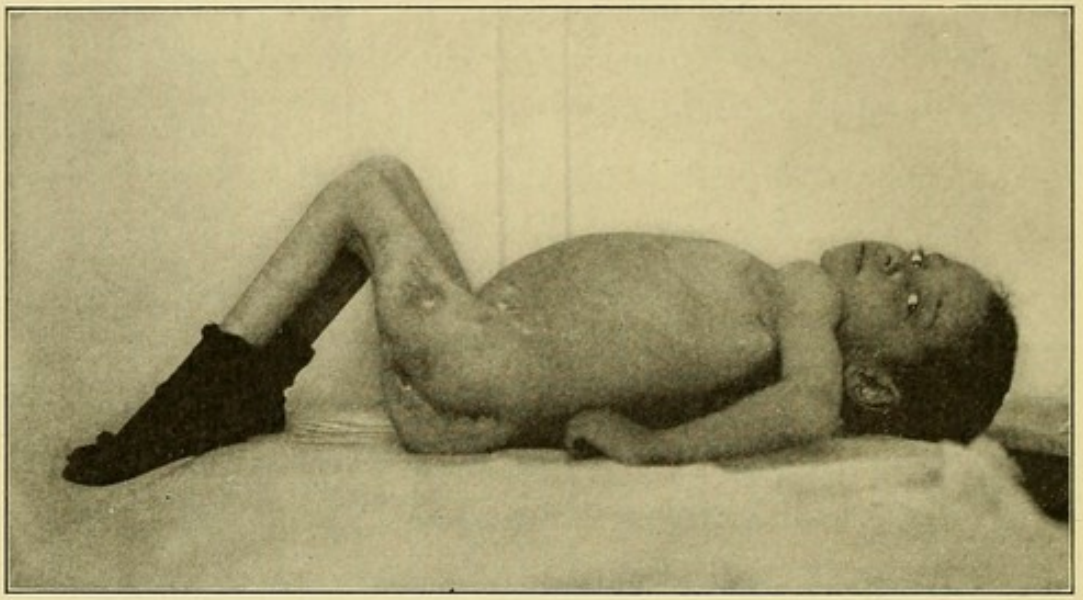


Fig. 17.—Pott's Disease Five Years, and Left Hip Tuberculosis, Four Years' Duration; Multiple Sinuses; Deformity; Waxy Viscera; Boy of Eleven.

As recovery takes place by walling off infected foci and cicatrization, these patients are liable to relapse after injury, though such relapses are not common when the general condition is good. In adults there is a greater tendency to visceral, and particularly pulmonary involvement, and while the prognosis is still good under good management, radical operations are much oftener indicated, and the percentage of recoveries is smaller than in children.

Treatment.—The two great indications in joint tuberculosis are to provide continuous rest and protection for the diseased joint and to improve the local and general nutrition. Proper treatment will also include the

prevention and correction of deformity. Under such management the large majority recover with fair health and good locomotion.

It was recognized by the American pioneers in orthopedic surgery that confinement to bed for long periods is unhygienic, and it is their great merit to have devised effective means of splinting and protecting the joints, while still allowing locomotion, at least during the long stage of convalescence, and permitting the patient to live in the fresh air, recognized then as now as our most powerful tonic. To neglect either side of the problem is a grave error; if by fats, milk, eggs, and a nutritious and generous diet, fresh-air life, attention to elimination and other means, we can improve the general condition, the richer blood will surely improve local nutrition. This will hardly be possible in the active stages of the disease, unless suffering is relieved, and joint damage prevented for a long period by mechanical means. For both general and local reasons, the patient's activity should be much curtailed, the hours of rest prolonged, and periods of recumbency enforced when indicated.

When the tuberculous focus is extra-articular and accessible, it should be removed by a surgical operation. In desperate cases, the result of neglect, or in those where the tonic and rest treatment has failed, as sometimes occurs, erasions and excisions may be required. Early excisions in children have been extensively tried and abandoned as unsatisfactory, but are occasionally demanded as a life-saving measure. The immediate and remote mortality is nearly one half, which may be better than the natural mortality in these desperate cases.

In adults excision of a tuberculous joint gives excellent results, and is often the treatment of choice.

DISEASES OF UNKNOWN ORIGIN

"Rheumatoid" affections form a very important and very difficult division of joint troubles, in which considerable interest has been aroused by the labors of Goldthwait and his associates in this country, and by other investigators. It is doubtful if there is any disease properly designated as chronic rheumatism; the affections heretofore so called, which may be monarticular or polyarticular, are divisible into

1. Villous arthritis, characterized by hypertrophy of the synovial membrane and its fringes.

2. Infectious arthritis, as already described; infections from various specific microbes and toxins.

3. Arthritis deformans, characterized by atrophy and stiffness, which may begin acutely with effusion and constitutional symptoms, but often becomes extremely chronic, and may result in much deformity, stiffness, and disability.

Villous arthritis is characterized by thickening of the synovial membrane and hypertrophy of the synovial villi. It may be primary, or secondary to various joint infections and to arthritis deformans. The joint may contain masses of soft tabs, or wormlike villi, which may cause enlargement and may sometimes be palpated. The hypertrophied villi may undergo fatty degeneration and change to a joint lipoma (lipoma arborescens). The rubbing of these masses when the joint is moved often causes more or less creaking and snapping. The knee

is the joint most commonly affected. If the masses are pinched in the movements of the joint a local synovitis with pain, swelling, tenderness, and disability may result; these symptoms sometimes resemble those of a floating body, or semilunar injury. Creaking is often present without other symptoms, and it is probable that hypertrophied villi of moderate extent often cause no disability.

Cases with pain, swelling, and moderate disability are often relieved by strapping, bandaging (or knee-cap), and the vibrator or high-tension current. Intractable cases may require excision of the villi.

Arthritis deformans is characterized by atrophy of bone and soft parts, wearing away of cartilage, deformity, pain, and stiffness. In the early stage there is joint effusion and swelling. It usually affects a great many joints, beginning with the proximal interphalangeal joints; there is a tendency to bilateral symmetry. It frequently begins in young adults, and a juvenile form has been described. In the form called osteoarthritis, in addition to atrophy of the pressure-bearing structures, there are bony outgrowths at the margins of the joints (Fig. 18), and in some instances, especially in the spine, there is ossification of ligaments. This form does not usually affect so many joints, and may be monarticular. It does not so often affect the finger joints, and when it does it usually affects the terminal joints first. It may affect a single joint after an injury or after repeated insults (great toe joint). The process may sometimes be arrested before causing serious damage. Senile changes may take place, particularly at the hip, knee, or shoulder,

which result in a wearing away of the joint surfaces, with the production of osteophytes about the periphery, causing pains, deformity, and stiffness. It is doubtful whether these cases should be classed with ordinary

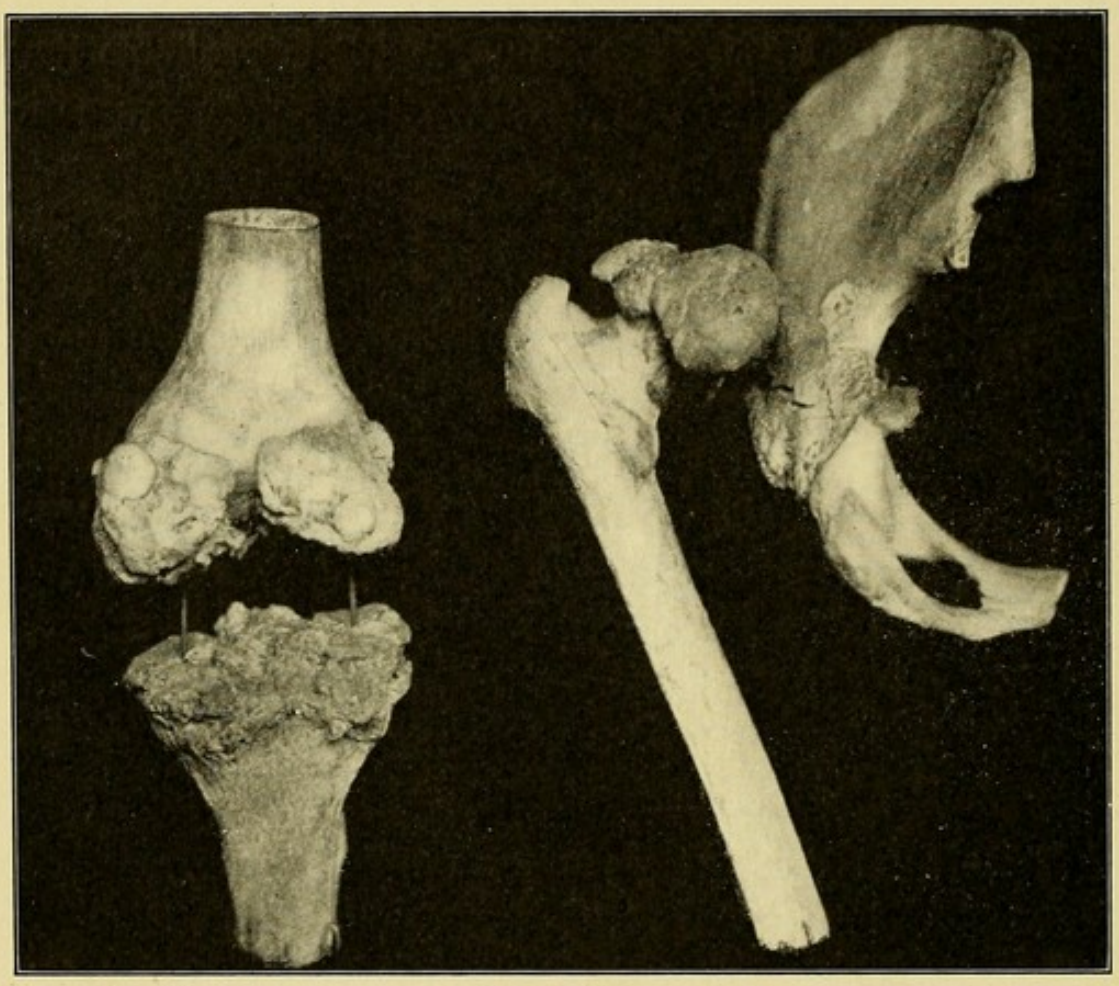


FIG. 18.—OSTEOARTHRITIS OF KNEE SHOWING OSTEOPHYTES. OSTEOARTHRITIS OF HIP SHOWING DEFORMATION AND DISLOCATION OF THE HEAD OF THE FEMUR. (Specimens from College of Physicians and Surgeons, New York.)

osteoarthritis. The cause of arthritis deformans with or without osteophytes is unknown, though it may be infection or autointoxication from intestinal indigestion in certain cases. Acute rheumatism, excluding the acute stage of arthritis deformans, and the specific joint infections, is rarely followed by permanent stiffness. Recent

investigations render it probable that acute rheumatism is also due to microbic infection, whether specific or not is still uncertain.

Arthritis deformans in the chronic stage demands tonic treatment, measures directed to improve the digestion (hydrochloric acid), and elimination, a nourishing diet which shall not exclude meat, and may often with advantage include fats and sterilized milk soured by lactic acid bacteria; and other measures to promote general and local nutrition, like vibration, oil inunctions, the high frequency current, electric light, hot air and sun baths, hot and cold douches, hot saline compresses, wrapping the joints with rubber tissue, and graduated movements. Antirheumatic treatment, such as the iodides, the alkalies, the salicylates, strenuous bathing, and a low diet, are usually harmful, and should be avoided.

In the active stage the patient should be kept quiet and the joints should be supported by splints, as in other joint inflammations. The relief given by such measures is often surprising. After subsidence of the acute symptoms, deformities may be overcome by stretching or the use of moderate force under anesthesia, care being taken not to attempt too much at one time, which usually does harm, and to retain the correction gained, by retentive splints. Protective splints are also sometimes of great utility.

Still's disease is a chronic polyarthritis of childhood, with enlargement of the liver, spleen, and glands, fever, and constitutional symptoms. Most of the joints become involved, and the child is cachectic and helpless (Figs. 19 and 20). The symptoms resemble those of an in-

fective process; there is considerable natural tendency to a recovery more or less complete. A similar polyarthritis occurs in children without notable visceral or glandular enlargement.

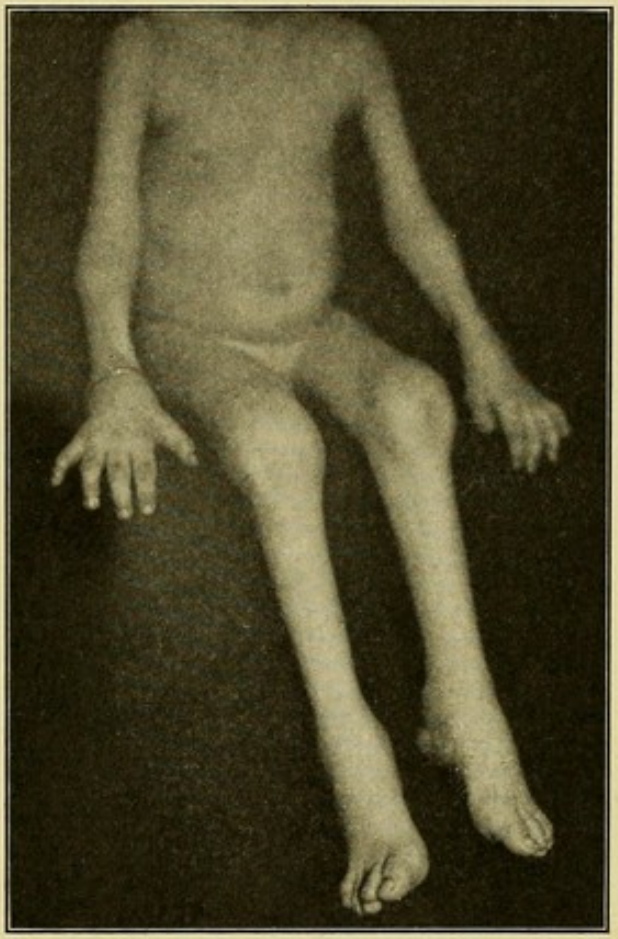


FIG. 19.—POLYARTHRITIS IN GIRL AGED SIX; ACTIVE STAGE. (Townsend's case.)

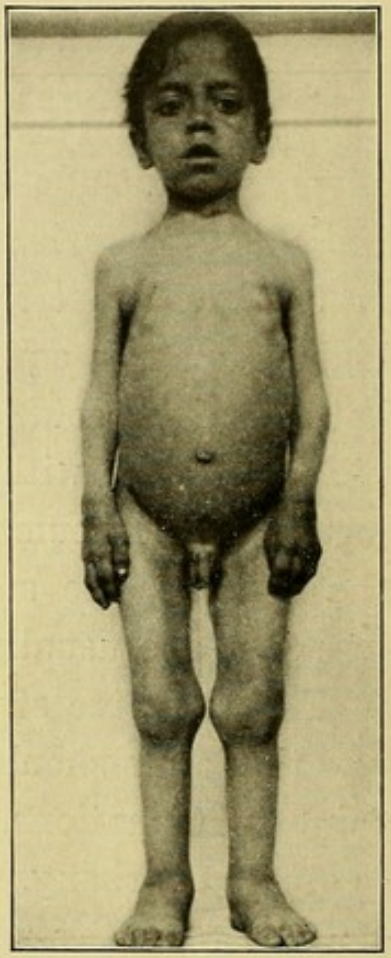


FIG. 20.—POLYARTHRITIS (STILL'S FORM), IN BOY OF FIVE. Began at one year of age; now convalescent under thymus extract.

In several recent cases remarkable improvement occurred after the administration of 5 to 20 grains of dried thymus gland three times a day (Nathan).

Toxic Osteoperiostitis (*secondary hyperplastic ostitis; ostéoarthropathie hypertrophiante pneumonique*).—This is a disease characterized by congestion and clubbing of

the fingers and toes, and enlargement of the phalanges from deposit of bone. It is always secondary to chronic visceral disease, usually of the lungs. It is sometimes found in children in connection with Pott's disease of the spine, when complicated with chronic lung disease (Fig. 21). In mild cases the digits alone, particularly the terminal phalanges, are involved; in more severe cases the forearm and leg bones are also affected. A few cases are so severe as to be distorting to the hands and feet and to

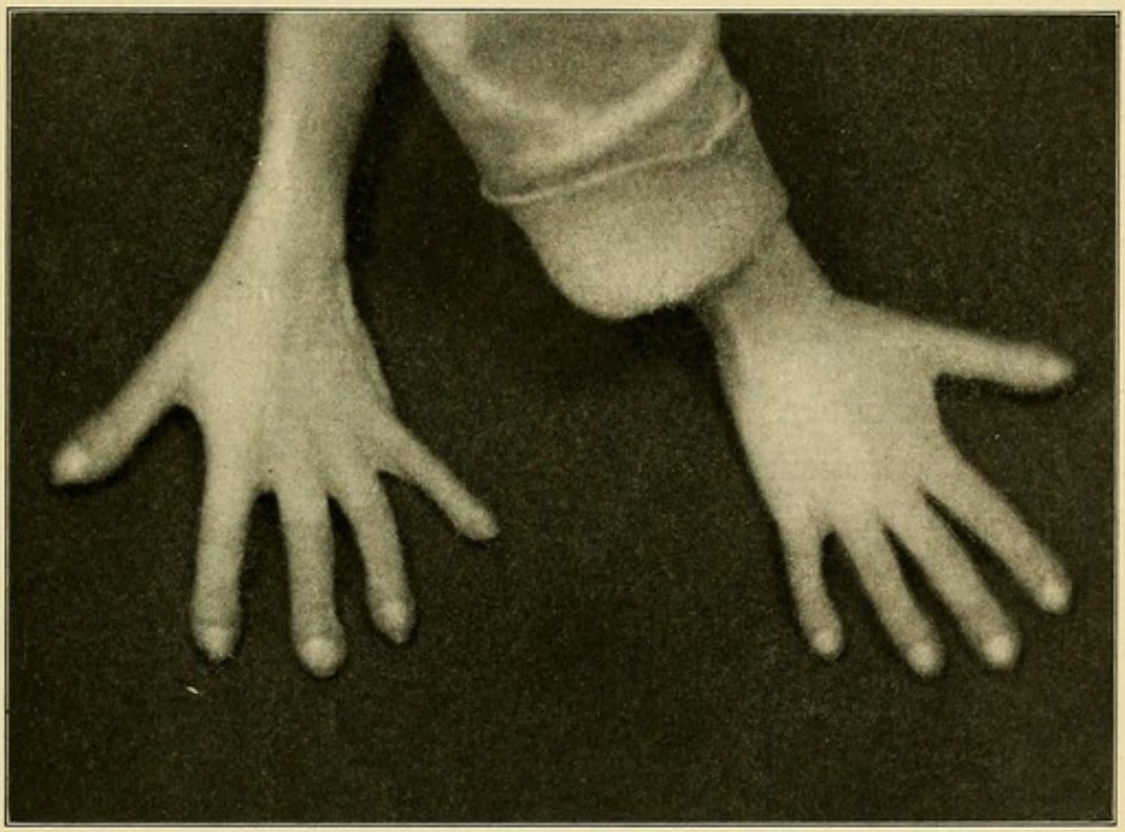


FIG. 21.—TOXIC OSTEOPERIOSTITIS IN A BOY OF TEN WITH POTT'S DISEASE. (NATHAN.).

cause marked hypertrophy of the bones of the extremities; it is then sometimes confounded with acromegaly, but lacks the hypertrophy of the face. The disease is uncommon and unimportant from an orthopedic standpoint.

Acromegaly is characterized by great enlargement of the hands, feet, and face; bones and soft tissues are hypertrophied. Certain cases, especially those starting in childhood, are associated with gigantism. Round back and lateral curvature occur. The disease is of slow development and course, occurs in adult life, and treatment is unavailing. It is thought to be due to disease of the pituitary gland.

Recently Hochenegg, of Vienna, reports a case of acromegaly of five years' duration in a patient aged thirty, in which he removed an adenoma of the hypophysis by the nasal route. The symptoms were alleviated within a few days, and the hands, feet, and jaws became smaller.

According to Hutchinson, acromegaly and gigantism are the same disease, occurring in adult life and childhood respectively.

Ostitis deformans (*Paget's disease of the bones*) is a disease of the long bones and skull, where regressive changes are accompanied by bone hypertrophy. The skull becomes large and thick, and the long bones increase in diameter and length; the femora and tibiæ often become bowed, and the back becomes rounded and sometimes scoliotic (Figs. 22 and 23). The disease may be restricted to a few bones (Fig. 181); it does not affect the face, digits, or joints. It is a disease of advanced life; the cause is unknown, and treatment unsatisfactory.

Hyperostosis of the skull (*leontiasis ossea*) is a rare disease, characterized by enormous enlargement of the bones of the skull and face, sometimes in the form of

tumors. It is chronic in its course, and of unknown causation.

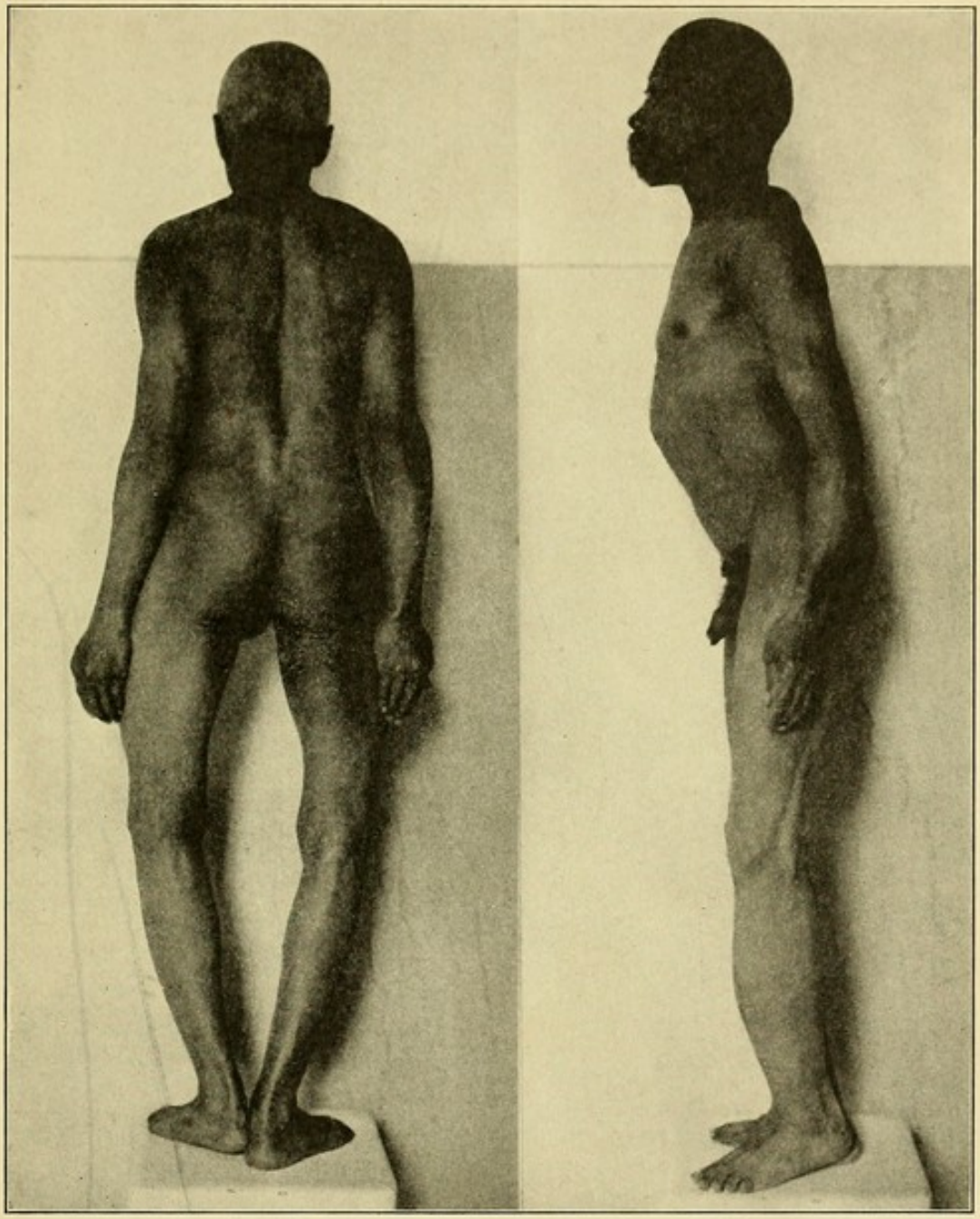


Fig. 22. Fig. 23.

Figs. 22 and 23.—Ostitis Deformans (Paget's Disease); Generalized Form.

In **ostitis fibrosa** the medulla of certain bones becomes in part replaced by fibrous tissue, with atrophy of sur-

rounding bone; the process is often painless. Cysts are sometimes formed from softening of the new tissue, and may lead to spontaneous fracture. This is a rare con-

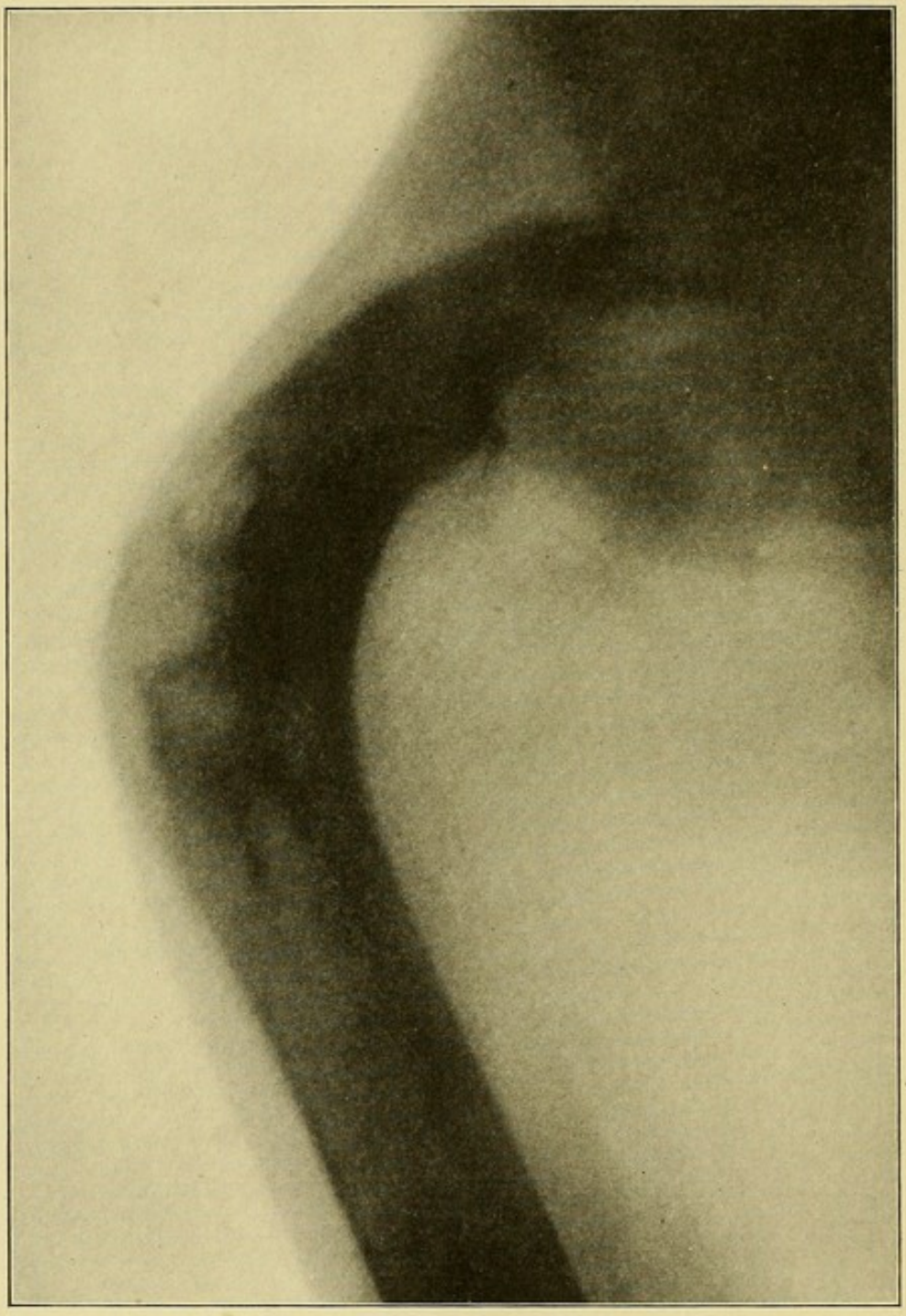


Fig. 24.—Osteomalacia in a Girl of Nine, Who Since Age of Five has had Repeated Fractures of Upper Ends of Both Femora. (Hospital for the Ruptured and Crippled.)

dition, but may occur in children and adolescents; it is very insidious. When it is discovered by the X-ray or after spontaneous fracture, the diseased tissue should be excised by an operation. In such cases the prognosis is good, as a radical cure nearly always results. It is probable that some of the cases of juvenile osteomalacia belong under this head.

Osteomalacia is a bone degeneration where the lime salts are absorbed and the bone rendered brittle or soft; it may affect most of the bones of the body. The puerperal form seems to be more common in Europe, but the disease may occur in men and in children; there is also a senile form. Spontaneous fractures often occur, frequently followed by deformation (Fig. 24). In puerperal cases good results have followed the removal of the ovaries. In men and children, measures directed to improve nutrition are the main reliance.

Bossi believes the fault to lie in deficiency of suprarenal secretion, and reports good results from the administration of suprarenal extract.

BENIGN TUMORS OF CARTILAGE AND BONE

Chondromata may occur as single tumors on or in any part of a bone, but are oftenest found near the extremities, especially the fingers; they are often multiple, and may be more or less ossified—osteochondromata.

Multiple osteochondromata are often an inherited family disease; their most frequent seat is near the ends of the shafts of large bones. They are benign in character, but tend to recur after removal, and often cause deformity and disability by their number and size and by

interfering with the growth of the bone to which they are attached. They occasionally spontaneously diminish in size.

Osteoma is a benign bone tumor, which may be developed from cartilage or fibrous tissue, and may be attached to bone or developed in other tissues (Fig. 25). When they become troublesome from their size or from interfering with function, they require removal.

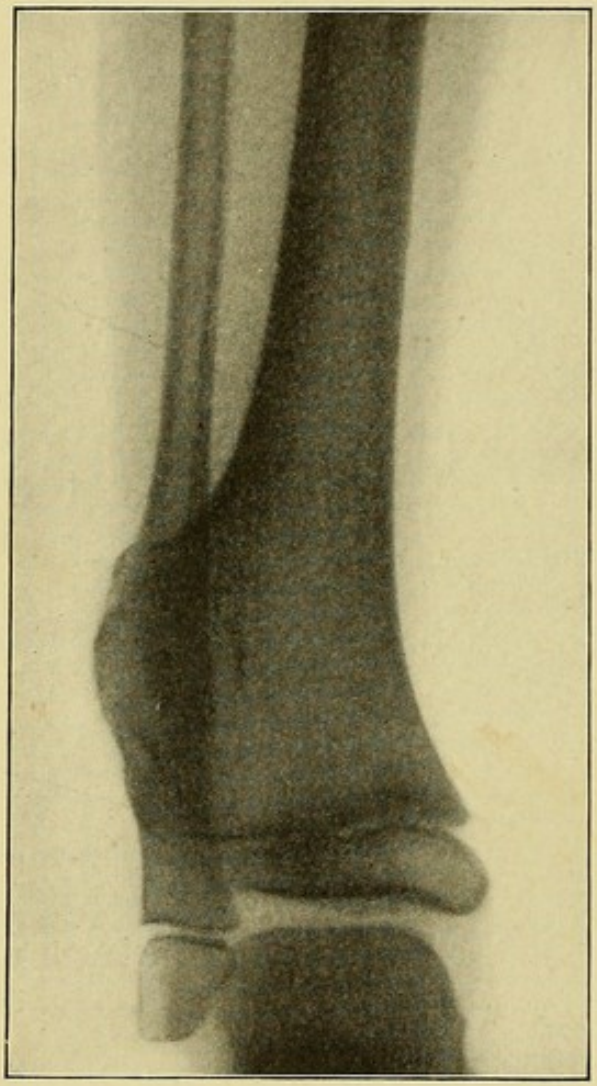


Fig. 25. — Benign Exostosis Lower End of Tibia and Fibula. (Hospital for the Ruptured and Crippled.)

Myositis Ossificans.— In the progressive form of this disease bone is deposited first in the trapezii or other back muscles; later many other muscles are successively involved, causing stiffness of the joints which they control (Fig. 26). Operative or other treatment is of little value. There are two traumatic forms, of which the first is caused by repeated slight local injuries; such are dancers' bone in the calf, riders' bone in the thigh adductors, fencers' bone in the bra-

chialis anticus, and gunners' bone in the pectoralis major. This form has no tendency to spread beyond the affected muscle.

A second traumatic form may be excited by a single sprain, bruise, or dislocation, particularly where the periosteum is injured (Fig. 27). This form may occur in children or adults; in Germany it is particularly common in recruits in the early twenties. Bone may be deposited within a month or two at the site of the injury, not always in muscle, and may be free or attached. The commonest site is on the upper arm and thigh, particularly the brachialis anticus, biceps brachii, quadriceps, and thigh adductors. The X-ray is required for exact diagnosis. If there is serious stiffness of the corresponding joint, the growth should be removed. Passive movements

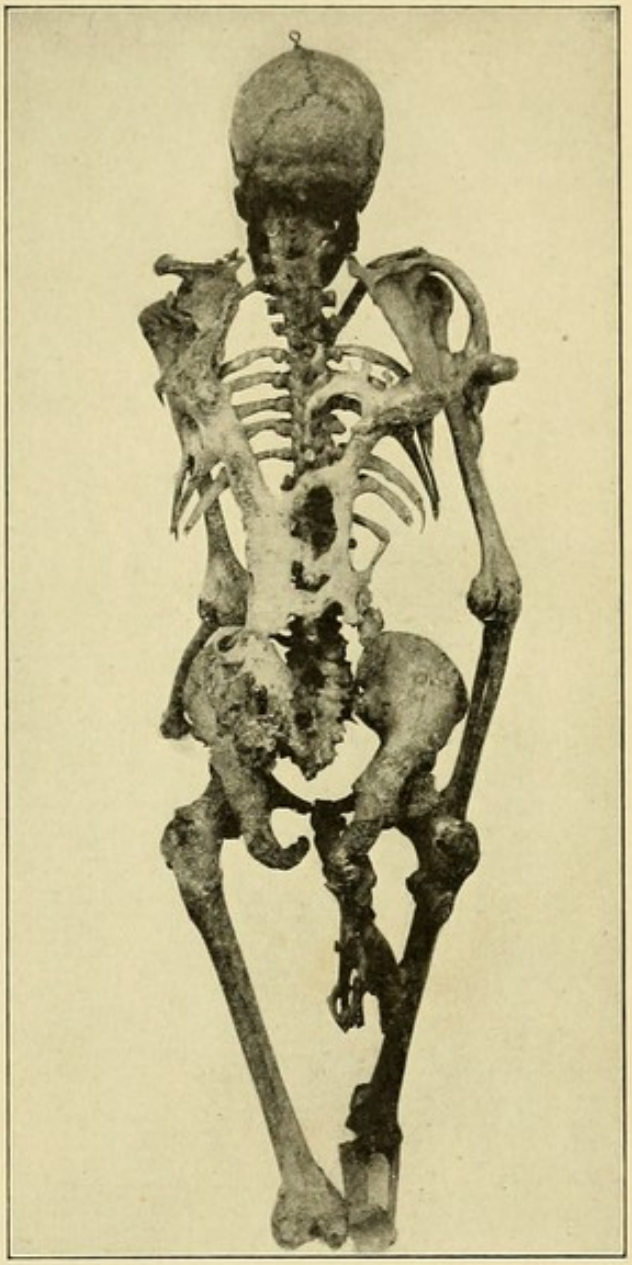


FIG. 26.—MYOSITIS OSSIFICANS, DIFFUSE FORM. (Royal College of Surgeons, London. Phelps.)

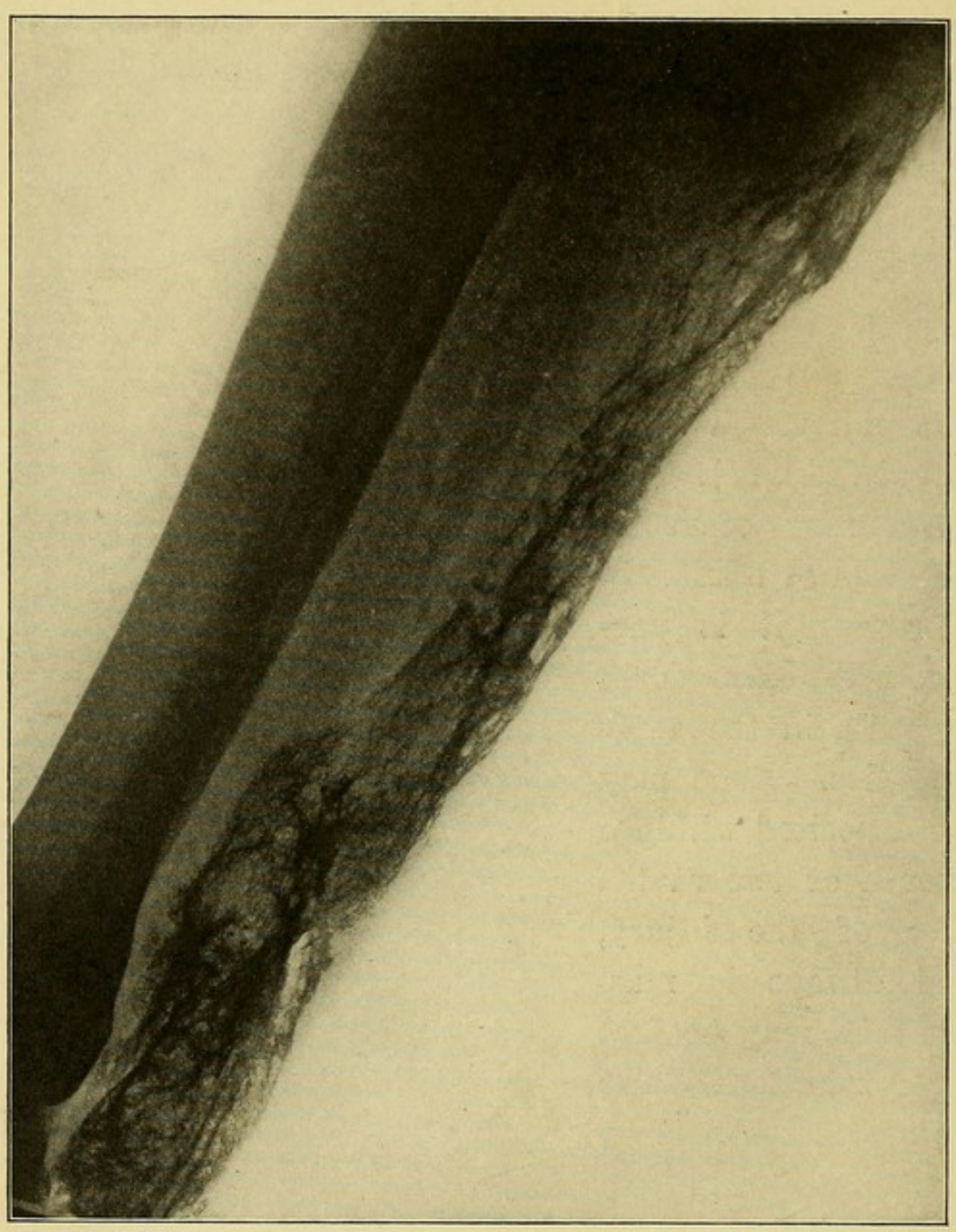


FIG. 27.—MYOSITIS OSSIFICANS, LOCAL FORM; MAN OF FORTY-FIVE. Blow on calf fifteen years before, followed by slowly progressing stiffness at ankle. (Hospital for the Ruptured and Crippled.)

should be delayed to avoid recurrence, which is not infrequent.

Bone Cysts.—Solitary bone cysts usually occur near the end of the diaphysis of the long bones, especially at the

upper end of the femur. They are found most frequently in children, adolescents, or young adults, and may cause pain, tenderness, lameness, and expansion of bone, and sometimes lead to spontaneous fracture (Figs. 28 and 29). They are usually revealed by the X-ray, or during

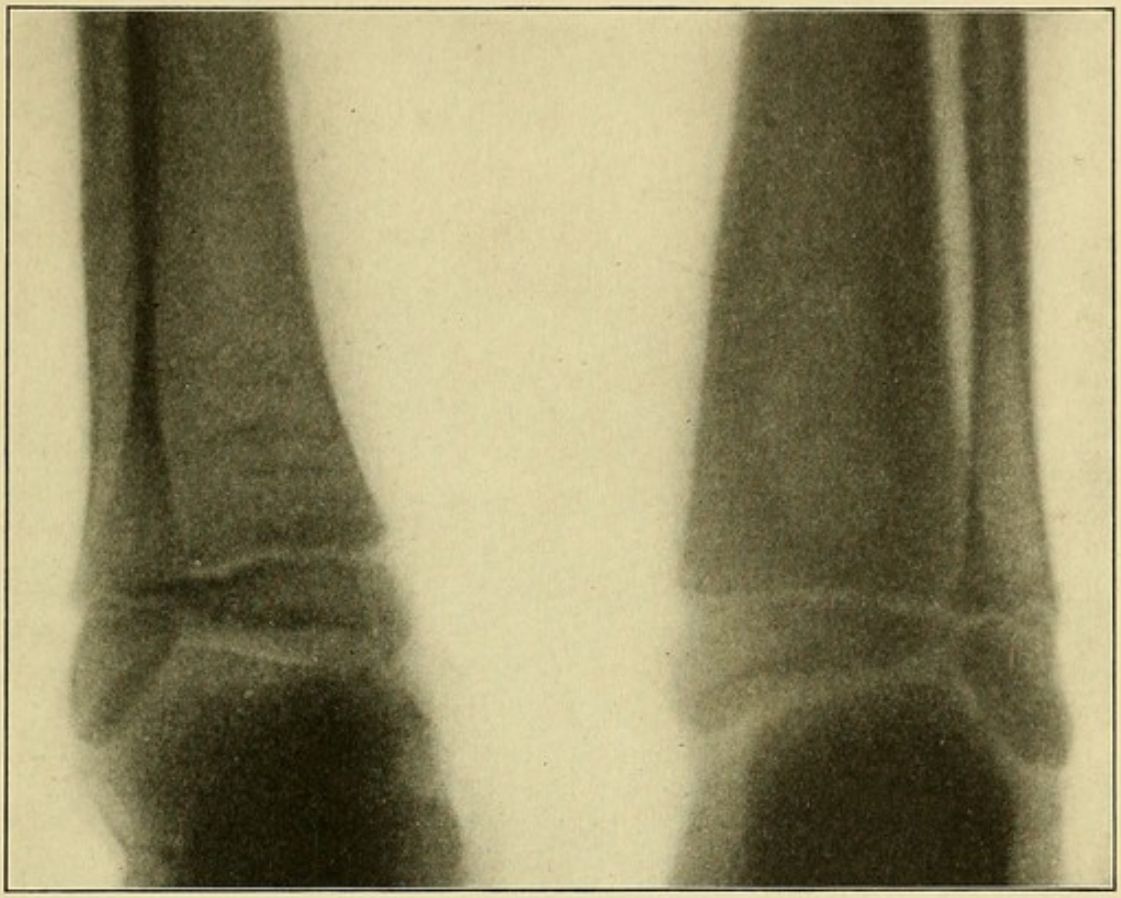


FIG. 28.—BENIGN CYST LOWER END OF TIBIA; SYMPTOMS TWO MONTHS; EXTIRPATION; RECOVERY. BOY OF NINE. Probably a case of ostitis fibrosa.

the course of an operation, and are benign and curable, if completely extirpated. They sometimes heal after simple puncture. There has been considerable discussion as to the pathogenesis of these cysts. The best opinion seems to be that they arise from the softening of enchondromata and giant-celled sarcomata, fragments of which have sometimes been found in the cyst walls. They may

also arise from inflammatory processes, such as rarefying ostitis, or ostitis and osteomyelitis fibrosa. The latter are sometimes multiple, and may involve nearly

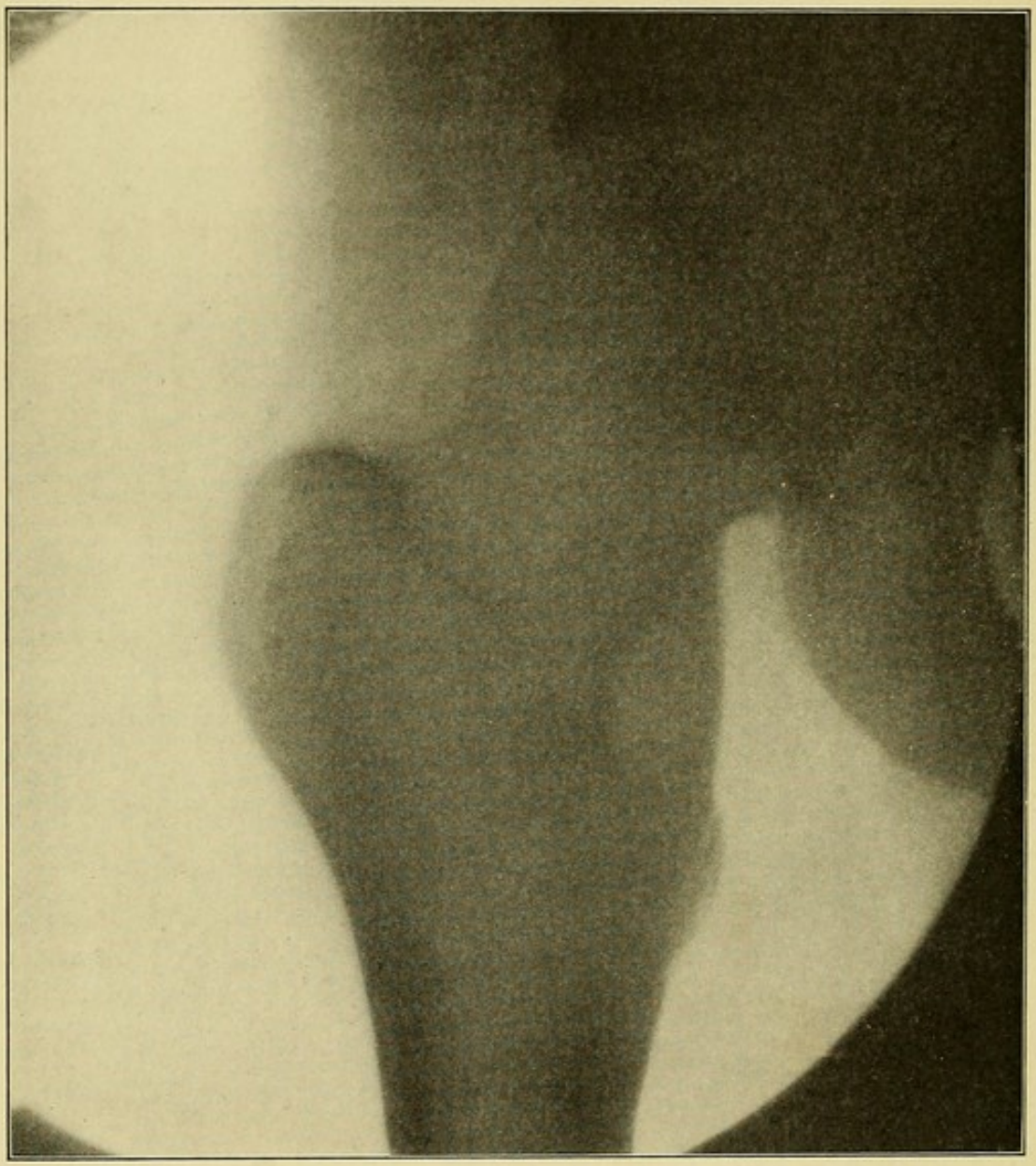


Fig. 29.—Benign Cyst of Neck of Femur in a Youth of Eighteen; Symptoms One and a Half Years; Extirpation; Recovery.

the whole of the shaft of the bone. Multiple bone cysts are, however, rare. They may result from the softening of new growths, and also occur in certain cases of

osteomalacia, ostitis deformans, and arthritis deformans. Normal bone may undergo excessive expansion and medullization after contusion or fracture—*cal soufflé.*

Bone tumors and cysts may also be of parasitic origin, as the cysts and tumors of the echinococcus, of the cysticercus, of actinomycosis, and of blastomycosis. Parasitic diseases of bone are rare in this country.

MALIGNANT DISEASES OF THE BONES

Sarcoma of the long bones may be central or periosteal; the latter are the more malignant. A history of injury is given in over one third of the cases. The growth usually appears a few weeks after the injury, but it is now known that in a few cases the tumor follows directly upon the injury, and increases with incredible rapidity. The favorite site is the most rapidly growing ends of the long bones of the extremities; the lower end of the femur, upper end of the tibia, and upper end of the humerus. The periosteal form, usually composed of round or spindle cells, often involves the middle third of the shaft (Fig. 30), and is more malignant than the medullary form, which is more often of the giant-celled variety. The disease is one of extreme malignancy; even after early amputation at the proximal joint fatal metastasis usually follows. Paradoxically, conservative operations, such as excisions of the tumor, give somewhat more favorable statistics than amputation, and are strongly advocated by some (Borchard). A few inoperable and recurrent cases have been cured by injections of the mixed toxins of the erysipelas and prodigiosus bacillus (Coley). While some good results have been reported from the

use of the X-ray, the treatment is usually disappointing, and often harmful. It is very important to distinguish between sarcoma and other bone diseases, and the X-ray is here very useful; when the diagnosis is in doubt, it is advisable to remove a piece of the tumor by an exploratory operation, and have it examined by a pathologist.

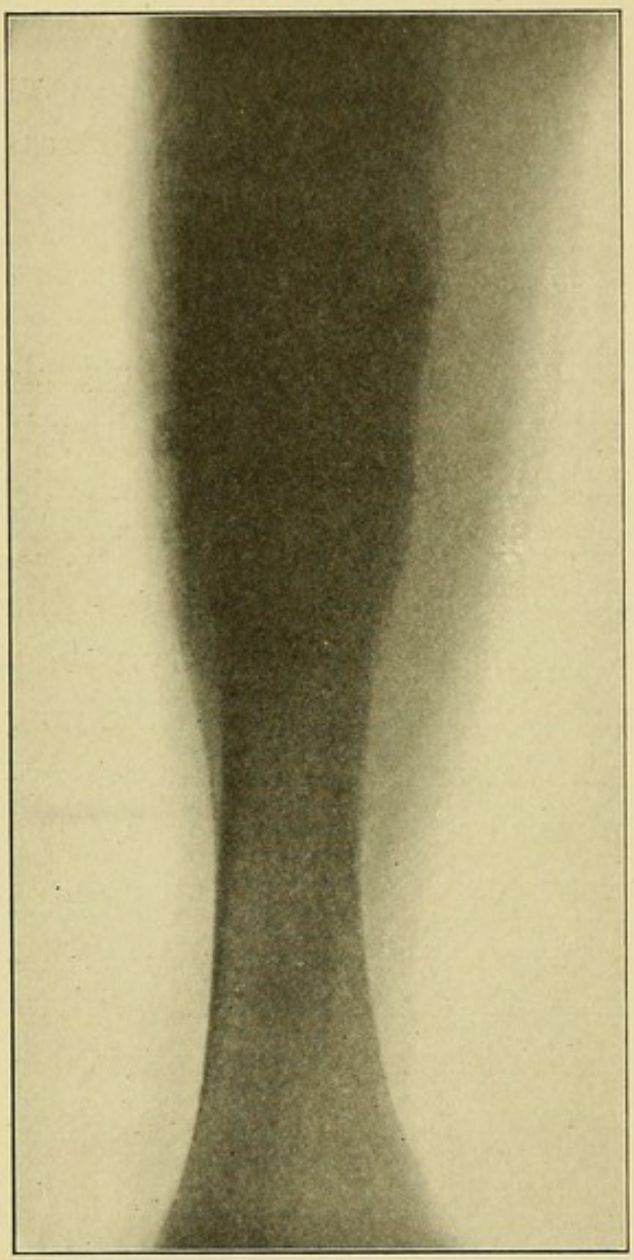


FIG. 30.—PERIOSTEAL SARCOMA OF UPPER END OF LEFT FEMUR. (Hospital for the Ruptured and Crippled.)

Disseminated sarcomatosis has little interest for the orthopedic surgeon.

Hypernephroma is a specific neoplasm of the suprarenal bodies; it sometimes involves one or more of the long bones secondarily. This secondary bone disease may be the first thing to attract attention, and may be the only complication. The appearance and course of the disease is much like that of sarcoma.

When a rapidly growing solid bone tumor is found in

a person past forty, the urine should be examined for blood, the kidney region for enlargement, and the scrotum for varicocele of sudden onset.

Carcinoma.—In general carcinomatosis of the bones, the latter may become soft and bend or break. This condition has sometimes been mistaken for osteomalacia, and has received the misleading name of osteomalacia carcinomatosa. This disease is secondary, and may last many years.

Local carcinoma of bone is also nearly always secondary; it occurs frequently with cancer of the thyroid, breast, pancreas, and prostate. Carcinoma of the spine occasionally develops after carcinoma of the pancreas, breast, and other viscera. It is extremely painful, and if the tumor presses upon the cord, it is complicated by a paraplegia which has received the name of paraplegia dolorosa. This should not be confounded with ordinary pressure paraplegia from Pott's disease, which is usually curable. Carcinoma of the bones is incurable.

Multiple myeloma is a term used for numerous small tumors of the medullary cavity of varying pathology, but usually malignant. There is pain and tenderness of the bone at times, and sometimes bone softening, but the bone symptoms are usually obscure, and frequently unnoticed. In many of these cases Bence Jones's albumose is found in the urine. The prognosis is unfavorable, and the treatment unsatisfactory.

FRACTURES

Spontaneous fracture may occur in tumors and cysts of the long bones, in rickets, in gummata, in tuberculous

or osteomyelitic diseases of the shaft, or of the neck of the femur; in parasitic bone diseases; in neglected cases of scurvy; in ostitis fibrosa, and in fragilitas ossium, and osteomalacia.

Ununited fracture occurs occasionally after cuneiform osteotomy, rarely, if ever, after linear osteotomy. It may occur from imperfect apposition or retention, after infected fractures, or from some defect in nutrition. The writer has seen a case of ununited fracture of both bones of the forearm, which had never been well splinted, unite in a couple of months after the forearm had been immobilized in a well-fitting splint. In the lower extremity, if the bone is held in good coaptation by a proper apparatus, the irritation of weight-bearing in walking will sometimes effect union. Cases of cure after the administration of extract of thyroid gland have been reported, also after the injection of blood (Bier), and of irritating fluids, such as tincture of iodin, or in the introduction of decalcified bone splinters about the site of the fracture (Phelps). One should not be too ready to cut down on the fragments and wire or suture them, as has been largely recommended and practiced. The results are often disappointing. The method of uniting the fragments by introducing small aluminium cylinders into the medullary cavity (Elsberg) is very promising. In old ununited fracture of the neck of the femur the fragments should be exposed, freshened, replaced, and united in forced abduction by a steel drill, or by sutures of silk or chromicized gut introduced through the periosteum.

The osteoplastic operation of Müller of Rostock is exceedingly clever, and should give good results in

proper cases. A long, tongue-shaped skin flap, with its base on the proximal, its apex on the distal fragment, is cut down to the periosteum. From its apex a thin layer of bone is chiseled off to the point of fracture; it lies under and is attached to the flap. From the fracture to the base of the flap the periosteum with the flap is separated from the bone, so that the skin flap carries periosteum at its base, periosteum and bone at its apex. The flap is raised, the fracture laid bare and refreshed, and interposed tissue removed, and the fragments placed in correct apposition. The flap is then drawn upward by wrinkling the base, so that the bone periosteum flap comes to lie over the point of fracture, overlapping both fragments. The parts are then sutured and immobilized.

NERVOUS AFFECTIONS

Peripheral, spinal, and **cerebral lesions** of the nervous system are a prolific cause of deformation and disability. Brachial-plexus palsy from rupture of one or more cords of the brachial plexus at birth, crutch palsy, and the drop-wrist of musculo-spiral and lead palsy are examples of crippling affections due to peripheral lesions. The resulting palsy is flaccid, and associated with rapid degeneration of the nerve peripheral to the lesion and to wasting of the connected muscles, and slower wasting of the limb; reflexes in the affected area are absent. If the injury is due to pressure, as in crutch and musculo-spiral palsy, recovery may be looked for on removal of the pressure. In using crutches, if the weight be largely borne on the hands, instead of on the axillæ, the danger of crutch palsy is avoided. If a nerve is torn or cut, it

usually unites, with regeneration and restoration of function, after nerve suture with excision of cicatricial tissue, and this is possible many years after the injury. In the management of the palsy, the paralyzed muscles should be protected from stretching and strain by being constantly supported in the relaxed (shortened) posture. For instance, in drop-wrist, the hand should be supported by a splint in hyperextension (Thomas); in facial palsy, the corner of the mouth should be hooked up. Such management favors the nutrition of the affected muscles, and prevents subsequent deformity.

In partial paralysis the weakened part should be used so far as possible, after the first few weeks, in the ordinary activities of life, and movements should be practiced to increase motion in the directions in which it is limited, and to develop weakened muscles. Most authorities lay great stress on the use of massage and electricity to promote local nutrition, but protection and use, with a few simple manipulations to facilitate joint motion, are much more important. The use of the vibrator in recovering palsies is often beneficial. Fixed deformities require special treatment, which will be described in the special part.

Cerebral palsies may arise from defective development of the motor tracts, often associated with premature birth, from hydrocephalus, head injuries at birth, and cerebral lesions in infancy and childhood. Cerebration is usually more or less impaired, and such palsies are common in idiots and imbeciles; convulsions occur in a considerable proportion. This is a somewhat heterogeneous group pathologically, but it is characterized clin-

ically by incoördination, rigidity, or spasticity of the muscles and increased reflexes in the affected area. True atrophy is absent, though growth may be retarded. The palsy may be a hemiplegia, paraplegia, or diplegia. If the affection is congenital or occurs before the child has walked, locomotion may be much delayed, though most of the cases not complicated by idiocy or hydrocephalus do finally walk, sometimes as late as the sixth or seventh year. There is a strong tendency to flexion, adduction, and inversion of the lower limbs from unbalanced muscular action, the stronger groups predominating. When patients walk, if both sides are affected, the gait is stiff and uncertain, the feet turn in, and the knees rub together. These contractions may be stretched out by the hand or by instruments, but they tend to recur. Very much may be done for these patients by systematic mind and muscle training, through purposive muscular movements. The deformities frequently require special treatment by tenotomies, myectomies, and splinting. Tenotomy of persistently shortened muscles not only corrects the deformity, but tends to allay spasm, and bring about a better muscular balance. Care should be taken not to overcorrect after tenotomy of the heel cord, as such overcorrection may become permanent.

Spinal paralyses form a very important group in the production of crippling affections. Destruction of the motor cells of the cord in a given area, as in acute poliomyelitis, causes a flaccid palsy with descending nerve degeneration, bone and muscle atrophy, vasomotor paresis, and diminished or absent reflexes. The symptoms are very much like those of peripheral palsy.

Acute anterior poliomyelitis is a definite local inflammation of certain motor areas, which is followed by degeneration of groups of motor cells in the anterior cornua. The trouble is probably due to an infection; it usually occurs in the summer, and sometimes in epidemics, in healthy children, from six months to five years, though these limits are often exceeded. The epidemic from June to November, 1907, in and around New York City, probably exceeded two thousand cases, and is the most extensive known. A small percentage of the cases were rapidly fatal, but the disease is not ordinarily dangerous to life. In a few cases the paralysis appears suddenly without constitutional symptoms. Complete recovery from the paralysis is very rare even in slight cases. The onset is sudden with fever, prostration, and sometimes with nausea or vomiting. The fever lasts from a few hours to several days. While the child is in bed or when it gets up, it is found to have partial or complete paralysis in one or more limbs. There may be pain in the paralyzed regions, which is increased on motion. The legs are much more frequently affected than the arms; the trunk muscles are occasionally involved. It is common for both legs to be helpless at first and for one leg to make an almost complete, the other a partial, recovery in the first few weeks or months. One or both arms may be paralyzed with or without paralysis of the legs. There is almost always considerable tendency to spontaneous recovery of power in the first six months; none thereafter. The final result is a palsy of muscle groups of very irregular distribution. There is seldom symmetrical palsy, except in the few cases where

a permanent paraplegia is left; hemiplegia is very rare. As the child lies in bed or begins to sit up adaptive changes occur due to habitual posture or unbalanced

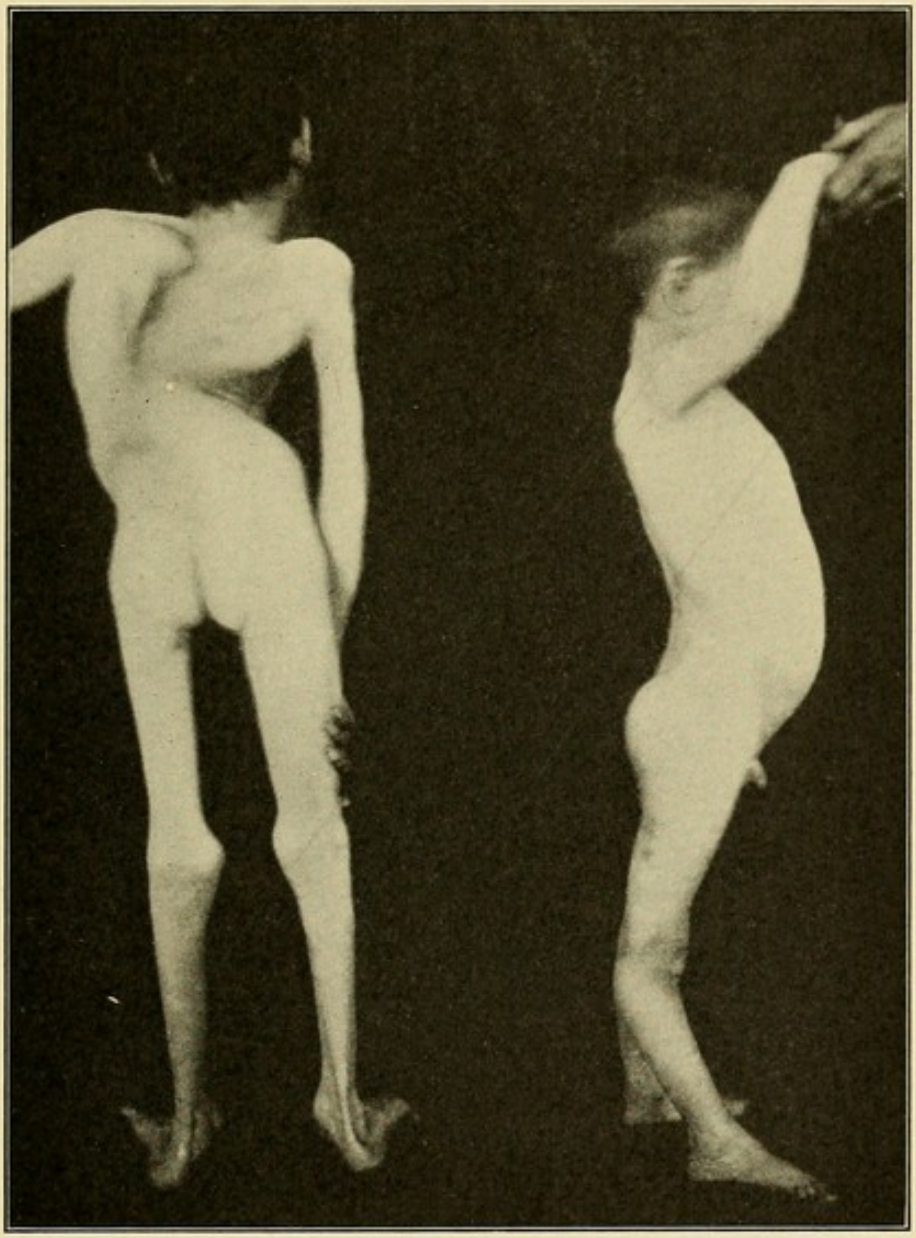


Fig. 31.—Deformities Following Poliomyelitis.
(New York City Children's Hospital. Ogilvy's service.)

muscular action, which often cause permanent deformities of the spine, hip, knee, ankle, and foot (Fig. 31). These often develop within a few weeks or months;

there is no spasm (Fig. 32). These secondary deformities or the inability to control one or two major joints, often prevent children from walking who otherwise would be perfectly capable of doing so. Paralysis

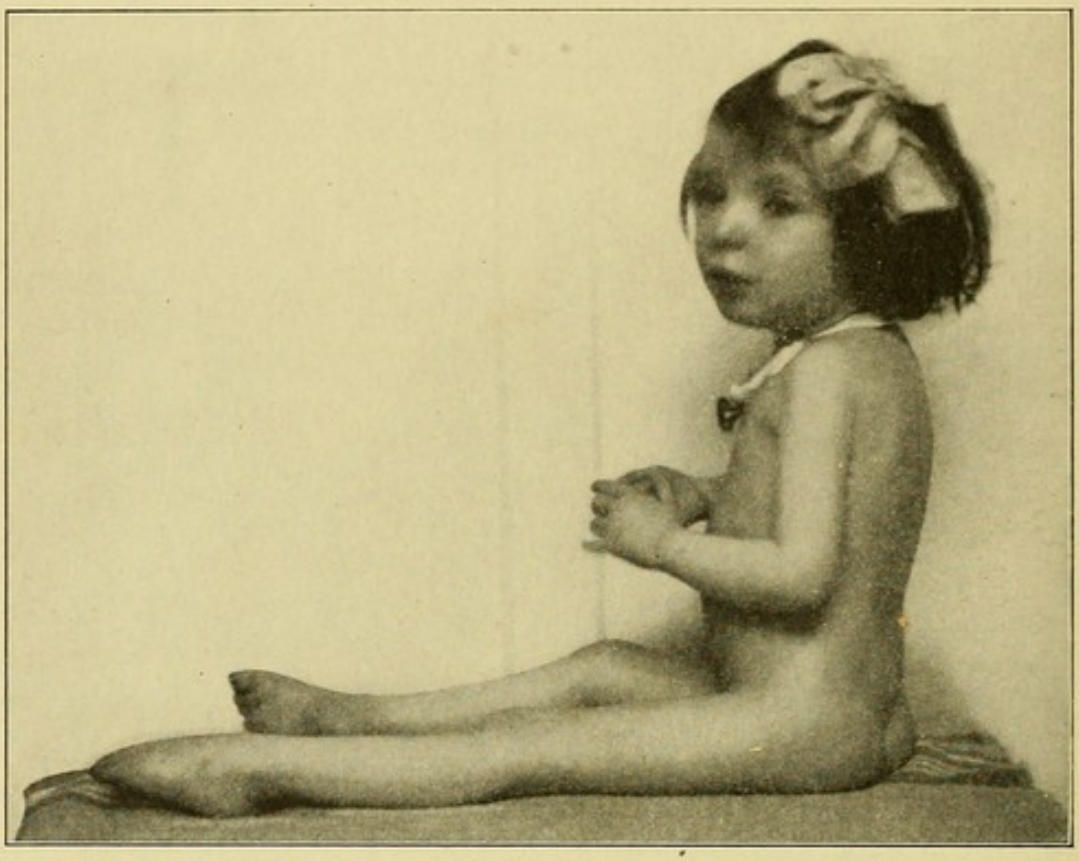


Fig. 32.—Fixed Drop-foot (Equinus) Acquired within Eight Months after an Attack of Poliomyelitis; Patient Unable to Stand.

of the muscles controlling the feet and of the quadriceps are among the commonest and also the most important disabilities. The knee reflexes are diminished or abolished; atrophy is marked and the surface is cold and bluish.

The diagnosis is seldom made until the paralysis is noticed; even then it frequently passes for rheumatism, and occasionally for joint disease. The mode of onset, and sequelæ are characteristic, and if carefully studied

will readily differentiate this disorder from other affections.

Treatment.—During the attack and for four to six weeks thereafter rest in bed is of the greatest importance, in order that repair may go on undisturbed. After this the prevention of the elongation of paralyzed muscles and of deformities, by appropriate apparatus, and improving the circulation and nutrition of the limb are very important. Nearly all deformities may be prevented by careful splinting to relax and protect stretched muscles. Circulation and nutrition are best kept up by the vibrator and by dry heat to the limb, and most important of all, by restoring the power of locomotion by the application of apparatus which gives necessary support. Jones justly lays down the principles that "a muscle, if stretched for a sufficiently long period, will cease to act," and "an overstretched muscle will regain its power if relieved from strain," and cites many examples. If patients apply after the development of deformities, these should be corrected by tenotomies and stretchings, and the proper supporting braces applied. Patients are often thus enabled to walk, who have never walked since their attack many years before. Arthrodesis to stiffen flail-joints and tendon grafting to supplement the action of weakened muscles are often valuable, but give the best results some years after the attack, and usually after the age of eight or ten. The treatment of individual deformities is taken up in the special part.

Another type of spinal palsy is caused by a transverse lesion as in Pott's PARAPLEGIA. In these cases cerebral inhibition and control is abolished, and reflexes

are exaggerated, below the lesion; wasting is not marked. If centers are involved there will be wasting and flaccid palsy in their distribution. For more details see Pott's disease.

Trophic Joints (*Charcot's joint*).—In locomotor ataxia and some other cord diseases, involving sensation and nutrition, a joint or joints in the affected area may become slowly and almost painlessly disorganized. Trophic joints occur in about five per cent of the cases of locomotor ataxia, and their development occasionally precedes the ataxia. The knee, hip, ankle, or lumbar spine may be affected. When one of the larger joints becomes chronically swollen without pain in a middle-aged man, the patient should always be examined for locomotor ataxia. The affected bone becomes extremely eroded, there is a large effusion with laxity of the ligaments, and finally a flail-joint (Fig. 174). This condition may be palliated by a stiff splint giving antero-posterior and lateral support. Excision has also been proposed.

Hysteria is a psycho-neurosis without demonstrable organic lesion. Paresis, deformity, and contractures are sometimes seen in the hysterical, and such affections may be difficult to diagnose and to treat. Hysterical stigmata will often be found, or the symptoms may be variable, or inconsistent with organic affections. The condition is usually curable under appropriate general and local management.

EXAMINATION AND DIAGNOSIS IN ORTHOPEDIC PRACTICE

Examination.—The key to orthopedic diagnosis in children is to remove the clothing and to examine them all over. More than half of the frequent and serious errors are due to failure to follow this simple plan. It will help vastly if one has a definite idea of what is to be looked for, and the determination to find an adequate cause for the symptoms. One should note primarily disturbances of form and function and only secondarily seek to determine the pathological cause. In general terms the examiner should look for weakness or laxity, stiffness or spasm, wasting, swelling, tenderness and deformity of the trunk and limbs, and particularly of the joints, and note their presence or absence. The examination begins the moment the patient enters. Even if the child is carried, its color, expression, nutrition, postures, movements, and general demeanor should give valuable information, while if the child walks, the gait, attitude, and movements should be critically studied. The tipped-back head, retracted shoulders, stiff back, and careful movements of Pott's disease, the waddling gait of bilateral congenital hip dislocation, the weak, floppy, or dragging walk of poliomyelitis, the stiff, spastic gait of cerebral palsy, and many others are practically pathognomonic. One may observe at once whether lameness is present on one or both sides, and whether the gait indicates weakness or stiffness, tenderness, shortness, or deformity and at which joint. All the movements should be carefully studied and deviations from the normal

noted, also whether handling and undressing the child causes pain. While the child is being undressed the main points of the history are ascertained, and particularly if there was a difficult labor, if there was any injury or abnormality at birth; what was the manner of feeding and the state of health during infancy; whether the child had been injured or had had one or more attacks of illness; what had first attracted attention in connection with the present affection; what had been the symptoms, their duration and order of development; whether they had come quickly or slowly and with or without constitutional reaction. The child, being now completely undressed, is asked to walk, to lie down and get up, and to pick up some small object. It is then examined standing for spinal stiffness or deformity and for pelvic obliquity. It is placed recumbent and later procumbent on a couch and the spine examined for stiffness and anteroposterior and lateral deformity, the limbs examined for weakness, wasting, deformity, and inequality of length, and the larger joints for pain, heat, tenderness, swelling, stiffness, and spasm. In making these tests, as it is necessary to get the child's confidence, all abrupt and rough manipulation should be avoided, and it is rarely necessary to cause pain. If the child is not frightened or hurt, it will be possible to distinguish between voluntary and involuntary resistance to joint motion, otherwise difficult. From such an examination one should be able to decide whether the trouble is local, central, or general, and if local which part is affected; secondly, whether the trouble is congenital, traumatic, static, paralytic, or pathological; if pathological, one should have a pretty definite

idea of the particular nutritional or infective change in question, and be able to decide whether the process has run its course or is still active.

In arriving at an exact diagnosis the examiner is much assisted by definite information on certain points in child physiology and pathology. The baby should hold its head up and begin to use its hands at three months, sit up at six months, creep at eight months, and walk and say a few words at fourteen months. There is large individual variation, but failure to do these things within two or three months of the usual time often indicates disease or abnormality. Failure to hold up the head or to sit up at the proper time may indicate hydrocephalus or other cerebral defect, idiocy, malnutrition, or rickets. Creeping has an important educational, gymnastic, and prophylactic value and should be encouraged; unfortunately it is sometimes curtailed or omitted. Failure to walk at one and one half to two years may indicate rickets, myxedema, joint disease, congenital hip dislocation, or paralysis. Unduly delayed talking may indicate unusually slow development or some form of mental impairment.

Young babies should be examined by the obstetrician for congenital deformities, and also after difficult labor for birth injuries, including head injury, sterno-mastoid injury, brachial plexus rupture, and fracture of the clavicle, humerus, and femur. In the first six months the joint infections are usually purulent, rarely tuberculous; in the second six months, if you see a baby with tender epiphyses, examine for scurvy. Rheumatism is rare in young children, very rare in infants, and in monarticular

form; though the various joint infections, scurvy, and the attacks of poliomyelitis are often so diagnosed. From the second to the fifth year, rachitic deformities, joint and spinal tuberculosis, and poliomyelitis are very common. Poliomyelitis often passes for an attack of indigestion until the fever subsides and weakness in the legs is noticed; congenital hip dislocation is rarely discovered until the child begins to walk. The static deformities due to overweighting, nonrachitic weak ankles, knock-knees, round back, and scoliosis occur after infancy and through adolescence. The typical age for the development of coxa vara and nonpathologic postural spinal deformities is from eight to fifteen. Such troubles, except coxa vara, are not painful; even the flat-foot of childhood is usually painless. Striking symptoms often indicate trouble at a distance, as the knee pain of coxitis and the abdominal pain of spondylitis. Night cries are frequently symptomatic of spinal or joint disease. In many cases of bone and joint disease a good X-ray plate is a valuable diagnostic aid. When the diagnosis is in doubt a subsequent examination should be insisted on. The writer recommends the careful examination of all children at birth and at least once a year thereafter, in order to detect and correct deforming affections in their incipiency. Many serious conditions are painless and extremely insidious and easily escape parental observation for years. It is the duty of the family doctor to recognize beginning deformity, and by timely measures to preserve the symmetry and competence of the bodily framework.

In the examination of adults much the same plan is

followed. When it is not advisable to remove all the clothing, at least a generous exposure of the suspected parts and their surroundings should be required, and the important regions of the body may be bared successively, if not all at one time. Inquiry as to the general health and other previous and present affections should never be omitted. One cannot treat a part properly without knowing something of the whole. The state of the digestion and elimination, of the thoracic, abdominal, and pelvic organs, and of the nervous and vascular systems is particularly important, also past or recent exposure to infection. A youth consulted the writer recently for flat-foot. He admitted, after questioning, a recent infection, and proved to be suffering also from gonorrheal endocarditis. If this information had not been elicited neither the foot nor the boy could have been successfully treated. Thus in adults, as in children, the entire individual should be considered, both in the examination and in the therapy.

History.—One should be familiar with the value of evidence in order not to be lost among vague, incorrect, or conflicting statements. All children have falls and it is often difficult to decide the relation of a particular injury to subsequent disease. Fractures are not infrequently diagnosed as contusions or sprains. Osteomyelitis may develop soon after injury. Tuberculosis of a joint may appear one to three months after an injury, which is usually moderate in character. Sarcoma of bone frequently develops a few weeks after an injury, and may come on very early. The bearing of the family history has already been mentioned. Personal habits of life

are often important. Many parents, especially the more ignorant, will unhesitatingly assert that early deformities are congenital; this is in many cases erroneous. Observation is also often at fault as to the duration of deformity in older children and adults. A flat-foot or a lateral curvature may attract no notice from the family or the patient until it has progressed for years. If the child does not complain little attention is paid to its shape, among certain classes. On the other hand, certain mothers are overanxious and are worried about trivial or imaginary blemishes.

Records of cases should be kept in books or on cards with photographs, tracings, measurements, and X-rays.

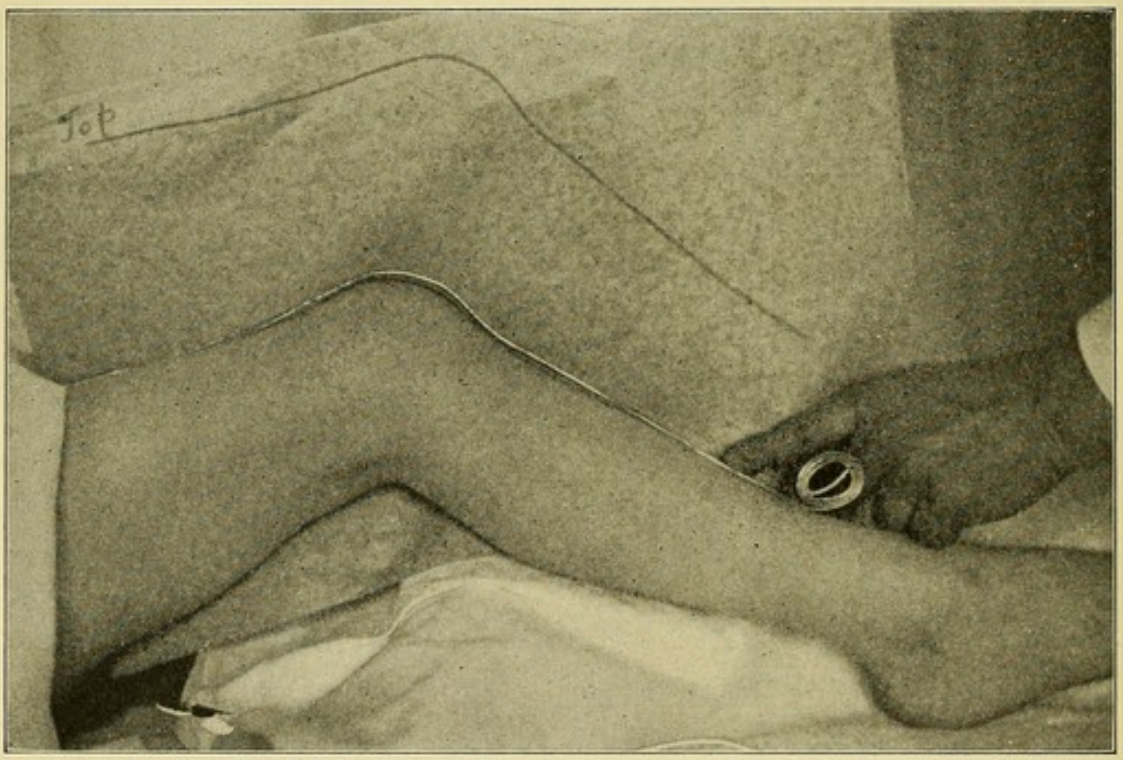


FIG. 33.—TAKING ANGLE OF FLEXION AT KNEE WITH LEAD TAPE.

Contours may be taken with a flexible lead tape 20 inches long, $\frac{3}{8}$ inch broad and $\frac{1}{16}$ inch thick. This may be molded to the part and traced off on paper by marking

along its edge with a pencil (Fig. 33). Angles may also be taken with the lead tape, or with a small protractor used as a goniometer (Fig. 34). A very useful method

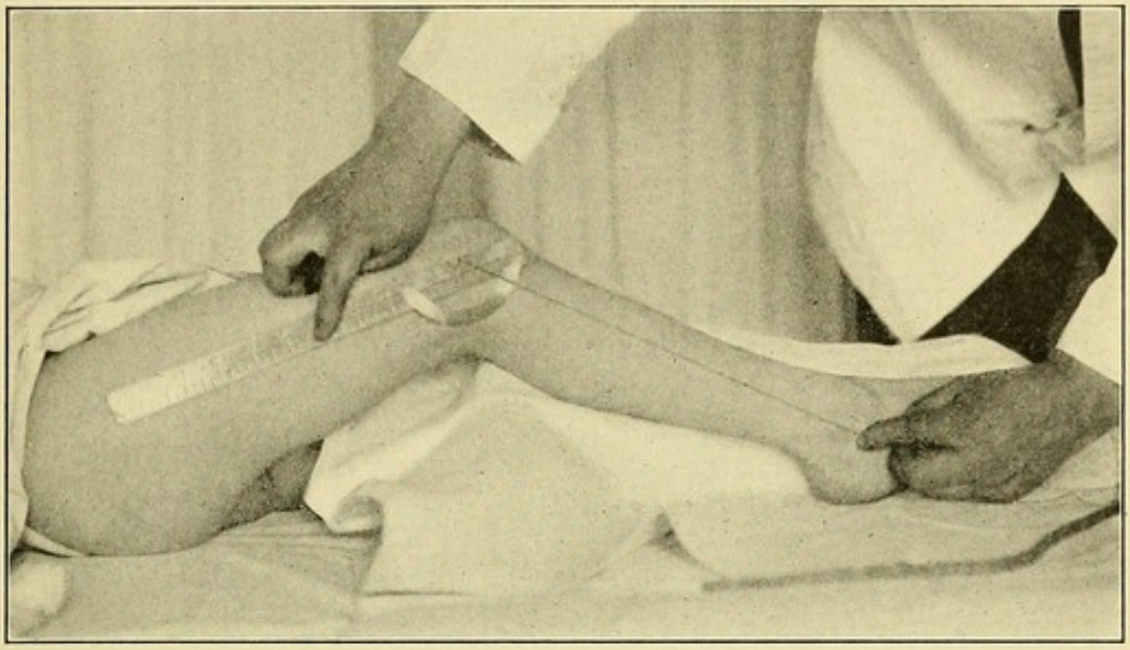


FIG. 34.—TAKING ANGLE OF FLEXION AT KNEE WITH HOMEMADE GONIOMETER; COST FOUR CENTS.

of record for deformities of the limbs is to trace an outline of the part on a piece of paper or directly into a large record book, by drawing beside it with a pencil. A front tracing will give a good record of bow-legs and knock-knees, while with the leg on the side, angular deformity at the knee and foot and anterior tibial curves are shown. Careful tracings of the limbs as well as measurements are indispensable in ordering braces.

Laboratory aids such as the examination of blood, fluids, and tissues, and the administration of bacterins and antitoxins are to be used as indicated, the latter sparingly, the former freely. The X-ray apparatus often gives indispensable information and should be largely used. It is to be noted, however, that the clinical study of the case

should precede the laboratory report and that the latter, including the skiagraphic appearance, should be interpreted in the light of the former. Scientific aids to clinical investigation should occupy a secondary, though often an important place, and the violation of this rule has resulted in errors as lamentable as they were unnecessary.

Skiagraphy.—Many cases are cleared up by one or more good skiagrams. The fluoroscope is of practically no value in orthopedic work; a clear negative is necessary, and for dense tissues like an adult hip the compression blend is required. A poor skiagram is usually worse than useless; it is frequently misleading; poor skiagrams are commoner than good ones. It is often necessary to take two or more views of an object to show an abnormality. A fracture may not show from the side, when it will be perfectly plain from the front or vice versa. It may be necessary to repeat a skiagram after a certain interval to note possible change. The earliest skiagraphic indication of a beginning bone disease is diminished density (bone rarefaction) on the affected side. When the bone disease recedes, the skiagram will show increasing density before the improvement is clinically evident (Freiberg). In arthritis deformans one will see lessened joint interval (condensation of cartilage), bone atrophy, and perhaps osteophytes. The appearances in a dislocated hip or coxa vara are usually obvious. It is often well to take corresponding parts on the same plate for comparison.

Diffuse tuberculous bone infiltration is not shown in the skiagram (König). Joints, especially the hip, may

appear ankylosed in the plate, when, in fact, considerable motion is present. In order to prove bony ankylosis by skiagram individual striæ must be traced from bone to bone.

Considerable experience is necessary to correctly interpret X-ray plates, if the subjects are at all obscure or difficult. The first essential is a working knowledge of bone anatomy, including centers of ossification and congenital anomalies.

PREVENTION

The prevention of crippling affections is partly a medical but largely a social question. It has to do with the nutrition, training, and occupations of childhood and adult life. The vast majority of children, and even of those afterwards crippled, are born healthy and sufficiently symmetrical. The problem is to keep them so. Whatever makes for vigor should be emphasized. At first the most important thing is proper and sufficient food, and this continues important through the growing period, and indeed through life. Improper feeding in infancy is responsible for marasmus, rickets, scurvy, and much of anemia and lack of vigor. Then comes the fresh-air life, with plenty of sunshine in the temperate zone; in the tropics they have too much. Exercise in proper amount and variety, diversion, play, and a bright and cheerful disposition are all important. In a word it is a question of the hygiene of childhood, which up to the age of six is largely a family problem, and is intimately connected with the earning power of the father, and the intelligence and home efficiency of the mother. From

six on the unsolved problem of school hygiene comes in to complicate matters, and after the age of fourteen, and often earlier, the burning questions of child labor and mother labor. The liquor and tobacco habits are important, especially in childhood and in relation to parentage. In the United States the strenuous life undoubtedly affects childhood unfavorably. Children do things unsuited to their age and condition, and often do them too hard; it must be said that the indolent life is even worse. Children are often encouraged to walk and stand too early, and many acquire foot, leg, and back deformities in this way. Spitzy has pointed out that creeping is a valuable physical training for the infant, and should be prolonged rather than abridged. Indeed there is a normal sequence of movements, occupations, and interests which should not be interfered with. The serious cultivation of instrumental music is undoubtedly depressing; vocal training, however, is favorable to health.

The prevention of infection is important, and progress is being made in the matters of a purer water and milk supply, and in the better training of the laity in the aseptic treatment of wounds, even when trivial. Invigoration is probably after all the best protection, as all are exposed to infection; the less vigorous succumb. The best training a child can receive from a physical point of view is the training to adjust himself to the ordinary conditions in which he lives, which, like cold or draughts, may be deleterious or beneficial, according as the child has led a free or a hothouse life. In our cities, houses and schoolrooms are usually kept too warm, and children are too much afraid of a cold splash. The ma-

jority of one class of infections, the venereal, which often lead to bone disease and deformity, may be prevented at will, by avoiding exposure.

The prevention of deformity should include the cultivation of normal postures in the ordinary activities of life and the avoidance of too prolonged standing and sitting.

When a crippling affection is once declared, the prevention of deformity is an important part of the surgical problem; and the keys are early diagnosis and adequate treatment. Deformity is prevented by limiting the duration and severity of the underlying cause through proper treatment, and by special measures, mechanical or operative, to keep or place the affected part in the posture of greatest safety and usefulness.

PROGNOSIS

The prognosis in the commonest deforming diseases is decidedly good as regards recovery. Rickets is self-limited and curable; scurvy, rapidly curable; syphilis, gonorrhea, pus, and other infections amenable to treatment. Bone and joint tuberculosis is curable in the majority of cases, and if germs remain latent they do not prevent in many instances long, active, and useful lives. Very much may be done for arthritis deformans. The most frequent congenital, rachitic, and paralytic deformities of the limbs may usually be corrected with restoration of locomotion, though many of the essential palsies are incurable. Even adult and neglected cases of joint ankylosis in bad posture and many other deformities can be readily corrected and the limb restored to usefulness. Severe deformities of the spine and thorax are

resistant to treatment, but can usually be prevented by proper management.

This generally favorable prognosis depends mainly upon two factors, early diagnosis and appropriate treatment, both of which the general practitioner should be prepared to give in a majority of the cases. They are seen early much oftener by the family doctor than by the specialist, and if recognized then, simple treatment will often suffice. It should also be generally known that even severe, neglected, and adult cases can often be relieved; they should not be permitted to go through life with serious disabilities, which are perfectly remediable. The prognosis in many of the deformities and crippling affections of adult life is nearly as favorable as in childhood.

TREATMENT

TREATMENT OF UNDERLYING CAUSE

General Indications.—The first indication in the treatment of a crippling affection is to cure the disease or toxemia causing the deformity, if that disease is still active. Rickets, scurvy, gonorrhea, syphilis, tuberculosis, require special treatment, which is always important and frequently successful. Curing the disease will sometimes remove the deformity, as in many cases of scurvy and syphilis.

It is often necessary to treat or remove infective foci at a distance from a joint disease.

The second important general indication is to increase general vigor; this is particularly necessary in tuberculous disease, and in the static, pressure, and

occupation deformities. This is best done by constant exposure to fresh air and sunshine, and by giving a simple but nutritious diet, including fresh or fermented milk, eggs and fats, with meat, vegetables, and fruits, and excluding a redundancy of starches and sweets. Water should be freely given, and elimination facilitated. Deep breathing and training in correct postures are often valuable aids. It is also important to regulate the physical and mental activity of the patient by the proper distribution of rest, recreation, and exercise, and to enforce hygienic conditions. School work, home study, piano practice, and hours for play, rest, and sleep will require the physician's attention. A hopeful, happy, and tranquil mind is a distinctly favorable factor.

Special Indications.—In many cases, while general treatment is important, it is nevertheless insufficient to control the local process, and the affected part must be immobilized, relieved of pressure, and otherwise protected in order that the focal disease may run a more favorable course. Abscesses or joint cavities may require aspiration or incision, and surgical operations may be necessary to remove pathological fluids or diseased tissues. A favorable effect on repair may be exerted by modifying the local circulation by strapping, bandaging, counter-irritation, heat, venous congestion, and in other ways. Counterirritation by tincture of iodin and blisters has lost its former commanding position, but iodin is useful in connection with bandaging and strapping in superficial inflammations such as simple bursitis and tenosynovitis; small blisters or the Paquelin cautery may be of real service in certain neuralgic and painful affections.

Bier's treatment by venous congestion or "dammed circulation" produced by an elastic band applied to the affected extremity between the trunk and the lesion is highly recommended by the Germans, and is deserving of trial. It is used in tuberculous, purulent, and other infections of the joints and soft parts, and even in arthritis deformans. The three-inch rubber bandage should be applied by five or six overlapping turns firmly enough to constrict the veins but not the arteries of the limb; the pulse beat should be as distinctly felt as on the other side. Soon after the application congestion of the limb distal to the band is noticed, which increases until the color is purplish. The limb should remain warm and without pain; if whitish, cold, or painful the bandage should be loosened. The bandage may be left in place one hour or longer, once or twice a day. Short sessions are usually sufficient in chronic cases, but in tuberculous joints the treatment must be continued more than a year, and splint protection should not be neglected. In acute infections, where the method shows its best results, much longer sessions up to eleven hours on and one off are practiced; the limb should be carefully watched to prevent possible accidents.

The regulation of posture is often important. The rachitic baby should often be kept from standing and sitting, and creeping and recumbency should be encouraged. Prolonged sitting and standing should be curtailed in the posture deformities of the trunk, and prolonged standing and long walks discouraged in weak and flat feet, bow-legs, and knock-knees. Special shoes must be fitted, and these may be made to assist the correction

of foot and leg deformities; waists, corsets, and suspenders must be correctly adjusted in postural cases. The proper treatment of crippling disorders will in most cases include the prevention of deformity.

Frames, jackets, corsets, and braces will often be required for traction or immobilization and to fulfill other definite indications.

COMPLICATIONS

A few words may be said about the general management of abscesses and sinuses, ankylosis and atrophy, since these are common and important complications of orthopedic affections, and misapprehension in regard to their treatment is widely prevalent.

Abscesses when due to or infected by pus organisms, causing local and constitutional symptoms and containing true pus, should be evacuated and drained at once. The collections of fluid, flocculi, and necrotic tissue [1] known as cold abscesses, but which are really pockets or cysts, are usually harmless so long as they remain uninfected. If there is much fluid or much tension, the fluid may be drawn off with the aspirator. One or more tappings cause the disappearance of the fluid in a certain number of cases, but usually it collects again and finally opens or is incised. A second mode of treatment, which has the advantage of allowing shreds and coagulæ of considerable size to escape, is to make an incision one half inch long, evacuate the contents, close the incision with a single stitch, and seal with collodion. One or more of such evacuations may cause a disappearance of the abscess.

[1] It is proposed to call this fluid ichor to distinguish it from pus.

A third method of treatment is to make a large incision, curet the abscess wall, remove diseased bone if found, and try to get healing by granulation from the bottom. This also sometimes succeeds and frequently fails. The tendency among the most experienced is to treat cold abscesses conservatively; extensive incisions and scrapings frequently diffuse the infection and are not nearly so common as formerly. Some eminent surgeons never open an ichor pocket (cold abscess), and claim brilliant results from aspiration and injection with iodoform (saturated solution in ether, or ten-per-cent emulsion in sterilized olive oil) or camphorated naphthol (Calot). The truth is that these pockets usually run a benign course under any rational method of treatment, provided the underlying bone or joint disease is recognized and properly managed, otherwise they do badly. Sinuses often result under any method of treatment, and as often under radical as conservative. Such sinuses should be kept clean and will sometimes heal under injections of tincture of iodin or of iodoform-ether solutions, or after operations to remove dead tissue. Lately the suction glass (Bier) has been highly praised; this should be applied daily five minutes on and three minutes off for half an hour. It is often impossible to heal them by any method and a scanty, thin discharge lasting years or decades often does no harm, disagreeable as it is. The appearance or opening of a pocket, if the latter is properly managed, does not necessarily add to the gravity of the case; it not infrequently, by relieving internal tension and discharging necrotic tissue, ushers in permanent improvement.

Since the above was written the injection of abscess cavities and sinuses with bismuth-vaselin paste has been highly extolled both for diagnosis and treatment (E. G. Beck). After drying the sinus with a strip of gauze, one part of bismuth subnitrate (free from arsenic) is mixed

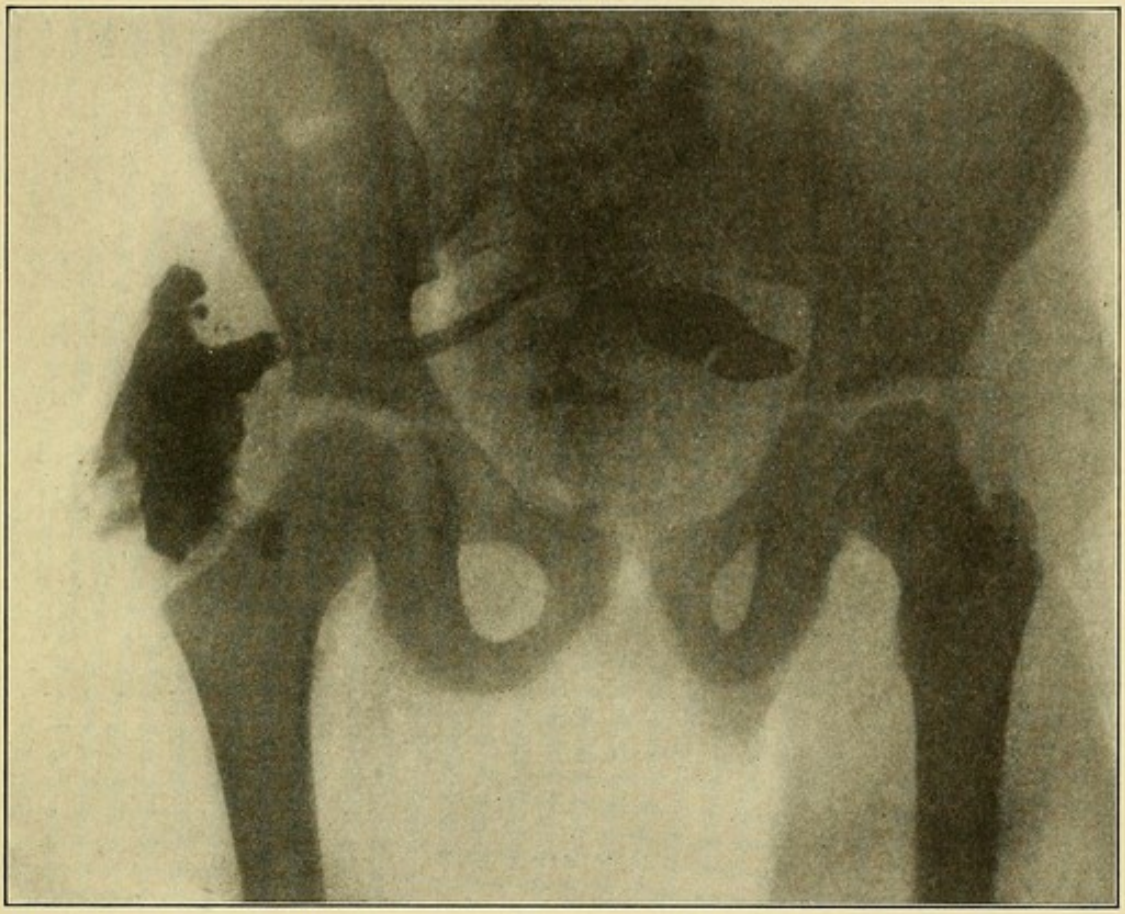


FIG. 35.—SHOWS POCKETS AND SINUSES MAPPED OUT WITH BISMUTH-VASELIN PASTE. The patient, a child of six, had a pocket (abscess) over the hip; the proper diagnosis of tuberculosis of the sacrum was not made until this skiagram was taken. After five or six injections, the discharge had nearly ceased. (Hospital for the Ruptured and Crippled.)

with two parts of boiling vaselin, sterilized, cooled to 110° or less, and slowly injected from a dry, sterile glass syringe. The paste, which is prevented from escaping by a gauze pad, distends all the ramifications of the sinus, and as bismuth is impervious to the X-ray, a clear

picture of the topography of the pockets and sinuses may be obtained (Fig. 35). For old sinuses a quantity of white wax and of soft paraffin, each equal to one sixth of the weight of the bismuth, may be added to increase the solidity of the mixture. One per cent of formalin may also be added if desired. Many obstinate cases have healed under one or more such injections, and the method seems to be a real advance. Lately ichor pockets have been opened and immediately injected with the harder bismuth-vaselin mixture with good results.

Ankylosis.—Of the several elements of deformity, stiffness, shortening, weakness, and malposition, malposition and weakness are certainly the worst. Ankylosis of hip, knee, or ankle in a good posture affects locomotion so little as to be scarcely noticeable; the same may be said of moderate shortening, say up to two or three inches, if properly compensated by a cork sole. Even the stiff elbow or shoulder in the position of choice gives a very useful arm. Some grades of paralysis, a dangle joint, a straight elbow, or a much flexed knee or hip, even with a fair amount of motion and no real shortening, is a calamity, preventing any satisfactory use of the member. When, however, corresponding major joints on the two sides are stiffened, as the two knees, hips, shoulders, or elbows, or when joints are ankylosed that cannot be compensated by other parts, as the maxillary joints or the cervical vertebræ, the interference with function is serious, and it is in such cases that an operation to produce a pseudarthrosis or a movable joint on one side may be indicated. Joints have been successfully transplanted from one part of the body to another (great toe to elbow,

Buchmann), and from amputated limbs (Lexer). There is, however, far too much fear of stiffened joints. In dangle and paralyzed joints ankylosis in proper position is a positive benefit, and is often intentionally produced (arthrodesis) to add to the stability and efficiency of the limb. Normal joints may be fixed for an indefinite time (many years) without fear of ankylosis; it is only inflamed joints that become permanently stiff. Anything that tends to reduce or limit the inflammation, even immobolization, tends to preserve the integrity of the joint and its ultimate mobility. Anything that increases the joint irritation causes an increase of destructive action and of adhesive inflammation. Injudicious passive or forced movements in the active stage of disease often do this. Forcible manipulations under anesthesia are frequently indicated after disease has subsided, but when disease is still present, rest, and often fixation, are required. It is a safe rule not to persist in manipulations that cause severe general or local reaction, or are followed by increased stiffness. The fear of ankylosis with some amounts to a mania, and much harm and suffering have been caused by ill-advised and useless manipulations.

Atrophy.—Another persistent error relates to the significance of atrophy, against which the therapeutic batteries are often directed with misguided zeal. Disuse from pain, tenderness, stiffness, weakness, or from splinting, causes, if long continued, considerable atrophy, and this atrophy is not confined to the muscles, but affects all the tissues including the bones. There is a rapid atrophy which is one of the early symptoms of

acute and chronic bone affections, and which is called reflex; its cause is still in doubt. There is also retardation of growth; for example, in a case of juvenile hip disease, whether splinted or not, after some months all the bones on the affected side, including the long bones, the foot, the pelvis, and the patella, are rarefied in structure and smaller in all dimensions. This wasting in the course of years may amount to several inches in the length of the limb. Notwithstanding, neither reflex atrophy nor the atrophy of disease ever causes a true palsy of the muscles or nerves. Their function is always manifest up to the point permitted by joint conditions. Knees have been restored to motion that have been fixed by adhesions for many years (up to ten or more), but not a case has been reported where the muscles controlling such a joint necessarily wasted by long disuse did not resume their function. Nothing more useless can be imagined than for the surgeon to order massage or electricity for the atrophy of a beginning joint disease, and take no measures to protect the joint. Paralytic or essential atrophy is undoubtedly serious, and merits serious treatment. It is the writer's belief, however, that nothing helps the cold and wasted leg following an infantile paralysis so much as the shortening of stretched muscles and the use of the limb in locomotion. Paradoxically, even a wasted muscle may regain power when movement is prevented. Robert Jones has pointedly called attention to the fact that muscles paralyzed and atrophied for years, after poliomyelitis, devoid of voluntary power, and where electric reactions denoted complete paralysis, may, if shortened and held in

the shortened position, recover considerable power in the course of a few months. If by the wearing of a proper supporting brace or an appropriate arthrodesis the function of locomotion, which has been impossible before, can be restored, greater benefit to the circulation, nutrition, and strength of the leg will accrue than from years spent in a chair, with daily electricity and massage to the nerves and muscles. Dry heat and vibration are valuable stimulants to nutrition.

TREATMENT OF DEFORMITY

We have already seen that during the active stage of deforming affections the treatment of the underlying cause is often the vital and usually an essential indication. The treatment of the deformity itself has for its object a restoration to normal form and function, or to as near the normal as the conditions permit. Early orthopedic work in this country relied mainly on mechanical means both for correction and retention; later the operative methods become more popular. At present, not only in this country but in Europe, the most eminent authorities rely largely upon forcible manipulations and cutting operations for the correction of severe deformities. In some locations (the spine) such methods are not applicable, and the general tendency is toward the adoption of the simplest method that will quickly and safely accomplish the result. The modern point of view is not nearly so operative as ten years ago (rejection of early resections in joint disease, and of bone operations in club-foot, conservative treatment of "cold abscesses"). Modern orthopedic practice, while

radical in its aims (early and quick correction) is conservative in its means. Orthopedic surgery is distinguished from general surgery mainly in its point of view. The orthopedic surgeon is thinking of the ultimate results, and is prepared to use means which make him independent of time. When operations are done, they are done to prepare the way, to remove the obstacle, to effect some definite result, but are often only an incident or a step in the treatment, not its principal or culminating feature. Much stress is laid on what the surgeon calls after-treatment; in other words, the treatment is varied at different times and stages to meet varying requirements.

Besides the usual medical and surgical means, of which it makes free use, orthopedic surgery has developed certain methods into special prominence and utility. These are:

I. Bandaging, strapping, splinting, and apparatus—mechanical treatment.

II. Manual and operative correction—operative treatment.

III. Exercises and gymnastics—gymnastic treatment.

Mechanical.—(*a*) The roller bandage is used to limit motion, or to afford support and compression, as in joint effusion and varicose veins. Lacings and elastic stockings and caps are often better.

(*b*) For continuous firm compression adhesive plaster strapping is very convenient and effective—joint effusions, strains, sprains, flat-foot. Adhesive plaster also affords a firm basis for traction.

(*c*) Fixation appliances may be plastic—best of plas-

ter of Paris—applied directly to the part or molded over a plaster cast.

The plaster splint has been carried to great perfection. It may be fixed or removable. The fixed plaster splint has the great advantages that it is easily applied and that it remains in place until removed and cannot be tampered with. It has the disadvantage of uncleanliness and liability to excoriation, and even constriction, if imperfectly applied or left on too long. Its advantages have caused its general adoption for fixation in most orthopedic clinics in this country and in Europe. Some very eminent men, however, do splendid work without using plaster at all.

Removable splints and jackets may be molded over a cast taken from a plaster splint used as a negative. Such splints may be made of plaster, leather, felt, paper, celluloid, aluminium, and other materials. They are made to lace or hook together.

Lastly, fixation, traction, correction, or supporting splints may be made of an annealed steel framework lined with leather, and secured by strips. With metal splints the direction and amount of motion may be controlled at will at the various joints, and they are largely used, but usually require to be made by an experienced instrument maker, after designs to suit the requirements of the case in hand. Wire or metal splints, if not jointed, may be readily manufactured by any mechanic.

Operative.—Correction of moderate degrees of deformity may often be made by the repeated application of plaster splints with moderate manipulation. Ordinary cases of infantile club-foot are frequently best treated

in this way. Correction of even severe deformity may frequently be effected by portative apparatus in skilled hands, but the process is rather slow.

It is the merit of modern methods to have given us means for rapidly and safely overcoming the severest deformities under anesthesia (Phelps, Lorenz), usually but not always at one sitting. This may be done by forcible manipulation, with or without appliances (wedge, redresseur, osteoclast), and is especially useful in club-foot, congenital hip dislocation, and fibrous ankylosis. Rachitic bow-legs may be manually corrected in children under three or four.

For many severe deformities of bones and joints, and in the older cases, osteotomies are indicated, which may usually be linear and subcutaneous. Excision, and even amputation, may be exceptionally required. Bones may be readily adjusted to any required position, and even when rachitic readily unite.

In the last few years tenoplasty has had an extraordinary vogue. Tendons have been lengthened, shortened, and grafted with great frequency, and often with fair success. A simple tenotomy is usually all that is needed to lengthen a tendon, since, unless infected, the tendon always unites by strong cicatricial tissue. Tenotomies of heel cord, plantar fascia, and adductors of thigh may be subcutaneous; in most other locations they should be open or half open (tendon hooked up through small incision), in order to thoroughly divide contracted tissues without danger to vessels and nerves. Tendons may be shortened by doubling, or by straight or oblique division, lapping, and suture. The tendon of an active muscle

may be sutured wholly or in part to the tendon of a paralyzed muscle, to replace the latter in function, or the paralyzed tendon may be grafted, with or without division, to the healthy tendon. Tendons may also be sutured to the periosteum, or drawn through a channel in a bone; they may be lengthened by silk threads. The suture material is braided silk No. 1 or 2, and strict asepsis must be observed. If much deformity is present, it is best to correct it before the grafting, and the operation should not usually be done before the age of eight or ten. Tendon transplantation is most used in the palsies of anterior poliomyelitis, and it was hoped that the function of paralyzed muscles would be sufficiently replaced to enable the patient to walk without apparatus. This is not usually the case. Many cases are unsuccessful, and in those which are successful the result is a corrected and more stable position, but not usually the restoration of muscular control.

This partial disappointment has led to the development of arthrodesis or artificial ankylosis. Here the joint is opened, the surfaces are denuded of cartilage and remodeled, as desired, and the limb fixed in the posture of choice. The results here, especially at the ankle and knee, are very good. A fibrous ankylosis at the ankle is the rule with a stable and useful joint. This operation may be combined with tendon grafting. The best results will be obtained by postponing this operation till after the tenth year.

Gymnastic treatment may have the stretching and mobilization of contracted tissues and the relief of deformity for its object, as in round back, scoliosis, and

weak foot. It may be assisted by special apparatus (pressure frame, bars, trapeze, stretcher), and consists in active and passive movements in free and assisted gymnastic exercises, and in manipulations. Special postures are much used in taking the exercises—creeping, lying, sitting, suspension, and others. Light gymnastics and breathing exercises are also used with special attention to posture, for their favorable effect on carriage and on the general health. The foundation of correct posture is the straight (in line of thrust), weight-bearing foot. This is the proper base in standing and walking, and not the out-toeing foot of the conventional gymnast and soldier on parade. One should also strive for a straight back, high chest, and moderately retracted chin, abdomen, and scapulæ. Besides its corrective purpose, special gymnastics aim to strengthen parts which have been weakened by disease or disuse, and to improve carriage by imparting more vigorous tone to the muscles.

Massage is of moderate value in orthopedic practice. It has been overused and overrated. An efficient vibrator, on the other hand, run by an electric motor, and in skilled hands, gives excellent results in backache, nervous depression, and many neuralgic and local affections. It combines a deep massage with a powerful and rapid shaking, and probably assists the circulation and drainage; whether it is capable of producing the powerful reflex effects claimed by some is uncertain. It should be used with a definite purpose, and according to a definite technic.

The tendency has been to exaggerate the results of

gymnastic treatment. Too much has been claimed for it; it has often been used too exclusively, and without discretion. Properly employed it is capable of giving results of great value in a restricted class of cases.

The different kinds of electric current, hydrotherapy, light, heat, the vibrator, and other physical methods of treatment are of great value in increasing local circulation and nutrition.

SPECIAL PART

SPECIAL PART

DEFORMITIES OF THE NECK AND TRUNK

DEFORMITIES OF THE NECK

Torticollis, or wry-neck, is symptomatic of several affections, and may be congenital or acquired. The form of most surgical interest is that due to shortening of the sternocleidomastoid muscle of one side. This may be a congenital condition, but it may also be due to an injury of the muscle at birth.

In **congenital torticollis** the deeper neck muscles and other structures may also be involved, and there may be anomalies of one or more cervical vertebræ (osseous torticollis). Wedge-shaped, defective, fused, and atypical vertebræ occasionally occur, causing stiffness, and sometimes shortness, of the neck, curvature of the cervicodorsal spine, and tilting and rotation of the head.

Acquired sternomastoid torticollis, the typical wry-neck, from the orthopedic standpoint, may be due to a partial rupture of that muscle at birth; a hematoma is formed, which is followed by fibroid degeneration and shortening, which approximates the mastoid process of the affected side to the episternal notch; the head is tilted toward the affected side, and the chin upward and away from it (Figs. 36 and 37). On attempting to correct the deform-

ity, the shortened muscle stands out as a tense band. Infants with torticollis are occasionally seen, in whom the hematoma can be easily felt as a resistant tender swelling in the body of the muscle. Frequently the results of

Fig. 36. Fig. 37.

Figs. 36 and 37.—Right Sternomastoid (Birth) Torticollis, Girl of Nine; Untreated Case. Front and back views of same patient.

the early injury pass unnoticed, and the child is brought to the physician months or years later for the neck deformity. At this time the swelling may have disappeared, and there is no tenderness or pain on motion, and no reflex spasm. If much time has elapsed and the deformity is marked, the corresponding side of the face, including the bones, will be flattened and atrophied, and

there will be a lateral bending and often a fixed curve of the upper part of the spine; the convexity is toward the sound side; there may be a compensatory curve below in the opposite direction.

Early and slight cases may be cured by corrective manipulation and support by a Thomas collar made high on the side toward which the head tips. Portative apparatus for continuous stretching are difficult of adjustment, and usually fail of radical correction. Most of the cases after infancy, where the shortening of the sternomastoid can be readily made out, require a tenotomy of that muscle.

This should be carefully and thoroughly done after three years of age, through an open incision, which may run parallel to the clavicle at its upper border for about two inches, or parallel to the direction of the muscle insertions. The two tendons should be separated by blunt dissectors, hooked up and divided. The jugular vein lies just behind the sheath. Contracted parts of the sheath, which become tense under corrective manipulation, should be carefully torn or divided. The neck and upper spine should be thoroughly manipulated, and put up in the overcorrected position over thick cotton padding in a plaster splint which includes the jaw and occiput, the neck, the shoulders, and upper part of the thorax. The patient should be carefully watched after the operation, to prevent choking from efforts at vomiting. Four to six weeks in this appliance should be followed by the plaster jacket and fixed head spring, with tilting and rotative action, a Thomas collar or other appliance (Fig. 38). Corrective manipulations and ex-

ercises should also be employed for several months. The success of the operation depends upon its thorough-

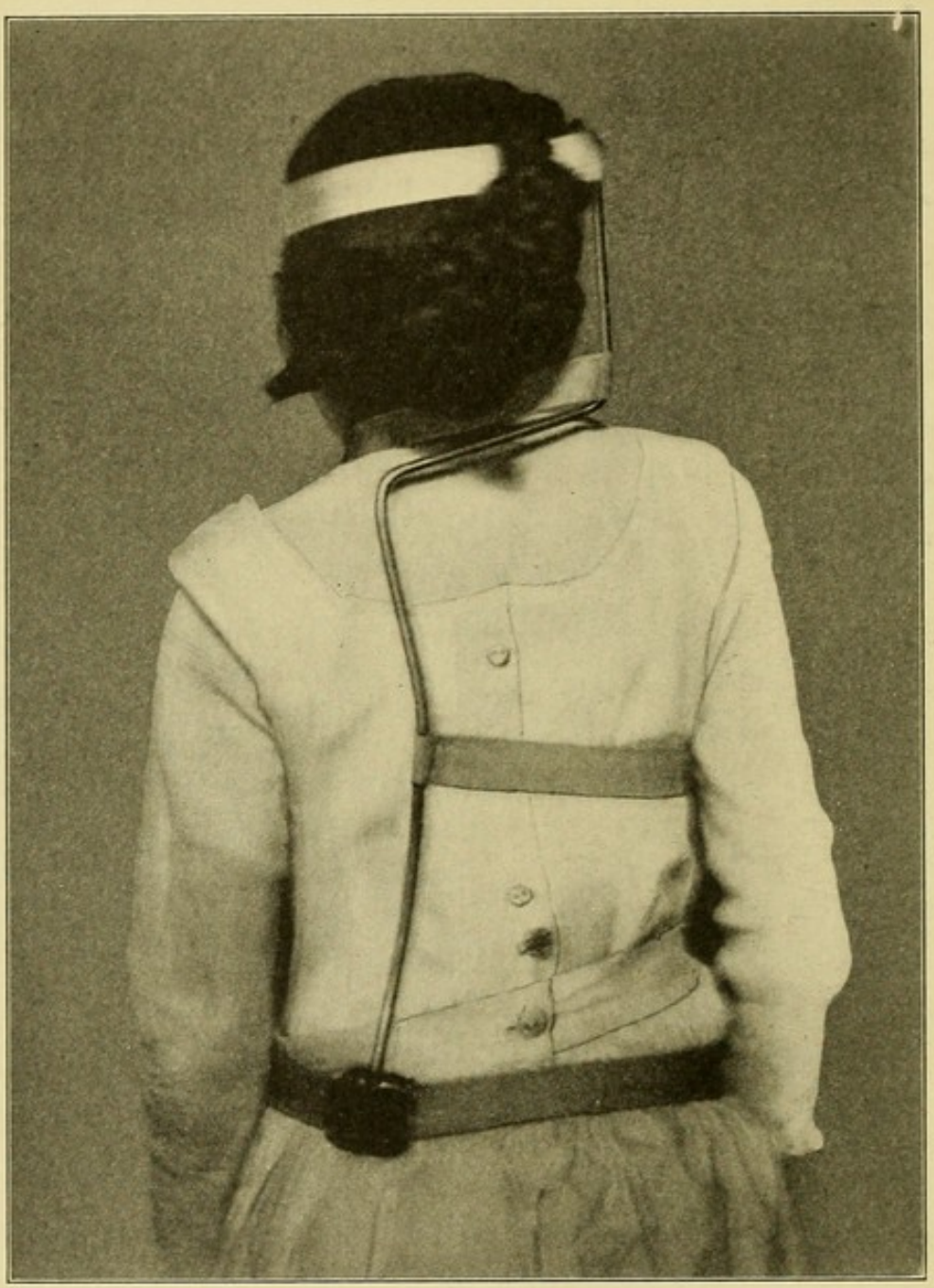


Fig. 38.—Bratz Apparatus for Torticollis. (Sayre.)

ness, upon fixation in overcorrection, and upon the after treatment; when these are not adequate, recontraction frequently follows. There is no advantage in dividing

the muscle below the mastoid process as recommended by Lange. In very severe cases Mikulicz's operation of excising the lower half or two thirds of the muscle may be employed.

Another injury which produces a characteristic neck distortion is **unilateral dislocation of the cervical spine.** Owing to their nearly horizontal position, an articular process in the cervical region may become displaced forward upon or in front of the process below, without fracture, and usually without paralysis. The face is turned away from the injured side. If the dislocation is upon the articular process the head inclines to the sound side; if the articular process is dislocated into the notch, the head leans toward the injured side. The reduction is effected without traction, the patient being seated, by rocking the head away from the dislocated side and a little backward, to disengage the dislocated process, and then rotating it back into normal position (Walton). Reduction may be effected up to six months after the injury. In bilateral dislocation spastic paralysis is common; the head is displaced forward and tilted back.

Wry-neck from Debility and Rickets.—Delicate or rachitic children often show weakness in the neck, and do not hold up the head properly. Aside from malnutrition and rickets, the commonest causes of failure to hold up the head at six months of age or later are idiocy and hydrocephalus. A certain number of delicate children, whose neuro-muscular tone is defective, habitually turn the head to one side. In these the head can be easily straightened without pain or resistance; indeed, the child may from time to time straighten the head voluntarily.

In these cases the nutrition needs attention, and tonics with a proper diet will often be sufficient. With increased strength the child holds its head properly. Not infrequently a thick, broad collar of cotton, higher on the side toward which the head tips, and retained by several turns of a muslin bandage and bound by adhesive plaster, will give beneficial support for a few weeks.

Acute or "rheumatic" torticollis—better, infectious torticollis—a not uncommon affection in the second septennium, is usually due to an infection of the deep tissues of the neck through the tonsils or pharynx during or after a pharyngitis, tonsillitis, grippe, or other acute infectious disease. The invasion is acute, with fever and constitutional symptoms during or after a sore throat; the neck is very stiff, and the head often turned to one side. Movements are very painful, and there is much local tenderness. The acute symptoms last only a few days or weeks, but adhesive inflammation sometimes cause severe and permanent stiffness. It is not probable that there is anything "rheumatic" about the condition. The throat or other sources of infection about the neck should be examined and properly treated.

For the neck itself rest and hot fomentations are necessary. The patient should be kept in bed so long as movements are painful—a rule which is often violated—and during the acute stage cloths wrung out of hot water or a hot poultice should be applied and changed frequently. After the subsidence of acute symptoms a thick collar of cotton, retained by muslin bandages and adhesive-plaster strips two inches wide, should be applied

until normal conditions return. If the neck remains permanently stiff and twisted after subsidence of inflammation, careful manual correction under an anesthetic may be indicated.

Any injury or disease which affects the side of the neck, and results in extensive swelling, inflammation, or cicatricial contraction, may cause a temporary or permanent wry-neck. Burns and tuberculous or suppurating glands are examples.

Cervical spondylitis tuberculosa is frequently accompanied by a gradually increasing stiffness and distortion of the neck. Voluntary movements are limited, and passive movements are more or less resisted—reflex or protective spasm. The chin usually drops toward the chest, and does not point to the opposite side, and the sternomastoid muscle does not stand out as a tense cord. The patient is less active, and may hold his chin on his hands. The general health is usually affected, and a pocket (abscess) may form in the neck or pharynx. The treatment is the treatment of cervical Pott's disease.

Cervical Spondylitis Deformans.—The neck becomes slowly stiffened and deformed. This stiffness is sometimes confined to the uppermost vertebræ, sometimes affects the whole neck, and sometimes a large part or the whole of the spine. Other joints may be primarily affected. The cause of the process is not known; it is extremely chronic, and there is no tendency to suppuration. Pain is often present. The process consists in an osteoarthritis of the spine, or in a simple atrophic arthritis without osteophytes, but with a tendency to ankylosis. There is in

both more or less absorption of the intervertebral discs, and in the former osteophytic growths about the periphery of the superior and inferior surfaces of the vertebral body.

While the affection seems unpromising, great relief, and sometimes cure, results from efficient spinal and head support and tonic treatment. Depressing remedies and too strict diet should be avoided. Antirheumatic treatment is often harmful.

Spasmodic and spastic torticollis is a disease of adult life due to irritation of nerve centers controlling the neck muscles. It may be characterized by sudden clonic spasms of one or more muscles of one side of the neck drawing the head toward the shoulder, and sometimes rotating it. The contractions may be violent and frequently repeated, or fibrillary and tremorlike, with spasticity; the disturbance may involve both sides, and may extend to other parts. The irritation is sometimes due to intestinal autointoxication; good results have been reported from the correction of digestive and neurotic disturbances, and from tonic and psychic treatment, manipulation, muscle training, the high frequency current, and intramuscular injections of hyoscin (Sachs), $\frac{1}{400}$ of a grain once or twice a day, carefully watched, and increased, for a week or two at a time. Mechanical treatment and myotomy are usually disappointing. In resistant cases stretching or excision of the spinal accessory nerve, and, if this fails, excision of the cervical nerves of the affected side, has sometimes proved successful.

A **cervical rib** may occur on one or both sides of the

seventh cervical vertebra; it is usually small and unnoticed, but may cause a hard prominence at the base of the neck and press upon the subclavian vessels or brachial plexus, and interfere with the circulation and innervation of the arm. Deformed and atypical vertebræ often accompany cervical ribs, causing lateral curvature of the cervico-dorsal spine, occasionally of other regions.

The results of excision of the redundant rib in these severer cases are excellent. The operation, however, on account of the proximity of the structures above mentioned and of the pleura, may be a rather difficult one. It is to be remembered that the vessels and nerves pass over or in front of the cervical rib, never below it, and that the pleura may lie almost in contact with its inner border. Through an incision like that for ligation of the subclavian artery the vessels are exposed and drawn to one side, the rib is dissected free with as much as possible of its periosteum, and removed.

CHEST DEFORMITIES

The **normal chest** varies within considerable limits, but it is characteristic of the adult human thorax to have a greater transverse than antero-posterior diameter (3 to 2). The infantile chest is much rounder, and more prominent in its anterior superior part. In other words, babies are more full chested than children or adults. The primitive or simian chest is more elongated and more rounded than the normal, and is a stigma of degeneration. It is such chests that are most prone to pulmonary phthisis (Hutchinson), rather than the flat chest. The emphysematous chest is large and barrel-

shaped—expiratory chest. Recent authorities claim that susceptibility to bacterial invasion of the lungs is due to a small heart or arteries, rather than to a defective chest. A small or weak chest is one cause of shortness of breath, and limits bodily efficiency.

Congenital Deformities

Congenital deformities of the thorax are not very common. The sternum may be fissured or perforated, forming one of many deformities at the median line of the body, caused by imperfect fusion of the primitive lateral flaps. Other examples are cleft palate, spina bifida, hypospadias, exstrophy of the bladder, and umbilical hernia. Parts of one or more ribs may be absent, causing a defect in the thoracic wall, which is covered only by soft parts (Fig. 39). The pectoral muscles of one side may be wholly or partly absent, a defect causing surprisingly little interference with the use of the arm.

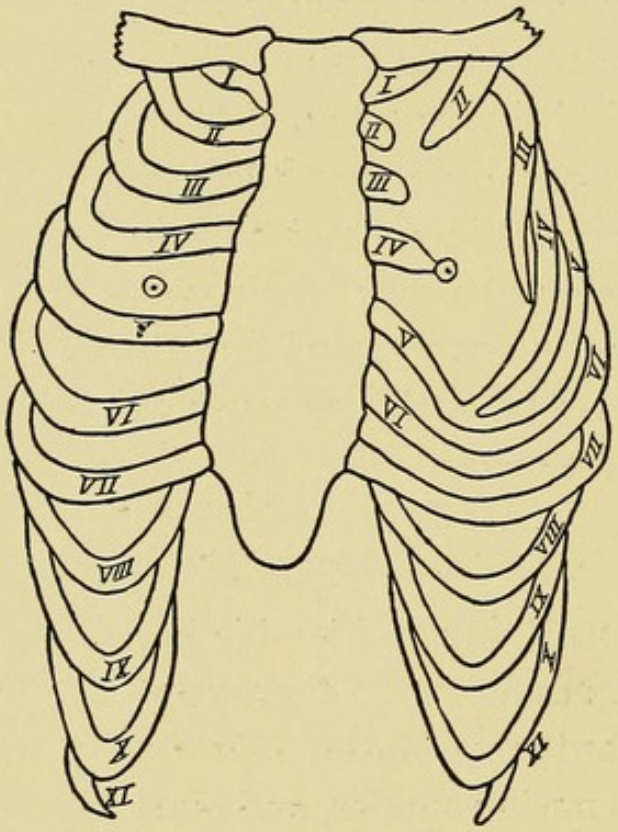


Fig. 39.—Defect of Ribs. (Osborne's case.)

Funnel chest consists in a marked depression of the lower end of the sternum and the adjacent parts (Fig.

40). It is usually symmetrical, or nearly so. Even when extreme, it does not interfere with health or strength, and is incurable. Funnel chest may also be rachitic, or due to certain occupations.

Rachitic Deformities of the Chest

Rachitic Rosary.—The swelling of the costo-sternal junctions forms a row of beady prominences at the sides

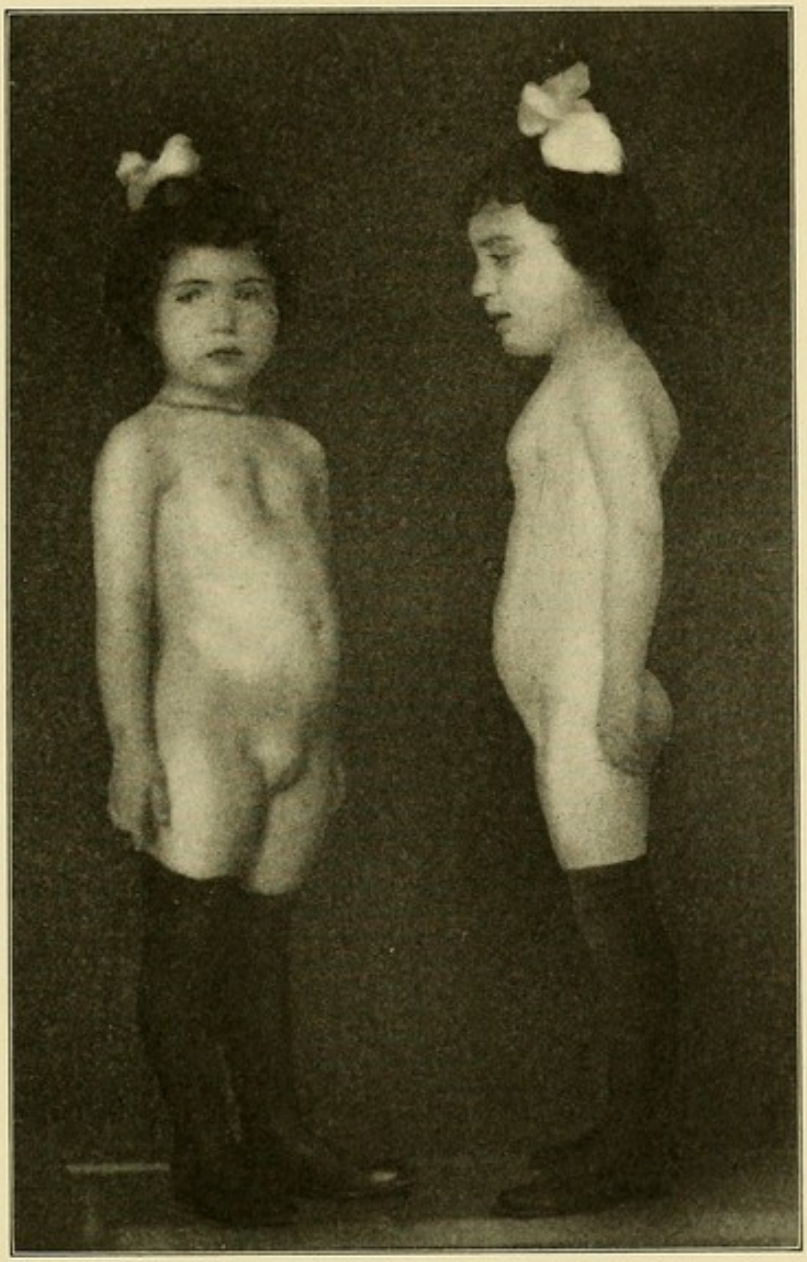


Fig. 40.—Funnel Chest and Pigeon Breast.

of the thorax which are easily palpable, and may be visible; they are one of the characteristic signs of rickets. A very slight enlargement is nearly always present in infants, and is not abnormal. The rachitic rosary, like most of the rachitic stigmata, tends to disappear as the child grows older.

Harrison's groove is a depression at the sides of the thorax, due to pressure of the air and of the flexed arms. The free borders of the ribs, on the other hand, are abnormally prominent from the outward pressure of the enlarged viscera.

Pigeon breast (*Pectus carinatum*) is the keeled anterior prominence of the chest caused by the forcing in of the sides (Fig. 40). It may be extreme. These deformities undoubtedly affect the breathing power of the individual, but it does not appear that after the active stage, lung complications are more common in the rachitics with severe chest deformities than in others. In all rachitics there is a marked tendency to catarrhs of the air passages and of the gastro-intestinal tracts during the active stage. The treatment of all these conditions is the treatment of rickets, with the possible addition of deep-breathing exercises. Mechanical treatment is of doubtful utility. In most cases the deformities themselves are of secondary importance.

Certain secondary deformities of the thorax regularly result from the antero-posterior and lateral spinal deformities, and from tight lacing; long-continued recumbency flattens the chest, behind and in front, especially in children.

DEFORMITIES OF THE SPINE

Normal Postures

The human body is still imperfectly adapted to the upright posture. Too little activity or too long persistence in standing may result in sagging, and ultimately in important structural changes. Hernias, displacements of the abdominal and pelvic viscera, varicose veins, hemorrhoids, flat-feet, round back, and lateral curvature are among the commonest afflictions of mankind, but are rare in quadrupeds, and are largely due to the mechanical stress of the upright posture in standing and sitting. Man's time is mainly divided between standing, sitting, and lying, each of which postures permits of infinite variation. Inactive standing and sitting are unduly prolonged in modern life, to the great detriment of form and posture.

The recumbent posture is usually one of relaxation, as during sleep, and the weight of the body is transmitted directly to the supporting surface and not through the spine, pelvis, legs, and feet, as in standing; it is consequently a relief to overweighted parts. The pillow should be low, in order to avoid poking the head forward. Procumbency is an excellent corrective of this tendency, and also of mild grades of round back. In the lateral decubitus the upper iliac crest is prominent from the sagging of the loin, and the spine is concave to the upper side for the same reason, and from the forcing upward of the shoulders. The posture is of some use as an adjuvant in the management of lateral curvatures, and may be maintained in sleep by strapping a spool

on the hip which is to be uppermost. The patient should lie on the side of the prominent hip.

In the sitting posture the base is formed by the buttocks and thighs, which are then analogous to the feet in standing. The back may be supported by a chair or remain free. In our present social, educational, and industrial life the sitting posture is very important. The tendency is to confine the body too long to this posture, and to allow too little freedom in it. In the normal sitting posture the thighs are directed forward, the pelvis is even and placed as far back in the seat as possible; as the feet do not carry the weight of the body, they may be placed in various positions, but should rest on the floor. The back is held straight, but not rigid, and the trunk may be swayed forward, backward, or to either side from the hip joints and lumbar spine (Figs. 59 and 60). A wide variety of movements should be encouraged, and occupations at the desk or bench should be varied. With all precautions, sitting should be alternated with standing movements, or, better, with walking, at frequent intervals. When sitting is not connected with an active occupation, much latitude may be allowed; but the common posture, with pelvis forward in the seat and a tilted or sagging lumbar spine, contracted chest, cramped viscera, and protruded chin, the posture of extreme relaxation, should not be habitual. The problem of the school desk, of the seated factory operative, and of the sedentary life cannot be solved by attention to the sitting posture or to the seat and desk alone, but must be approached from the point of view of general development and rational hygiene. Recesses, change of occupation,

and corrective exercises, sports, and dancing are some of the means that should be employed to counteract what is really a serious evil.

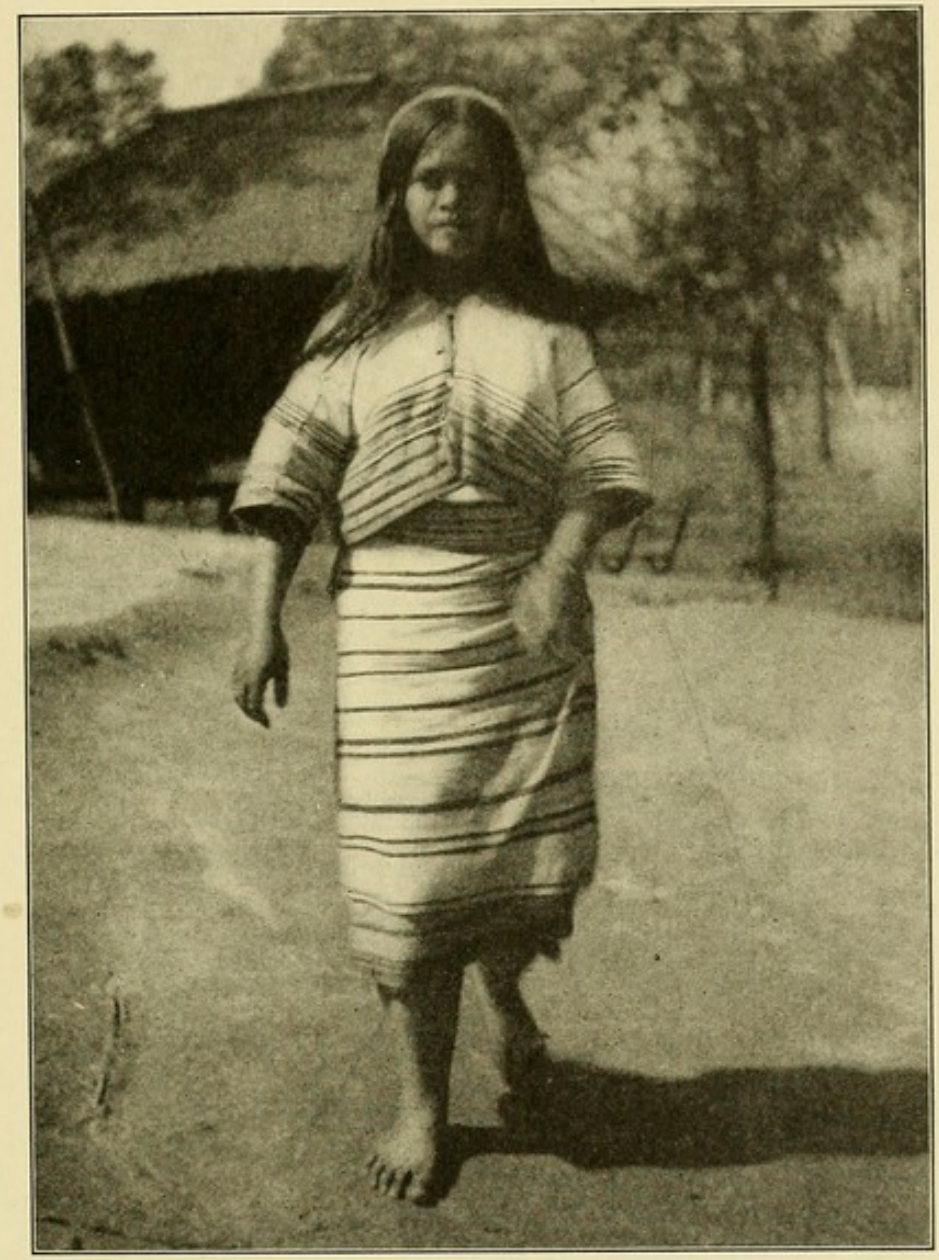


Fig. 41.—Normal (Straight-foot) Walking Posture.
Igorrote woman. (Hoffmann.)

The upright posture is the one best fitted for activity. Its inherent instability is less felt and its evils are less conspicuous during action. Prolonged walking is less

harmful than prolonged standing, and climbing is less harmful than walking on hard, level surfaces. When, however, the upright posture is used as a passive or resting posture for long periods, the strain on the back and feet often becomes harmful, and may result in serious disability. The tendency is to relapse into postures of relaxation and fatigue; prominent inner ankle bones, outtoeing and everted feet, and a rounded back with prominent chin and abdomen indicate the lack of muscular tone. The strain is put upon ligaments instead of muscles; these yield in the end, and habitual vicious posture and structural changes result. While much variety of posture is allowable, and even desirable, the foot which is bearing the weight, the active or working foot in standing and walking, should be directed forward to oppose the forward thrust of the body (Fig. 41). In standing, the weight should be

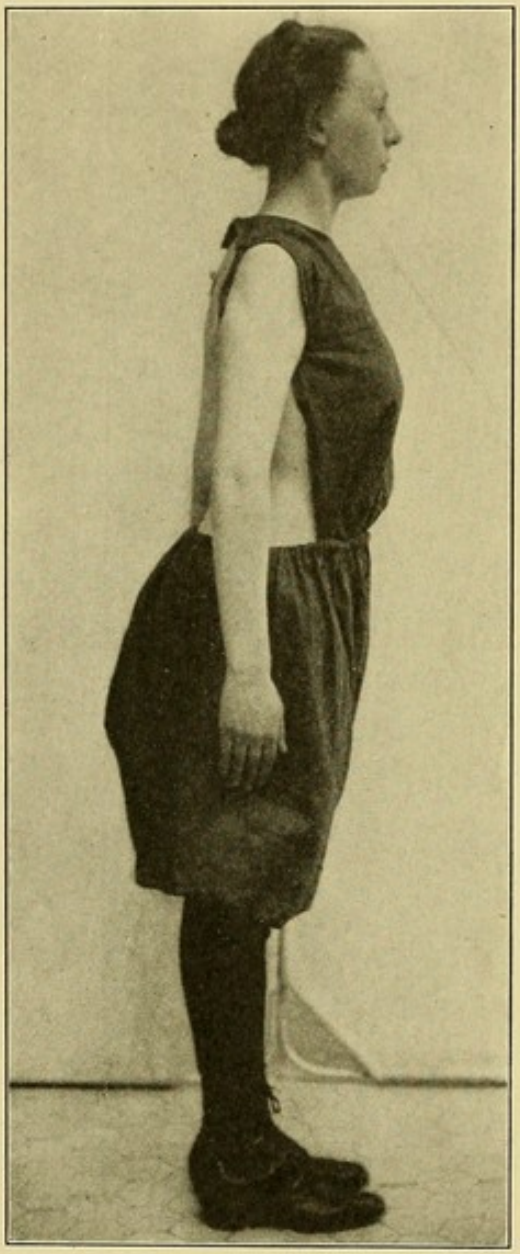


FIG. 42.—CORRECT STANDING POSTURE. Notice straight back, straight feet, forward slant, absence of hypertension, and freedom from exaggeration, so common in conventional gymnastic postures.

frequently shifted from one foot to the other. The posture of the pelvis controls the spine, and consequently depends largely upon the posture of the feet and legs. The straight back, one without a too pronounced pelvic tilt, should be cultivated, and the chest should be held high and the chin and abdomen somewhat retracted (Fig. 42).[1] The gymnastic and military ideal of rigidly retracted scapula and knees is both offensive and injurious.

The Spine

The spine, consisting of the sacrum and twenty-four presacral vertebræ with their elastic discs, is nearly straight in infants, and acquires the lumbar and cervical concavity and dorsal convexity through the early efforts at sitting and standing. The curves which characterize adult life are fairly well marked about the seventh year. The column is most flexible in the cervical region, and least in the dorsal. Motion may take place in the sagittal (flexion and extension), or frontal plane (lateral bending), or about a vertical axis (rotation). The lateral movements are normally combined with rotation, except in the lumbar region.

Congenital Anomalies of the Spine

According to Dwight, absence or surplusage of one or more vertebræ is not excessively rare. The commonest anomaly of number is to have eleven or thirteen thoracic vertebræ. Wedge-shaped half vertebræ may occur

[1] The posture is shown somewhat exaggerated for corrective purposes in Fig. 56.

on either side (Fig. 43), or two unfused halves may exist. Adjacent vertebræ may be wholly or partially fused on one or both sides; lumbar and cervical ribs may occur adjacent to the thoracic spine, and the transitional vertebræ, the seventh cervical, and the first and fifth lumbar are often atypical. Thus the fifth lumbar may be sacralized, and the sacralization may be unilateral or asymmetrical, and com-

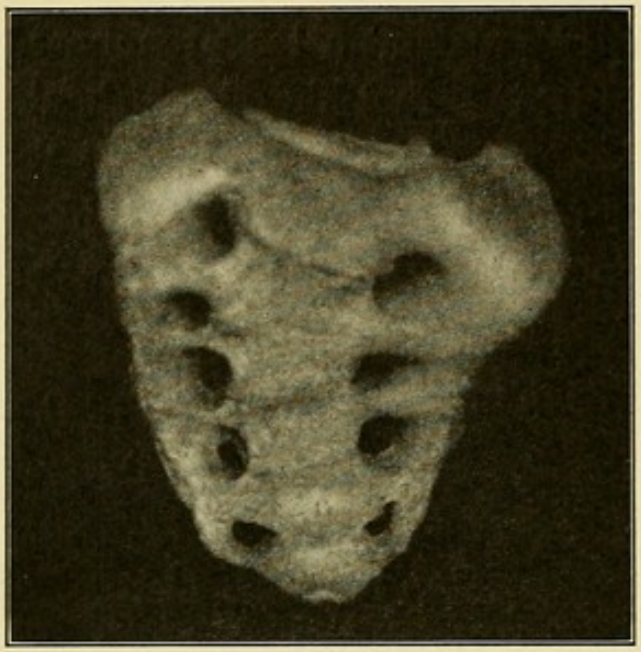


Fig. 43.—Asymmetrical Sacrum; Six Vertebræ on Right Side, Five on Left. (From specimen in College of Physicians and Surgeons, New York.)

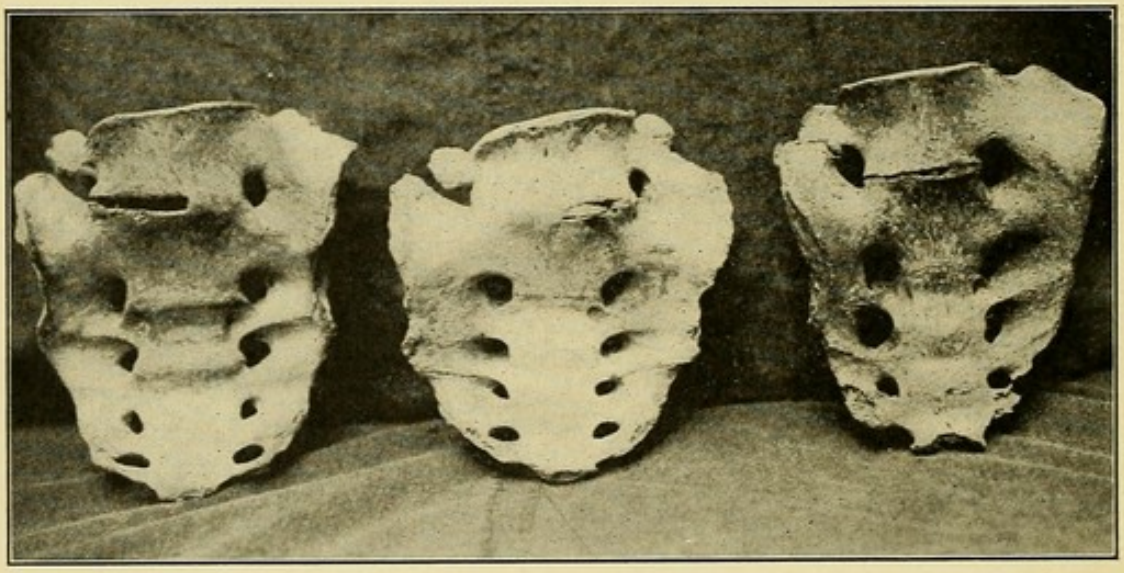


Fig. 44.—Sacralization of Fifth Lumbar Vertebra, More Marked on Left Side. The specimen to the right is more completely sacralized and has only four lumbar vertebræ. (From specimens in Cornell Medical College.)

bined with asymmetrical fusion (Fig. 44). The segment of the sacrum articulating most largely with the ilium is called the vertebra fulcralis. Counting the sacral segments as vertebræ, this is normally the twenty-fifth, but may be the twenty-fourth or twenty-sixth.

When the vertebral arches are incomplete the condition, if local, is called spina bifida; if it involves the greater part of the spine, it is called rachischisis. In either case a sac containing membranes, and often nerve structures, usually protrudes, and various anomalies of the soft parts occur. Spina bifida is often complicated with paralysis and deformity of the feet and legs. Sensation is involved as well as motion, and pressure sores are easily produced.

It is well to remember that individual spinous processes may be bifid or deviate to one side without functional or pathological significance.

Acquired Deformities of the Spine

Antero-posterior Postural Deformities

Round back or **round shoulders** (kyphosis) is the term used to designate faulty postures in which the posterior convexity of the spine has increased from vicious poise or muscular weakness. Sometimes the whole spine is involved in the backward curve, in other cases the rounding is principally in the dorsal region, and the lumbar hollow may be exaggerated. In the common form the head and neck sag forward, the chin is protruded, the shoulders and scapulæ slide forward, the chest is sunken, the viscera are cramped, and the abdomen is prominent.

It is a posture of relaxation, weakness, and fatigue. It is often the expression of a general condition, and frequently associated with weak and outtoeing feet, knock-knees, and lack of vigor. As a matter of balance it is evident that when the spine is projected backward, some part of the body must be projected forward as a counterpoise; the parts so projected are the head and abdomen or pelvis (Fig. 45). When round back is allowed to continue it may become a serious fixed deformity. It is probable that prolonged relaxed sitting is in many cases an important causative agent.

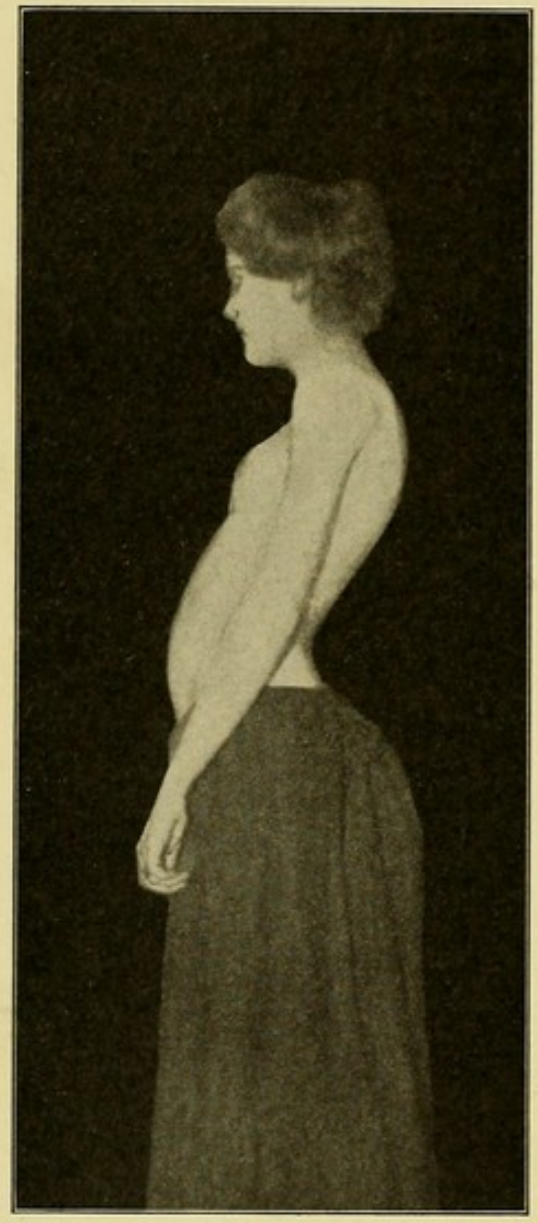


Fig. 45. — Atonic Round Back; Girl of Fifteen.

Round or weak back is caused by overweighting of the spinal column or by weakening of its muscular and bony supports. The overweighting may be due to too long confinement in the sitting or standing posture, or to the carrying of loads, as in the case of grocers' boys and others, or to a combination of both. Muscular support is weakened by any condition that depresses neuro-

muscular tone, such as congenital or acquired weakness, convalescence, overwork, underfeeding, fatigue, and old age; also certain paralytic affections. Round back may also be favored by imperfect development of the chest —primitive chest—by faulty postures in which trunk flexion predominates, and by unbalanced muscular action, as in the round back of boxers and certain gymnasts. Certain children's diseases soften bone, weaken the tissues, and depress tone; such are rickets, marasmus, scurvy, and cretinism. In these affections the sitting posture often results in a posterior projection of the spine, of which the rachitic spine is typical. In such infants sitting should be forbidden, and recumbency and creeping substituted, while the nutritional disorder is being corrected. There are also a number of trophic and infectious processes affecting the spines of adults which interfere with its supporting power, and often result in a round back with more or less rigidity; examples of such diseases are spondylitis deformans, osteoarthritis, ostitis deformans, and acromegaly. The list is similar to that of the causes of scoliosis, but in that deformity the cause works asymmetrically. It is common for slight degrees of lateral curvature to coexist with round back.

School life, by its monotonous confinement to the desk, doubtless tends both to impair vigor and to flex the spine, and is an important cause of round back. Nevertheless, round back often affects children after infancy and before school age. Such children are often rachitic, delicate, or physically degenerate. Round back may be caused by the muscular weakness and faulty postures

favored by an occupation—cobbler, tailor—but a boxer, gymnast, or blacksmith may have a round back and also very strong muscles. He may have developed his muscles in a bad posture, or the spine may be too rigid to be held in proper erectness.

The mental element in round back is frequently important. In the lethargic and dull there is not sufficient mental stimulus to maintain an erect, active, and effective posture, and the posture becomes careless and the back rounded. Round back and flat chest may be due to adenoids and nasal obstruction, and may be favored by near-sightedness.

The tendency of functional round back, if severe, is to become structural and rigid, if uncorrected, but some paralytic round backs are abnormally flexible.

In the round back of old age, as in other senile affections, it is hard to draw the line between the normal and pathological. Frequent examples of perfect erectness in old people prove that the sagging spine of old age is not inevitable. On the other hand, the aged are especially prone to spines which are pathologically stiffened and weakened. In a spondylitis deformans or infectious arthritis of the spine, if the ankylosing process proceeds rapidly the spine may remain straight, but if it be slow and accompanied or preceded by general debility, the spine sags and acquires a posterior or lateral bend.

Another large and important class of cases originates before or about puberty in school or industrial life, and, as in the corresponding class of scoliotics, has no definite pathology beyond the normal or exaggerated laxity of

tissue common at that period. Some of these cases develop extreme forms with great rapidity, and become very resistant; in such cases there is doubtless compres-

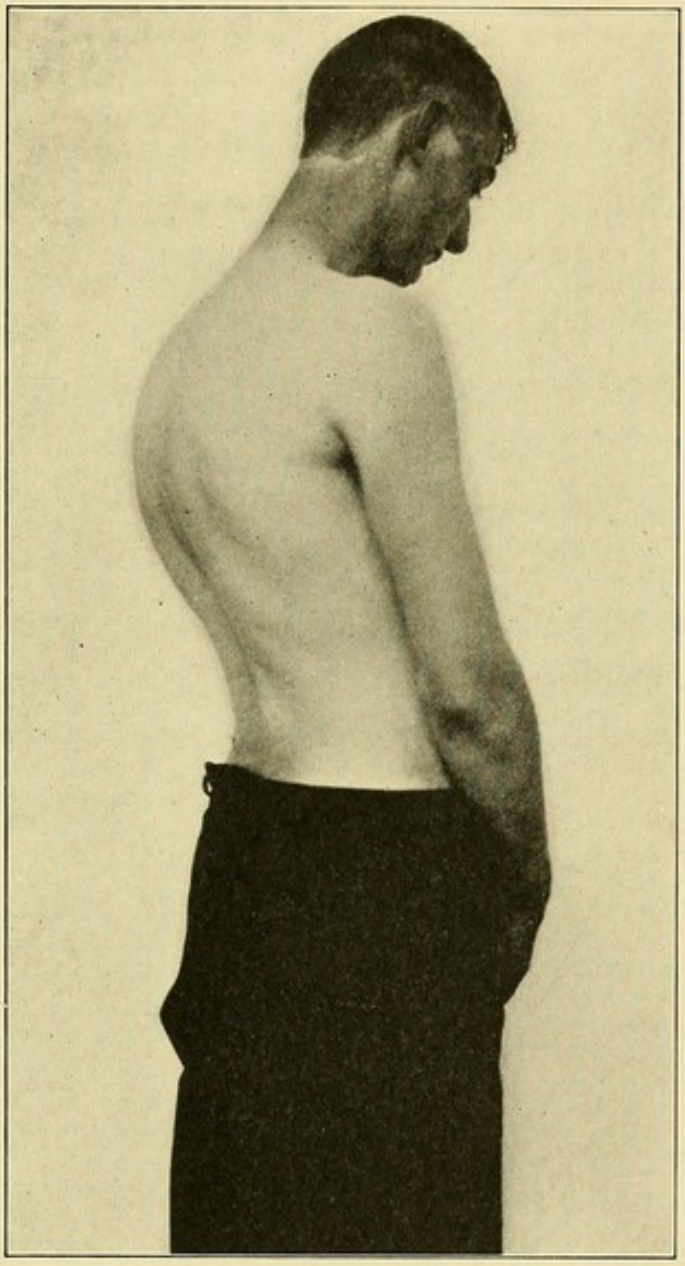


Fig. 46.—Recruit, 16¾; Accepted for Navy, February; Discharged for Round Back the Following June; has also Weak Feet.

sion of the intervertebral discs and vertebral bodies on the concave side (Fig. 46). Prevention is to be sought in the conservation of vigor and a better hygiene of

childhood outside as well as inside the schoolroom. We should work for better conditions of living, food, light, air, exercise, and play, less piano practice and more singing, more sports, games, and play out of school, proper seats, desks, air, light, exercise, and frequent change of posture in the school. One of the stock questions of a distinguished orthopedic surgeon in posture cases is: "When do you play?" The question often evokes astonishment in lieu of an answer. We must insist on a better hygiene of the shop, factory, and tenement, more reasonable work hours, less standing and sitting, more variety of employment, and more recreation for the child and for the mother. So long as any considerable part of the burden of civilization is borne on the back of the child and of the woman, just so long will those backs bend to the load. Not less serious is a hothouse life, with an atmosphere of indolence, limitation, and tension.

Diagnosis.—The cases due to weakness, paralysis, and pathological conditions should be carefully distinguished. The term kyphosis, as applied to round back, is unfortunate, since it is also applied to the deformity of Pott's disease, from which it must be sharply distinguished. The Pott's kyphosis is nearly always at first the sharp projection of a single spinous process; it is accompanied by spinal stiffness, characteristic pain, posture, and constitutional symptoms. The pathological round backs of adult life can usually be distinguished by their stiffness and by their history.

The treatment of postural round back consists in invigoration and in posture training; in structural cases,

mobilizing and corrective exercises are useful. General vigor is to be increased by improving the nutrition, by attention to general hygiene, and by exercise; posture training may be given by means of selected gymnastic exercises, and spinal mobilization by suitable exercises with or without apparatus. The use of the vibrator to the spinal muscles is stimulating and refreshing. The much-used shoulder braces are usually useless, and frequently harmful; only a few of the severer cases require spinal support by jackets, corsets, or braces in connection with the gymnastic work, and still fewer forcible correction. The matter of proper clothing support is often an important one. Children's clothing should be supported by straps or suspenders, taking their base near the neck, and not far out on the shoulders, as is unfortunately the practice in most waists, suspenders, and similar garments.

The gymnastic work should not be confined to the trunk, but should aim at harmonious general development; it should especially aim to strengthen the feet, waist, chest, and neck, and should include breathing and balance exercises. Conventional gymnastics may be made useful, but are often defective from imperfect sense of posture, and from an unwise selection of exercises. If too strenuous, they may do harm to delicate children. Certain sports and games, like swimming and basket ball, involving the larger muscles of the torso, are often of great benefit.

The following exercises are useful; they should be practiced slowly, with a pause at the end of each movement, and each should be repeated about six times:

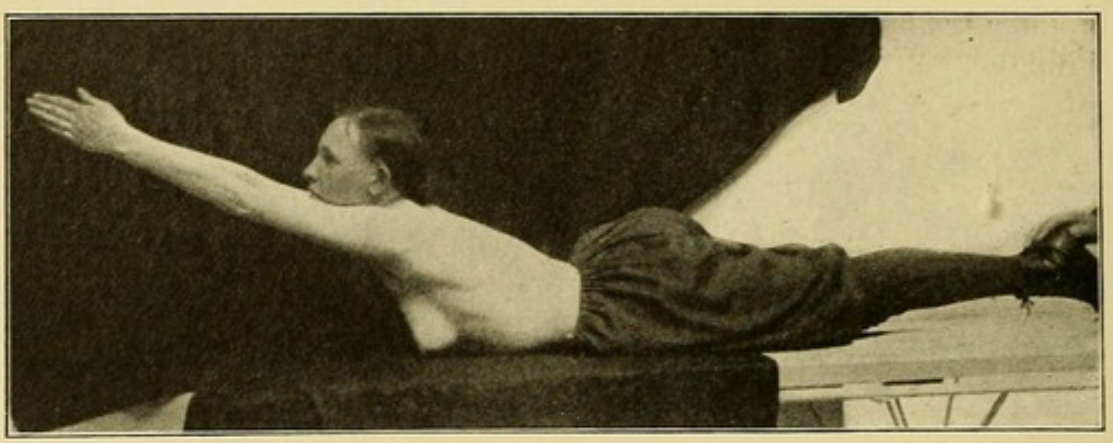


FIG. 47.—SWIMMING MOVEMENT 1.

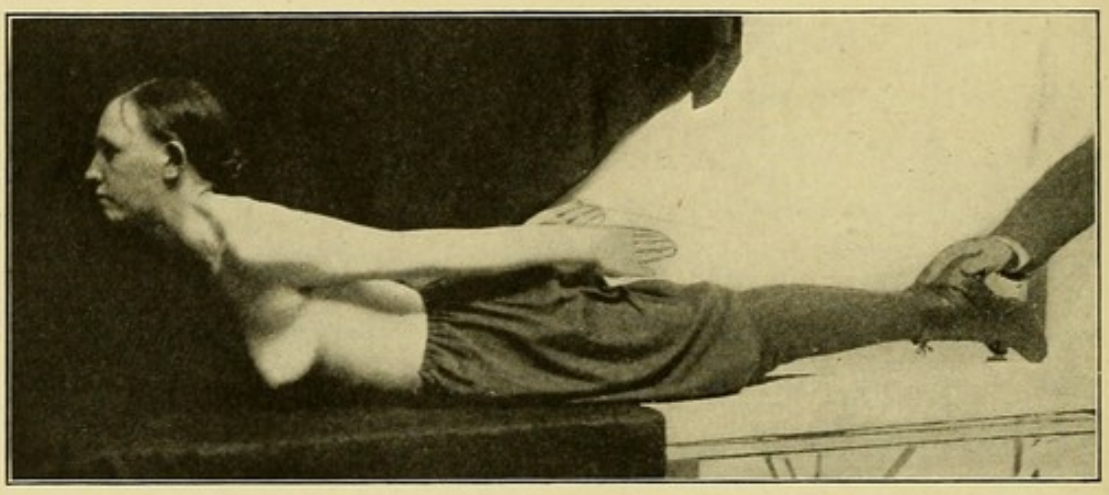


FIG. 48.—SWIMMING MOVEMENT 2.

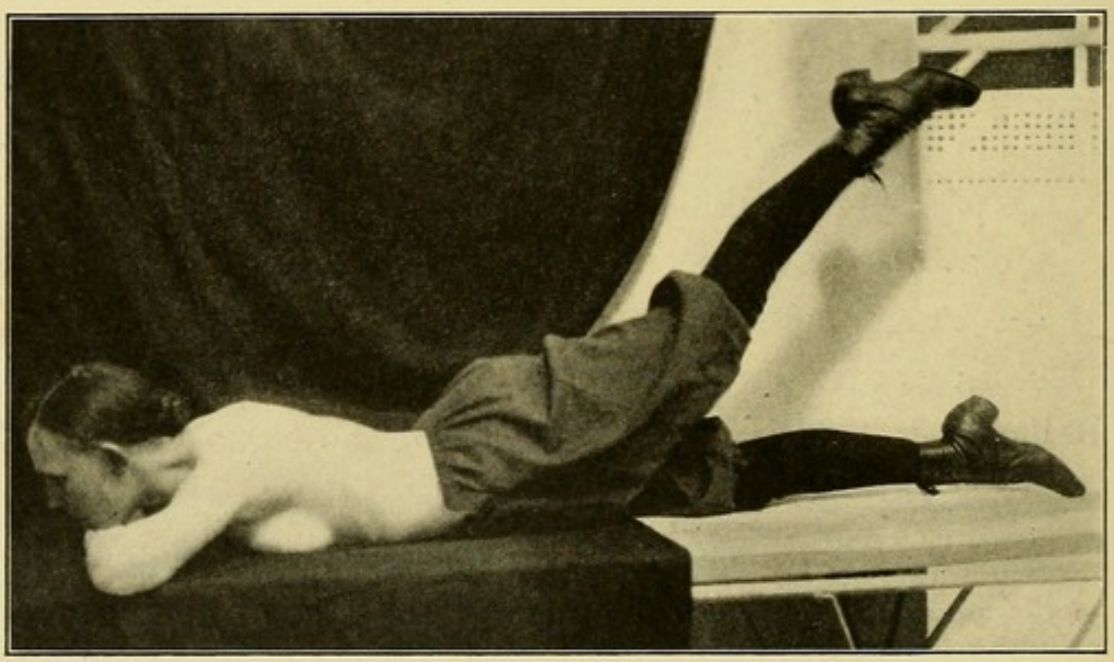


FIG. 49.—LEG RAISING, PATIENT PRONE.

Lying on face.

1. (Swimming movement.) Head and shoulders elevated, arms stretched forward. (*a*) Sweep arms back-

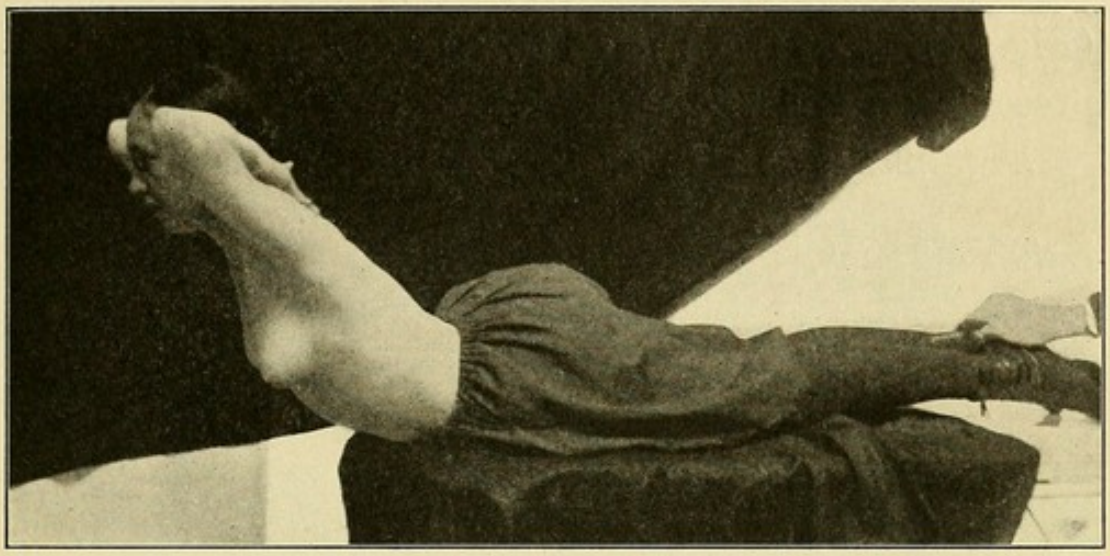


FIG. 50.—TRUNK RAISING; HANDS BETWEEN SCAPULÆ.

ward till hands are over hips; (*b*) bring hands to shoulders; (*c*) stretch arms forward (Figs. 47 and 48).

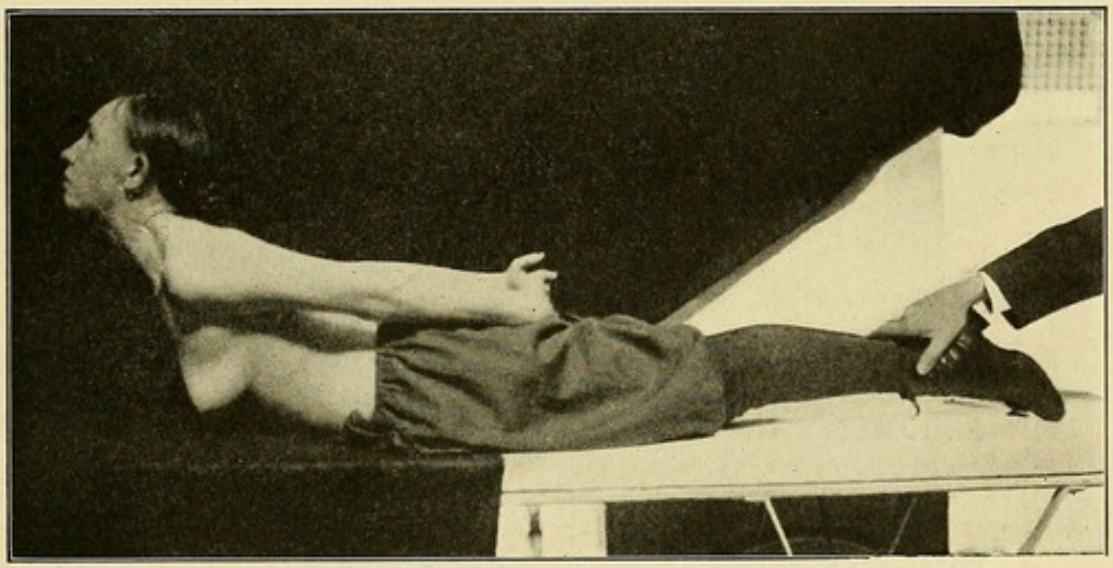


FIG. 51.—TRUNK AND HEAD RAISING; HANDS CLASPED BEHIND.

2. (Leg lifting.) Hands under chin; knees straight. Extend thigh; alternate right and left (Fig. 49).

3. Hands between scapulæ. Raise trunk (Fig. 50), or

3A. Elbows straight, hands clasped behind. Extend trunk; supinate forearms, bringing thumbs backward (Fig. 51). The feet should be held down in this and the preceding exercise.

Fig. 52 shows a corrective resting posture.

Lying on back.

4. Hands behind neck, knees straight. Flex thigh alternately right and left. Later circle thigh.

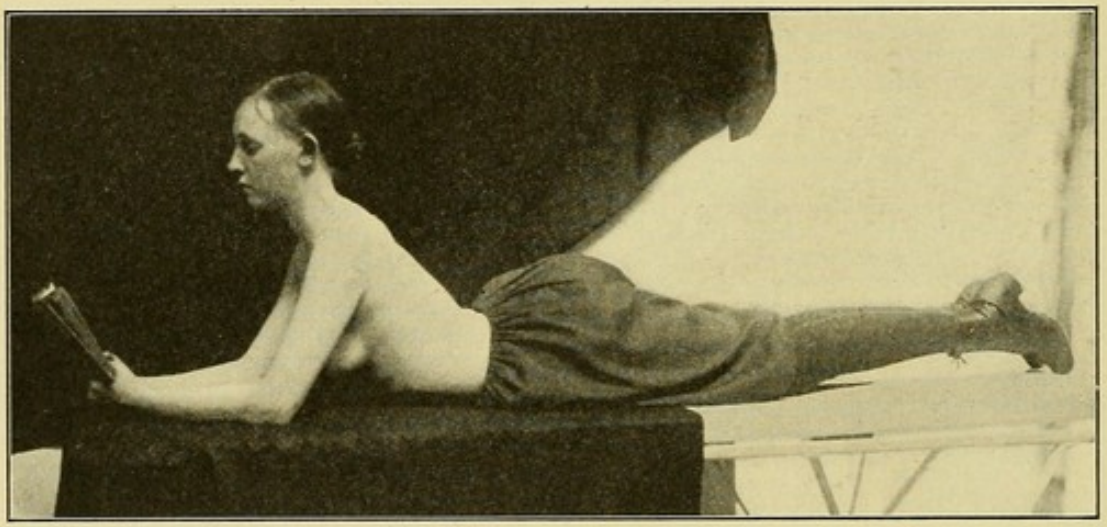


Fig. 52.—Corrective Resting Posture for Round Back.

5. Small pillow behind chest. Breathe deeply; sweep arms upward to limit during deep inspiration, and depress arms to side during expiration.

Sitting.

6. Patient sits on stool, with hands clasped behind neck, and bends back, while the operator pulls back on the elbows and presses forward with his knee against the curve of the spine (Fig. 53).

Hanging from trapeze or bar, head back.

7. Separate and close legs.
8. Twist pelvis to right and left.
9. Operator pushes against dorsal convexity.

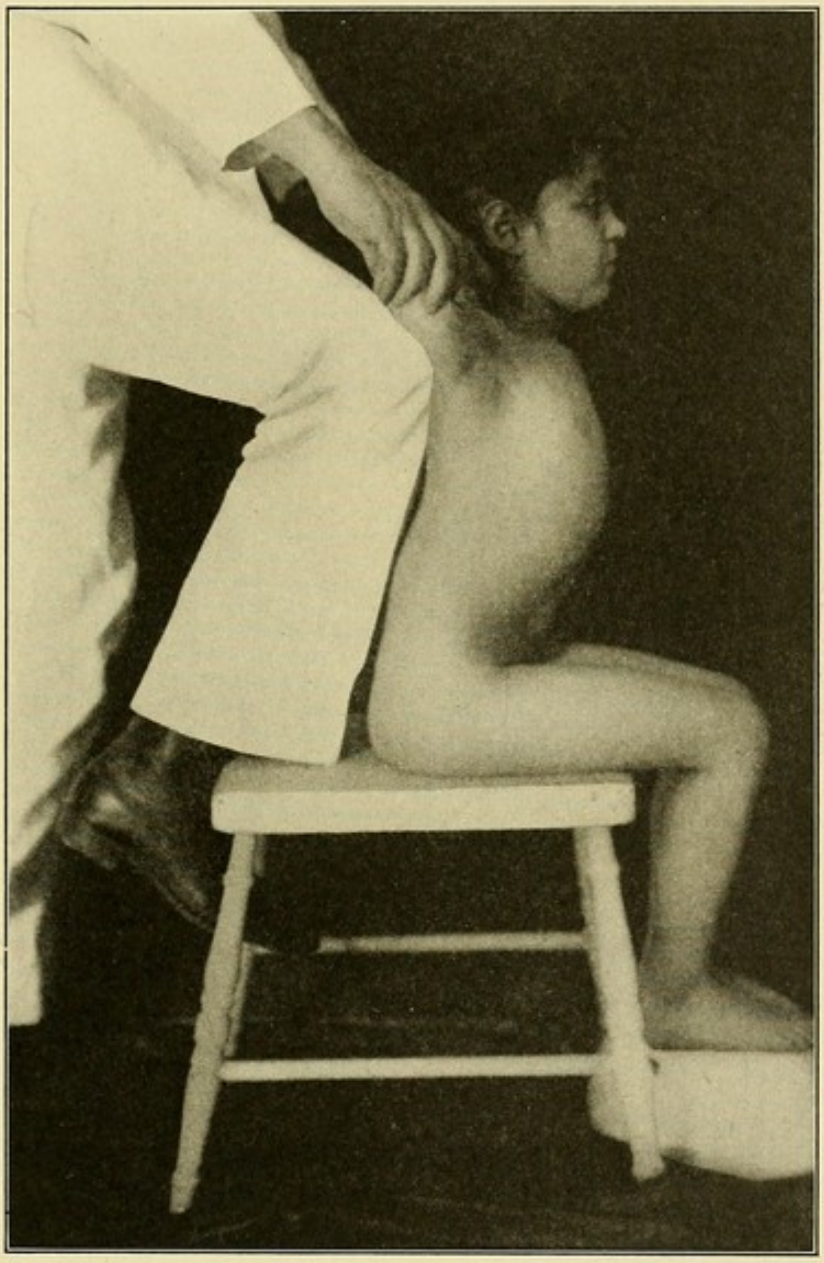


Fig. 53.—Correction of Round Back by Knee Pressure.

Standing.

10. Swing arms forward and back, or walk backward to get proper poise on balls of feet.

11. Hands clasped behind head, elbows well back. Push back with head against resistance of hands.

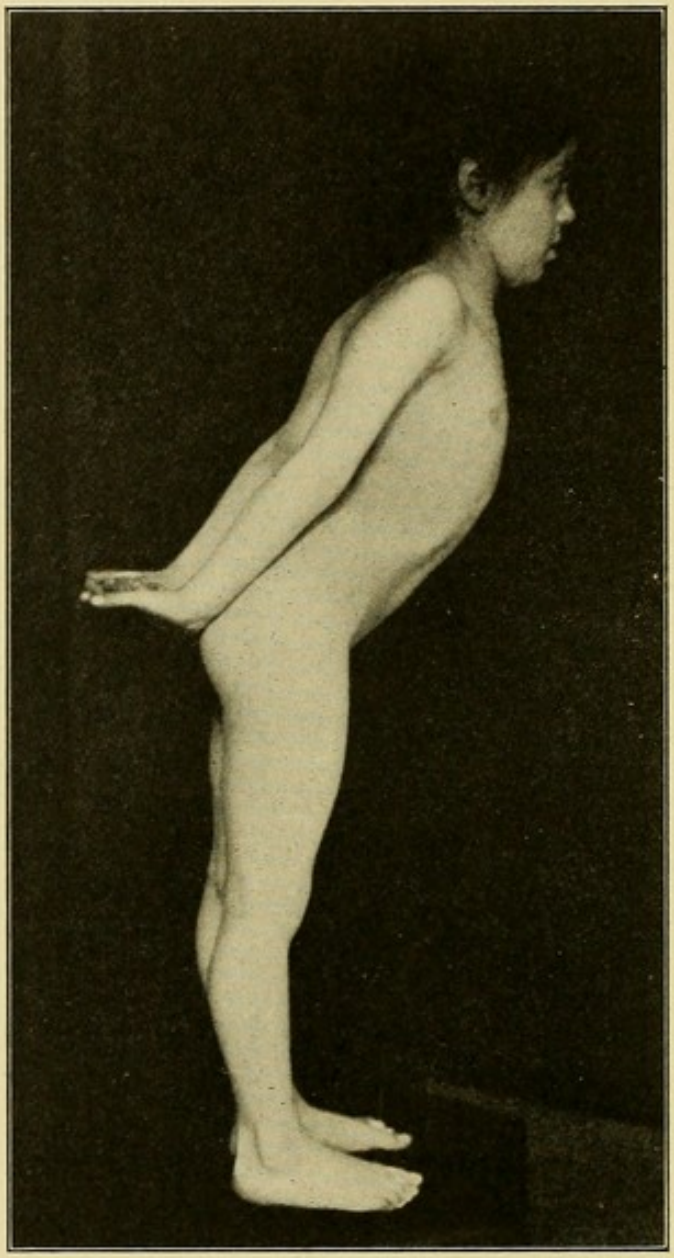


Fig. 54.—Self-Correction of Round Back by Head and Spinal Extension, Hands Clasped Behind.

12. Hands clasped behind back, elbows straight. Bend forward at hips; extend trunk; arch head and spine backward, while holding arms stiff (Fig. 54).

13. Deep breathing.

14. One foot forward, knee bent, body inclined forward, arms stretched out in front. Swing arms back horizontally. Repeat with other foot forward.

15. Walk with shot bag on head.

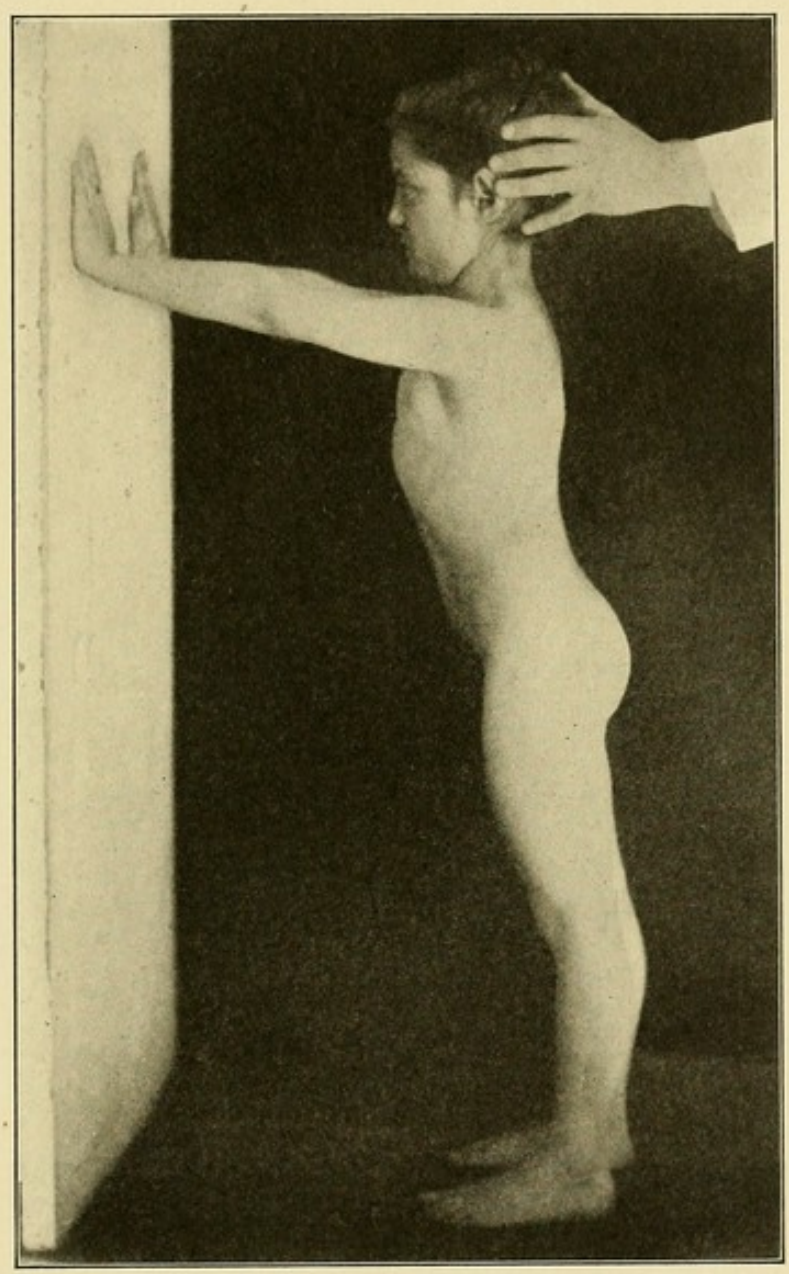


Fig. 55.—Retraction of Head Against Resistance, Hands Against Wall, for Correction of Head and Spinal Deviations.

16. Stand two feet from wall; rest separated hands on wall at level of shoulders, elbows straight. Opera-

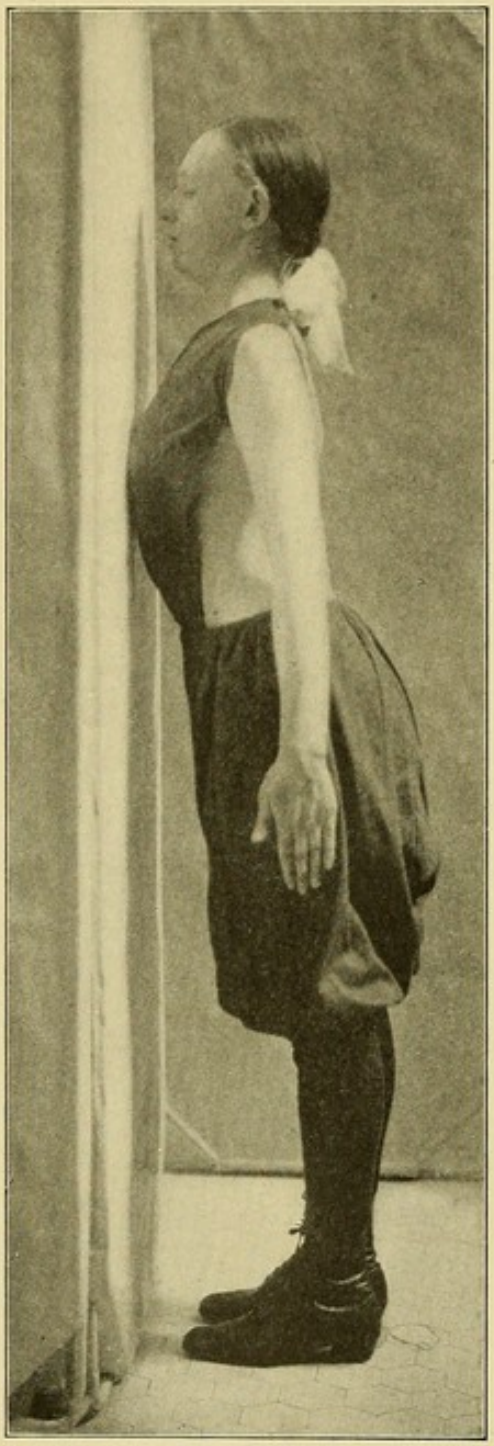


Fig. 56.—Chest Against Wall; Correction for Round Back.

tor's hand presses patient's head forward (Fig. 55). Patient pushes head strongly backward against resistance of operator's hand, pulling chin in.

17. Patient stands with upper chest against wall, head and feet slightly retracted (Fig. 56).

1, 3, 6, 9, 11, 12, and 16 are particularly corrective.

All-around invigoration, with mobilization through trunk extension, the development of weak parts and of breathing power, and education in correct posture, is the aim of gymnastic treatment, and should result in *habitual maximum self-correction*, which is of all means probably the most effective. Consult also the section on round shoulders.

Lordosis.—There is considerable variation within normal limits in the amount of the lumbar hollow, due to the inclination of the pelvis and the forward bending of the lumbar spine. Certain cases of round back, particularly

in the dorsal region, are associated with lordosis, others are rounded throughout, while in another type of back the upper part is straight and the lower hollow. Lordo-

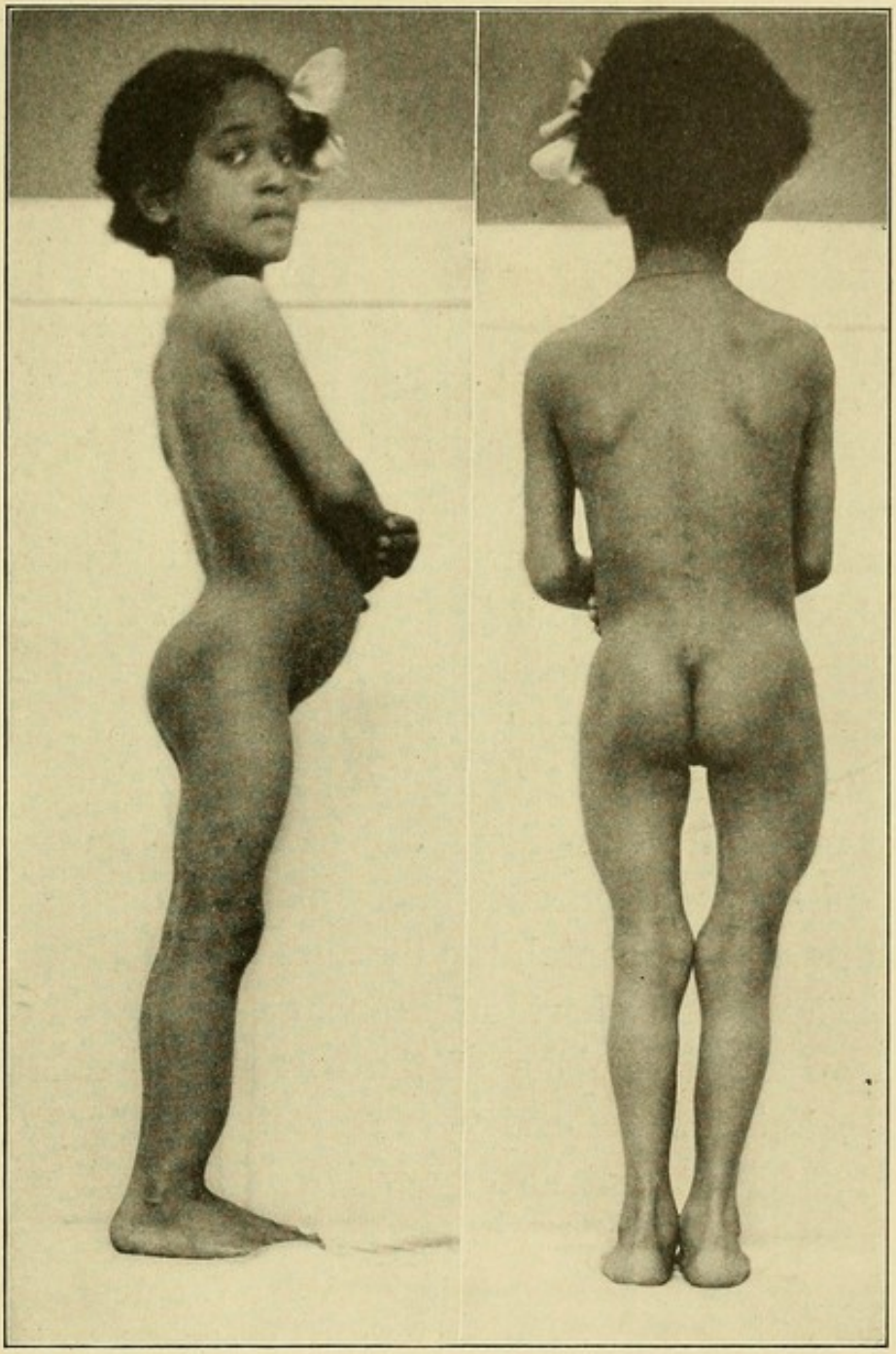


FIG. 57.—LORDOSIS FROM BOWED (RACHITIC) FEMORA.

sis may be symptomatic of weakness or palsy of the lumbar or abdominal muscles, as in pseudo-hypertrophic

muscular atrophy, or to other causes interfering with the balance of the pelvis, such as corpulence, pregnancy, rickets (Fig. 57), bilateral congenital hip dislocation, bilateral coxa vara, flexed hip, spondylolisthesis, and Pott's disease. The treatment of lordosis is the treatment of the primary affection; in a few cases jackets or corsets may be useful. Many cases do not require treatment.

In normal standing, walking, and working postures, lordosis is to be avoided, as it is both inept and unsightly, and the "straight back," with but a slight lumbar concavity, should be cultivated in daily life, and in gymnastics and posture work.

Spondylolisthesis is the name given to a sliding forward of the body of the fifth lumbar vertebra upon the sacrum; the sliding may also take place between the fourth and fifth lumbar. It is most frequent in pregnant women owing to the laxity of their ligaments, but may occur also in men, with or without violence. Weakness of the back and lack of endurance is complained of; the pelvis is abnormally horizontal, the iliac crests prominent, and the lumbar spine short and concave. Palpation may reveal an abrupt sinking of the corresponding spinous process, but the deformity can exist with the arches so stretched out that no depression is felt. A middle-aged man with this affection, seen by the writer, had been treated without benefit by exercise for neurasthenia for a year or more. The treatment should be spinal support by a plaster-of-Paris corset or other efficient appliance.

Softening of the lumbar vertebræ from locomotor

ataxia may give rise to displacements easily mistaken for spondylolisthesis.

Lateral Deformities of the Spine

Scoliosis, or lateral curvature of the spine, may be congenital or acquired; there is also an intermediate or latent form depending upon a congenital anomaly of the vertebræ, which may determine the development of a scoliosis some years later. Acquired scoliosis is by far the more common form, and may be functional and readily corrected by manipulation, or by the effort of the patient, or structural and persistent. The functional [1] form often changes into the structural, if neglected. Like round back, scoliosis is often secondary to pathological conditions, general or local, but the ordinary cases are postural,[1] due to overweighting or decreased spinal resistance combined with one-sided postures; whether there is an obscure underlying local pathological process is still under discussion. When the term scoliosis is used without qualification, the postural form, which is also the commonest, is meant.

The CAUSES OF SCOLIOSIS are very similar to those producing round back, but in scoliosis the two sides of the spine are unevenly affected. As in round back, the fundamental difficulty is the instability of the trunk in the upright posture. Acquired lateral curvature may be divided into the following groups:

I. Postural scoliosis due to overloading or decreased

[1] The term "functional" is used to designate a degree of the affection, the term "postural" to denote causation; the term postural is used by some authors in the sense in which functional is used here.

resistance in growing individuals who sit, stand, or work in faulty and one-sided postures. Some oculists believe that habitual faulty postures may be produced by certain forms of astigmatism and by asymmetrical weakness of the eye muscles. A unilateral deafness is also said to favor the development of scoliosis.

II. Static scoliosis is due to pelvic obliquity, usually from a short or flexed leg.

III. Contraction scoliosis of a severe type follows pulmonary collapse and pleuritic obliteration after empyema.

IV. Paralytic scoliosis is an intractable form due to asymmetrical palsy of spinal and trunk muscles. It not infrequently complicates poliomyelitis, Friedreich's disease, and syringomyelia. Pseudo-paralytic or spastic scoliosis may be present in hysteria.

V. Pathological scoliosis results from certain general and local diseases, such as tuberculous and other deforming diseases of the spine, osteomalacia, acromegaly, osteitis deformans, sciatica, and sacro-iliac disease, or, indeed, any disease or injury having a one-sided effect on the stability of the spine.

A. Congenital Scoliosis

Congenital scoliosis is not common; it is frequently unnoticed until some months after birth. The early cases are often single. The X-ray may assist in the exact diagnosis, and may clear up certain of the older cases, which appear to have developed as postural cases, but are really due to misshapen vertebræ. Treatment is difficult, but considerable may be done in the infantile cases

by attention to the baby's postures on the mother's arm and elsewhere, by strapping down the high shoulder with adhesive plaster, by placing a thick felt pad under the prominent side, by periods of recumbency on the hollow side, by encouraging creeping and procumbency, or by continuous recumbency on the padded frame. The best results in the single cases seem to be obtained by pulling the shoulder and thigh on the convex side toward each other, by a soft bandage applied to the side of the neck on the concave side, crossing itself through a slit over the high shoulder, crossing itself through another slit over a felt pad over the convexity, passing under the thigh of the same side to be pinned to the other end, thus pulling the flexed thigh upward. The two ends of the bandage and the crossings are pinned. This removes the curvature, and allows the child to bend toward the former convexity, but not toward the former concavity.

B. Acquired Scoliosis

I. **Postural (Habit) Scoliosis.**—This is the largest, most important, and least understood group. A "high shoulder" or "high hip" is usually first noticed by the mother or dressmaker at the age of seven to twelve; in other words, in the early school years. Girls are more frequently affected than boys, but when boys are affected the deformity is often excessive and intractable. It usually, but not always, occurs in delicate and neurotic children.

It has been pointed out that, if an infant is carried constantly on the same arm of the nurse, an obliquity of the baby's pelvis occurs, which produces a spinal bend-

ing; such a bending might become fixed in a rickety or marantic child. The weight of the baby on one arm may cause a lateral correction in the nurse if the latter is a delicate, growing girl. When in acquired cases the distortion develops before school age there is usually, but not always, a rachitic basis. In a large number of children it is an occupation (school) deformity due to prolonged sitting in faulty postures, and with too little activity. In others it may be provoked by carrying the schoolbooks or a baby on one arm, usually the left; New York grammar school children carry habitually five pounds of books to and from school (Gulick). Or it may be due to certain habits or tricks of standing, sitting, or lying, or to all of these. It is doubtful, however, if such faulty postures alone usually cause the trouble. Another factor seems to be necessary, namely, the weakened resistance of the osseous and neuro-muscular apparatus, either by rickets in early childhood, by an exaggeration of the normal laxity characteristic of the pubertal and prepubertal periods, or by some process not understood. Of late much importance has been attached to the sitting posture at the desk, and it has been sought to remedy the evils of faulty desk postures by improving the seat and desk, and by introducing the vertical style of writing. The latter has, however, been criticised both from the practical and the hygienic point of view, and seems to be losing ground in this country. The school desk should clear the knees, and should be low enough for the arm to rest on it comfortably without bending the back; its top should slope about fifteen degrees. The seat should be of such height that the feet will rest

easily on the floor. The height of the desk and seat should therefore be adjusted to the pupil. The seat should be placed at a sufficient distance to allow a moderate forward inclination of the body in writing. The seat should be hollowed for the thighs and buttocks, and should be slightly higher in front; its front edge should not project more than one inch under the desk. The back of the chair should be flat and narrow, and slightly inclined backward, and should be open behind the buttocks. It should support the back below the waist (lumbo-sacral junction), and in the lower half of the dorsal region, including the lower angle of the scapulæ when the pupil is reading or resting. All the edges of a school chair should be rounded.

The chair recently devised by Miss Emma J. Sebring, principal of St. Agatha's School, New York City, seems to the writer to be a distinct advance, and by far the best yet offered for sedentary occupations (Fig. 58).

"This chair is designed with the distinct purpose of at least inviting or encouraging, if not compelling, correct sitting posture. It is maintained that the only comfortable position in this chair is the correct sitting position, and that when this position is taken the chair is perfectly comfortable.

"Correct sitting posture involves free movement of the trunk backward, forward, and sidewise on the hip joints; a straight spine, supported just below the waist and at the shoulder-blades, elsewhere free, and held very nearly at right angles with the thighs; square shoulders; erect chest, and feet resting squarely on the floor (Figs. 59 and 60).

"The following advantages are claimed for this chair:

"1. It is not screwed to the floor, and may therefore be pushed backward or forward at varying distances

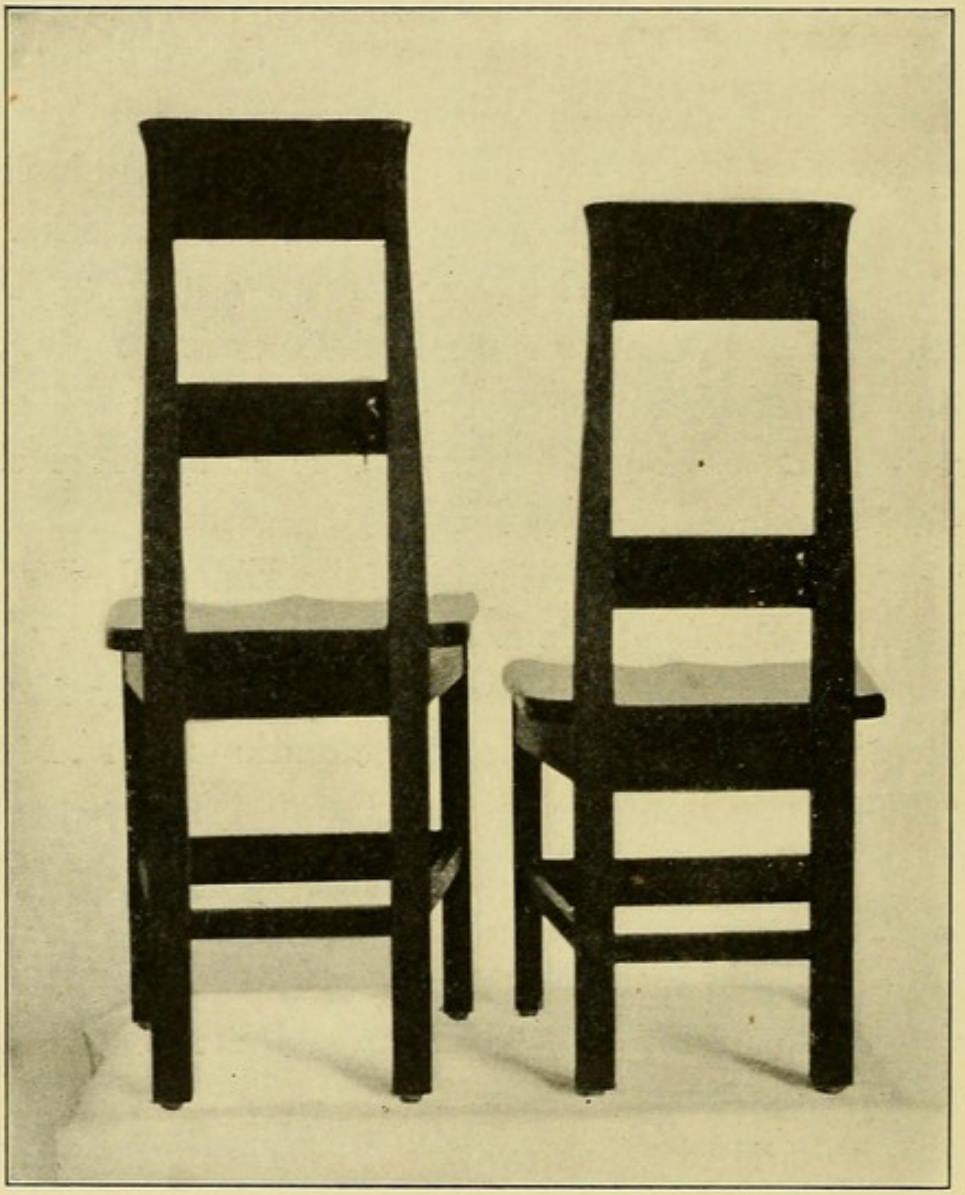


FIG. 58.—MISS EMMA G. SEBRING'S SCHOOL CHAIR WITH ADJUSTABLE LUMBO-SACRAL SUPPORT, FAVORING CORRECT POSTURE.

from the desk, thus allowing freedom of movement at the hips, and permitting the necessary adjustment of distance from the desk for various kinds of work.

"2. The back of the chair is straight and very nearly

at right angles to the seat, thus holding the sitter's back erect.

"3. The back of the chair is open at the base, thus allowing the base of the spine to be pushed well back and giving it perfect freedom, which is necessary.

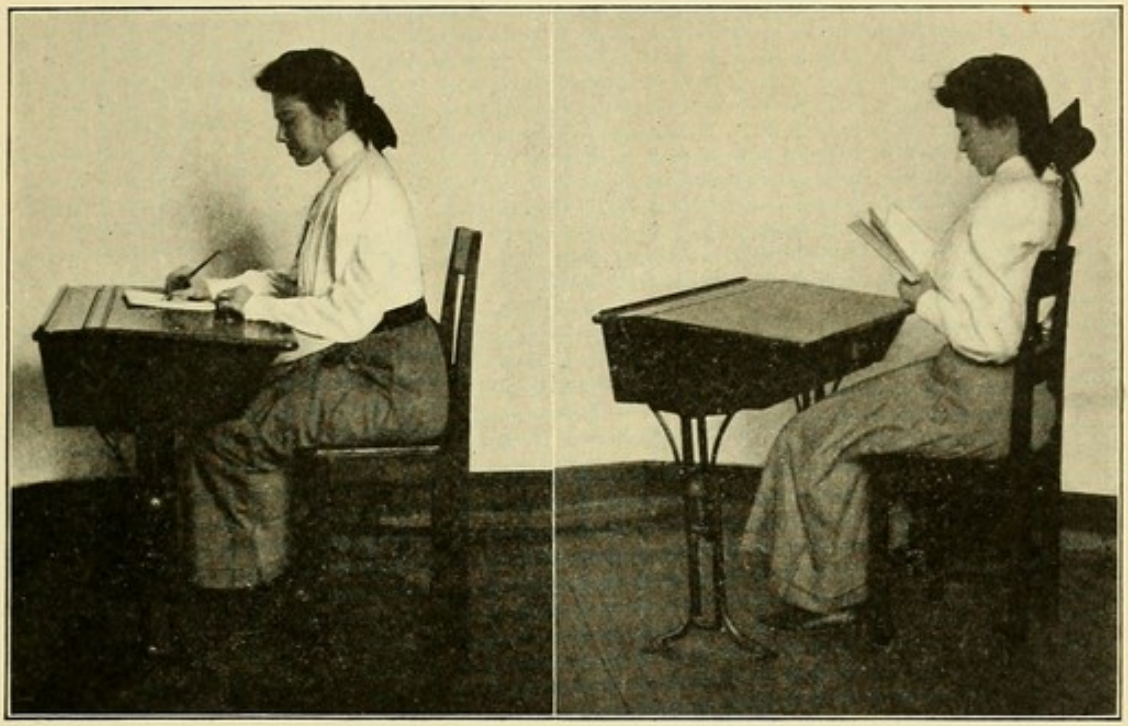


Fig. 59. Fig. 60.

Figs. 59 and 60.—Correct Postures at Desk; Sebring Chair.

"4. The back of the chair has two points of support, a fixed upper slat and an adjustable lower slat, which by means of its adjustability may be made to support any sitter's back at the proper point.

"5. The back of the chair is both narrow and straight. This allows the shoulders to be square and avoids all rounding of the shoulders necessarily caused by a curved chair back.

"6. The chair is made of different heights from the floor to fit all sizes of people." (Sebring.)

Actual trial in the schoolroom has shown that the pupils sit better and are more comfortable on the Sebring chair than on the usual school furniture. If desired, the Sebring seat may be attached to an adjustable base fixed to the floor.

Anything that weakens general vigor and interferes with nutrition will evidently decrease the resistance of the tissues and render the child more vulnerable to the unfavorable influences to which all children in civilized life are inevitably exposed. One such influence is a pampered or hothouse life; another is overstudy; another is too much time devoted outside of school to things in themselves wearying, like violin or piano practice, than which there are few things more depressing. Voice culture, with its associated breathing movements and insistence on good posture, is, on the other hand, beneficial. In another class it is overwork, underfeeding, and the violation of the more obvious hygienic laws.

That a certain predisposition toward scoliosis exists in many children is shown by the fact that some observers have found scoliosis in the family in fully one quarter of the cases. Slight or moderate scoliosis is often combined with round back. Adenoids, hypertrophied tonsils, and nasal obstruction are present in some cases of scoliosis.

The PATHOLOGICAL ANATOMY of scoliosis reveals the adaptation of the spinal column and thorax to the abnormal posture. The spine as a whole is bent to the side in one or more regions, twisted and skewed. The column of bodies is more bent than the column of arches and processes; this is the result of rotation or twisting.

For this reason the scoliotic column, viewed from in front, shows much more deformity than from behind.

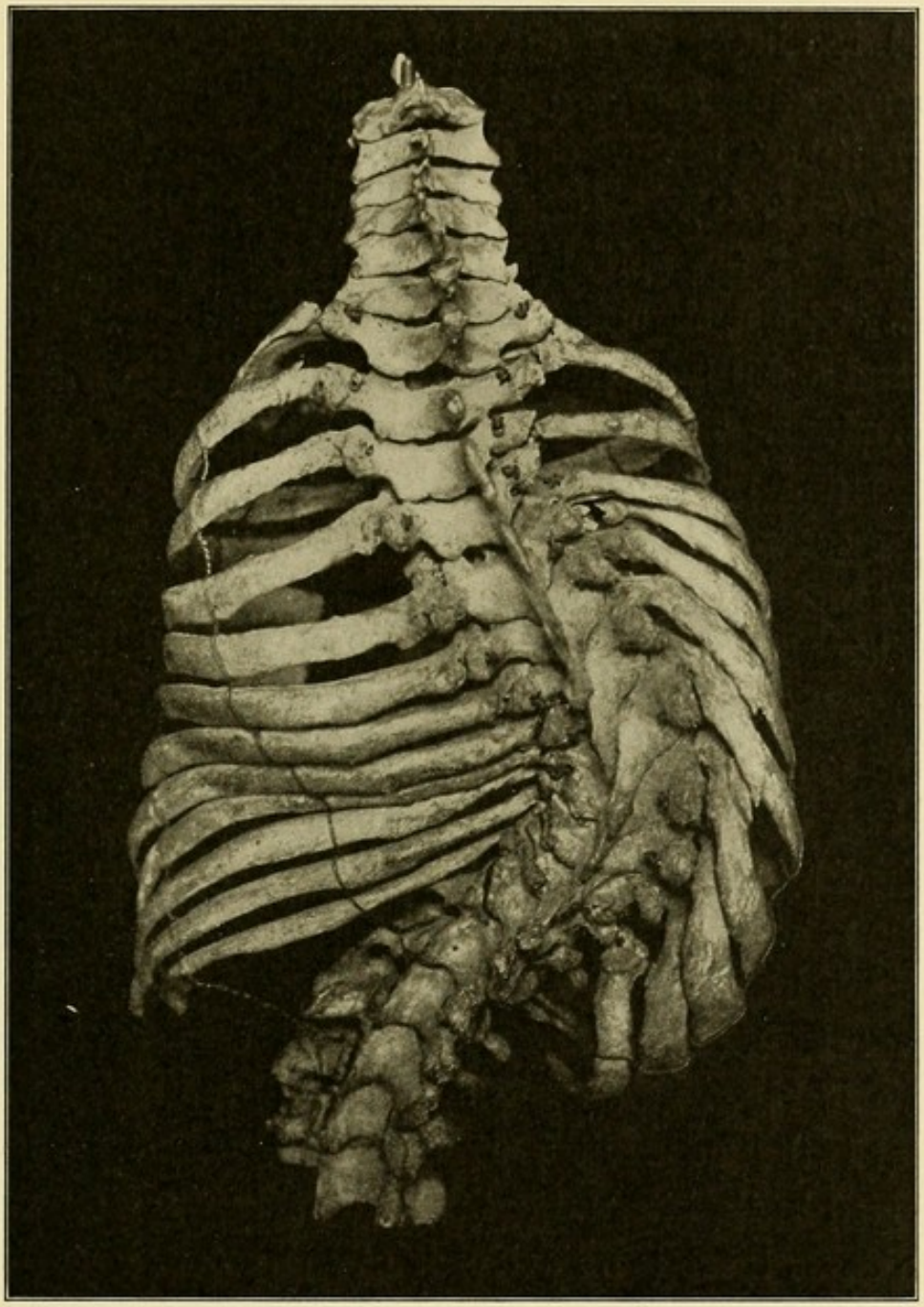


Fig. 61.—Scoliotic Spine; Secondary Changes in Vertebræ and Ribs. (Author's specimen.)

In other words, the deformity is much worse than it appears. The ribs being tied to the sternum, this rota-

tion toward the convexity bends the ribs at their angles, causing bulging on the side of the convexity, and flattens or straightens them on the concave side. This results in a large increase of one diagonal of the thorax and a corresponding decrease of the other. The ribs on the convexity are broadened, those on the concavity are narrowed (Fig. 61). False joints result from the crowding together of the spinal ends of the ribs. The obvious effect of these changes is a decrease in the height, capacity, and mobility of the thorax, and certain characteristic deformities. The lateral tilt and bulging ribs cause elevation and prominence of the scapula (high shoulder) on the convex side of the thorax, and the contrary effect is produced on the concave side. There are corresponding changes in the front of the thorax. Rotation in the lumbar region causes effacement of the waist on the side of the convexity and increased hollowing above the iliac crest on the concave side (high hip); this may be neutralized by the shifting of the body to the side opposite to the rotation.

Each individual vertebral body participating in the curvature is also deformed. If near the center of the curve it becomes wedge-shaped, with the narrow side toward the concavity; it also becomes skewed and changed in its internal architecture. In the simple posture cases there is no evidence of disease. In the forms of scoliosis secondary to bone disease, the changes characteristic of the disease in question may also be found in the vertebræ.

An early diagnosis is of the greatest importance, and should be made by the family doctor. It is only in the

functional cases, still free from rigidity and fixed rotation, that perfect results from treatment may be looked for. Every postural anomaly pointed out by the parents, or noticed by the physician, should be critically examined and conscientiously rectified. It is unfortunately true that most cases are discovered by the mother or dressmaker, after fixed deformity makes a perfect restoration impossible, though much may still be done to ameliorate the condition. A rigid examination of growing children for faults of posture should be made at least once a year by the family physician.

For the EXAMINATION all clothing should be removed from the hips up, and the waist bands loosened and pinned at the level of the trochanters; the shoes should also be removed. The patient so prepared stands with the back to the examiner, who notes the posture of the head, the outlines and levels of the shoulders and hips, the side lines of the trunk, and the line of the spinous processes, which may also be palpated (Fig. 62). The flat hands are placed over the iliac crests to ascertain if they are on the same level, care being taken to have the patient stand with straight legs and equally on both feet. The patient is then instructed to bend forward, allowing the head and arms to hang down. This causes the scapulæ to slide away from the spine, exposing the angles of the ribs, and any posterior projection due to rotation will be apparent (Fig. 64). The lateral mobility of the spine may then be tested, after which the posture may be viewed from the side, and the front of the thorax may be inspected for costal or thoracic asymmetry. The feet should be examined for flatness or

weakness and shortening of the heel cords, and the knees for knock-knees, and if pelvic obliquity is suspected the

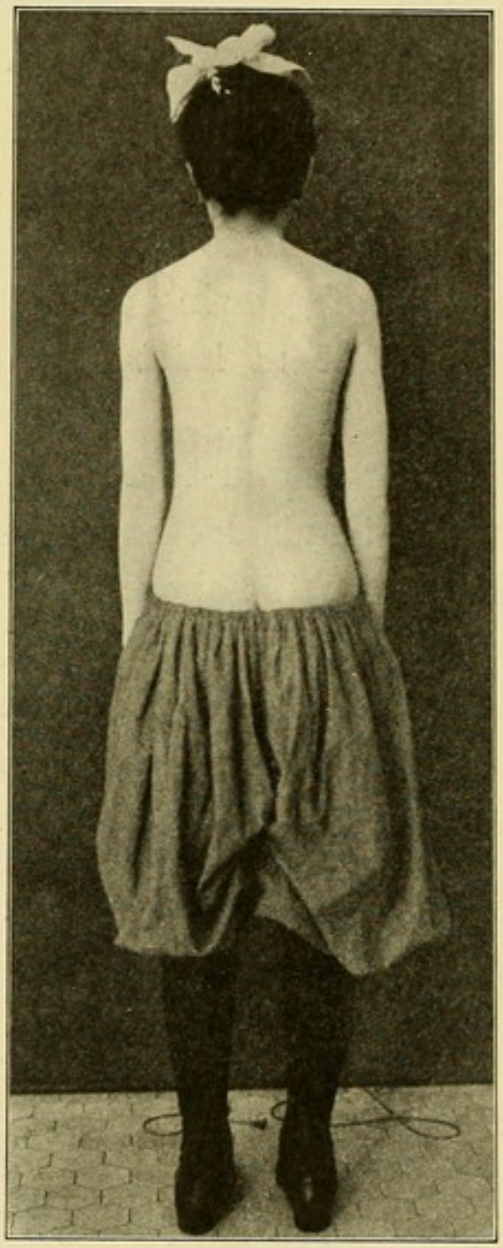


FIG. 62.—RIGHT DORSAL, LEFT LUMBAR SCOLIOSIS; GIRL OF TWELVE.

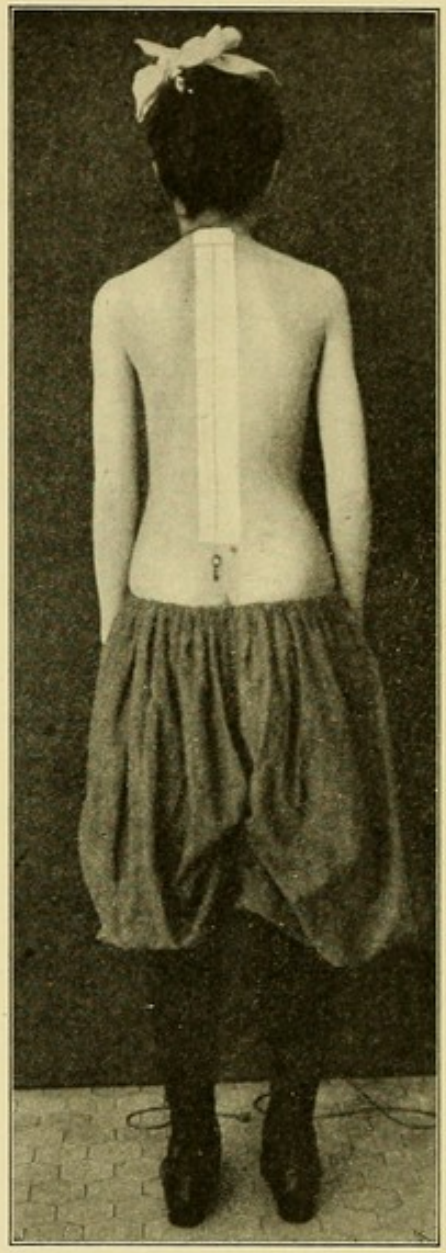


FIG. 63.—SAME, WITH STRIP OF ADHESIVE APPLIED FOR TRACING, AND PLUMB LINE.

length of the legs should be measured in recumbency from the anterior superior spine of the ilium to the tip of the internal malleolus.

For RECORD the weight, height, and chest girths in expiration and inspiration should be taken, and a tracing of the spinous processes marked in pencil on a strip of zinc oxid adhesive plaster two inches wide and eighteen inches long, which has been stuck to the back from the seventh cervical to the sacrum (Fig. 63). The level of the lower angle of each scapula and the true vertical at the gluteal notch should also be marked on the strip, which should be dated and pasted in a book with the history of the patient. To indicate the rotation the transverse contour of the posterior half of the thorax may be taken in the forward stooping position, with a lead tape at the point of greatest deformity (Roth), and traced off into the history book. A photograph of the back to scale is also desirable for purposes of record.

FIG. 64.—SAME, DORSAL ROTATION TO RIGHT UNMASKED BY FORWARD STOOPING.

CLASSIFICATION OF CURVES.—Lateral curvature may be classified according to the number and location of the

curves into simple and compound. The curves are named from the direction of the convexity. The simple or C curves may affect the whole spine, or its upper or lower

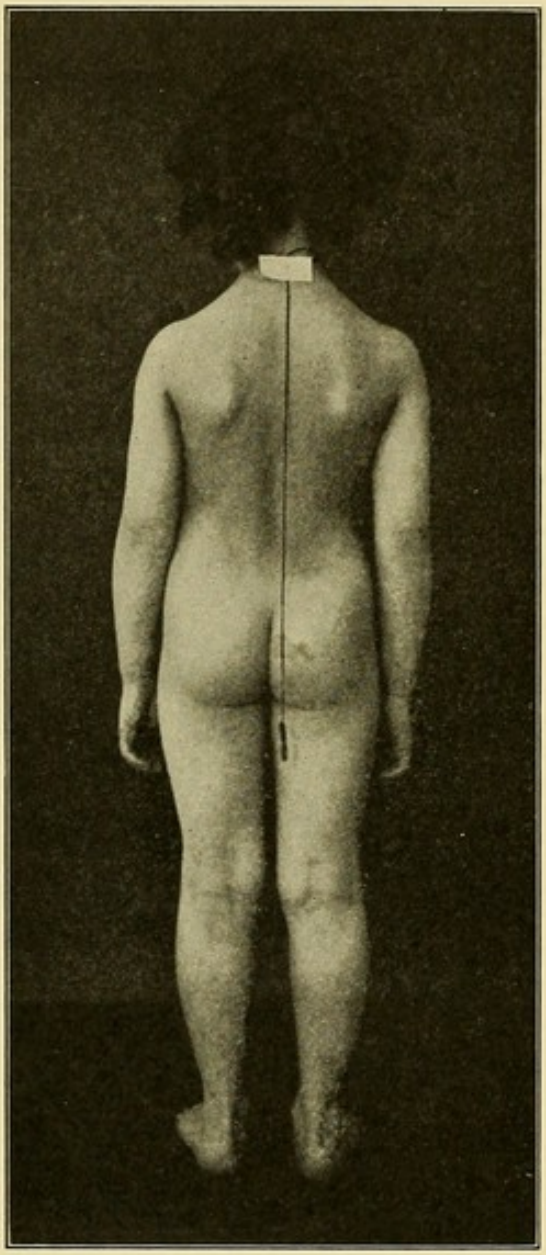


FIG. 65. — LEFT TOTAL SCOLIOSIS; GIRL OF SEVEN.

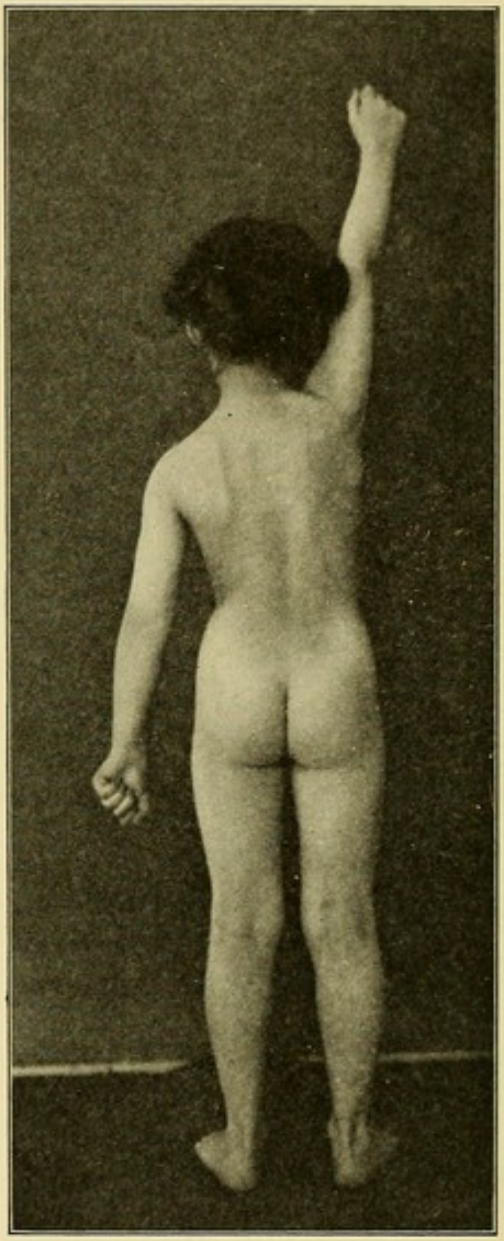


FIG. 66. — SELF-CORRECTION BY RIGHT UPWARD, LEFT DOWNWARD STRETCH.

part only, and the convexity may be turned to the right or to the left. The simple curves to the left are common, to the right much rarer. The left total scoliosis,

or C curve, is the commonest of all forms in schools and gymnasia (Figs. 65 and 66). In this form the left shoulder is high, the right hip prominent, and the trunk may be carried to the left so that the left arm swings free. The angles of the ribs are more prominent on the left side from the rotation, and this fullness is more apparent when the patient bends forward with the arms hanging. In merely functional cases, however, the fullness may be on the right or concave side.

In left lumbar scoliosis the picture is much the same except that the curve only involves the spine below the scapulæ, and in the early stages the shoulders are level. There is bulging in the left lumbar region, flatness in the right. Both the left total and left lumbar scoliosis have a tendency to pass into the right dorsal, left lumbar compound or ≀ curve by the addition of a secondary or compensating curve convex to the right in the dorsal region.

This right dorsal left lumbar ≀ scoliosis may also be formed by a primary right dorsal scoliosis adding a compensating left lumbar curve. These compound right dorsal left lumbar curves are the ones most frequently seen in special practice, and are sometimes of dorsal and sometimes of lumbar origin. When this dorsal curve is primary the rotation and deformity are usually much more disfiguring, as the thorax and shoulders are more distorted (Figs. 67 and 68). In the right dorsal (primary) left lumbar compound scoliosis, of fixed type, the right shoulder is high and prominent, the left shoulder low, the left hip prominent, and the right effaced; the spinous processes form an ≀ curve, of which the dorsal

curve is the larger. There is marked backward projection of the ribs on the right side, more evident in the

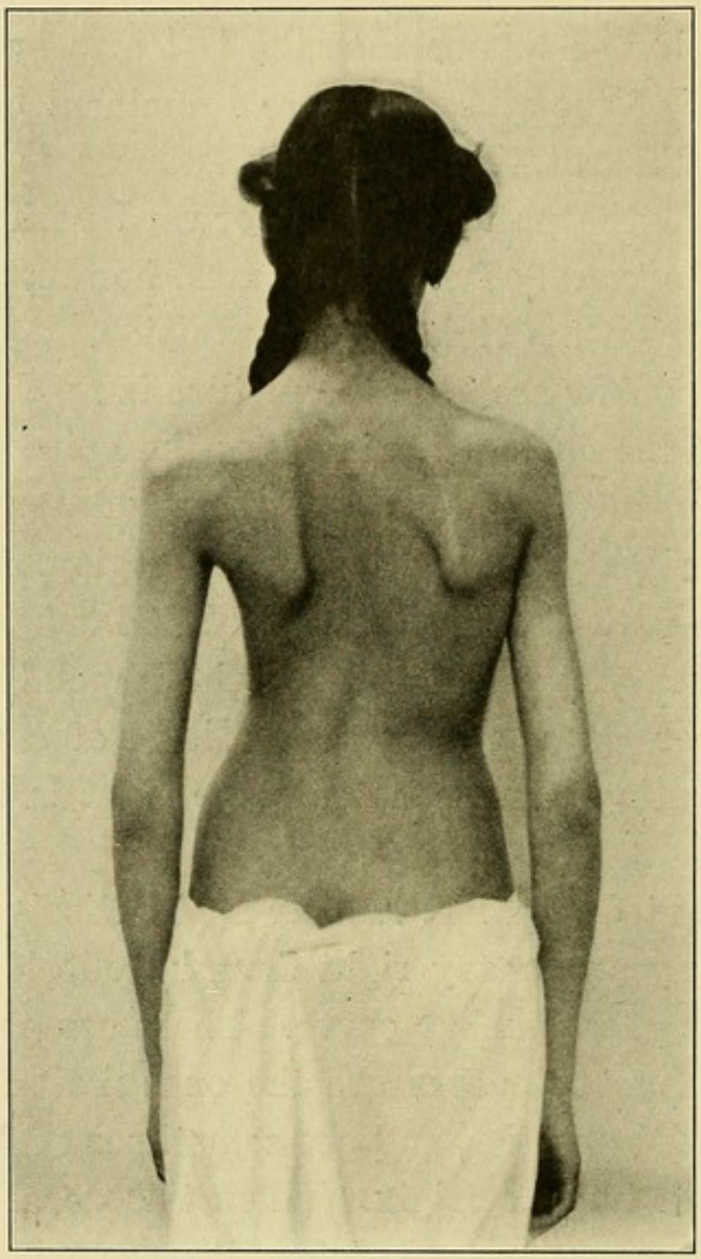


Fig. 67.—Right Dorsal Scoliosis; Girl of Fifteen.

stooping posture, while the ribs under the left scapula are flattened. The left side of the lumbar region is full, but less so than in primary left lumbar curvature. The trunk is shifted to the right. The left breast and left side of the thorax in front are prominent.

When the posterior projection is marked the deformity is called a kypho-scoliosis (Figs. 69 and 70).

In certain cases secondary curves are formed both above and below the primary dorsal curve, giving a { -shaped curve.

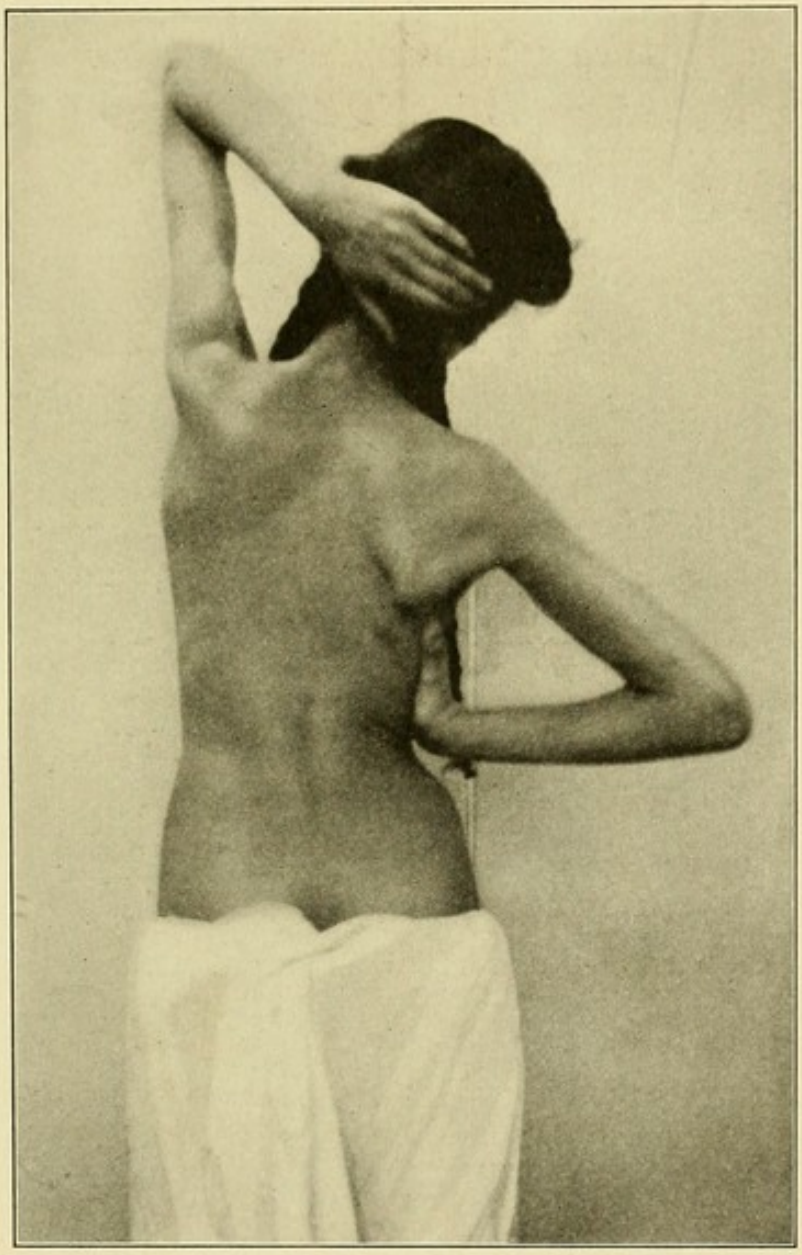


Fig. 68.—Self-Correction by Side Pressure.

The total curves to the right and the left dorsal right lumbar curves are the reverse of those de-

scribed, and of much less frequent occurrence (Figs. 71 and 72).

Besides the curvatures themselves and the accompanying rotation and secondary changes in the thorax

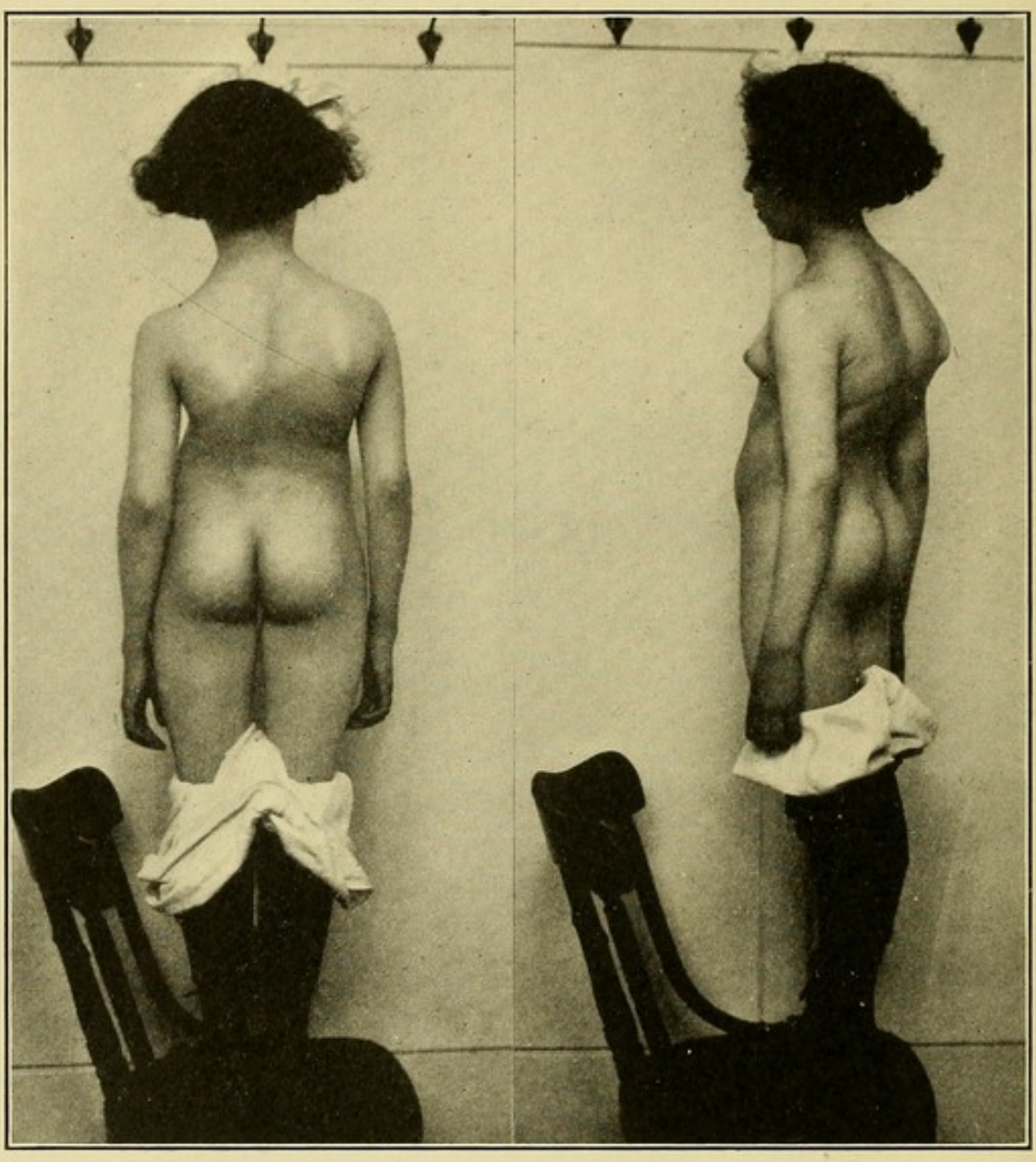


FIG. 69.—KYPHO-SCOLIOSIS TO RIGHT DORSAL.

FIG. 70.—SAME; THREE-QUARTER VIEW.

and ribs, hips, and shoulders, with the peculiarities of posture and limitation of motion imposed by fixed curves, there are few SYMPTOMS. Pain, backache, or tenderness

are unusual, except in neurotics and in the extreme distortions of adolescents and adults, when there may be pain from abnormal contact of bone or from nerve com-

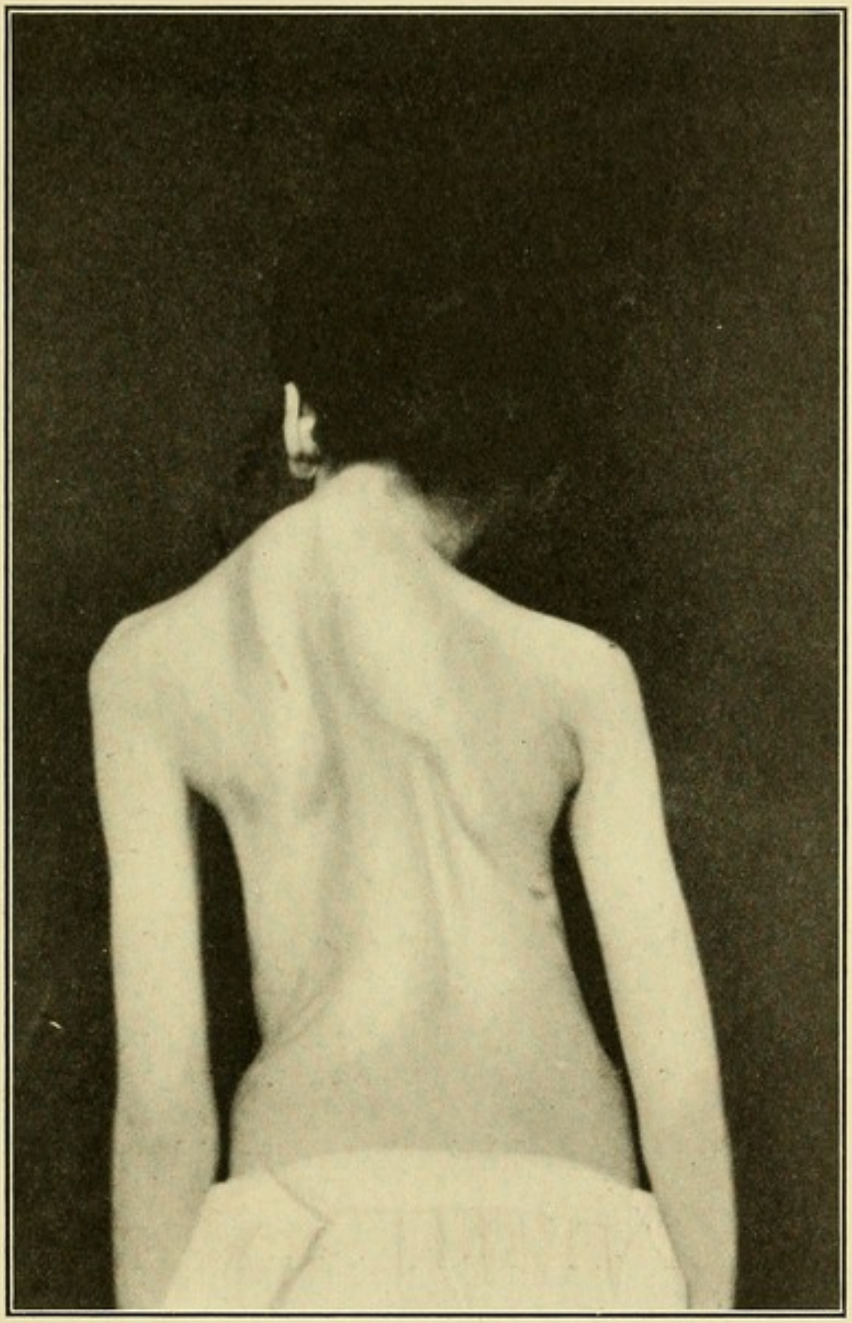


Fig. 71.—Cervico-Dorsal Scoliosis to the Left.

pression. There may be considerable displacement and compression of thoracic and abdominal viscera, but the tendency to pulmonary disease does not seem to be in-

creased, and the harmful effect is shown in severe cases rather in a delicate or dwarfed physique, a careworn facies, and lack of endurance than by local visceral dis-

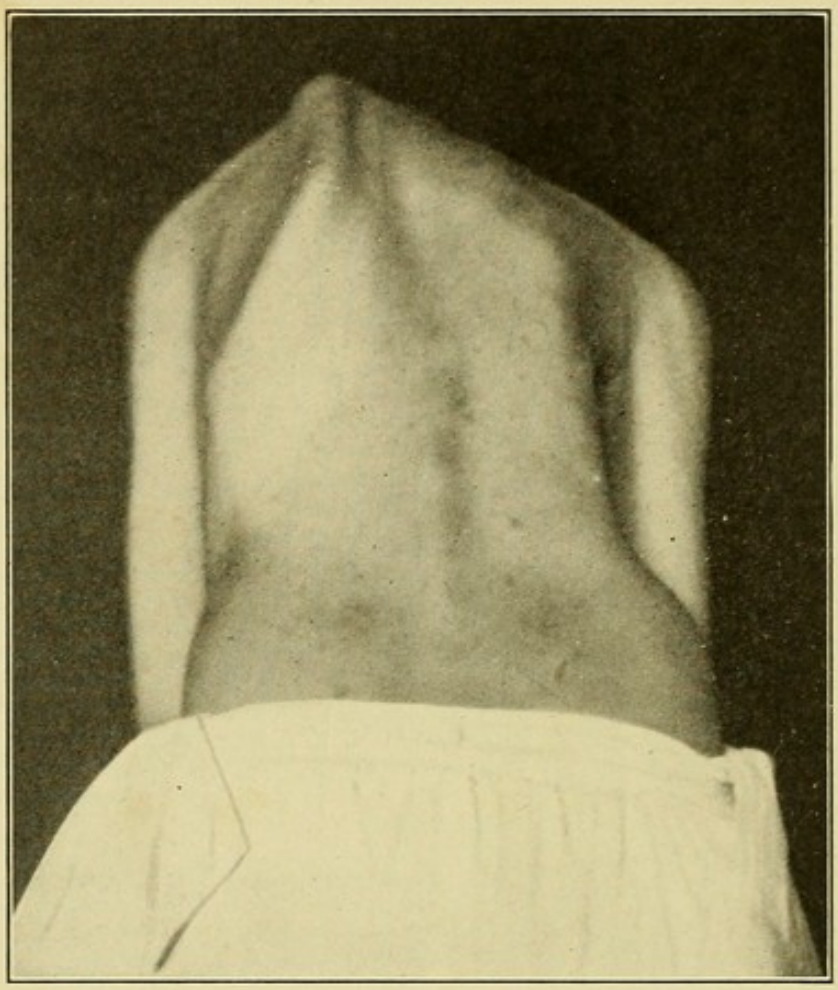


FIG. 72.—KEEL-SHAPED PROJECTION OF LEFT RIBS DUE TO ROTATION UNMASKED BY FORWARD BENDING. Same patient shown in Fig. 71.

turbance. Shortness of breath and rapid pulse are common in severe cases.

The DIAGNOSIS is usually not difficult, except in very early cases. When a lateral bending or inclination is found it is vitally important to determine whether it is uncomplicated or is secondary to some pathological cause, as the treatment is very different. In particular, those cases due to congenital malformation, paralytic

conditions, and bone disease should be strictly differentiated from the uncomplicated or postural cases, and in these one should endeavor to distinguish the functional from the structural. It is specially to be remembered that lateral deviation or shifting at the point of disease is very common in early spondylitis (Fig. 90); also that in some advanced cases of scoliosis the posterior bosse may be so extreme as to resemble the deformity of old Pott's disease when the patient is clothed. Examination, however, will always show that in scoliosis the deformity is due to the projection of the ribs on one side. The subject is still further complicated by the not infrequent occurrence of scoliosis in the late stages of Pott's disease.

The PROGNOSIS of postural lateral curvature is very good under proper management in the early (functional) stage, before bony changes have taken place; and in structural curves of moderate degree the results of treatment are very satisfactory. It must be admitted, however, that neglected and extreme cases present one of the most difficult problems in orthopedic surgery, and that the results of treatment are only palliative. There are few cases, however, where the vigor, strength, and carriage of the patient cannot be improved by persistent treatment. Light cases with little or no tendency to increase, of which there are many, may easily be made too much of; such cases are in no way serious. On the other hand, many cases are made too little of, and neglected until a hideous deformity is fastened on the patient for life. One cannot always distinguish the curvatures that are likely to increase from those that will probably

remain stationary; therefore, all should be kept under observation. It is to be remembered that the curves beginning in the dorsal region, and showing a great deal of rib deformity and posterior curvature, are usually serious. Also that once the frame is consolidated, after the early twenties, progress of the deformity is not to be feared, except in unusually bad cases, after exhausting diseases, during and after pregnancy, and in old age.

The TREATMENT OF FUNCTIONAL SCOLIOSIS consists in invigoration and postural education, to the end that the patient may acquire the sense of correct posture and that he may have the desire and the strength to assume correct postures habitually. In the case of adolescent girls, the appeal to a proper pride is seldom without effect. The regulation of activities and the elimination of detrimental elements is much the same as in round back. Of importance is the matter of seats and desks, and of reading, writing, and other sitting postures; the mode of clothing support; the condition of the eyes, ears, and throat; the question of standing postures and pelvic obliquity; and the matter of overwork and persistent fatigue. It will often be wise to sketch a daily programme, with stated times for work, play, and rest. It may be necessary to lighten or suspend school work, abolish piano and violin practice, and enforce regular hours. A half hour to an hour of rest in recumbency early in the afternoon will often be very beneficial, and ten hours' sleep should be insisted on. Open-air sports, if not one-sided, are beneficial; swimming (breast stroke) is the best, cross-saddle riding in good posture, running, and climbing are good; voice culture is excellent. Tennis,

golf, and side-saddle riding are often objectionable. In connection with posture training special gymnastics, consisting mainly of trunk movements, both standing and recumbent, balance movements, stretching movements, suspension movements, deep breathing, and a certain number of corrective exercises, should be given, preferably by an expert, two or three times a week for several months; and at the same time, and afterwards, certain exercises should be practiced at home. It is necessary that the whole body, and especially weak parts, like the feet, waist, chest, and neck, be harmoniously and adequately developed. The use of the vibrator after each session is refreshing, and stimulating to the spinal muscles. The work should progress from easy to difficult, but should be kept simple. The majority of the exercises will be symmetrical or alternating, according to the best modern practice. The exercises should be done slowly and exactly, with a pause at the final pose, and each exercise repeated six to twelve times. In simple and lumbar curves it is often useful to sleep on the side of the high hip.

Jackets or artificial supports will not usually be required for the purely functional cases, but numbers of the moderately resistant cases will be much improved by the application of a light supporting corset. The form lately used by the writer, and giving much satisfaction, is a corset-brace, made of strong coutil and in appearance much like a woman's long corset; this is carefully fitted to the patient from the axillæ to the trochanters, and reenforced by three pairs of light steel bars shaped to produce the pressure desired behind and at the sides; the

corset is provided with broad shoulder straps, starting under the axillæ, passing over the shoulders, crossing behind the scapulæ, and buckled low down in front (Fig. 73).

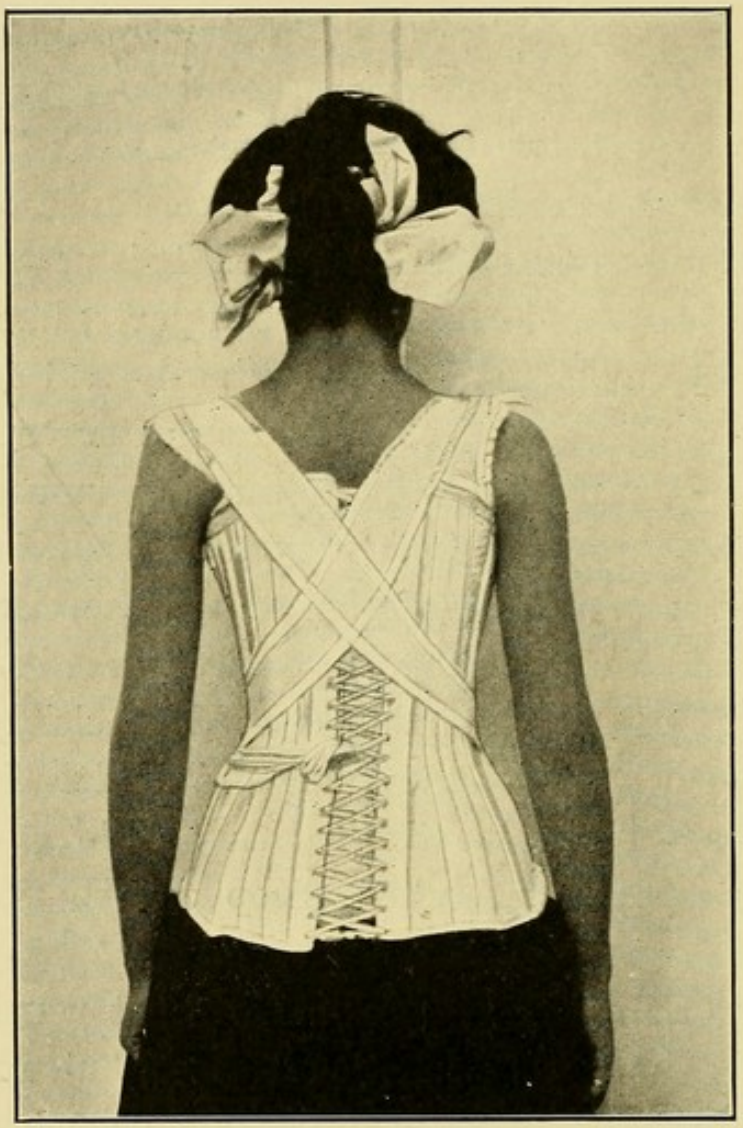


Fig. 73.—The Van Winkle Corset-Brace Adjusted in a Marked Case of Scoliosis, Low Dorsal to Right, Lumbar to Left.

Structural scoliosis will require much the same treatment in the lighter grades, but with more emphasis on corrective work; in the severe forms, the stretching of retracted tissues, mobilization of stiffened parts, and mechanical retention of correction gained may be impor-

tant. These objects are accomplished by gymnastics, with and without apparatus, stretching, forcible correction, and spinal supports.

The stretching may be done by lateral suspension, and by pressure boards or frames. Suspension from the hands with side pressure, as in the stretcher (C. F. Taylor) is one of the simplest and most effective means (Fig. 74). Stretching over the padded bar or end of couch is similar in effect. Side pressure in the horizontal kneeling posture, as in Lovett's pressure board, is also excellent (Fig. 75). Mobilization may also be effected by heavy dumb-bell and bar work (Teschner), and by the various special corrective postures and exercises.

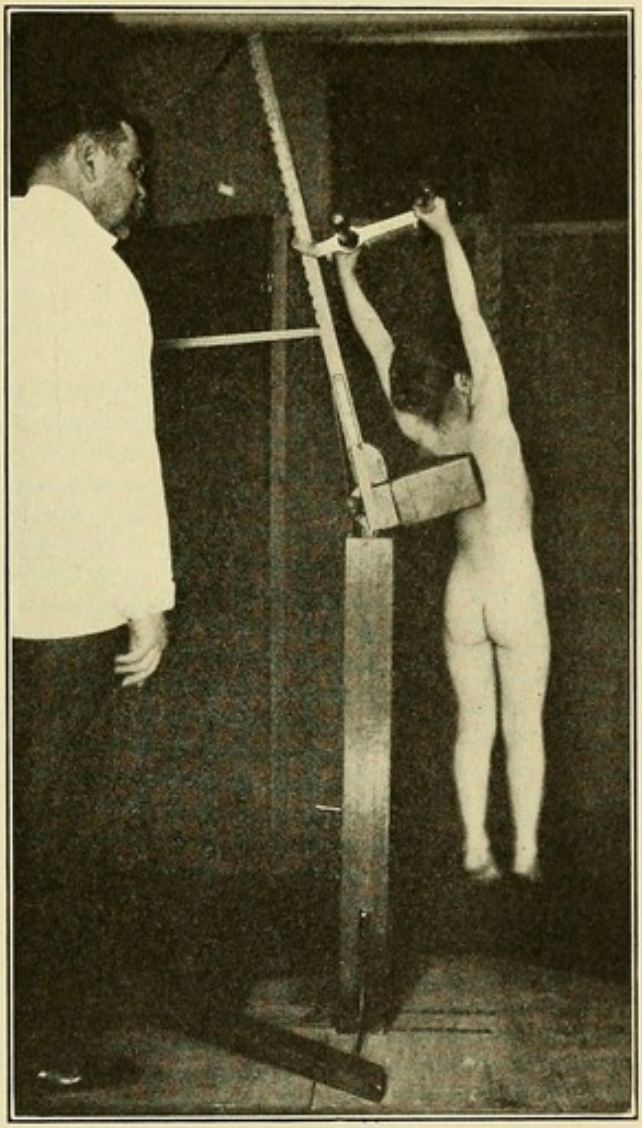


Fig. 74.—C. F. Taylor's Lateral Suspension Apparatus for the Correction of Scoliosis.

Coincidently with mobilization and correction the muscles are trained and strengthened to hold the spine in the improved posture. Many of these cases will require

corrective corsets or jackets, which may be applied directly to the patient or made over a corrected cast. A good method, when the plaster corset is directly applied,

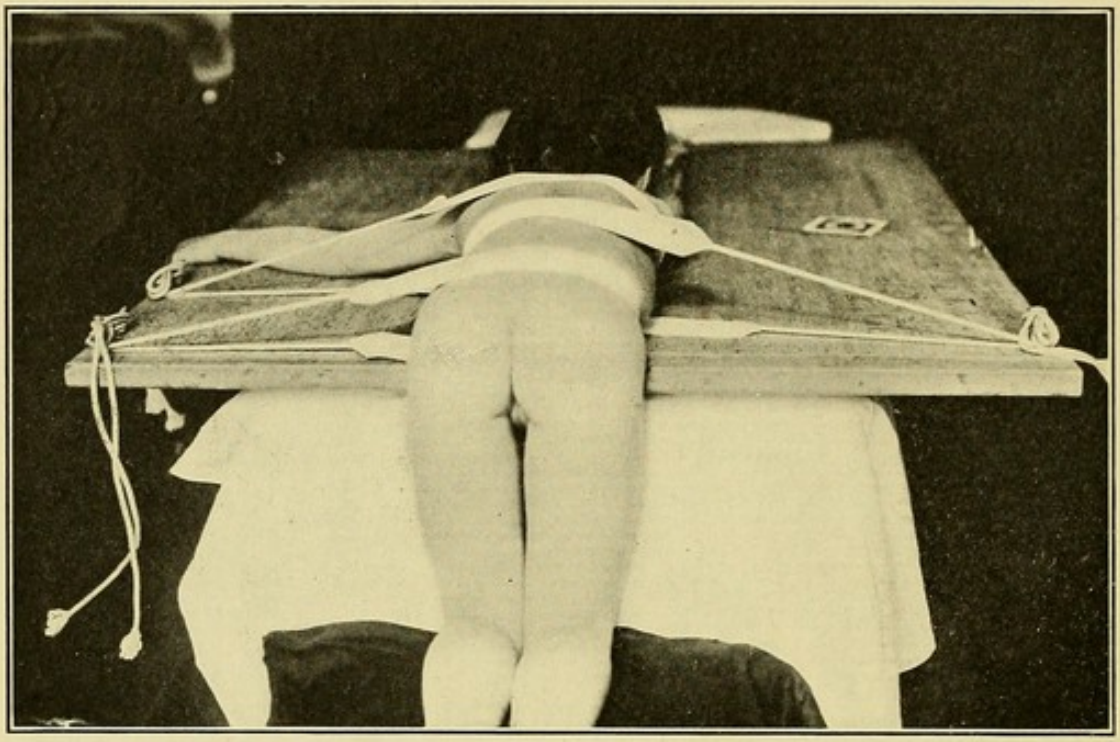


FIG. 75.—LOVETT'S STRETCHING-BOARD WITH SURCINGLES.

is to fill out the hollow side with cotton, which is removed after the corset is finished, to allow room for expansion, and to increase the pressure over the convexity of the curve by attaching felt pads to the inside of corresponding parts of the corset (Fig. 76). The same result can be accomplished by corrections to the plaster torso taken from the jacket as a negative. A plaster, paper, leather, or aluminium corset may be made over this corrected torso. Most braces bought in the shops are worthless, and many are injurious. When corsets are used, they are intended to keep the gain made by the exercises and manipulations. They should be renewed or corrected every few weeks or months, and the exercises

should be continually practiced. The use of braces and corsets without gymnastics is usually injurious, and the use of gymnastics alone in severe cases is usually fruitless. The application of great force, followed by reten-

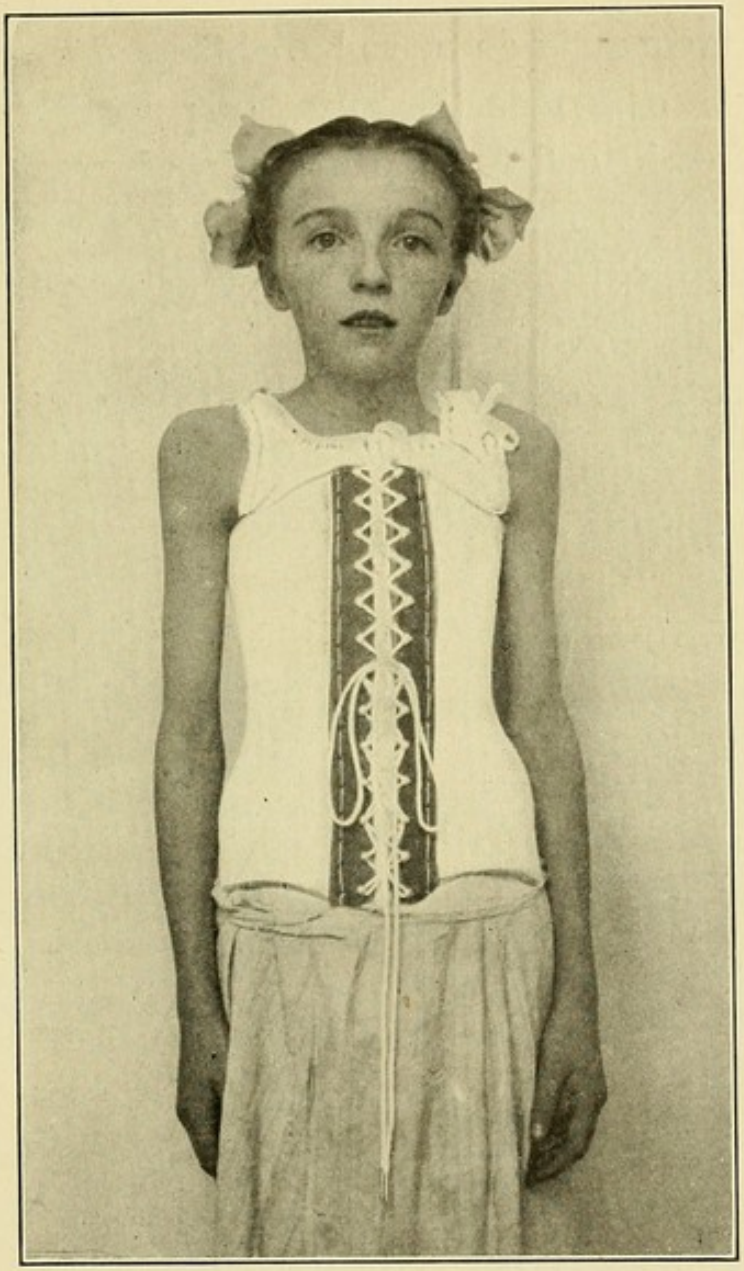


Fig. 76.—Plaster-of-Paris Corset.

tive jackets, is not free from danger, and is of questionable value except in rare instances in the hands of experts.

The treatment of structural cases must be undertaken seriously and systematically, and kept up for a long period in order to give results. It is not infrequently necessary to remove the child from school for a time. Serious gymnastic work, in addition to school duties, will frequently do more harm than good. The kind and amount of gymnastics and the regulation of the patient's life will call for the exercise of great judgment and good sense. Even in bad cases, however, the general health may nearly always be built up, strength and vigor increased, the posture improved, and the deformity kept from increasing. In extreme cases the curvature may be obscured by compensation above and below, and the carriage may be improved by training the patient to maintain his best postures.

II. The curvatures due to the **pelvic obliquity** caused by a short leg are rarely serious. Even in the excessive deformities due to coxitis, unilateral congenital dislocation, and other conditions characterized by a short leg, fixed curves with rotation are rare. Shortening of a quarter to half an inch without assignable cause is not very rare, and frequently passes unnoticed by the patient. It very rarely causes any permanent deformity of the spine. If the patient is a child, the difference should be equalized by adding a cork sole to the shoe of the short leg; if an adult, differences of a fraction of an inch are usually perfectly harmless.

III. Scoliosis due to **contraction of the pleural cavity** following empyema may be of severe grade. If, however, the lung regains its expansion, as sometimes happens, the spinal deformity largely disappears. The treatment

in recent cases should be directed to expanding the collapsed lung by deep-breathing exercises, which may be made unilateral. It is important that adhesions between the parietal and pulmonary pleura should be thoroughly separated in order to allow the lung to expand at the

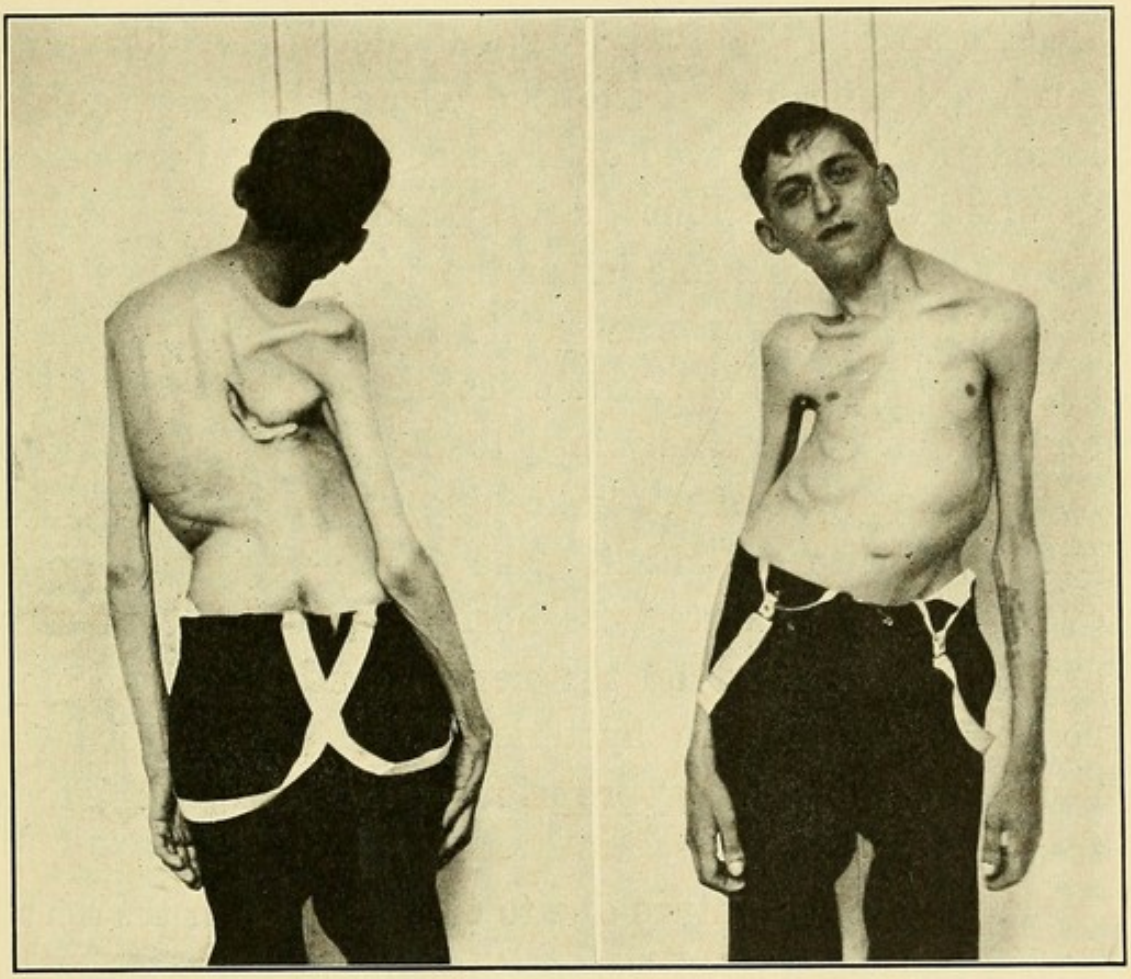


Fig. 77. Fig. 78.

Figs. 77–78.—Collapse of Right Lung and Secondary Scoliosis Following Empyema at the Age of Five. Portions of two ribs were excised: the opening never closed and after eighteen years is still discharging. Patient is now twenty-three.

time the chest is evacuated (Lloyd). In the old and resistant cases the usual treatment for rigid scoliosis may mitigate, but cannot correct, the condition (Figs. 77 and 78).

IV. Scoliosis is a rather frequent sequela of **acute poliomyelitis.** It does not develop from a short or weakened leg, but only from asymmetrical paralysis of one or more of the back or abdominal muscles (Fig. 31). When this condition exists the deformity may be aggravated by a short or deformed leg. Scoliosis and spinal weakness make the treatment of the locomotor disability much more difficult. It is of the greatest importance that locomotion be improved or restored by the correction of deformities of the limbs, and by the use of supporting splints, and a cork sole under the short leg. When scoliosis or spinal weakness exists to a disabling degree, spinal supports in the form of corsets, or, better, a steel and leather apparatus joined to the pelvic band of the leg brace, may be of use in keeping the patient erect and helping him to get about. The spinal deformity, however, usually persists. Scoliosis may complicate several other diseases of the nerves, and it should not be forgotten that an hysterical form exists which is usually curable by appropriate tonic and suggestive treatment.

V. Lateral curvature due to **disease in or near the spinal column** is best treated by treating the primary disease, be it tuberculosis of the spine (Fig. 90), sacro-iliac disease, or some other affection. When due to general involvement of the spine in a slow asymmetrical ankylosing process in adults, as in osteoarthritis, ostitis deformans, and the like, spinal support by means of jackets and corsets may be of great value, not only giving the patient great relief, but favoring the termination of the process.

Strengthening, Postural, and Corrective Exercises Useful in Most Forms of Scoliosis

Posture.—The chest being held high, the chin and abdomen somewhat retracted, and the feet pointing forward (Fig. 42), the correct forward inclination, and poise on the balls of the feet may be acquired by (1) swinging the straight arms strongly and briskly forward and backward; (2) walking backward and stopping suddenly.

Spinal **correction** is obtained by tilting and turning the head and shoulder girdle, which control the upper spine; by tilting and turning the pelvis, which controls the lower spine; by side pressure, and by other corrective movements, all of which are more effective in horizontal posture and in suspension, since gravity is then eliminated or made to assist in the correction.

In vertical free exercises the effect may often be intensified by fixing the pelvis, which is done to a certain extent in sitting. Trunk rotation causes a dorsal curve in the opposite direction, and is raised in trunk flexion, lowered in trunk extension. In hyperextension the dorsal spine is locked for side flexion (Lovett).

Corrective and asymmetrical postures and exercises are very far-reaching in their effects, and not easily localized and controlled; moreover, the effect on the scoliotic spine cannot always be predicted from the effect on the normal spine. It is therefore wise to rely mainly on symmetrical, nearly symmetrical, and alternating exercises for the basis of the work, adding only such asymmetrical movements from time to time as prove to be really corrective. Symmetrical exercises, properly se-

lected and executed, have not only a strengthening but also a corrective effect, since their general tendency is to bring the spine toward the median line. Persons with only a superficial knowledge of scoliosis and of remedial exercises are quite as apt to do harm as good by attempting corrective work. The patient should be drilled with the back bare, in order to observe the effect of the different exercises. This is easily done by removing the clothing down to the hips, and covering the front of the chest, if desired, by a small apron or shield tied around the neck.

Breathing exercises, balance movements, trunk flexions, horizontal exercises, and exercises in suspension, graduated according to the strength of the patient and to the effect observed, may be used for general development, control, invigoration, and mobilization, as in the treatment of round back. The horizontal exercises prescribed for round back (Numbers 1 to 5, page 127) make a good series to begin on and for home practice (on the floor). Several may be made corrective by slight modification. For instance, with a curve to the left, if in prone leg lifting the left leg is slightly abducted and lifted high, the lower spine will bend to the right. Also in trunk extension with hands clasped behind, if the hands are carried to the side of the concavity, the movement will be corrective. The term corrective should be understood in the sense of momentary improvement in posture; if the exercises do not result in a better habitual posture, either aided or unaided, the correction amounts only to a mobilization.

In the following prescriptions of corrective exercises

each exercise is first named; next the posture is given; lastly the movement is described. It is understood that each movement is to be executed slowly, exactly, and with force, holding the final pose a moment; the exercise is completed by a return to the original posture, and is to be repeated several times. I am specially indebted to the descriptions and movements in Lovett's excellent brochure on lateral curvature.

CORRECTIVE EXERCISES FOR LEFT LUMBAR CURVES

Standing.

1. Up-and-down stretch. Elbows bent, hands in front of shoulders, trunk inclined forward from hip-joints; stretch right arm up, left down (Fig. 66).

2. Hip sinking (Hoffa). Hands on hips (or behind neck), right foot placed forward and outward two foot lengths; with forward inclination of the body, rock forward and back by bending the right knee (Fig. 79).

3. Hip sinking from stool. Hands on hips; stand on left leg on stool, sink right leg.

4. Half circle to side. Arms stretched upward; swing arms and body forward and to the left and upward with a circular motion, while the body and feet turn to the left.

Prone lying.

5. Left leg raising. Hands under chin; raise left leg in slight abduction, as much as possible (Fig. 49).

Hanging from trapeze.

6. Feet pressed together; carry both feet to the left.

In right lumbar curves the direction of the movements is reversed.

CORRECTIVE EXERCISES FOR LEFT TOTAL CURVES

1. Up-and-down stretch (Fig. 66).
2. Hip sinking (Hoffa), with left hand pressing against side and right hand clasping head.

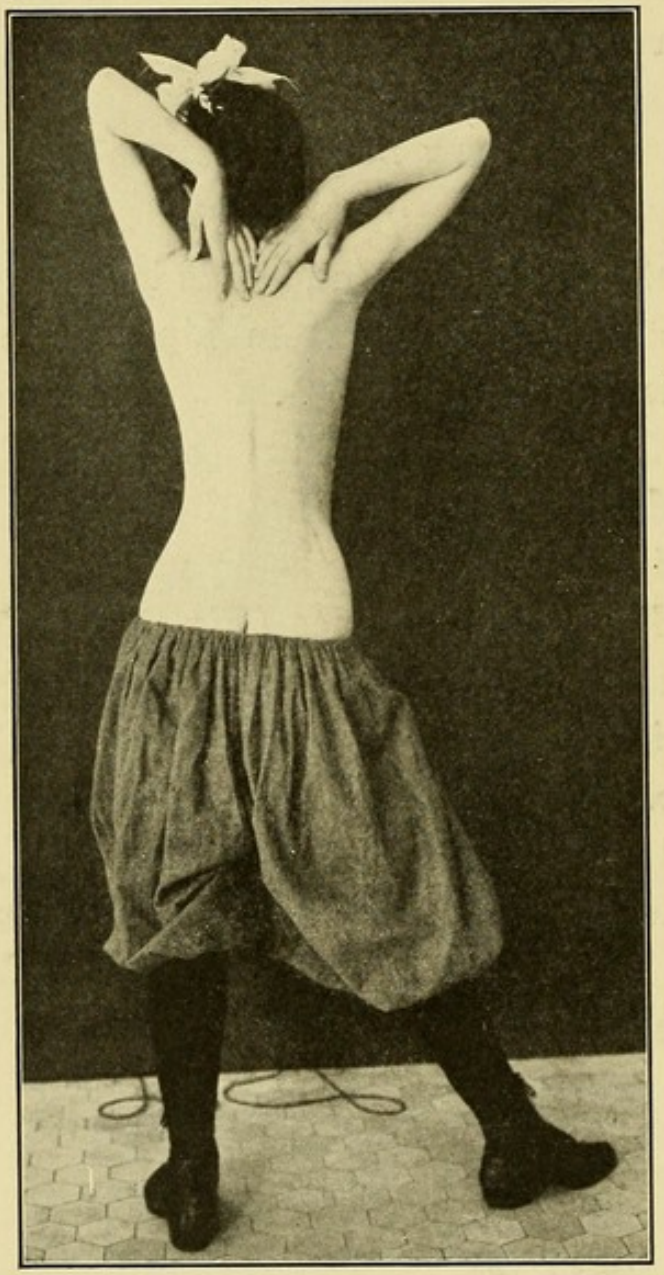


FIG. 79.—SELF-CORRECTION FOR RIGHT DORSAL LEFT LUMBAR CURVE. Left shoulder is elevated, right hip depressed.

6. With right side of trapeze raised, push feet to left.
7. Partial suspension by one arm with opposite arm and leg locked. Standing on right leg and holding bar with right hand extended above head, with left thigh flexed and left arm passed under left knee, flex right knee.
8. Side pressure with side bending (Lorenz). Sitting or standing, the left hand presses against the side, while the right hand clasps the

head; press left hand against side as trunk bends to left (Figs. 80 and 81).

9. Creeping (Klapp), hands, knees, and toes padded.

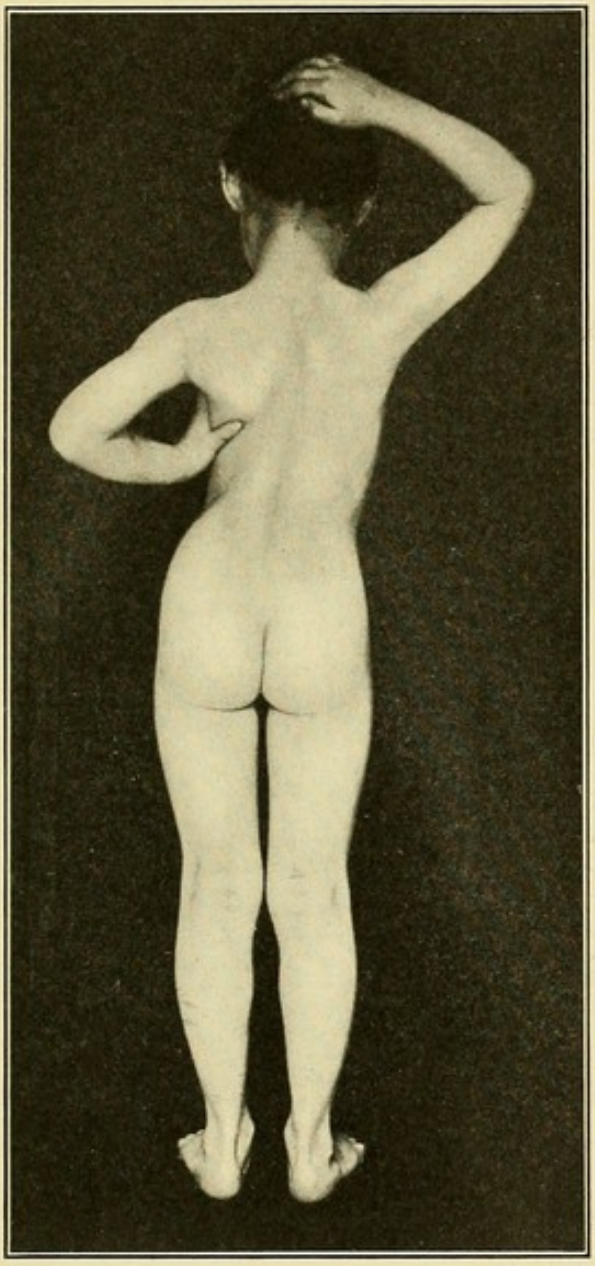


FIG. 80.—SIDE PRESSURE.

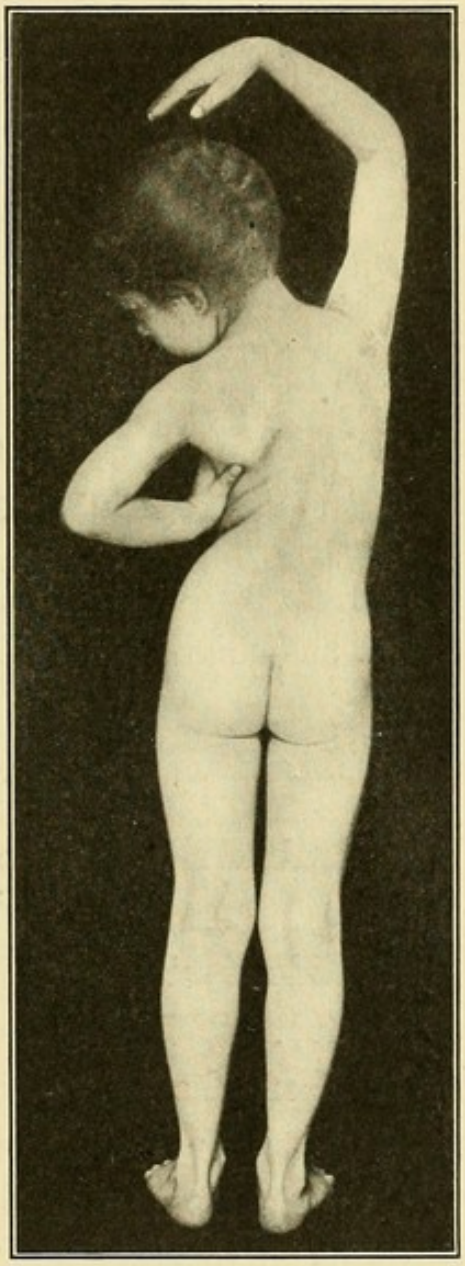


FIG. 81.—SIDE PRESSURE WITH SIDE BENDING; THE HAND SHOULD GRASP THE HEAD.

(*a*) Left hand and knee approximated, right hand and foot stretched far apart; creep, with emphasis on this posture.

(*b*) Creep sideways to right in above posture; face looks to left (Fig. 82).

Reverse these exercises for right total curves.

Fig. 82.—Klapp's Creeping Posture for Left Total Scoliosis.

Corrective Exercises for Right Dorsal Curves

4. Half circle to side. Half circle to right. (See No. 4, page 167.)

8. Side flexion with side pressure (Lorenz) to right (Fig. 68).

10. Left chest expansion. Right hand presses against right side, high up; raise left arm, droop hand over head with inspiration, while head bends and turns to right and right hand presses hard against chest.

11. Side flexion with hands clasped behind (Mikulicz). Hands clasped behind, elbows straight; bend forward, energize arms, bring scapulæ back, and half turn trunk to right. Particularly indicated when a rib kyphos is combined with the dorsal scoliosis (Lovett).

Sitting.

12. Trunk twisting. Hands behind neck; twist trunk to right with elevation of left shoulder. With forward bending the effect will be higher; with backward bending, lower.

Trapeze.

13. Feet on ground; bend and stretch to right.

Creeping.

9. (*a*) Right hand and knee approximated, left hand and foot stretched far apart; creep sideways to left, head to right.

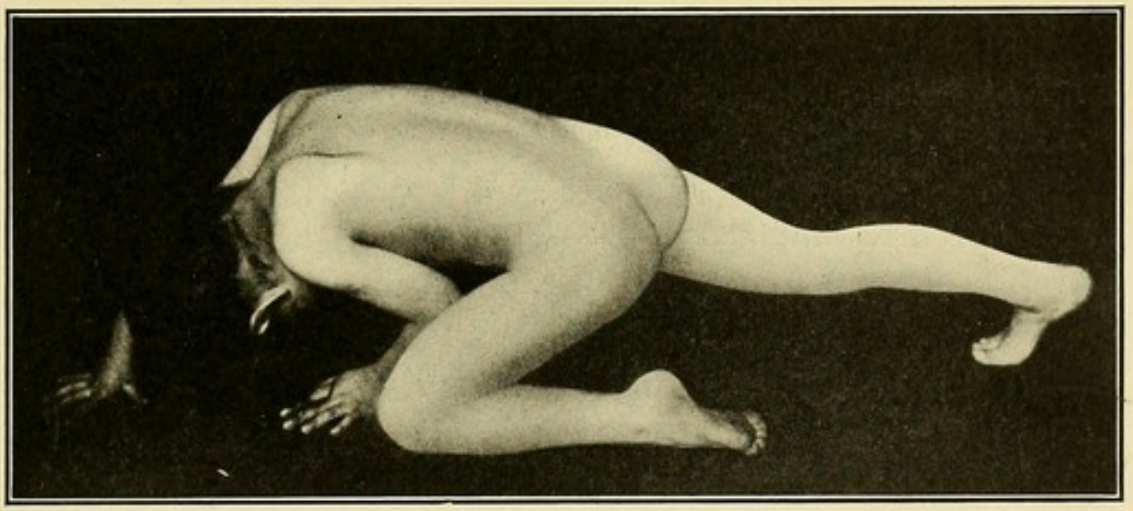


FIG. 83.—KLAPP'S CREEPING POSTURE FOR LEFT DORSAL CURVE.

(*b*) In same posture, rotate trunk till left arm is above head; straighten left leg and back upward beneath left arm.

Reverse the exercises in left dorsal curves (Fig. 83).

Cervical curves to left.

14. Neck side bending. Bend and turn neck to the left.

15. Passive neck tilting. Grasping top of head with left hand, pull it over to the left.

16. Inclined head nodding. Head tilted to left, flex and extend neck.

If one shoulder is high, this should be depressed during the neck movement.

Simple curves are much easier to control than compound ones; in the latter the exercises that correct one curve often increase the other. In simple curves, approximating the hip and shoulder of the convex side, which inclines the shoulders and pelvis in opposite directions, effects an improvement in posture. In S-curves the shoulders and pelvis must both be inclined to the side of the dorsal convexity, or the double correction may be effected by side pressure or by suspension.

CORRECTIVE EXERCISES FOR RIGHT DORSAL LEFT LUMBAR CURVES

Standing.

17. Trunk bending to sides with hand pressure (Mikulicz). Right hand presses against right side under shoulder-blade, left hand presses against left lumbar region; bend trunk slowly to right, then to left. Can also be done sitting.

18. Self-correction with hip sinking (2 and 8). Left hand clasps top of head, right hand presses against right side, right foot two foot lengths forward and outward; sink right hip by bending and straightening right knee, and at the same time press right hand against side.

19. Lunge. Stand with face, left foot, hand, and shoulder facing the left, right foot pointing forward;

advance left foot one yard to left with knee bent, and thrust hand forward and upward, left hand downward and backward (Fig. 84). The lunge may also be done

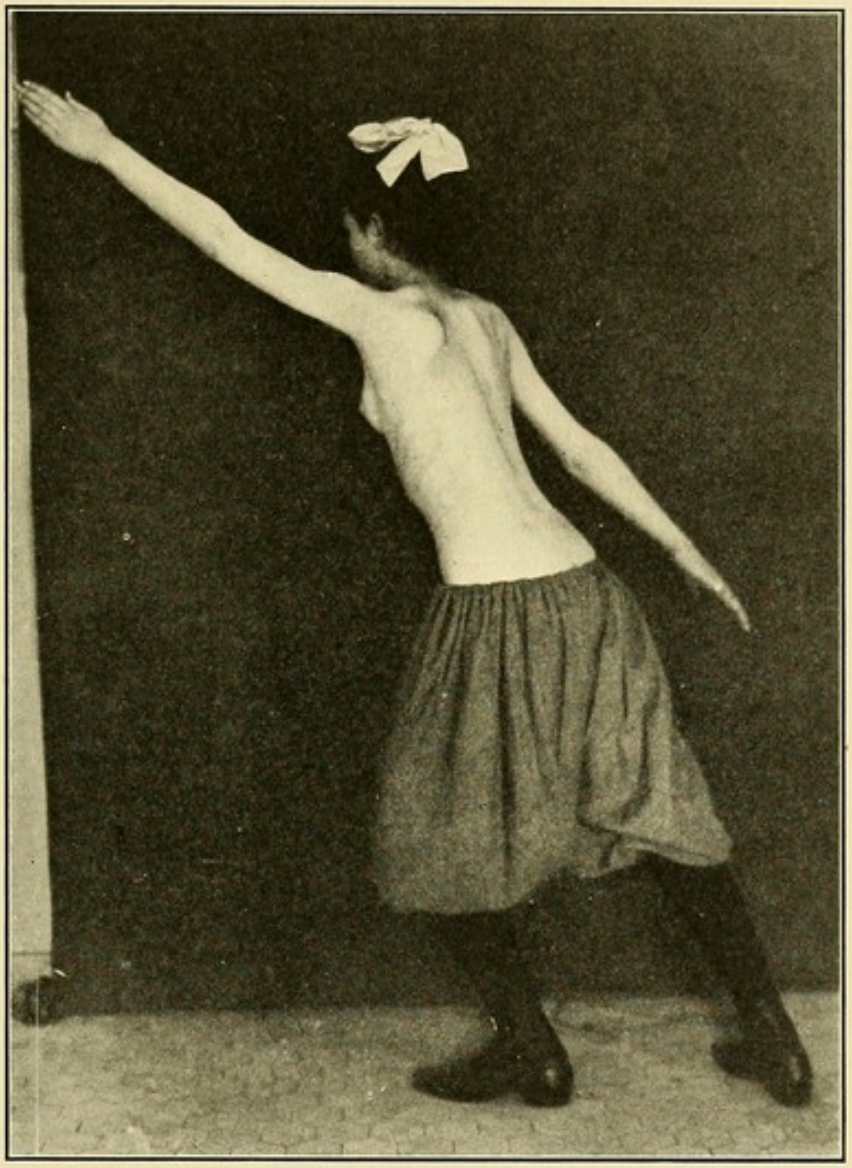


Fig. 84.—Lunge Posture for ? Curve.

with the left hand clasping top of head, and right hand pressing against the right side.

The lunge and modified lunge may also be taken sitting on the edge of a stool.

20. Suspension by hands from trapeze. Feet to-

gether; elevate left side of trapeze, if left shoulder is low; place feet together and push feet to left.

Prone kneeling

With side pressure in pressure board or pressure frame.

In left dorsal right lumbar curves the exercises are reversed.

Diseases of the Spinal Column

Several inflammatory affections of the spinal column cause local softening, necrosis, or ankylosis, and lead to the formation of a bosse, gibbus, or hump by the sinking and falling forward of that portion of the trunk above the point of disease. If the local destruction progresses more rapidly on one side, a lateral deformity may occur.

The most important destructive disease of the spinal column, and one of the most important orthopedic affections, is **spondylitis tuberculosa, or Pott's disease** of the spine, the common cause of humpback. In New York it forms about two fifths of all tuberculous joint affections.

Occurrence.—The disease may occur at any age, but is commonest in early childhood; more than half the cases occur under six. The age of greatest susceptibility is the third year; it is very rare under six months. It occurs oftenest in the dorsal region, and next in the lumbar; the liability of the cervical region is considerably less. Its distribution in the spine seems to agree with the exposure of the part to trauma. There is often a history of phthisis, alcoholism, or chronic ill health in the parents, and occasionally a history of phthisis in the

same apartment, not necessarily in a member of the family. There is often a history of a fall or moderate injury, which may serve to excite or to localize the process when the proper internal conditions exist. The disease frequently begins after measles, whooping-cough, scarlet fever, and other acute infectious diseases. The whole system is profoundly affected, the rate of growth is lessened, and in extreme cases the body is poorly nourished and dwarfed. There is not much tendency toward serious general or visceral affections, though this occurs in a small percentage of the cases, usually in the form of general tuberculosis or tuberculous meningitis. Pulmonary involvement is rather rare in children, more common in adults. Occasionally several joints are affected, when the possibility of syphilis should always be considered.

Pathology.—This disease is now known to be a bone tuberculosis, starting in the cancellous tissue of the body of a vertebra, and spreading by extension of the tuberculous granulation and gravitation of necrotic products to the intervertebral discs, to the bodies of the adjacent vertebræ, and to the surrounding parts. The vertebral arches and articular processes usually escape. The disease is a local destructive process of low grade and long duration, with a strong tendency to recovery by expulsion, absorption, or encapsulation of the morbid products, and the cicatrization or ossification of the damaged part. The disease is thought to be secondary to a thoracic or abdominal tuberculous adenitis in most cases.

The tuberculous granuloma is of low vitality, and as it becomes larger by encroaching upon resorbed neigh-

boring tissues it often breaks down at the center with the formation of a cheesy mass or of sequestra. If the disease is not arrested the bodies of one or more vertebræ are often entirely destroyed. If the process is more rapid on one side, a lateral inclination may result in addition to the posterior projection, and frequently a fluid (serum, ichor) containing flocculi and necrotic débris, but not true pus, may collect near the focus and find its way along the muscular or fascial planes toward the surface. Such cold or gravitation abscesses (ichor pockets) usually cause but little disturbance unless they become infected. They may point in the lumbar region, or, following along the psoas muscle, may cause its contraction and appear in the thigh below Poupart's ligament (Fig. 85). Tuberculous granulations or fluid may ex-

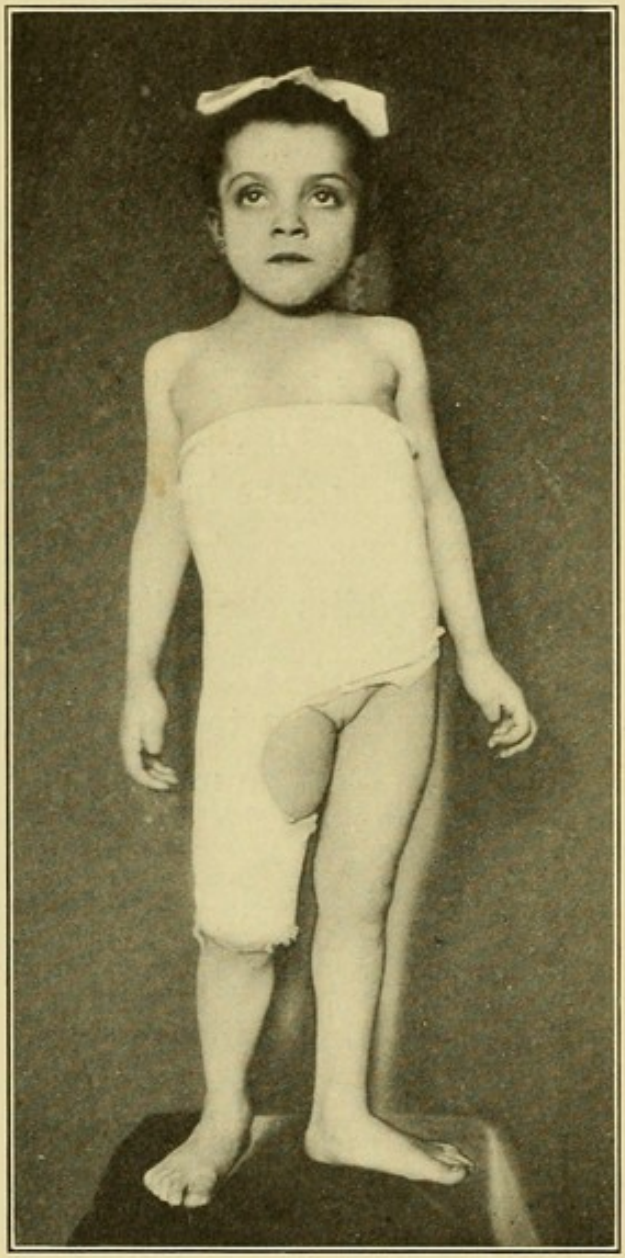


Fig. 85.—Large Psoas Abscess (Ichor Pocket) from Lumbo-sacral Pott's Disease, in a Girl of Seven.

ert pressure on the cord or excite a spinal pachymeningitis, causing a pressure paraplegia. No matter how great the deformity, there is rarely any bony pressure on the cord. Owing to the vertebral erosion, the upper segment of the spinal column slowly sinks forward until it finds support, which may not occur until the spine is doubled on itself and the lower ribs rest within the pelvis (Fig.

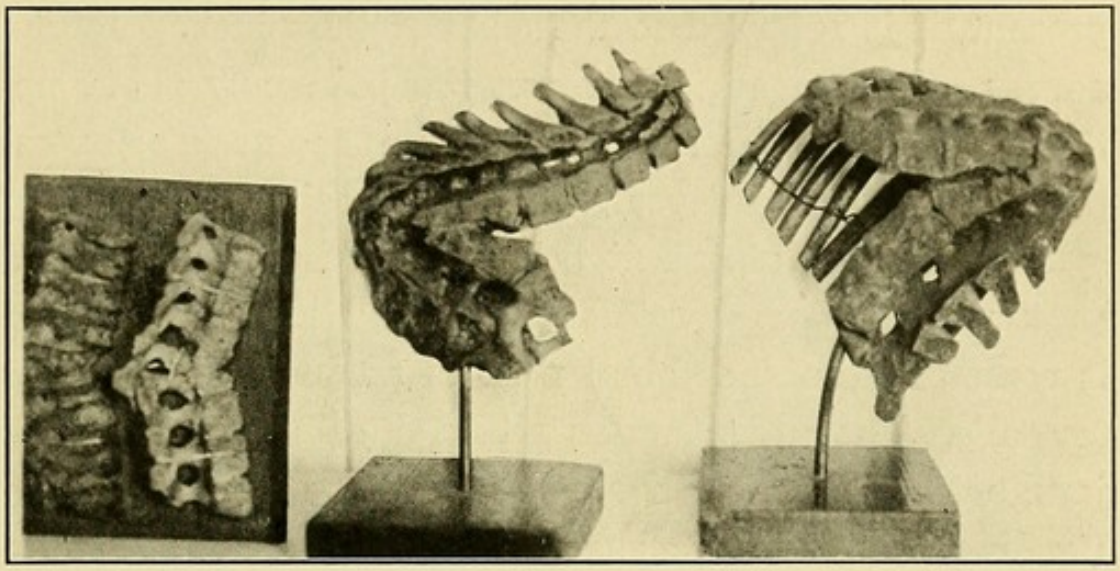


FIG. 86.—TUBERCULOSIS OF THE SPINE; EARLY CASE AT THE LEFT. Note that even in the cases of extreme deformity the caliber of the spinal canal is not constricted. (Author's specimens.)

86). The buckling of the spine shortens its vertical height, and consequently the height of the patient. It also produces secondary deformities of the chest, such as a form of pigeon-breast, and cramps the thoracic and abdominal viscera. More or less ankylosis of the involved vertebræ finally occurs in many of the cases that recover, but synostosis is later and less extensive than is usually assumed.

The SYMPTOMS of Pott's disease are usually characteristic before the appearance of deformity. One of the earliest signs is a certain stiffness and awkwardness of

posture, a tendency to restrict spinal movements, to avoid strains and jars. The child often rests his chin on his hands or his elbows on the furniture, and avoids play and activity. The affected part of the spine resists passive movements (reflex spasm). The child cries out at night as if in distress, often without waking. The pain varies with the location of the disease, but is most commonly abdominal; it may be entirely absent. When present, it is referred to the ends of the pinched spinal nerves. In the cervical region the pain may shoot up the back of the head, along the sides of the neck, or down the arms. In the dorsal region the pains are usually symmetrically situated at the sides or in the abdomen. In the upper dorsal region, short and rapid breathing is common; the abdominal pain is frequently mistaken for colic. The patient walks with a shuffling gait to avoid jars, with shoulders squared and head thrown back. Bending forward is difficult. The child dislikes to pick things from the floor, and will bend the knees, holding the spine rigid when doing so, and support the hands on the thighs in rising (Fig. 87). In lumbar disease the lower segment of the spine is stiff and the lumbar lordosis lessened or effaced; the pains may be in the iliac fossa, in the thighs, and even as low as the ankle. Local tenderness to pressure over the spine is an inconstant symptom, and of little value in diagnosis. Coughing, sneezing, and laughing often cause pain, as do jars and shocks from without; but the latter should never be employed in examination, as injury might result. The fear of being handled is so great, especially in very young children, as to constitute a sign of some importance; all manipu-

lations in examination should be of the gentlest. The characteristic attitudes and movements and spinal stiffness are the most important signs in beginning cases, and should always be studied after removal of all the clothing. A lead tape tracing of the spine with the child procumbent should be taken for record (Fig. 88).

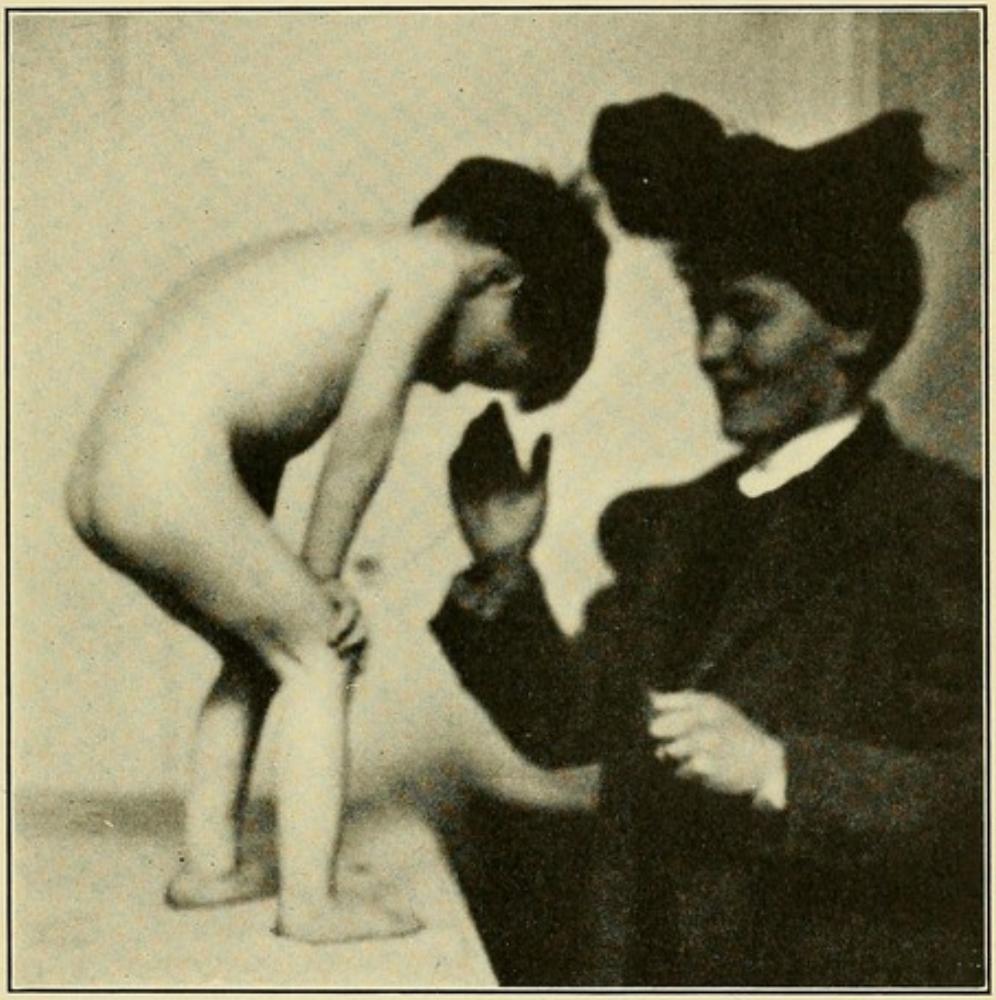


Fig. 87.—Beginning Pott's Disease in a Boy of Three; Slight Projection at First Lumbar; Characteristic Posture.

The gibbus appears first as a slight but sharp projection of one vertebra; unless arrested it gradually increases to include several vertebræ, finally forming in the dorsal region a large kyphos; so long as the projection is sharp, disease is still active; the projection be-

comes smoothly rounded by the time the disease has run its course. The projection is the center of the spinal stiffness, but this stiffness may extend some distance

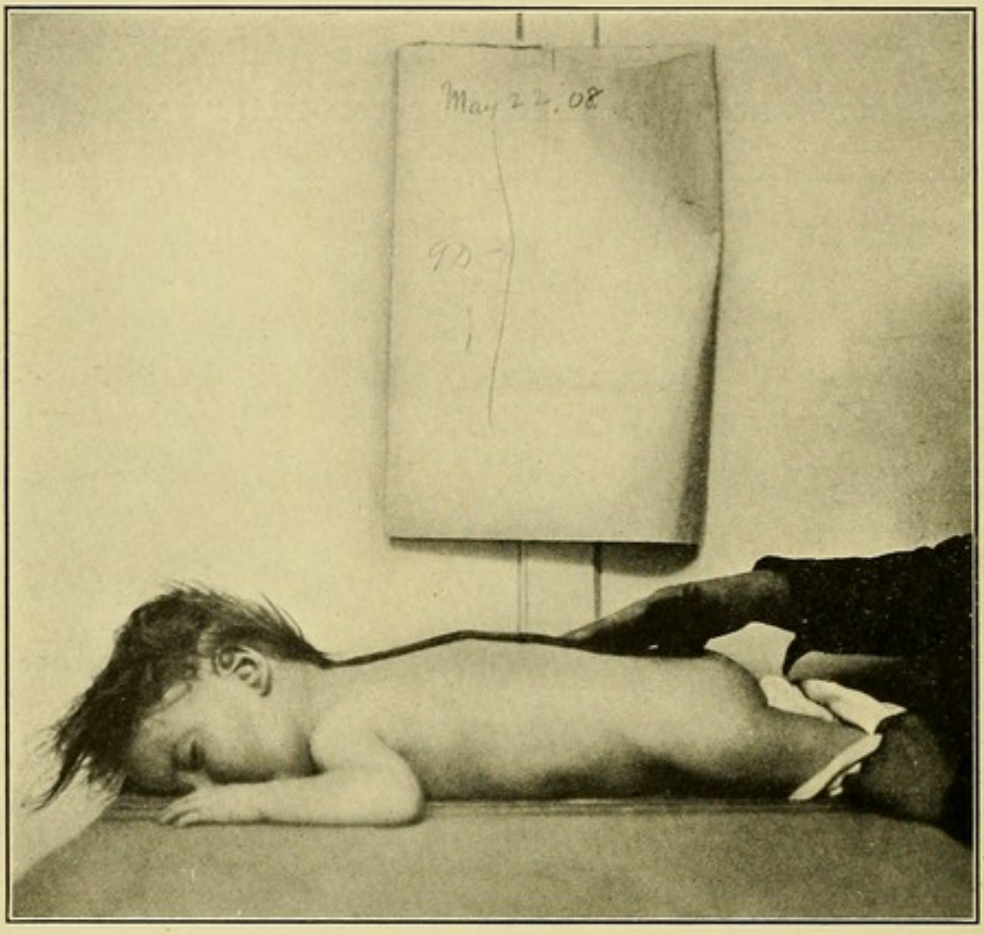


FIG. 88.—EARLY POTT'S DISEASE AT NINTH DORSAL IN CHILD OF TWO; TAKING CONTOUR FOR RECORD WITH LEAD TAPE.

above and below; it is due to instinctive or reflex contraction of the muscles to prevent injurious motion. The spinal stiffness and the posture characteristic of vertebral disease in different regions should be carefully studied. Stiffness in the lower half of the spine may be elicited by lifting the legs during procumbency (Fig. 89). With the formation of the kyphos compensatory secondary changes take place in the shape of the spine above and below, varying with the location. In upper dorsal

disease the mid-dorsal region is flattened and the dorso-lumbar region has a rounded kyphos, which is often mistaken either for the original site of the disease or for a secondary focus. The lateral deviation due to one-sided involvement of the column is frequently an early symptom, but it does not resemble scoliosis, as the deviation is angular and at the point of disease, and is combined with stiffness and characteristic postures (Fig. 90).

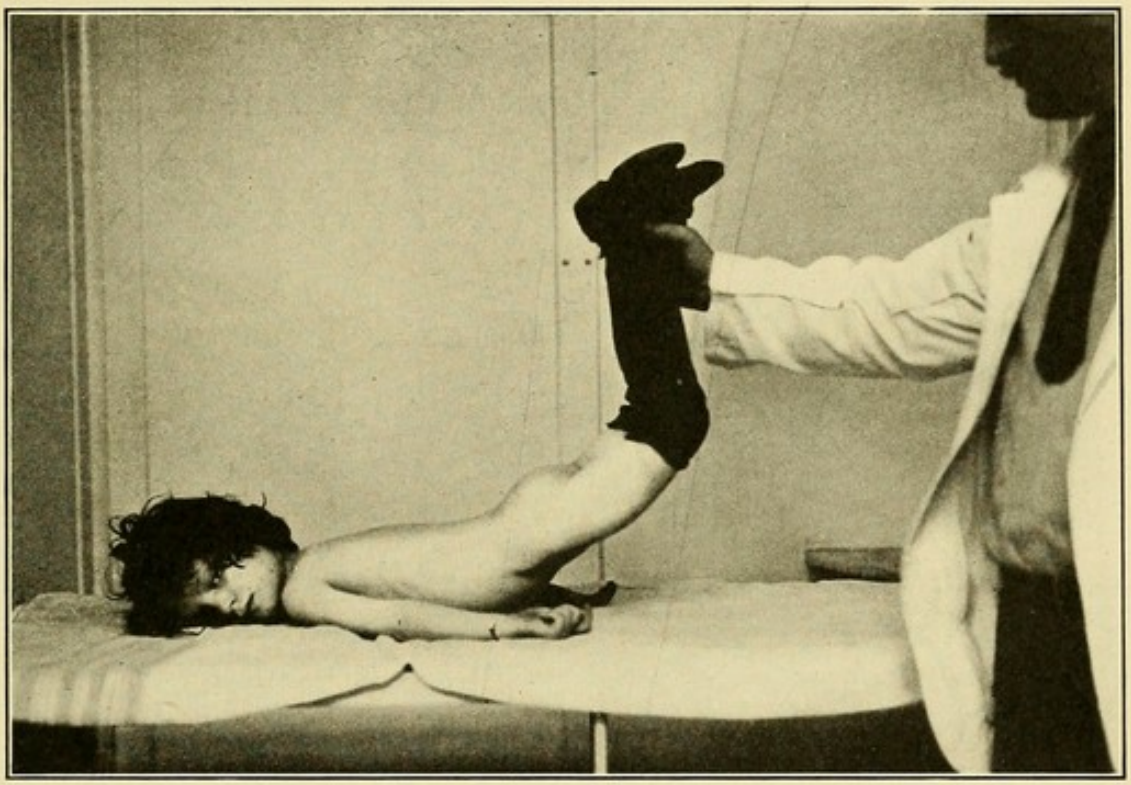


Fig. 89.—Test for Spinal Stiffness; Very Early Pott's Disease.

There may be in the later stages a true secondary scoliosis from mechanical conditions.

Complications.—An ichor pocket (*cold abscess*) is one of the most frequent complications, though many escape entirely. In the neck, a pocket may break into the pharynx or at the side of the neck. Upper dorsal pockets may form in the posterior mediastinum, and are

then dangerous. Lower dorsal and lumbar pockets may appear at the side of the spine, but more commonly work along the psoas muscle or appear in the loin. They seldom break into the abdominal cavity, though they occasionally penetrate the intestines. By flexing the thigh and relaxing the abdominal muscles pockets may often be felt in the iliac fossa before they reach Poupart's ligament, or they may cause dullness to percussion at the side of the spine. They are sometimes absorbed and sometimes remain stationary for an indefinite period. When the psoas muscle is irritated, a psoitis is provoked which produces a psoas contraction, with flexion of the thigh. Secondary infection of a pocket may cause sepsis, or long-continued suppuration with waxy degeneration of the viscera, and death from kidney complications or exhaustion. The early stages of waxy degeneration are probably often curable, and moderate suppuration may

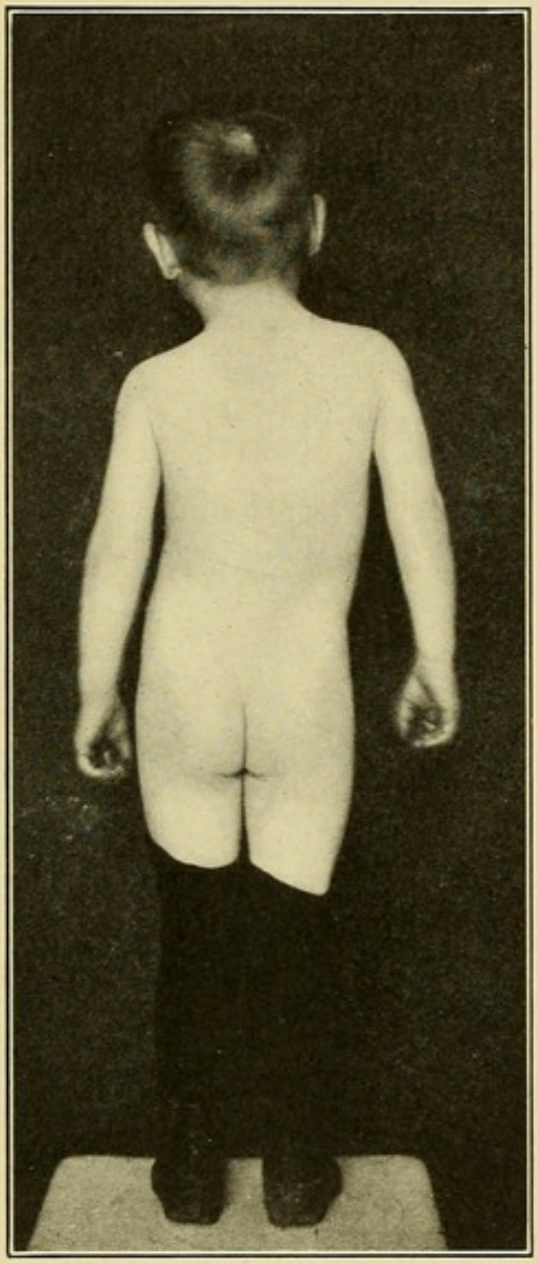


FIG. 90. — LATERAL DEVIATION IN EARLY POTT'S DISEASE.

last for an indefinite period without serious harm. The writer has known cases where suppuration has lasted twenty years or more, and yet the patient has remained in good or fair health, and the sinuses have finally healed.

Psoas contraction is caused by the irritation of fluid from the bone focus following along the psoas muscle. Psoitis causes flexion of the thigh and lameness, and is not infrequently mistaken for hip disease. With these symptoms the back as well as the hip should be examined, and it should be remembered that both may be affected. To test for psoas contraction (hip flexion), while the child lies prone and relaxed the ankle is grasped, the knee being flexed and the thigh gently lifted and rotated. If hip motion is free, the knee can be readily raised from the table without moving the pelvis (hyperextension of the thigh) (Figs. 144 and 145), and to an equal distance on both sides. If psoas contraction is present, the knee cannot be lifted from the table without lifting the pelvis, or it cannot be lifted so far as on the well side. Motion in psoas contraction is smooth and free from spasm, and extension only is limited; in hip infections there is muscular spasm, and rotation, as well as extension, is limited. Psoas contraction may be slight and may pass away without the appearance of an abscess, or it may be severe and, in a few cases, persist as a permanent flexion from fibrous shortening. In psoas contraction a fluctuating mass should always be looked for in the groin, iliac fossa, or loin. The treatment is the treatment of the vertebral disease, and so long as psoas contraction is present recumbency should be emphasized in addition to spinal support.

Another alarming complication is *paraplegia*, due to pachymeningitis or the pressure of inflammatory products, which occurs in perhaps ten per cent of the cases. Weakness often appears first in one leg, but soon involves both, and may progress to total motor paralysis. If sensory paralysis is added the lesion is more severe and the prognosis graver. The reflexes are usually increased, though in the later stages of some cases they may be abolished. In the severe dorso-lumbar cases the control of bladder and rectum may be impaired or lost. One should distinguish between automatic micturition and defecation, reflex phenomena, and retention with dribbling due to palsy of the centers; the latter is the graver. Both ichor pockets and paralysis are rarer under mechanical support. There is a strong tendency of the inflammatory products and thickened tissues, which press on the cord, to be absorbed or reduced by rest and splinting.

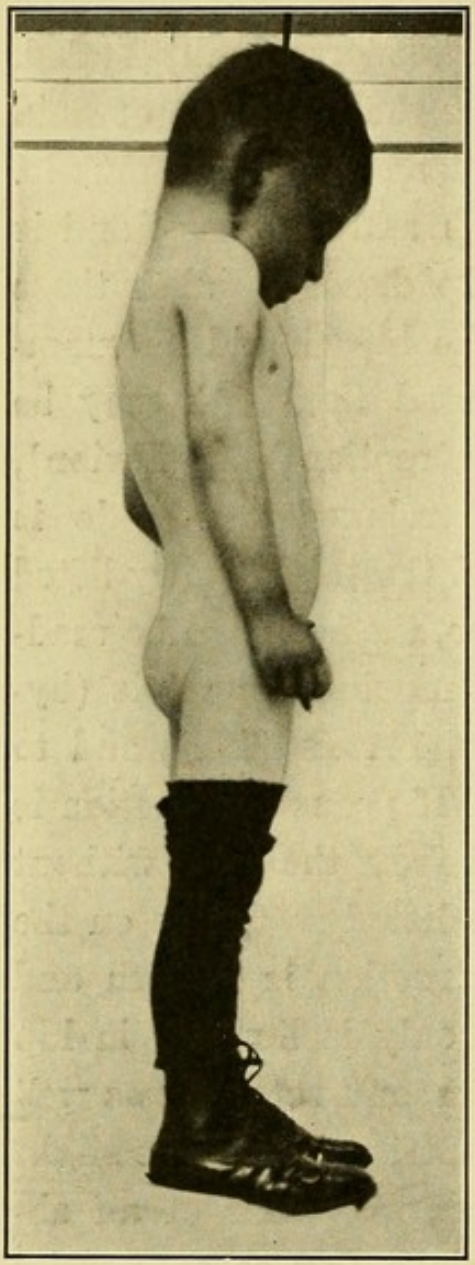


FIG. 91.—POTT'S DISEASE AT THE SECOND CERVICAL IN A CHILD TWO YEARS OLD. The head drops forward and is often supported by the hands.

Under protective treatment the prognosis is decidedly good, even in long-standing cases, and laminectomy is very rarely indicated.

Differential Diagnosis.—The range of diseases for which Pott's disease may be and has been mistaken is very wide. In the neck it may be taken for torticollis, in the thoracic region for disease of the lungs or abdomen, and in the loins for kidney, appendical, or bladder disease. The affections from which it most needs to be distinguished are rachitic spine, "rheumatoid" spine, round back, lateral curvature, and neurotic spine; it must also be differentiated from hip disease, sacro-iliac disease, perinephritic abscess, and abdominal adenitis.

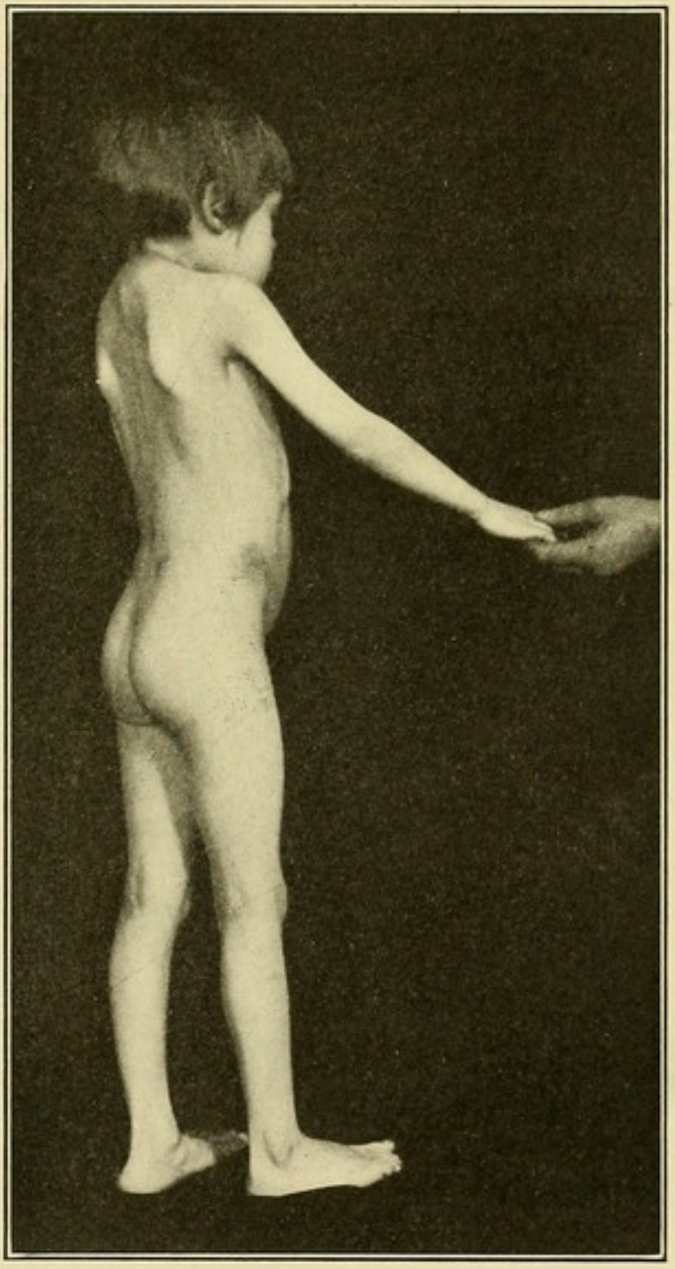


Fig. 92.—Upper Dorsal Pott's Disease in a Girl of Five, who has Worn a Jacket with Jury Mast Two Years. The disease is quiescent but not cured.

The diagnosis of cervical spondylitis from acute or in-

fectious torticollis is not always easy. The invasion of spondylitis is usually slower and more insidious; a projection is often felt in the neck, and the posture and care in supporting the head are often characteristic.

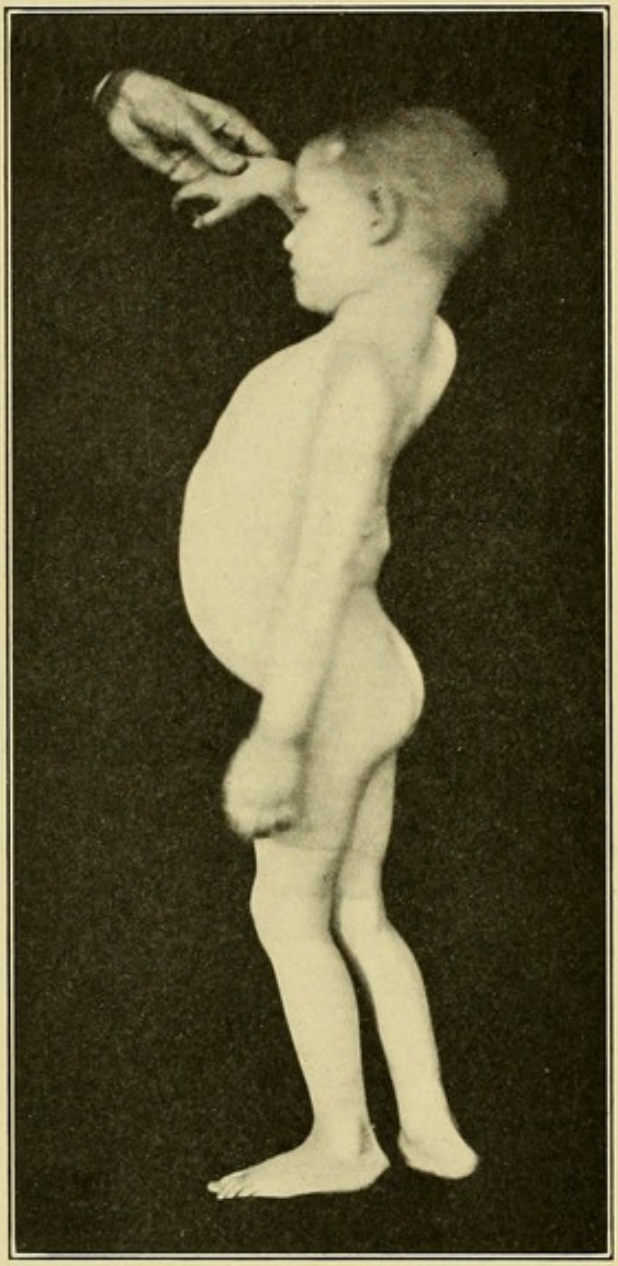


Fig. 93.—Lumbar Pott's Disease; the Posture Indicates that Disease is Still Active.

In rachitic spine, a rounded back from relaxation, the child has the symptoms of rickets, which are usually absent in Pott's disease; the curve is rounded, mainly below the shoulder-blades, and partly or wholly disappears in the prone posture (Figs. 105 and 106). There is no characteristic pain and no reflex spasm. In Pott's disease the projection is in the active stage nearly always sharp, and confined to one or two vertebræ. There is local stiffness, and the deformity does not disappear when the patient is prone.

In ankylosing arthritis there is stiffness, which may

be local or general, with or without a round back or scoliosis; other joints may be involved. There is no suppuration, and no localized or sharp projection (Fig. 108).

Scoliosis and round back should be easily excluded, as there is no characteristic pain or muscular spasm, and the posture is different; in the severe cases the spine may be more or less stiff.

In neurotic spine, backache and spinal tenderness are present, but there is no characteristic pain or deformity. There is tenderness to light pressure over the spinous processes or the vertebral arches, which may be extreme. It may be in any region or affect the whole spine; the upper cervical, interscapular, lumbar, and coccygeal regions are favorite sites. Similar tenderness often exists over the bony prominences of the pelvis or in the iliac fossa, and elsewhere, and symptoms of hysteria or neurasthenia are usually present. Spinal hyperesthesia is not characteristic of spondylitis, and pains induced by moderate pressure along the spine are indicative of a neurotic spine rather than of Pott's disease.

A psoas contraction may be mistaken for hip disease, but there is limitation to extension only, and no spasm; in hip disease there is usually some limitation in all directions, or at least to rotation, even in the early stages. One should, however, remember that tuberculosis of the hip and spine may coexist. Pain across the back of the pelvis, with tenderness over the sacro-iliac joint, and disability and pain in standing, sitting, and lying, are indicative of sacro-iliac disease.

Carcinoma of the spine is rare, and usually secondary; in it the pain is agonizing, and unrelieved by support.

In perinephritic abscess (Fig. 94), appendicitis, tuberculosis of the abdominal glands, and other inflammatory abdominal affections there may be thigh flexion and spinal stiffness, and the postures may suggest spinal in-

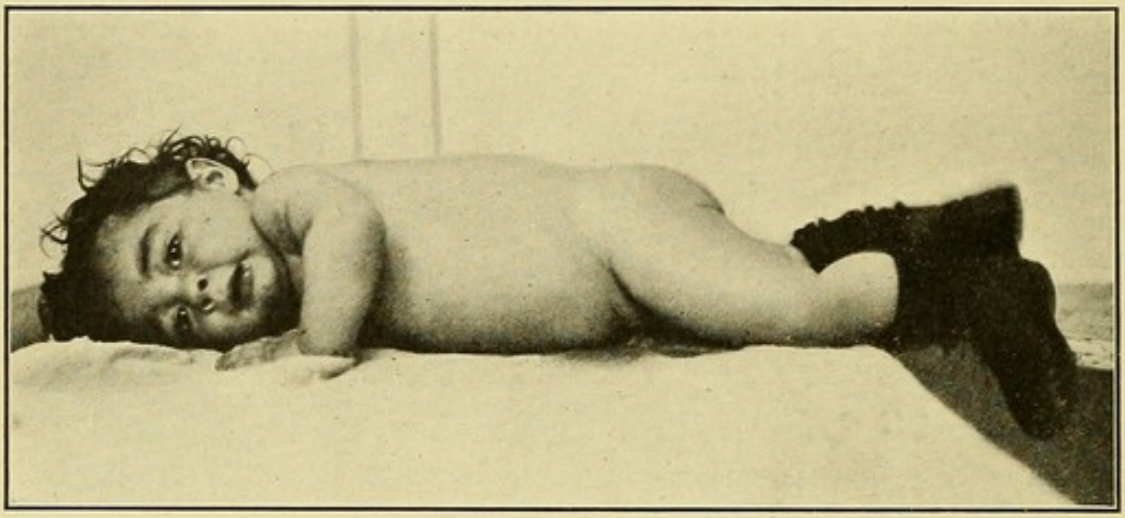


FIG. 94.—PERINEPHRITIC ABSCESS OF LEFT LOIN, SIMULATING SPINAL ABSCESS. Symptoms one week, abdominal rigidity. Abscess showed staphylococci.

volvement. In these affections, however, there is nearly always more or less involuntary abdominal rigidity over the affected area, which in the case of diseased glands may be below the sternum.

TREATMENT.—The objects of treatment are to improve nutrition, to enforce spinal rest in order to favor healing, and to prevent deformity.

The nutritional indication is common to all chronic tuberculous lesions, and is met by fresh air, sunlight, and generous feeding, including fats. The second and third indications are met by periods of recumbency, by splints, jackets, and frames, and by the strict avoidance of strenuous activity and of movements and jars affecting the spine. The patient should never sit up without spinal

support, which should be worn day and night; when the support is removed the patient should be rolled over, not lifted.

In children of two years or under the gas-pipe or wire frame, as modified by Whitman, is the best support (Fig. 95). It is made of quarter-inch (caliber) gas pipe, and is five or six inches wide and a foot longer than the child. It is covered by a canvas lacing, and should be bent up in the region of the kyphos, where felt pads are added to exert greater leverage. The canvas is protected in its middle half by a rubber cloth, and the child is strapped to the frame by a broad apron with webbing straps at the sides fastening into buckles on the back of the canvas. The skin of the back should be in-

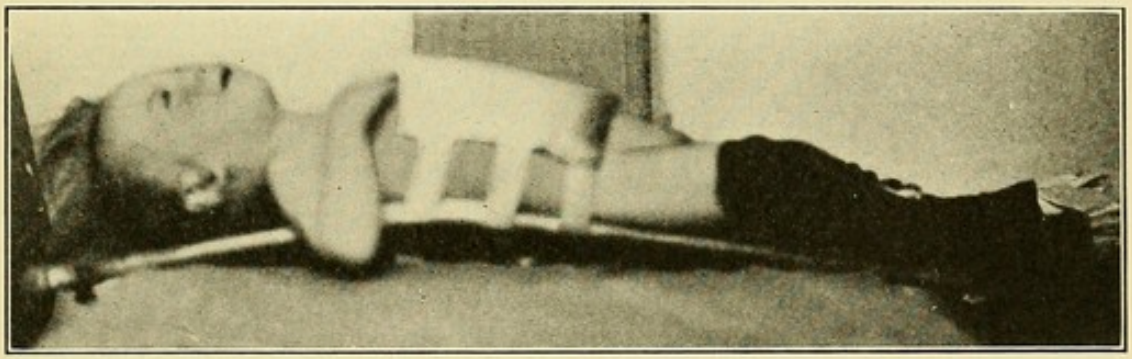


Fig. 95.—Whitman's Gas-pipe Frame.

spected daily and kept powdered and dry. The clothing should be adjusted over the frame, and the child may be carried about on it, as on a pillow. A small child may be kept on such a frame for a year or two, if necessary. When desirable, T-shaped attachments may be added for extension at the feet and head, in which case the frame should be six inches longer.

After the age of two and a half or three, antero-

posterior support may be furnished by a steel brace or by a jacket. The advantages of a fixed plaster-of-Paris jacket are that it is applied by the physician himself, and that it must remain in place until removed (Fig. 96). Its disadvantages are that it is uncleanly, and does not permit inspection of the spine or ready readjustment. The points in its favor, however, are so important as to make it the favorite method in dispensary practice, and with those who are unfamiliar with the management of apparatus. If the disease is above the tenth dorsal the leverage should be increased by a head or chin support, whether a jacket or brace is employed. Removable jackets or corsets are not so efficient or useful as fixed jackets, except in selected cases under strict control and in convalescents. The best material for a jacket is plaster-of-Paris, and it is usually applied

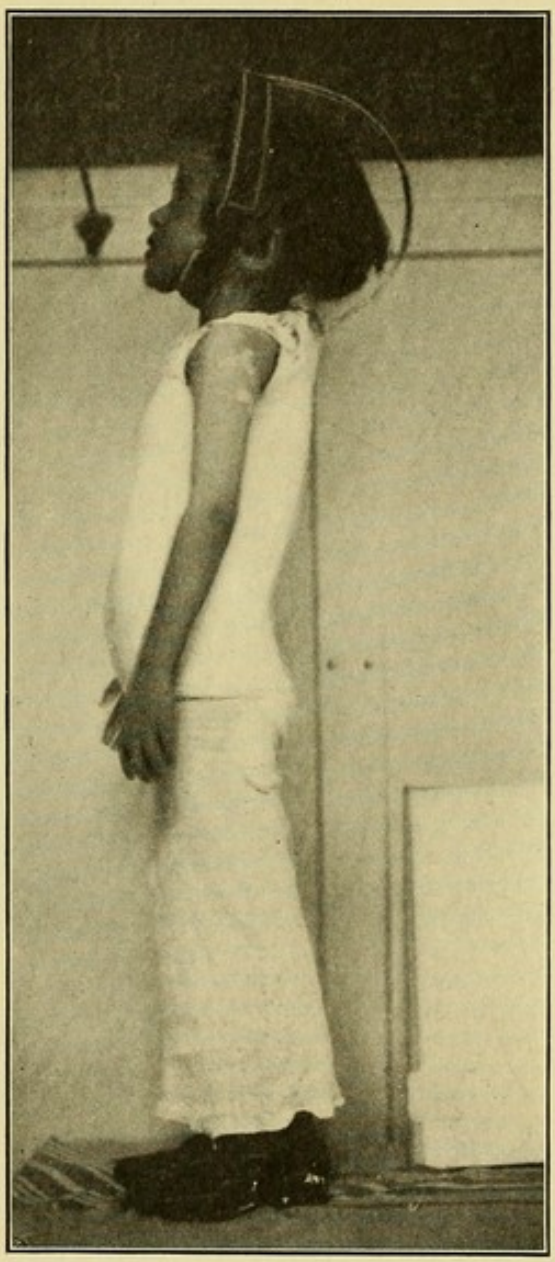


FIG. 96.—PLASTER JACKET WITH JURY MAST, JUST APPLIED. Note tilting back of head. The stockinette hanging down will be turned up over the jacket and sewed to itself at the top.

with the patient vertically suspended or partly suspended from the chin and occiput. It may be applied with the patient horizontally suspended on a frame or hammock. The jacket should be applied with the spine in hyperextension, and should be changed every two or three months; thick felt pads should be used either side of the kyphos for stronger leverage. Many jackets are inefficient because they are not made long enough or are not molded to properly distribute the pressure. The front and back of the jacket, according to Calot, are united over the shoulders (Fig. 97), and if the disease is above the ninth dorsal, the neck, chin, and occiput are included (Figs. 98 and 99). A large fenestra is cut out in front, to increase comfort, and a smaller one behind, over the ky-

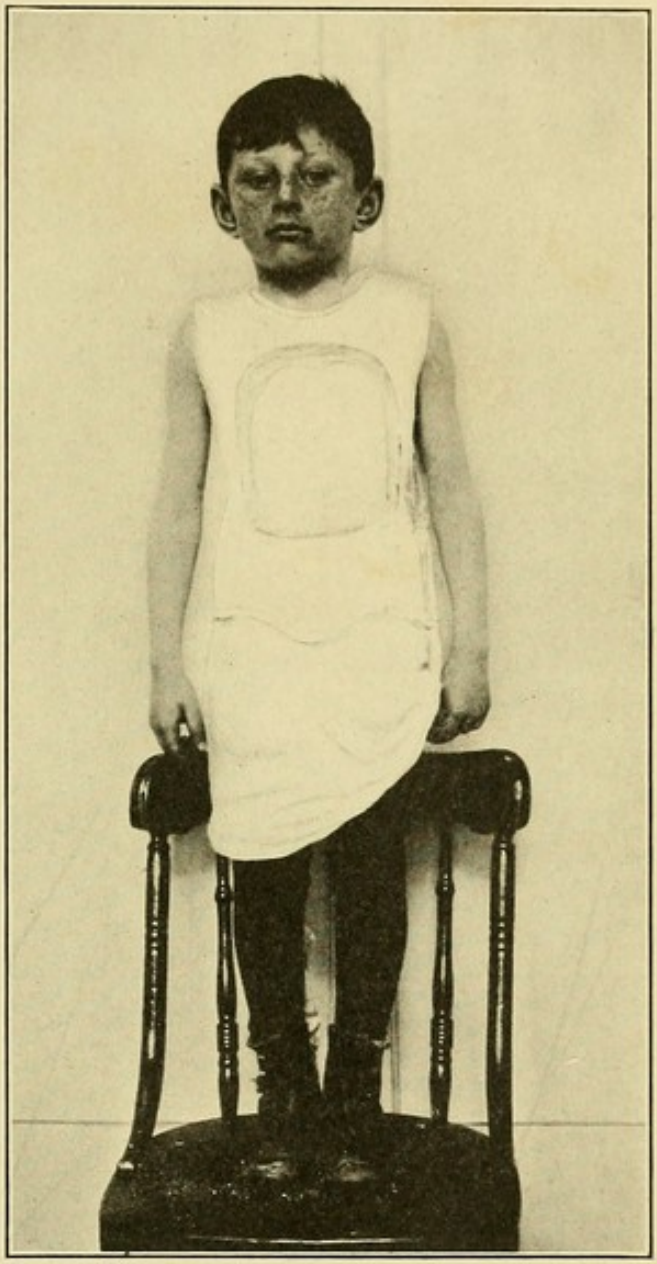


FIG. 97.—CALOT JACKET REACHING OVER THE SHOULDERS, AND WITH FENESTRÆ IN FRONT AND BEHIND.

phos, through which cotton is stuffed either side of the spine to increase the pressure; the fenestra is then filled

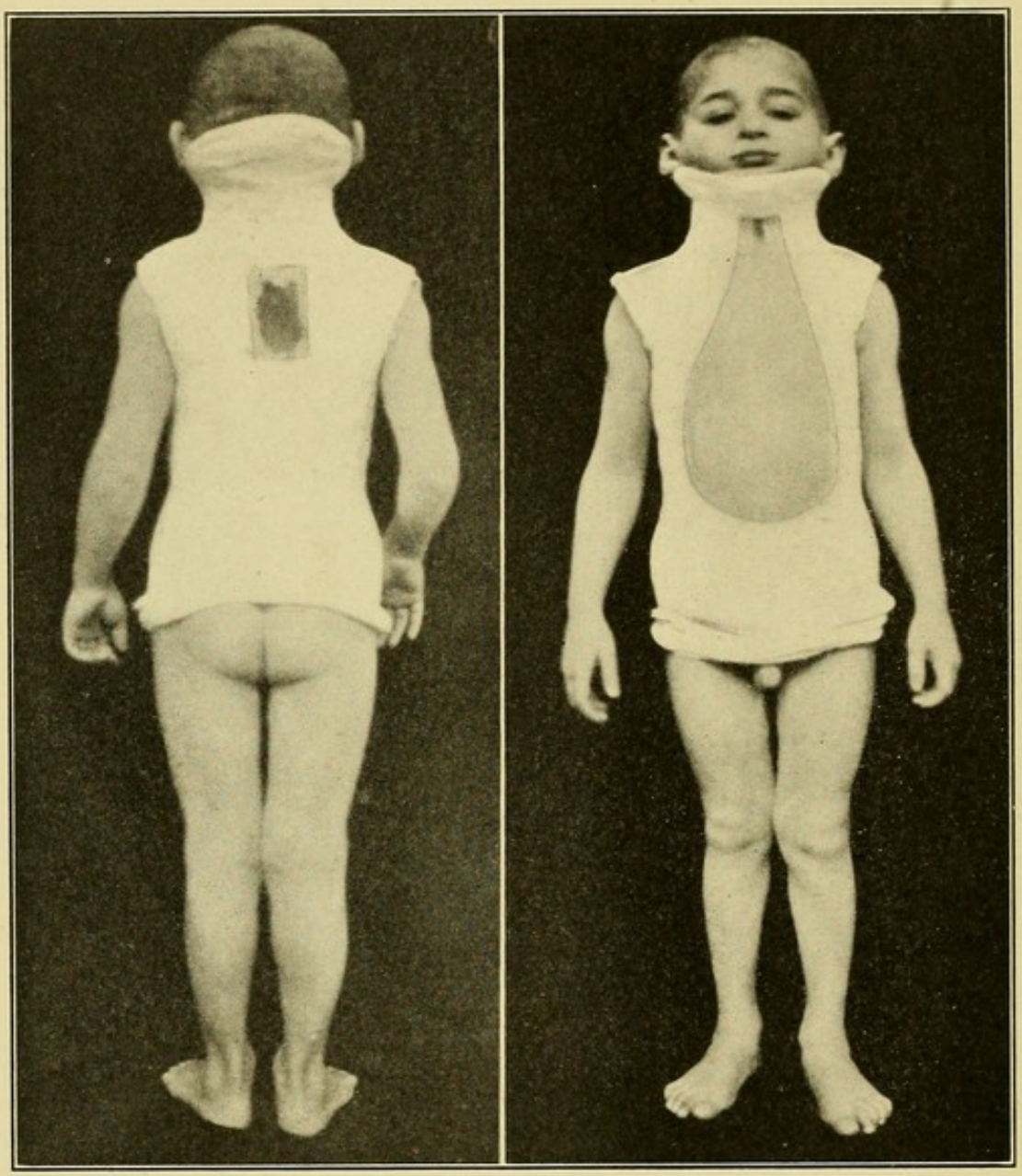


Fig. 98. Fig. 99.

Figs. 98 and 99.—Upper Dorsal Pott's Disease; Recovery from Pressure Paraplegia Under the Calot Jacket, with Recumbency. Patient at Hospital for Ruptured and Crippled. Front and back view of the same patient.

up with tightly packed cotton, which is kept in place by a bandage. By inserting fresh cotton as the old becomes

packed down, the leverage is kept at its maximum. It should be stated that Calot keeps most of his cases recumbent. Forcible correction of the kyphos cannot be commended. When good coöperation and regular attendance can be secured, especially in private practice, a steel and leather leverage splint with an apron, permitting frequent bathing, and inspection and readjustment when necessary, is preferable in the hands of an expert (Fig. 100). The chin rest is to be added for disease above the tenth dorsal. When the posture is bad or pains persist, the patient should be put to bed in addition, for several weeks or months; it is well to prescribe several hours of recumbency daily, as well as long night rests. Indeed, during the active stage it is best to keep the child from school, and to allow only so many hours out of bed morning and afternoon, as his condition may warrant.

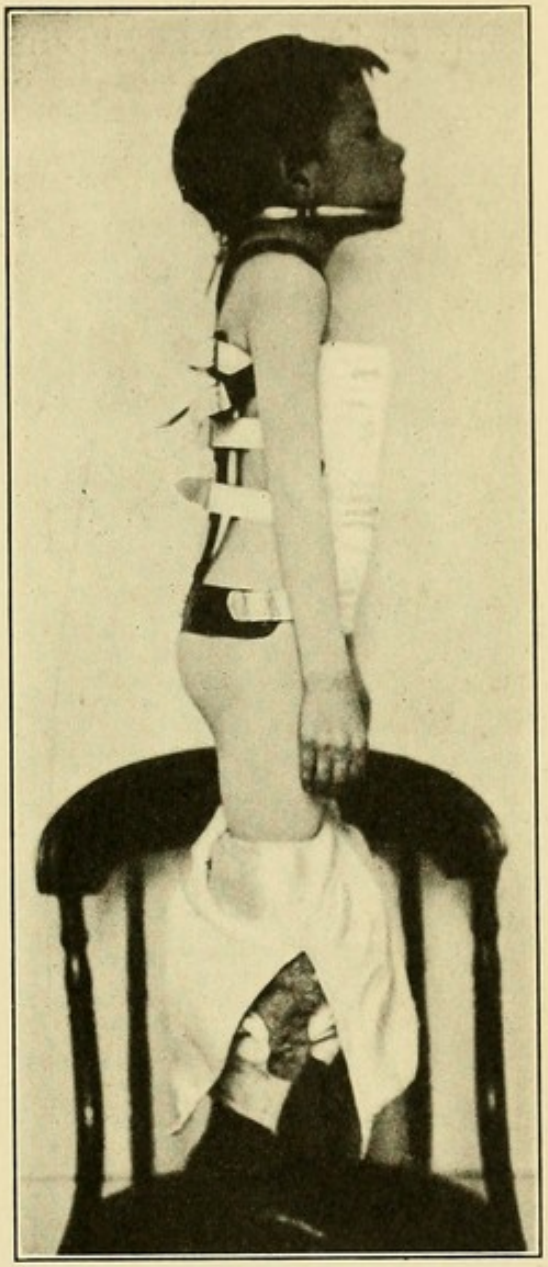


Fig. 100.—C. F. Taylor's Spinal Splint with Head Support.

The immediate effects of efficient spinal support are

very striking. Most patients are relieved of their pain at once or in a few days, their appetite and general condition improve, and they become more active. Many cases become so free from symptoms that the physician is tempted to intermit or discontinue the spinal support and the periods of recumbency. This temptation should be steadfastly resisted, as the disease is rarely cured in two years, and then only in the cervical region. In other regions spinal support for four to five years or more is necessary. If abdominal or other characteristic pain recurs, if the patient's general condition is unsatisfactory, or if he leans to one side or does not hold himself well, spinal support should be improved and the patient put to bed for a time.

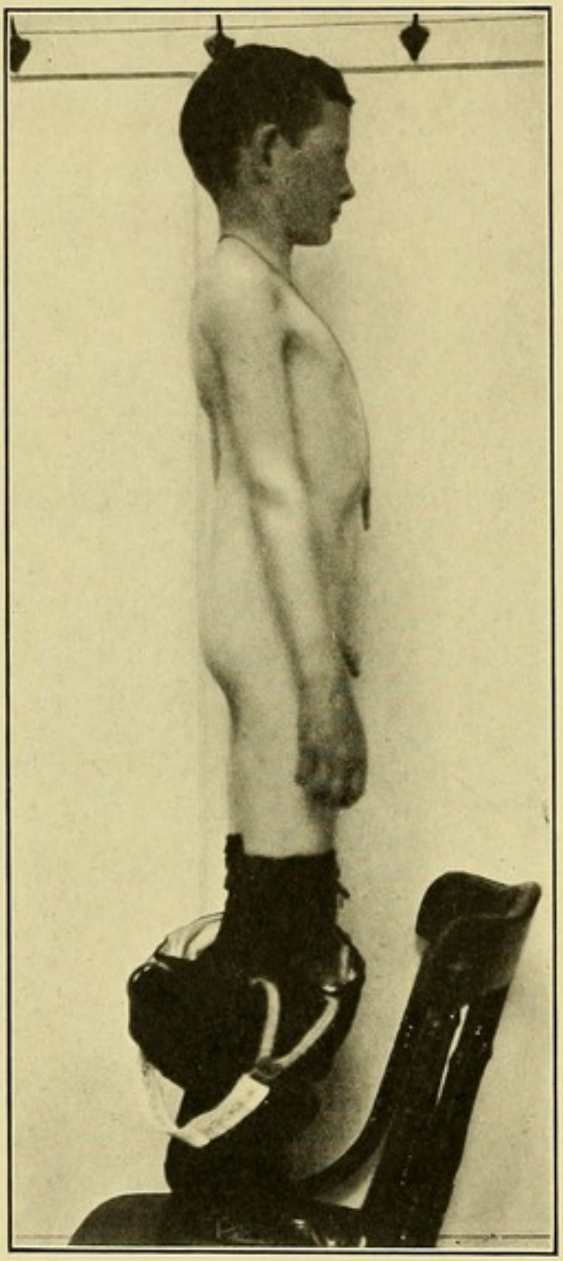


FIG. 101.—LOWER LUMBAR POTT'S DISEASE, CURED AFTER SIX YEARS' SUPPORT WITH PLASTER JACKETS, AND ONE WITH PLASTER CORSET. BOY OF TEN. Has been one year without support.

When to Leave Off Spinal Support.—The spine should be splinted for a year or more after all active symptoms, including reflex spasm of the

spinal muscles, are past. The spinal deformity must be rounded and the patient must be able to hold himself well without support. Growth in children should be increased to one and a half or two inches a year. It is usually necessary to prolong the support, except at night, for a considerable time after an anatomical cure, in order to prevent the gradual increase of the kyphos from static conditions. This often takes place without recurrence of disease. Support should be discontinued by degrees; at first at night, later a few hours at a time in the daytime. It is best to continue to abstain from active exercise, and to prolong the hours of recumbency for a considerable time.

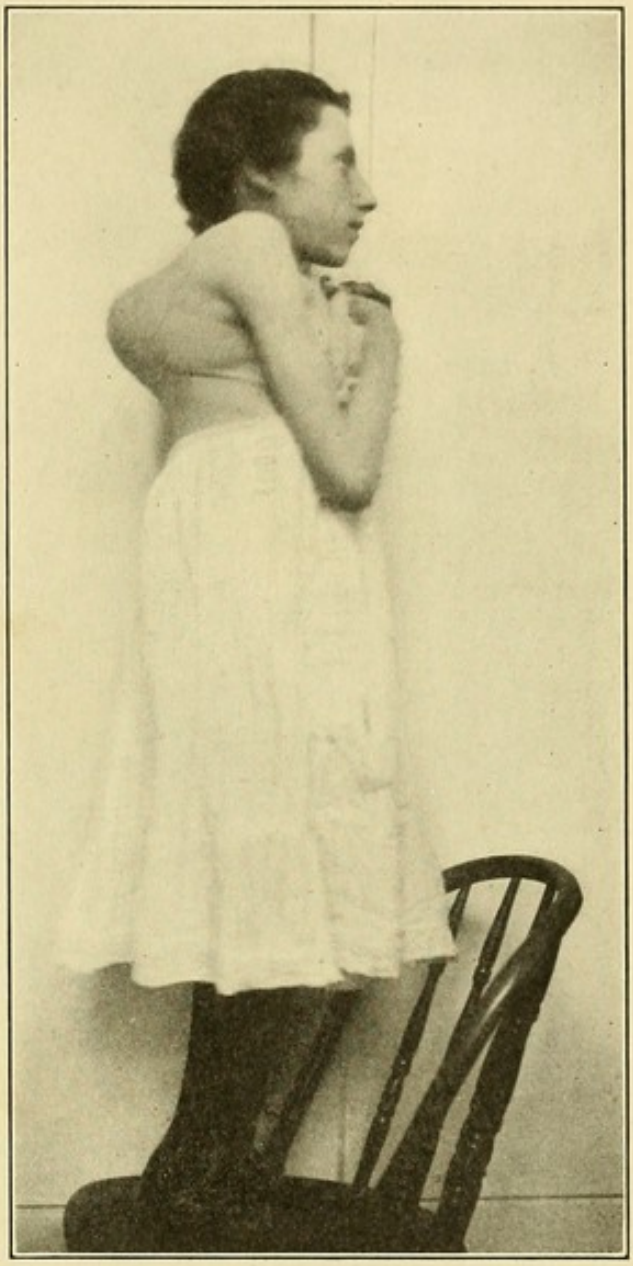


FIG. 102.—UNTREATED POTT'S DISEASE; IT BEGAN AT FIVE YEARS OF AGE, AND AT THE NINTH DORSAL VERTEBRA; NO ABSCESS OR PARALYSIS; GIRL OF EIGHTEEN.

PROGNOSIS.—There is a strong tendency to self-limitation and a natural cure, but the course in untreated

cases is very long (five to twenty years), and many die of tuberculous meningitis, general tuberculosis, waxy viscera, exhaustion, or intercurrent affections. The resulting deformity is severe and the effect on the constitution is profound (Figs. 102 and 103).

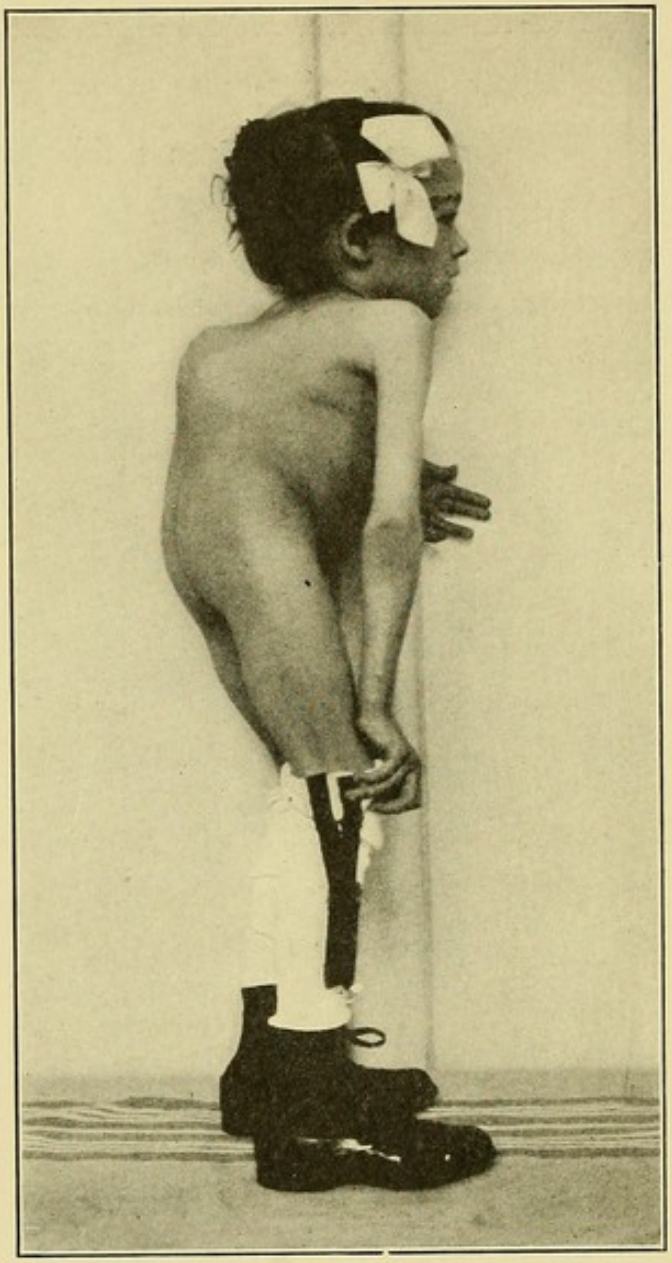


Fig. 103.—Dorsal Pott's Disease in Girl of Seven; Three Years Duration; No Spinal Support; Disease Still Active. Compare Fig. 104.

Under efficient hygienic and protective treatment the mortality is smaller, the complications are rarer and less serious, and the final deformity is less (Fig. 104). The results are better in private than in hospital and dispensary practice. Occasionally cures are obtained with little or no deformity, and in exceptional cases marked deformity may recede under treatment; but as a rule deformity progresses slowly for a number of years, though pain and acute symptoms are quickly relieved, and the final result is

recovery with more or less, often considerable, deformation.

Tuberculous disease of the atloido-oxoid and occipito-atloidean articulations has been called **spondylarthritis tuberculosa.**

On account of the close proximity of the affected structures to the spinal cord, the latter is often compressed with resulting paralysis, at first of the arms; pharyngeal abscess may occur, and brawny induration of the upper neck is often noticed. When one side is more affected the head is turned to one side; the neck is held stiff and pressure is very painful; the pain is referred to the back of head and ear; there may be tongue and eye symptoms.

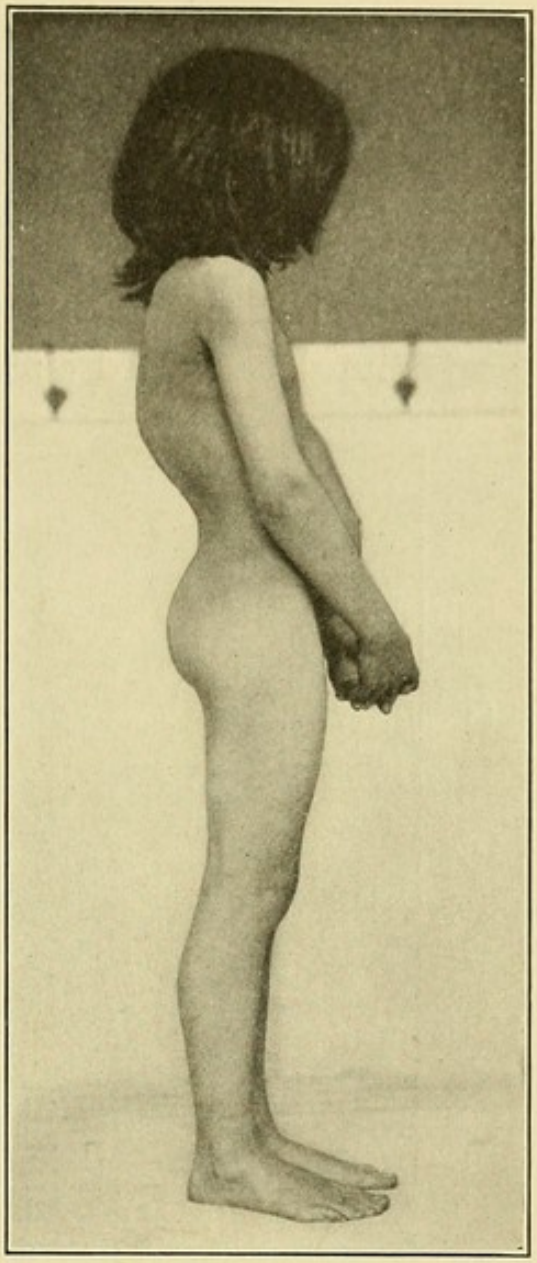


FIG. 104.—POTT'S DISEASE AT ELEVENTH DORSAL, CONVALESCENT WITH SLIGHT DEFORMITY AFTER FIVE YEARS OF SPINAL SUPPORT; GIRL OF NINE.

The treatment is the same as for cervical Pott's disease.

Tuberculosis of the abdominal glands, particularly of the mesenteric glands, may cause spinal stiffness and disability, and may end in abscesses and sinuses. There is

more or less abdominal rigidity, sometimes enlargement, particularly at the upper part, and with symptoms of toxemia. The spine may or may not be secondarily diseased, but is usually stiffened. There is no sharp kyphos, but there may be a rounded curve.

The **rachitic spine**, considered here for convenience, is the postural backward curve of the spine often seen in

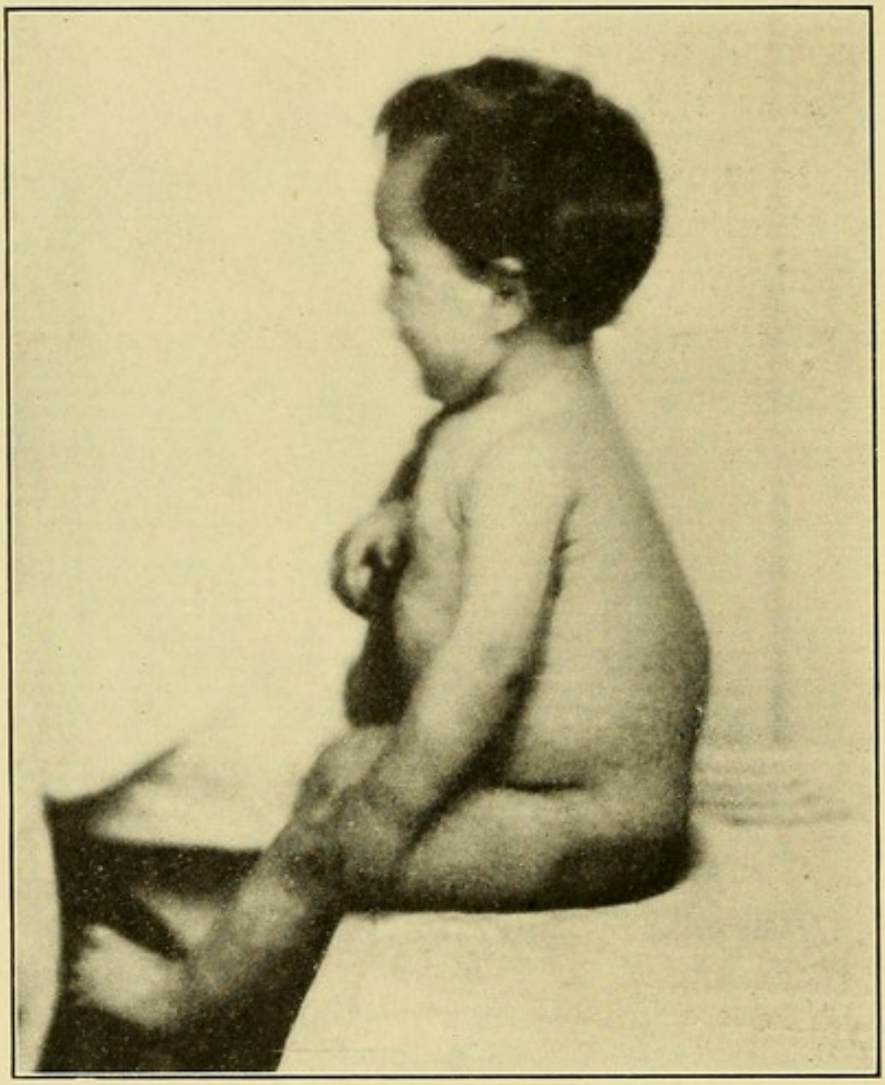


FIG. 105.—RACHITIC SPINE IN A CHILD ONE YEAR OLD.

rachitic infants, particularly when sitting. The curve may involve the dorsal and lumbar regions, or only the lower part of the spine, is never sharp, and disappears

or is diminished in the prone posture; reflex spasm is absent (Figs. 105 and 106). The treatment is that of rickets, with recumbency added. A frame may be used to prevent sitting in the bad cases, if desired; jackets

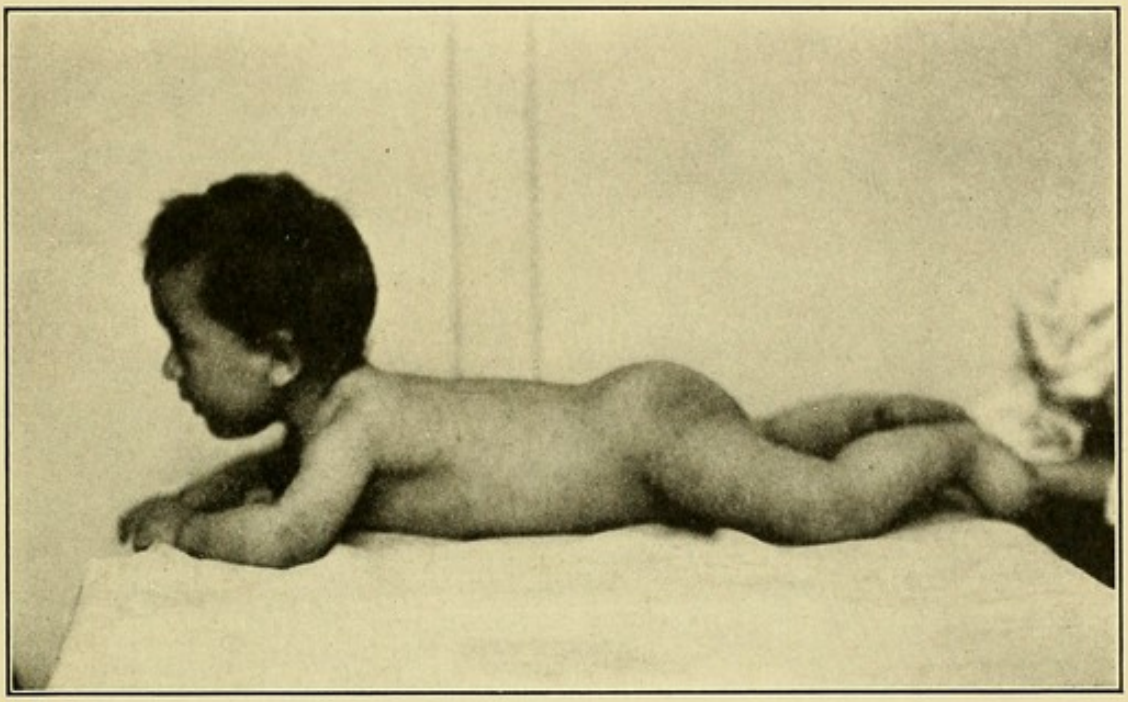


Fig. 106.—Same as Fig. 105; Showing Disappearance of Kyphos in Prone Posture.

and braces are unnecessary. A similar condition may exist in other forms of infantile malnutrition, as in myxedema, scurvy, chondrodystrophia, and marasmus, in each of which the primary condition will require appropriate management.

Spondylitis Traumatica (*Kümmel's Disease*).—A severe injury of the spine, from a fall or blow, may produce immediate and obvious symptoms of fracture or other gross injury of the spinal column, including spinal deformity and paraplegia. In less severe injuries the spinal symptoms may at first be mild or absent; there may or may not be a slight projection at the point of

injury, but if absent a prominence is noticed a month or two later, which slowly increases. There are spinal stiffness, pain in the back, side, or abdomen, and inability to stoop. The original injury was probably a crush, crack, or bruise of one or more vertebral bodies without much displacement; this was followed by a traumatic rarefying ostitis of the implicated vertebral bodies. The symptoms are milder than in spinal tuberculosis; the projection, which is usually in the middle of the back, is more rounded. The course of the disease is shorter, and the ultimate deformity less. There is little or no tendency to suppuration.

The TREATMENT is spinal support and fixation by braces or jackets; the relief is usually prompt, and most cases terminate in cure in a year or two, with some stiffness and slight deformity at the point of injury.

Spinal support may also be indicated in *sprains* of the *spinal ligaments*, if the soreness, stiffness, and disability do not pass off in a few days or weeks.

Typhoid, syphilitic, actinomycotic, and pus infections of the spinal column are rare, but the possibility of their occurrence is to be borne in mind.

Progressive Ankylosis of the Spine.—Under this title may be grouped a number of chronic pathological processes affecting the spine or its ligaments which result in spinal stiffness, often with pain and deformity, but with no tendency to suppuration. The process may affect the greater part or whole of the spine, or may be confined to a few vertebræ only. In osteoarthritis of the spine the lateral bands of the anterior spinal ligaments become ossified, the rims of the vertebræ may become lipped,

and may fuse with growths from neighboring vertebræ (Fig. 107). If ankylosis takes place quickly there is little or no deformity; if slowly, extreme round back or scoliosis may result. The larger joints, particularly the hips and shoulders, may be similarly affected (Fig. 108).

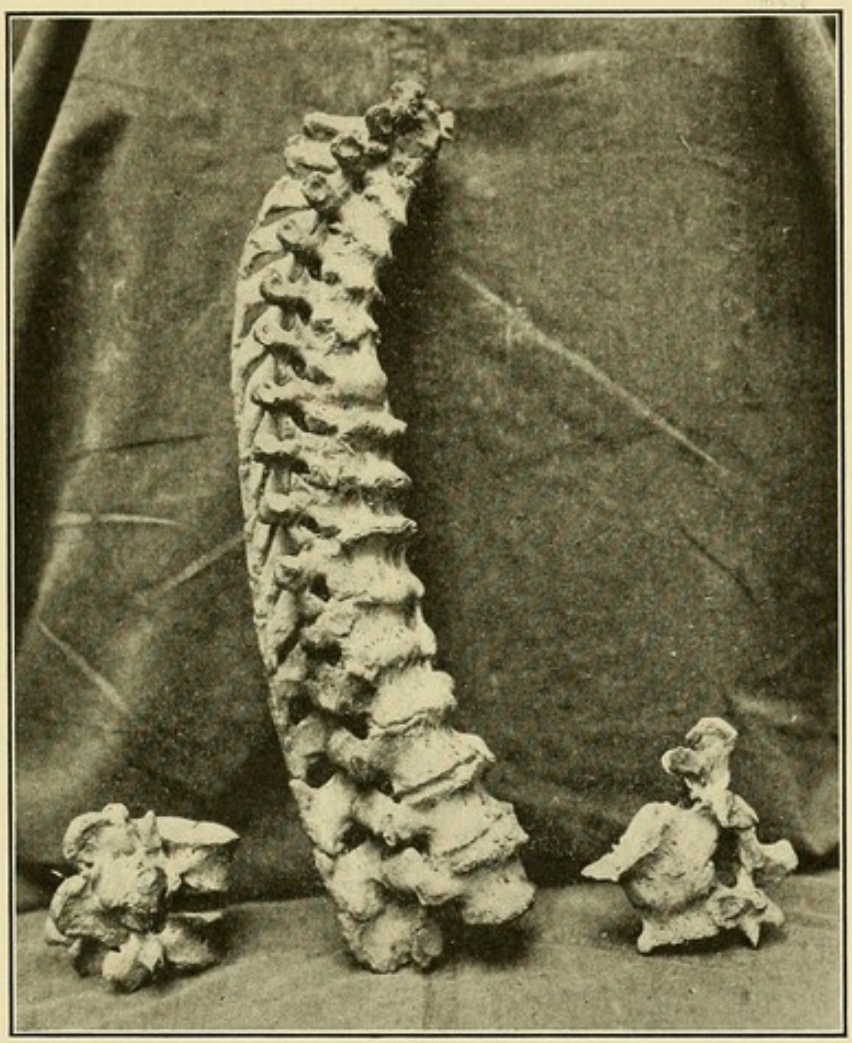


Fig. 107.—Osteoarthritis of the Spine.
(Specimens from Cornell Medical College.)

In the atrophic type without osteophytes the small spinal articulations and the joints of the hand and feet are often affected. In still another form the supraspinous ligaments may become ossified (Elliott).

Many cases are due to infection, particularly to gon-

orrhea, and occur most frequently in young adults; in others, exposure to cold and wet seems to be the exciting cause. Some cases seem to be due to intestinal auto-intoxication or nutritional disturbances. There may be

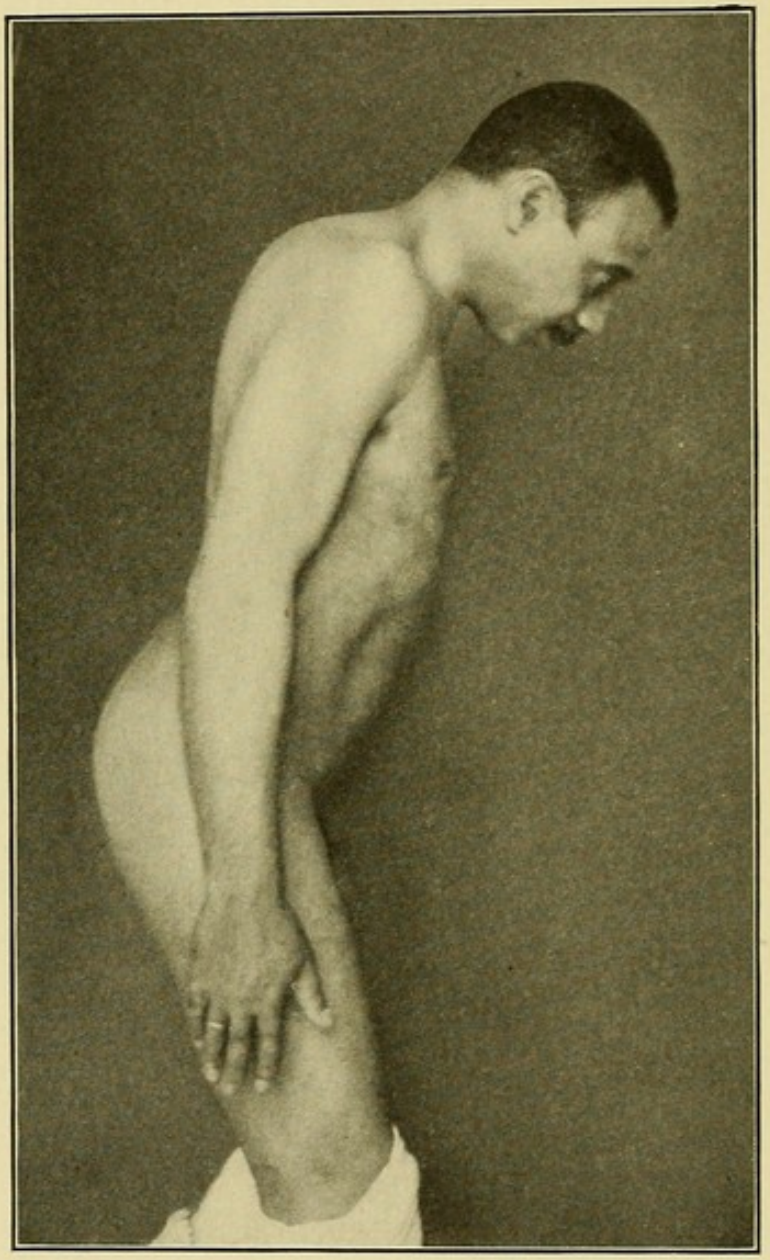


FIG. 108.—ANKYLOSING ARTHRITIS OF THE SPINE, HIPS AND ONE SHOULDER. THE DISEASE BEGAN AT EIGHT YEARS OF AGE. (Hospital for the Ruptured and Crippled.)

referred pains from nerve pressure, and abdominal breathing from ankylosis of the ribs.

In many of the early cases spinal support by jackets or braces, by allaying irritating pressure and friction, relieves the pain, and not infrequently, especially when combined with nutritious diet and tonic treatment, or the treatment of intestinal putrefaction (mineral acids and soured milk), shortens the morbid process and leads to a complete cure, so that all symptoms except local stiffness disappear, and the patient is able to go back to work. Antirheumatic treatment and a low diet are often harmful. When the process has run its course, and extensive ankylosis has taken place, there is little to be done so far as the spine is concerned.

Neurotic spine, while not pathological, is considered here for convenience. There is a large class of neurotics, many of them bed-ridden, and suffering from hysterical or neurasthenic symptoms, who attribute great importance to spinal pain, tenderness, and weakness. These patients in not a few instances have been sent to bed by their physicians, sometimes under a mistaken diagnosis of spinal, pelvic, or other organic disease, and they often remain in bed for years, in helpless invalidism, until, under the stimulus of some strong personality, medical or lay, their apprehension of imminent disaster is removed, and they will to make the exertion to get up. Lesser degrees of invalidism, combined with spinal weakness and backache, are very common; if an old lateral curvature is present, however slight, it is claimed to be proof positive of the spinal origin of the mischief. The pain in these cases is often severe and increased on exertion, and there may be spots of exquisite tenderness to slight pressure up and down the spine, over the pelvic

and other bony prominences, and in the iliac fossæ. Neurasthenic or hypochondriac symptoms, with or without intestinal indigestion, are usually present, while those of organic disease are lacking. These cases are in a pitiable condition and merit serious treatment, especially as the prognosis under rational management is very good.

Local treatment, including spinal support, is, as a rule, to be avoided. The patient should be assured of the curability of the condition, and trained in moderate and regular exertion. Mild tonics, massage, active and passive movements, nutritious diet, and other measures to improve digestion, nutrition, and elimination, should be prescribed. Of more service than any other one thing, except inspiring the patient with confidence and hope, and often giving brilliant results, is the use of a powerful vibrator, applied with moderate pressure the length of the spine on either side of the spinous processes in the interval between the arches, a few seconds at each spot. The tonic effect of this measure, when properly carried out, is usually prompt and surprisingly good. The symptoms complained of often disappear in a few weeks under moral support and proper training, and patients who have been utterly helpless, and even confined to the bed for years, have in numerous instances been restored to health and usefulness.

DEFORMITIES OF THE SHOULDER-GIRDLE AND UPPER EXTREMITY

GENERAL

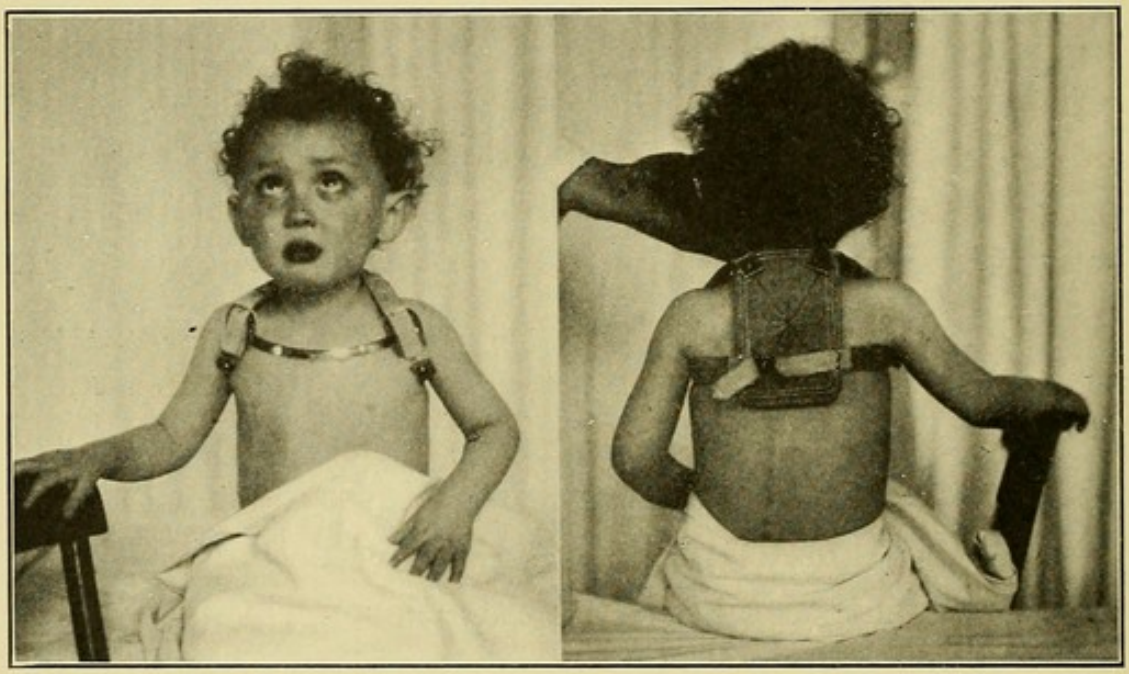
The upper extremity is characterized by its pendency, and by the variety and range of its movements; in a reasonably supple person there is no part of the surface of the body that is beyond the reach of the fingers. Many employments require free use of the hand and arm. It is particularly important in daily life that the head and face should be within reach of the hands; this can be done with the elbow flexed beyond a right angle, even if it is stiff. Many arm movements are made from the sterno-clavicular joint as a center, and the sliding of the scapula over the posterior thorax may compensate to a considerable extent for stiffness at the shoulder-joint. The absence of weight-bearing accounts for the less frequent occurrence of rachitic curvatures of the arm bones and of tuberculous affections of the joints of the upper extremity.

SHOULDER-GIRDLE

Clavicle

The clavicles may be partly or entirely absent on one or both sides. This deformity, however, is very rare. The shoulders drop forward and inward, but the disability is slight.

Fracture of the clavicle may occur from injury at birth. The clavicle may be chronically subluxated at its sternal or acromial end. In all these conditions, and in recent fracture in children and adults, C. F. Taylor's clavicle splint gives excellent results (Figs. 109 and 110). It consists of an adjustable curved steel band carrying a long pear-shaped pad at each end, to which the straps from a large stiff scapular pad are attached. It acts as a double clavicle, opposing the forward droop of the shoulders and the tilting of the scapulæ, and at the same



FIGS. 109 AND 110.—C. F. TAYLOR'S SPLINT FOR FRACTURED CLAVICLE.

time permits the free use of the injured arm. It has proved very satisfactory in practice.

Many fractures of the clavicle in young children show little or no tendency to displacement, and such cases require no treatment beyond the suspension of the arm in a sling, or, better, by a neck halter, or by pinning the end of the sleeve high up to the neck of the coat

or dress (Fig. 111). This management has been practiced by the writer in the majority of fresh fractures of the clavicle in young children seen by him, and gives as good results as any form of splinting with a minimum of confinement and discomfort.

Fig. 111.—Safety-pin Dressing for Fracture of the Clavicle in Children.

Scapula

The scapulæ vary greatly in size and shape in different individuals; many of these variations are unimportant, while others must be taken into account. Such are the length and position of the coracoid process, which sometimes impinges upon the tuberosity of the humerus, causing pain and irritation when the shoulder droops forward (Goldthwait).

Bowed Scapula.—In certain persons the scapulæ are bowed by the bending forward of the upper angle or margin, usually in adaptation to the droop-shoulder pos-

ture; the projecting part may cause pain by rubbing against the ribs, and may form an obstruction to correction of posture. The rubbing, which may be felt when the scapula is moved, was formerly thought to be due to a bursitis, but its true nature was pointed out by Goldthwait, who has obtained excellent results by excising the projecting part.

Goldthwait's operation for correction of bowed scapula is by removal of its upper portion. An incision three inches long is made just above and parallel to the spine of the scapula. In order to leave a less conspicuous scar, the incision in women may curve from the lower part of the scapula to near the acromion. The skin and fascia are dissected back to the attachment of the trapezius to the spine of the scapula; this attachment is divided for two inches from the inner edge. The supraspinatus muscle is exposed and scraped back from the part to be removed, and the tendon of the levator anguli scapuli is separated by the periosteal elevator, but not divided. Enough of the upper part of the scapula is then removed with the bone forceps to permit the scapula to lie flat in its normal position without rubbing against the ribs. The trapezius is sutured and the wound closed without drainage, and dressed with gauze and a bandage. The patient is usually up in a week, and using the arms in two weeks. Developing exercises and posture training should follow.

Congenital Elevation of the Scapula.—In this deformity (Sprengel's) the scapula and shoulder of the affected side are higher than normal; they have not fully descended from the higher position normal to the early

stages of development. The scapula may be small, and is so rotated that the inferior angle approximates the spinal column. The affection is occasionally bilateral, and may be associated with other congenital malformations. When unilateral there is often a cervico-dorsal lateral curvature of the spine convex to the affected side; there is no paralysis, and the movements of the shoulder-joint are free. In a few cases the upper part of the scapula is joined to the spine by a bony process, which may require excision. The disability for ordinary movements is usually slight, though the deformity may be considerable. Remedial gymnastics will sometimes effect improvement.

Forward shoulders is a better term than round or droop shoulders for the persistent forward posture of the shoulders determined by the position of the scapulæ; it is the characteristic posture of weakness and relaxation of the shoulders, and usually accompanies or is secondary to a weak and round back and general faulty development. It should be remembered that the center of motion of the shoulder, as a whole—not the shoulder-joint—is the sterno-clavicular joint, since this is its only articulation with the thorax. In forward shoulders, the muscles which bind the scapula to the spine and give it its only posterior support are relaxed and lengthened, and the scapulæ slide forward and outward. When this has persisted as the habitual posture for a long time, the serrati magni become contracted; the pectorals, contrary to received opinion, do not (Fitz). In extreme cases the coraco-clavicular and the acromio-clavicular ligaments may be shortened, and the scapulæ

may be bowed. The treatment includes proper hygiene, and the toning up and development of the muscular system in proper postures. Some inveterate cases may require forcible correction and retention, with straightening of the dorsal spine and approximation of the scapulæ. The treatment of the concomitant round back is often more important than the treatment of the shoulders. Posture must be corrected from feet to chin, not trunk or back alone, still less shoulders alone. This includes straight foot standing, and straight back standing and sitting, with stretching of the serrati and strengthening of the trapezii and rhomboidei. The ambiguity of the phrase "put your shoulders back" should be recognized and the phrase discarded, as the patient will not know whether he is desired to throw the whole upper thorax back, or to approximate the scapulæ. The former is the movement usually executed, and is, of course, noxious to posture. The command should be "bring your shoulder-blades together," if this movement is desired, and the trainer must see to it that this is done with the upper chest high and forward, and with a straight spine slightly inclined forward. When accompanied by a resistant round back, this will frequently need correcting and strengthening exercises, and occasionally corrective corsets or braces. Corrective exercises should always be added to mechanical treatment. (See Round Back.)

One prominent scapula is usually secondary to a dorsal rotary lateral curvature. The scapula and shoulder are elevated and prominent on the side of the dorsal convexity; that is, the side toward which the rotation takes

place, and on which the angles of the ribs are prominent. The scapula and shoulder are low and flattened on the concave side of the scoliosis. The treatment of the lateral curvature corrects or improves the posture of the shoulders. Prominent scapulæ may accompany round back.

A **winged scapula** is one whose posterior border and inferior angle are prominent from paralysis of the serratus magnus.

Acute osteomyelitis of the scapula may occur, and may require partial or total excision. If done subperiosteally the scapula may reform.

Exostoses occasionally require removal.

Shoulder

Congenital ankylosis of the shoulder is very rare.

In a case of **congenital axillary web** preventing free arm abduction, the writer made incisions as shown in

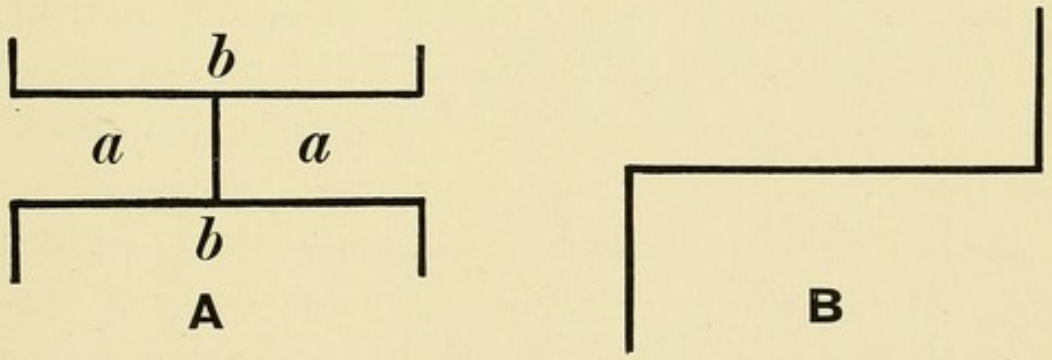


Fig. 112.—A. Incisions for Axillary Web; the Fold is Narrowed and Lengthened. B. Lengthening May be Accomplished with Less Narrowing by the Z-shaped Incision, with Dissection of the Flaps. (McCurdy.)

the cut (Fig. 112), excised the limiting bands, allowed the end flaps (*a a*) to retract, and brought the side flaps (*b b*) together. The result was excellent.

So-called **congenital dislocation of the shoulder** is also rare. What usually goes under this name is a displacement secondary to brachial plexus palsy.

Birth palsy is due to stretching or rupture, during delivery, of one or more of the cords of the brachial plexus, usually the one formed by the union of the fifth and sixth cervical nerves (Fig. 113). There is usually a history of difficult labor and instrumental delivery or manual traction. The baby's arm, in the usual type, is helpless at the shoulder, and often at the elbow, but the hand and fingers can be moved. The arm hangs by the side with the hand pronated. If the lower cords of the plexus are involved, the hand is also paralyzed. There may be some improvement, but there is usually considerable permanent disability, most severe at the shoulder, which may become partially fixed from

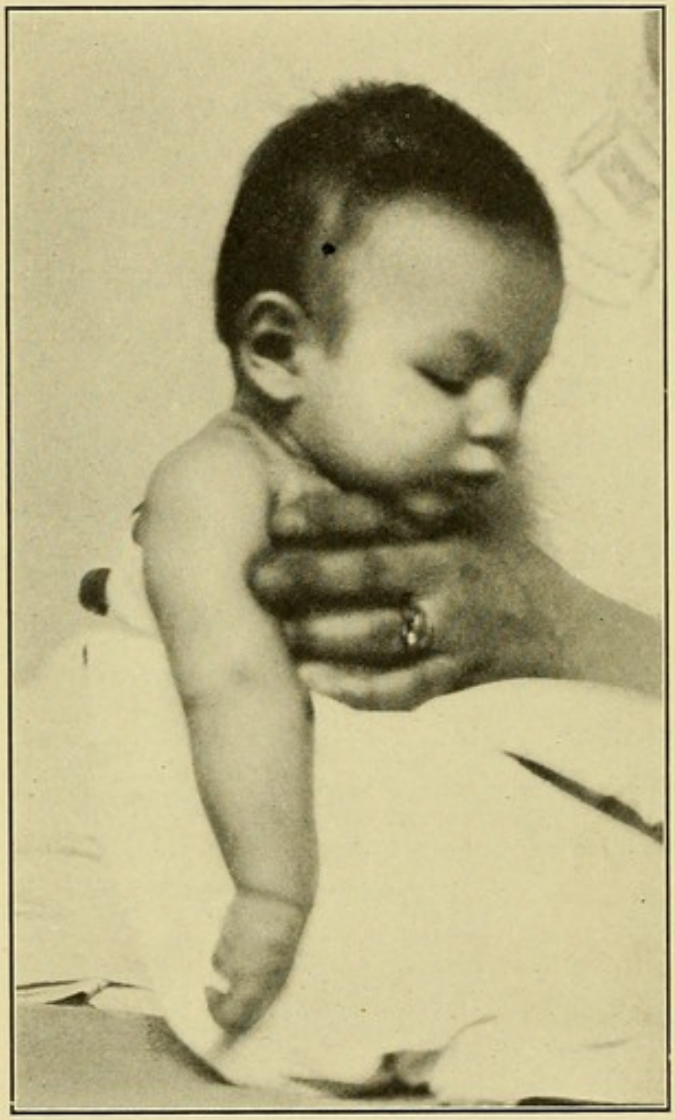


FIG. 113. — OBSTETRIC PALSY WITH FRACTURE OF SCAPULA; INFANT THREE MONTHS OLD.

adaptive shortening of the adductors and subluxated from continuous pressure on the capsule. The prognosis as to complete recovery is bad. The treatment is a sling at first, to relax stretched muscles and to correct deformity, passive motion after recovery from the injury, and motor education in the use of the hand and arm in grasping, feeding, and putting on clothes. Forcible correction of displacement, or to obtain better postures and to increase motion, or surgical interference, may be indicated in special cases. Suture of the brachial plexus has been done; the results, while somewhat encouraging, seem of rather slight practical value. Similar palsies occur in children and adults from dislocation of the shoulder and other injuries.

Dangle shoulder usually occurs in an arm atrophied from a previous attack of poliomyelitis. Muscular support being gone, the weight of the arm stretches the capsular ligaments, and drags the humerus away from the glenoid cavity. In such a case all the parts in and about the shoulder-joint, including the shoulder-girdle and arm bones, are much atrophied, and the deltoid and external rotators are practically destroyed. If the muscles which move the scapula are still intact, something may be done by an arthrodesis at the shoulder-joint so that the humerus may be moved with the scapula. If the trapezius is intact, its anterior border may be separated and transplanted into the humerus to take the place of the deltoid, or a strip from the pectoralis major may be attached to the trapezius. Owing to the extent of the palsy the result of these operations is usually mediocre.

Traumatic Conditions.—Dislocations of the head of the humerus and other injuries are often followed by a circumflex neuritis or palsy, with pain and weakness of the deltoid. Stiffness often follows fractures and other injuries near the shoulder, partly due to adhesions or thickening about the joint, but frequently to adaptive shortening of the anterior and posterior muscles which hold the arm to the side (adductors), with atrophy of most of the muscles which move the shoulder. It is sometimes difficult to decide, without an X-ray or narcosis, whether bony ankylosis is present. After recovery, massage, vibration, and passive motion are valuable to restore muscle tone and increase motion. Narcosis and forcible manipulation, taking care to fix the scapula, are sometimes indicated. One should not attempt to do too much at one sitting, lest the reaction do more damage than the mobilization does good. Active shoulder movements and creeping up the wall with the fingers may be beneficial afterwards. The use of light chest weights or pulley devices, and of the wand grasped by both hands, is often useful; also hanging from the trapeze, with the feet on the floor.

Recurrent Dislocation of the Shoulder.—It sometimes happens that the capsule of the shoulder-joint becomes loose after a dislocation, and that a slight movement of the kind which produced the original luxation will throw it out again. After several repetitions the shoulder is very readily displaced. A shoulder cap may be fitted to the shoulder and upper arm, and attached by straps under the opposite axilla. This prevents abduction of the arm, and allows the stretched parts to shrink. Goldthwait has

pointed out that shoulder movements are much more extensive in the forward or drooped posture; he recommends holding the shoulders back by an appliance in recurrent dislocations. When such means are insufficient the capsule may be tightened by excision of the redundant part, as in

Burrell's Operation for Recurrent Dislocation of the Shoulder

"The following technic is slightly modified from that of Burrell and Lovett. An incision is made from the coracoid process downward and outward, following the line of the cephalic vein to about the insertion of the deltoid muscle. The cephalic vein is drawn inward, and the intermuscular septum between the deltoid and pectoralis major is recognized and those two muscles separated by blunt dissection. The coraco-brachialis and short head of the biceps come into view in the upper end of the wound, and the insertion of the pectoralis major in the lower angle of the wound. The head and neck of the bone is then exposed by thorough blunt dissection. In order to do this it is necessary to carry the incision in its whole depth up to the coracoid process, and free carefully the tendons of the coraco-brachialis and short head of the biceps quite up to their origin on the coracoid process. The anterior and inferior aspects of the capsule are then exposed by developing the pectoralis major and latissimus dorsi and retracting them downward, and by dividing a portion of the subcapularis muscle and retracting it upward (Fig. 114). The arm should then be abducted from the body about thirty degrees. This pos-

ture allows the best exposure as well as best relaxation of the capsule. The loose part of the front and inferior aspect of the capsule is then grasped with three hemo-

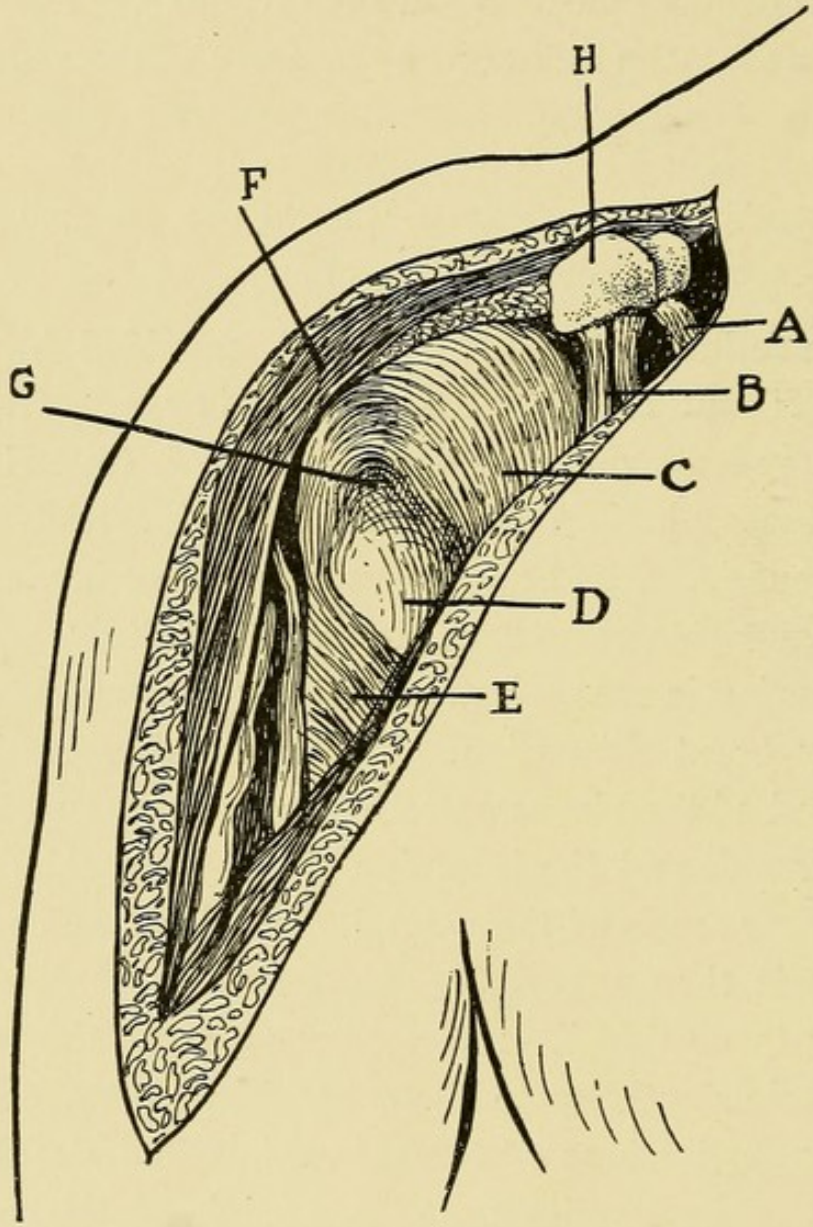


FIG. 114.—BURRELL'S OPERATION FOR RECURRENT DISLOCATION OF THE SHOULDER. A, Pectoralis minor; B, coraco-brachialis; C, subscapularis; D, humerus; E, pectoralis major and latissimus dorsi; F, deltoid; G, lower part of capsule; H, coracoid process. (*Albee in American Journal of Surgery.*)

stats. Three sutures of No. 1 chromic catgut are inserted with a curved needle beneath this fold of the capsule,

from which an elliptical piece one inch long and one half inch wide is excised between the placed sutures. When these sutures are tightened and tied it will be found that the capsule is distinctly shorter.

"A broad retractor without sharp points, to retract the coraco-brachialis muscle and vessels inward, is a great help. When the arm is brought to the side all the structures fall into place, and it is only necessary to suture the superficial fascia and skin. The arm should be held to the side with a plaster shoulder cap and a tight sling over elbow and forearm, to remove the weight of arm from the sutures, and should be retained in this splint for two weeks, when the plaster is removed and moderate passive movements begun. At the end of three weeks the sling should be discarded also, and both active and passive exercises begun. In five weeks the patient will usually be able to return to work" (Albee).

Isolated fracture of the greater tuberosity of the humerus is a rare accident from a fall on the shoulder or hand (Figs. 115 and 116). It is followed by a great deal of ecchymosis down the arm. Displacement is ordinarily not great, and a good result is obtained by simple immobilization of the shoulder in a sling or halter.

Juxta-epiphyseal fracture of the upper end of the humerus occurs oftenest from the tenth to the twentieth year. The upper epiphysis includes the head and both tuberosities, and these fractures are situated between the anatomical and surgical neck, and may be mistaken for a fracture of either or for dislocation at the shoulder, on account of the rounded upper end of the lower fragment. This is a difficult fracture to treat by the usual methods, and

even if reduction is accomplished there is a strong tendency to displacement. On account of the action of the muscles inserted into the tuberosities the fractured surface of the upper fragment is rolled upward and forward until further elevation is prevented by the impinging of the greater tuberosity on the acromion. This was observed by Albee in May, 1906, while operating on a

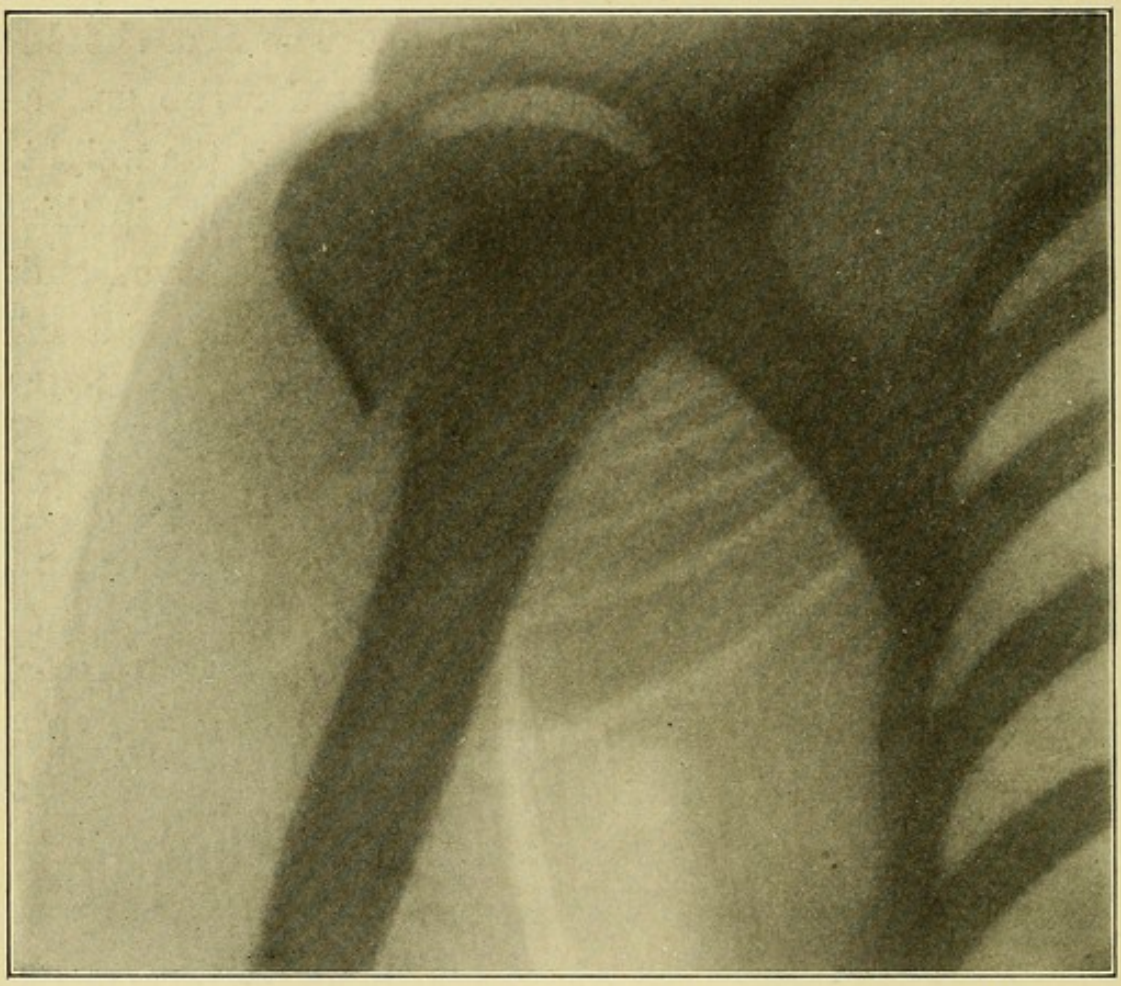


FIG. 115.—ISOLATED FRACTURE OF GREATER TUBEROSITY OF THE HUMERUS FROM FALL ON TIP OF SHOULDER; MAN OF FORTY-SIX. (Skiagram taken at Roosevelt Hospital four days after the accident.)

fracture of this type. As it was found difficult to roll the upper fragment downward, the lower fragment was aligned with it in an anterior horizontal position, slightly

rotated inward, and with the elbow flexed at a right angle. The arm and shoulder were held in place by a plaster spica reaching from the wrist to the waist (Fig.

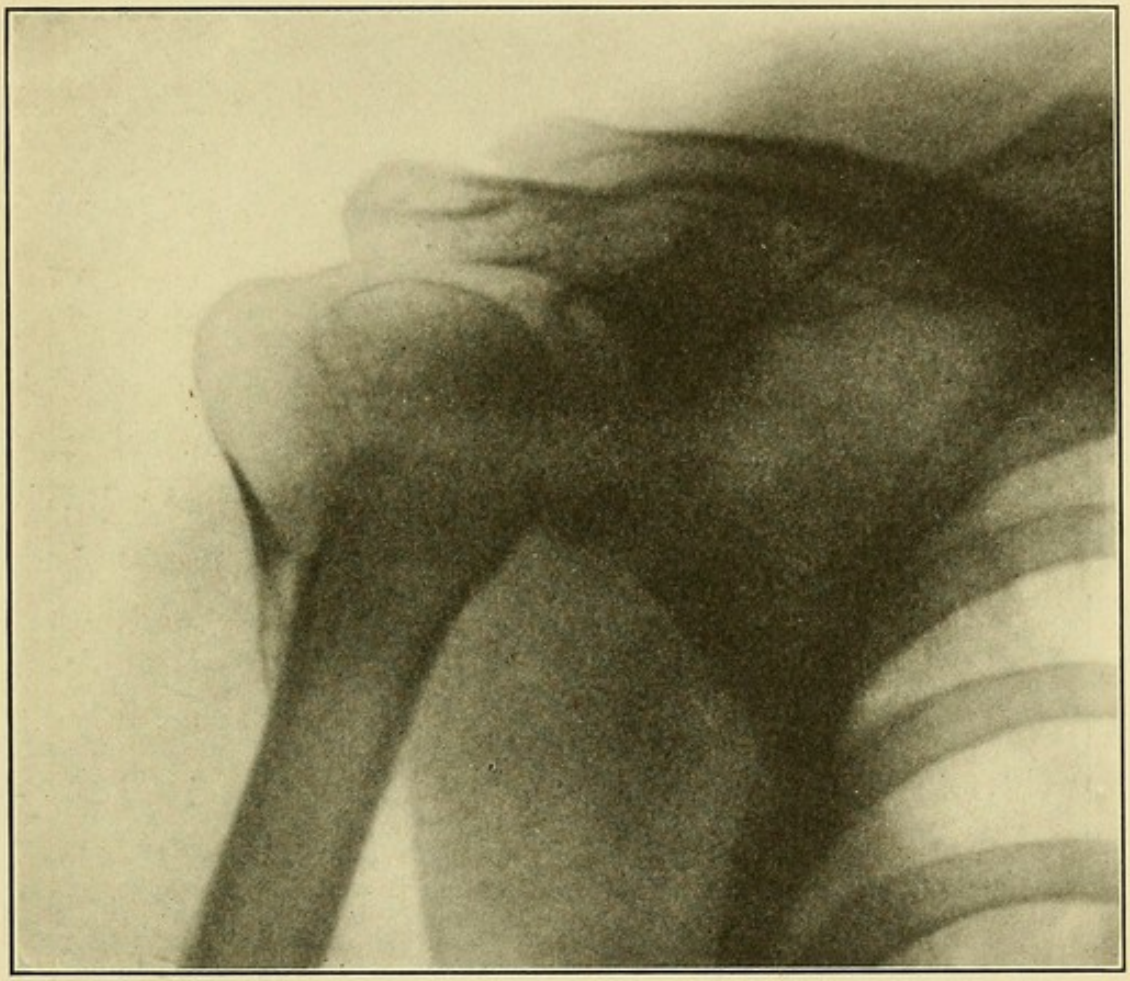


Fig. 116.—Same Shoulder Three and a Half Years Later, Showing Bony Union. The only treatment was support in a sling; function is perfect.

117). In this and a subsequent case the fragments have been easily held and the results excellent. The last patient won a swimming competition three months after the reduction (Albee).

Bursitis.—The subdeltoid bursa is as large as the palm of the hand (Codman), and is spread over the shoulder like an epaulet. There is a bursa under the acromion

which may connect with it. The subdeltoid bursa may become inflamed after injury or infection, causing pain

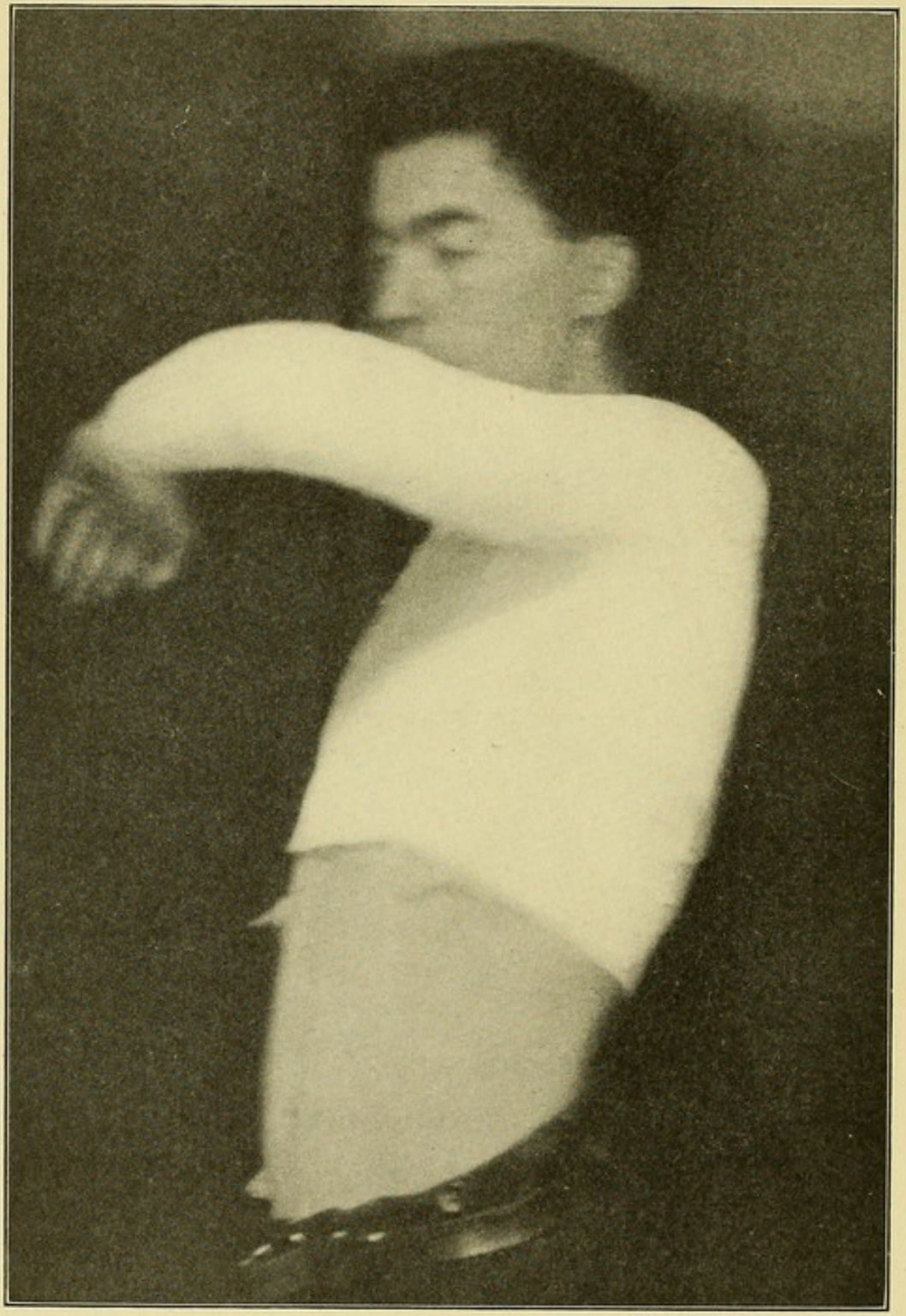


FIG. 117. — ALBEE'S POSTURE FOR JUXTA-EPIPHYSEAL FRACTURE OF THE UPPER END OF THE HUMERUS. (From *The Post Graduate*, June, 1908.)

and swelling over the top of the shoulder and restricting motion. In its active stage rest and counter-irritation by iodin is indicated. The arm should be kept abducted. To combat the subsequent stiffness forcible manipulation may be needed, though many cases yield to vibration and passive and active movements. In obstinate cases the bursa may rarely be opened and cleared of adhesions through an open incision (Codman), or it may be excised (Baer). The subacromial bursa may become inflamed from the pressure and rubbing of the tuberosity of the humerus in the droop-shoulder posture. This may give rise to pain and disability, and may be relieved by holding the shoulders back by a back brace or shoulder straps (Goldthwait).

Infections and Trophic Changes. — The shoulder may be infected by pus cocci, gonococci, syphilitic and tuberculous microbes, and may be the seat of "rheumatoid" affections. The treatment is the treatment of the primary condition, and immobilization of the shoulder. The latter is often sufficiently accomplished by the Thomas wrist halter, by which the wrist is elevated and suspended from the neck. Pus joints require incision. Arthritis deformans of the shoulder may come on slowly or rapidly without known cause, or after an injury. There are pain and increasing stiffness and more or less grating, but no tendency to suppuration. The treatment is rest, if symptoms are acute, passive movements, vibration, and measures to increase local circulation and nutrition in the inactive stage.

Fibrous Ankylosis.—In the stiffness following shoulder inflammations, one should be careful not to begin painful

movements too early or to push them too far or too rapidly. When the joint becomes stiffer after exercise or manipulation these should be interrupted or reduced, as harm is being done. Exercises similar to those recommended in the first part of this section are often useful. Forcible manipulation under ether is sometimes required.

THE ARM

Deformities of the Shaft of the Humerus

The humerus may be congenitally short or wholly or partially absent (phocomelia). Deformities from badly united fractures may require manual or instrumental correction (Thomas wrench) within a few weeks of the injury, osteotomy if older.

Deformities of the Elbow

Congenital luxations of the proximal end of the radius may occur forward, backward, or outward, and are occasionally bilateral. Luxation of both bones of the forearm is rare, and of the ulna alone unknown. Motion at the elbow is diminished, the ends of the bones may be deformed, and growth impeded. In early cases, repositions may be attempted. Function will usually be improved in the older cases by excision of the head, and sometimes of a portion of the shaft of the radius.

Congenital stiffness of the elbow is rare. **Abnormal looseness,** especially in hyperextension, is more frequent. In **cubitus valgus** the forearm deviates outward (radialward), in cubitus varus toward the body (ulnaward). The latter is common after fractures of the internal condyle,

and may be corrected by an osteotomy above the elbow. According to Thomas, fractures about the elbow, except fractures of the olecranon, should be treated with the

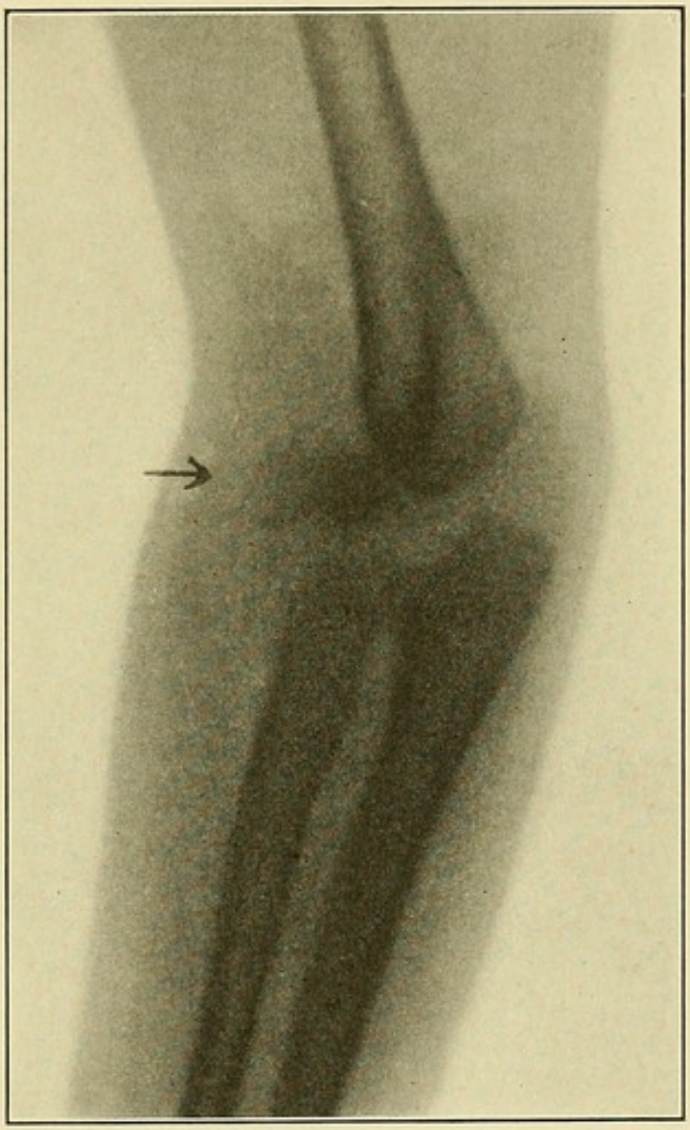


FIG. 118.—DETACHMENT OF EXTERNAL CONDYLE PRODUCING A STRAIGHT ARM WITH VERY LITTLE MOTION; BOY OF FOUR. Removal of fragment by Albee eight weeks later; result, perfect motion.

elbow flexed beyond a right angle. If stiffness should result, this is the most useful posture. Some authorities, however, report excellent results in condylar fractures from splinting in the extended posture if the fragments

are first carefully reduced and maintained. Injuries about the elbow may be followed by osteomata interfering with motion, which may require removal, as do sometimes displaced fragments of bone (Fig. 118), exuberant callus, and floating bodies, broken from the olecranon or coracoid process.

Bursitis.—There are some fifteen bursæ about the elbow, several of which are clinically important. The subtendinea and intratendinea olecrani may become irritated after heavy work, also in lawn-tennis players (Lloyd); they are also liable to tuberculous and other infections, when the olecranon may become secondarily diseased. The radio-bicipitalis bursa may become irritated in golf players (Lloyd) and others, giving rise to a tender, elastic swelling in front of the radius near the insertion of the biceps.

Rest, counter-irritation, and pressure are usually curative in simple bursitis. In tuberculous or pus infections the bursa should be opened and scraped out, with adjacent diseased tissue.

Infections of the elbow-joint are treated as elsewhere by incision and drainage if purulent, by immobilization if tuberculous (Fig. 119), by massage, douching, and electricity if "rheumatoid." Inflammations of the elbow, wrist, hand, and even of the shoulder, may be treated by Bier's method of venous congestion. Molded or circular plaster splints may be used for immobilization, or the wrist halter may be used, or the sleeve pinned up with a safety pin. Excision is occasionally useful to remove extensive disease, or to mobilize an elbow ankylosed in a bad posture. The result is usually a movable,

and sometimes a flail, joint. Murphy reports good results from arthroplasty.

In the cured cases measures to improve local nutrition and judicious active and passive movements to increase mobility are of use. Operations to overcome a moderate degree of flexion are not indicated, since this does not interfere with practically full use of the arm. Jones cuts out a large diamond from the skin at the bend of the elbow, and sews the upper and lower halves together in order to hold a paralyzed and loose elbow in the flexed position, so that the hand may still be used.

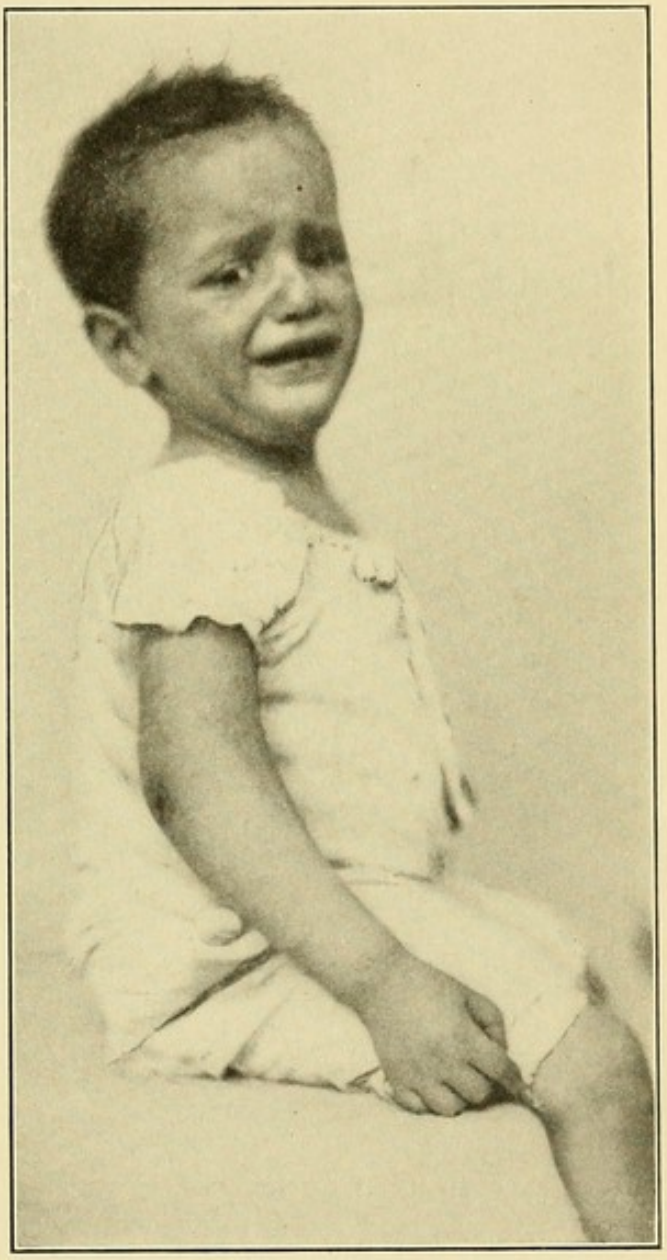


Fig. 119.—Tuberculous Elbow with Sinus.

Persistent pronation from overaction of the pronators after paralysis of the supinators in obstetric and other forms of arm palsy may be obviated by dissecting the pronator teres loose from its origin on the

internal condyle and neighboring parts and suturing it to the external condyle (Hoffa). Its action may also be reversed by detaching its insertion from the radius, passing it through the interosseous septum, and again attaching it to the radius.

Deformities of the Forearm

Congenital Deformities.—Absence of the ulna is rare. Absence of the radius, complete or partial, on one or both sides, is occasionally seen (Fig. 120). In the latter condition the ulna is short and bent, the hand deviates

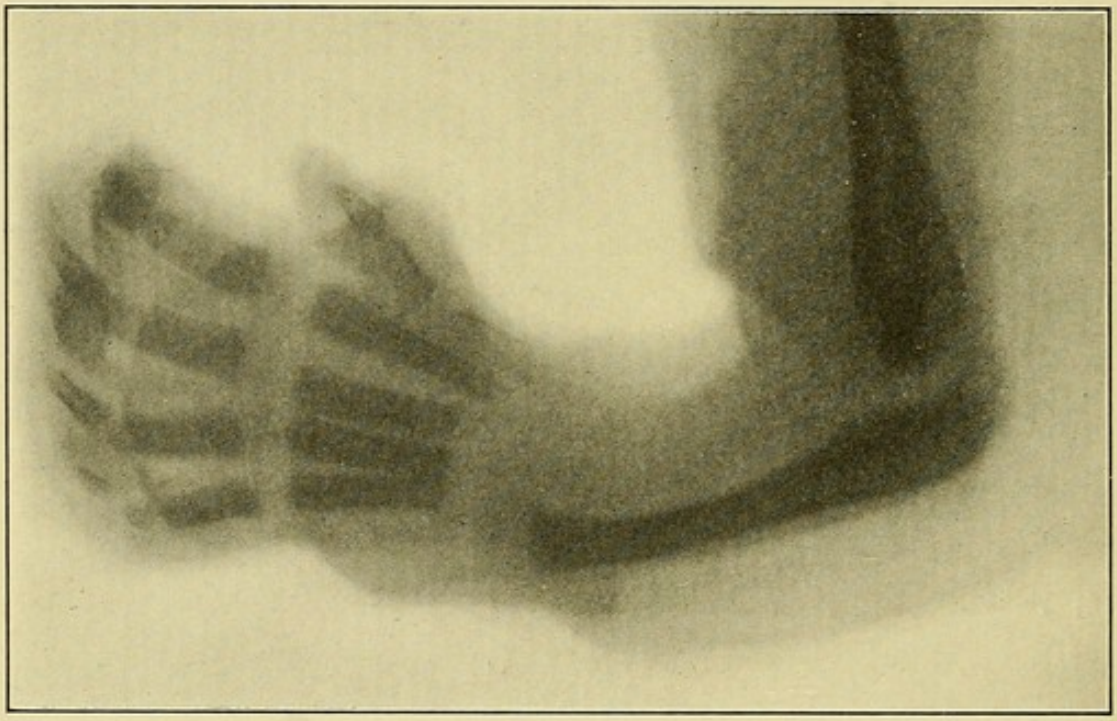


Fig. 120.—Absence of Radius, Both Sides; Girl Fifteen Months Old. (Skiagram by Martin.)

to the radial side, and one or more digits may be absent from the radial side of the hand. In spite of the severe deformity, these persons sometimes use the hands so skillfully that it is doubtful if the condition is much im-

proved by implanting the ulna into the carpus, as has been done.

Deformation of the forearm after fractures may require correction. In the green-stick fracture of children the necessary correction may be made with the hands. Deformity after Colles's fracture, if not too old, may be adjusted by the hand or by the Thomas wrench; in old cases by an osteotomy.

Manus valga or vara may be produced by bending or unequal growth of one of the bones of the forearm from rickets, osteomyelitis, fractures, osteochondromata, and other causes. Osteotomy or the excision of a piece of the longer bone is sometimes indicated to correct the deformity.

Deformities of the Wrist and Hand

In the **lobster-claw** deformity there are two large digits and the hand is split. Certain carpal and metacarpal bones and digits may be absent when the radius or ulna is deficient; the hand is bent toward the side of the missing bone.

Congenital dislocation of the hand forward or backward is a rare condition.

Congenital club-hand corresponds to club-foot, and sometimes accompanies it, but is much rarer. The deflection may be dorsal, palmar, radial, or ulnar. It is due to the pressure of the uterine walls. Gradual correction by aluminium, plaster, or other splints is usually possible. Some forms of club-hand are due to absence of the radius or ulna.

Spontaneous subluxation of the hand forward is an unusual deformity occurring most frequently in girls who work hard with the wrist flexed, particularly washerwomen; it may be unilateral or bilateral, and may rest

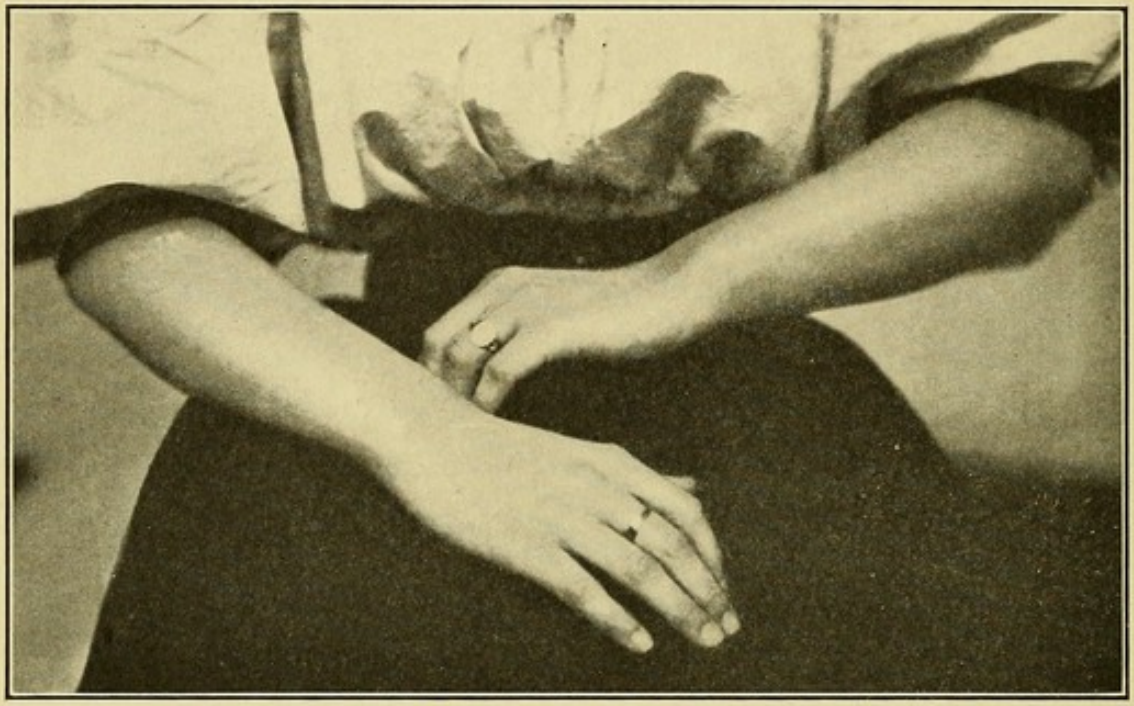


FIG. 121.—DISLOCATION OF HANDS FORWARD BOTH SIDES; GIRL OF EIGHTEEN; OLDER SISTER HAS SAME DEFORMITY.

on a congenital basis (Fig. 121). There is a change in the plane of the radio-carpal joint, caused by absorption at the volar edge, and by curvature of the lower end of the radius with volar concavity. The wrist is broadened, and the distal epiphyses of the radius and ulna are prominent at the back of the wrist. The hand is displaced forward, and often deviates laterally; the flexor tendons are prominent. Wrist extension is limited, and often painful. At the beginning of the process heavy wrist work should be interdicted, and the wrist put at rest by strapping or a light splint. In advanced cases the wrist may be manipulated and put up in moderate extension.

Obstinate cases may be corrected by osteotomy of the radius or readjustment at the proximal carpal joint.

In **spastic palsies** and **hemiplegia** the elbow and hand are often flexed and the hand deviated to the ulnar side. In paralysis of the extensors the hand drops into the posture of flexion, and there is often accommodation shortening of the flexor muscles and ligaments, preventing

FIG. 122.—ALUMINIUM WRIST AND HAND SPLINT; THE PATIENT HAS TUBERCULOSIS OF THE WRIST.

passive correction. The flexed position at the wrist renders the hand almost useless, as the flexors cannot be used in this posture. Stretching and splinting by the

cockup (Thomas) splint (Fig. 122) may correct this deformity, and if the paralysis is temporary the extensor muscles may regain their tone. In other cases it may be necessary to divide the palmaris longus, and to lengthen the carpal flexors. The extensors may also be shortened. In not too severe cases with flexion and ulnar deviation an excellent result may be obtained by shortening the radial extensors of the carpus, and splinting the hand in the overcorrected posture. In cases of permanent palsy of the extensors with carpal flexion, one or more of the superficial flexors may be brought through the interosseous space, and stitched to the extensor tendons. Improved posture is usually secured, but the functional results of this operation are not very brilliant.

Volkmann's Ischemic Palsy.—The pressure of splints or constricting bands may be followed by nerve lesions and fibrous degeneration of the muscles near the site of the injury. Permanent paralysis with flexion of the wrist and fingers of severe grade (claw-hand) may result (Fig. 123). Operations to free the nerves from their fibrous envelope are sometimes indicated, but are complicated in many instances by the degeneration of the muscles themselves. Tenotomies and lengthening of the shortened tendons and even excision of one or two inches of the shafts of the radius and ulna have been done to correct the deformity, but the ingenious method of splinting in stages advised by Robert Jones makes such operations unnecessary. With the wrist fully flexed small splints are first applied to the palmar surfaces of the fingers; after these are straightened the fingers and metacarpus

are splinted and only after the hand and fingers are straight is the wrist attacked by a long palmar splint. This method has recently proved entirely successful in

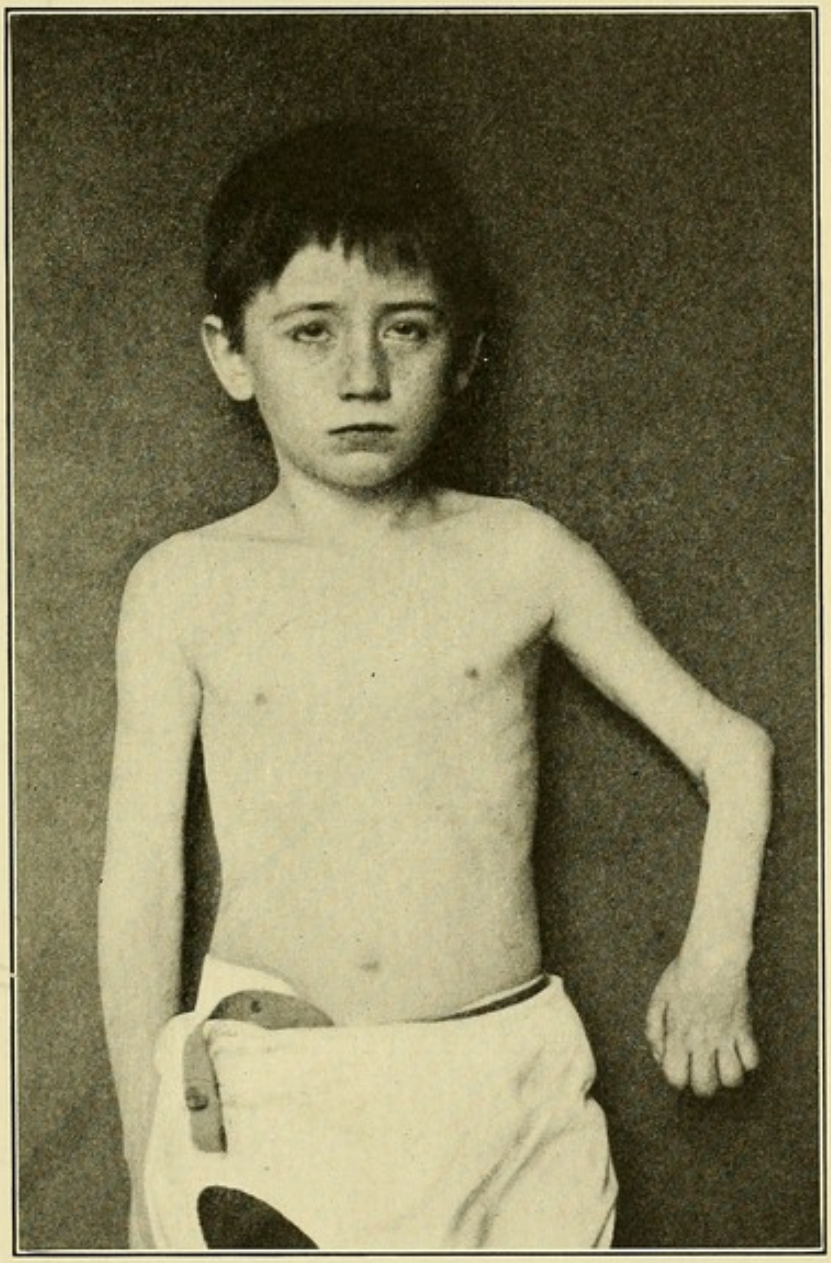


FIG. 123.—ISCHEMIC PALSY FOLLOWING TIGHT DRESSINGS FOR FRACTURE INVOLVING THE ELBOW.

an obstinate case of the writer's who used a splint of aluminium made from tracing the hand with slightly spread fingers. This was bent to the deformity, each

finger strapped to its splint with adhesive plaster, and the hand plate held in place by a strap over the dorsum. The finger pieces were gradually straightened, then the metacarpo-phalangeal region, the correction taking only a few days. Then an arm splint was riveted to the hand piece and the wrist forced down by a strap.

Ganglia of the wrist due to local collections of gelatinous fluid in a dilated bit of tendon sheath may be dissipated by rupture followed by local pressure. If on the dorsal aspect, the part is made tense by flexing the wrist and sharply struck with a book. A covered coin or wooden button is then placed over the part, fastened by adhesive plaster, and allowed to remain three weeks to prevent reaccumulation. Tuberculous and other intractable forms of bursitis will require extirpation. Small fatty tumors, simulating ganglia, occasionally occur near the tendons of the fingers and wrist, and should be excised.

Disease at the wrist-joint is treated on the same principles as at other joints; blennorrhagic involvement is not rare. Tuberculous infection requires prolonged fixation, but this joint, as well as the elbow, is suitable for the Bier congestion treatment. Mobilization of stiffened joints after the subsidence of operation is effected by vibration, massage, baking, electricity, and active and passive movements. If there is bony ankylosis with the wrist flexed, excision of the carpus or other bone operation may be indicated to correct the deformity; here, as in many locations, a deformed joint is worse than a stiff one.

Deformities of the Fingers

Redundant fingers (*polydactylism*) or parts of fingers should be removed during the second year.

Congenital absence of one or more fingers is usually associated with partial or complete absence of one of the bones of the forearm. The absent fingers are always on the side of the defective bone. Fusion of fingers may occur.

Fig. 124.—Congenital Web Fingers, Left Hand.

Congenital webs of the fingers (*syndactylism*) (Fig. 124) occasionally occur, and, like acquired webs from burns

or other causes, require a plastic operation to separate the fingers.

Congenital deviations of one or more end phalanges to the radial or ulnar side are occasionally seen, and may be corrected by small aluminium splints and adhesive plaster. The small finger may also be flexed. Both these deformities are hereditary in certain families. The flexion deformity may be corrected by a small padded splint of aluminium or other material, fixed in place by adhesive plaster. It may be shaped to the deformity at first, and gradually straightened.

Drop phalangette (Stern), or mallet-finger (Fig. 125), is due to a complete or partial rupture of the extensor tendon near its insertion into the base of the end phalanx. It may be produced by a blow on the end of the finger or by a forced flexion while the extensor is tense.

In recent cases the end phalanx should be forced into hyperextension by a small palmar splint, and the wrist and finger kept in extension to relax the tendon. In old cases, or where splinting has failed, the tendon should be attached to its insertion by a suture.

Stiffness of the fingers, either extended or flexed, the result of inflammation in the forearm, wrist, or hand, or in the finger-joints, is common, and is often combined with wrist stiffness. Very much can be done by persistence and thoroughness in many of these distressing cases. Baking, vibration, massage, electricity, and active and passive movements of the hand and arm are of great value after subsidence of inflammation. Indeed, it is possible in some severe cases to effect a cure. Flexed

fingers may be straightened by splints, and the straight fingers may be flexed by a stout glove, which carries tapes at the ends of the fingers, which are drawn through

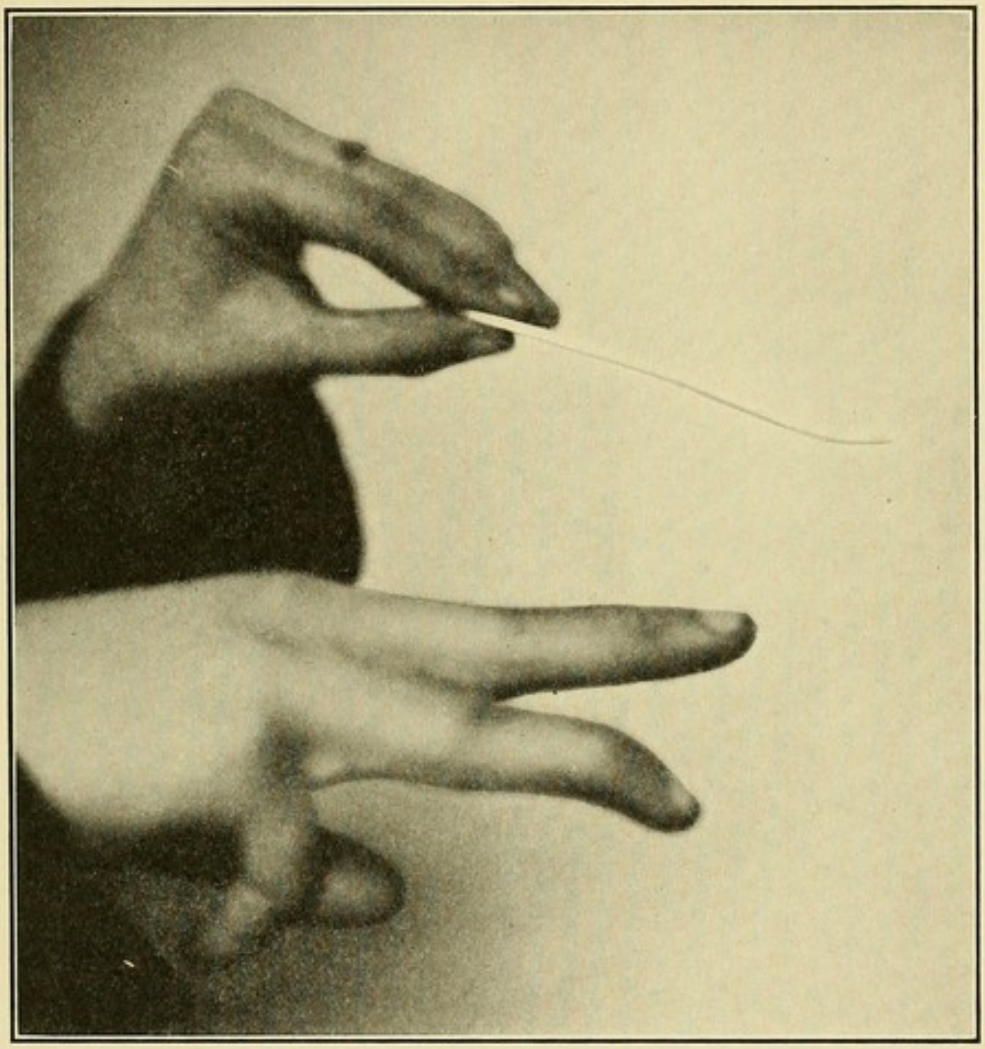


Fig. 125.—Aluminium Splint for Drop Phalangette.

rings fastened near the wrist (Krukenberg). Simply bandaging the fingers over a wad of cotton or a ball of yarn may be effective.

Dupuytren's contraction of the fingers occurs most frequently in middle-aged men (Fig. 126). It is caused by a slow inflammation and contraction of fibrous bands of the palmar fascia due to gout, diabetes, tabes, or

trauma, especially slight trauma frequently repeated, as in hard work with hand tools. Permanent flexion of one or more fingers results. The treatment is multiple subcutaneous section of the contracted bands, or their com-

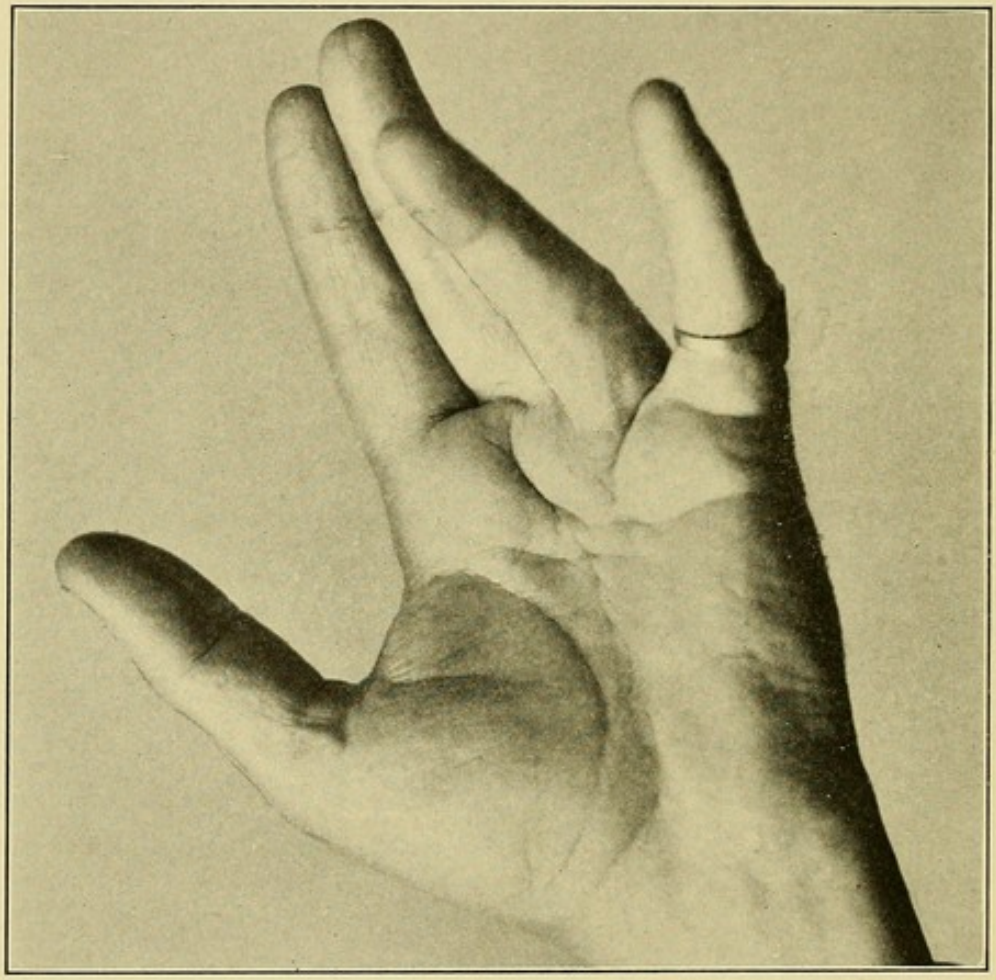


Fig. 126.—Dupuytren's Contraction; Ring Finger. (Phelps.)

plete excision, through open cuts, followed by correction and retention in the extended posture for two or three weeks. This is to be followed by massage and movements.

Krukenberg's finger deformity is a flexion deformity of the fingers with ulnar deviation and luxation of the extensor tendon into the metacarpal space. This deform-

ity occurs as a complication of arthritis deformans. When the luxated extensor contracts the two distal phalanges are extended and the proximal is flexed. It is sometimes advisable, if joint function is good, to cut a groove in the metacarpal head and replace the tendon.

In **trigger-finger** there is an obstruction at some point in flexion or extension, which is overcome with effort. When it is overcome the movement is suddenly completed with a jerk. This phenomenon is due to a thickening near one of the joints or in the tendon or tendon sheath, which may be due to injury, arthritis deformans, or certain occupations. It may in mild cases disappear spontaneously; other cases may be cured by wet compresses, vibration, massage, and movements, while obstinate cases can only be cured by removing the obstruction.

Professional Cramps.—Writers', pianists', violinists', telegraphers', and seamstresses' cramps are characterized by incoördination, pain, and weakness or spasm of the muscles of the forearm and hand, which have been habitually overworked, particularly by long-continued, finely adjusted movements. The pains and cramps are often so severe that the occupation causing them has to be given up. Spastic, paralytic, or tremulous symptoms may predominate. Delicate and neurotic people are most subject to these affections. Treatment is often difficult and usually prolonged, but frequently successful. The occupation causing the cramp must be given up until the cure is complete, or nearly so. Massage or vibration of the arm and upper spine, galvanization, and

muscle training, especially in the larger movements with tonic treatment, usually give satisfactory results. In writers' cramp the use of the typewriter is often of great assistance.

Hysterical contraction of the fingers and hands is sometimes severe. The treatment is the treatment of hysteria with such local treatment as may be necessary.

DEFORMITIES OF THE PELVIC GIRDLE AND LOWER EXTREMITY

AFFECTIONS OF THE PELVIS

Affections of the Pelvic Bones

The bones of the pelvis sometimes become infected by pus, tubercle, or other microbes, without the involvement of the hip-joint or spine. Such infections may be puzzling and difficult to treat, but the principles of treatment are those laid down in the general part. Secondary involvement of the pelvis is common in hip disease.

Affections of the Sacro-iliac Joints

Anatomy and Causation.—The sacrum is connected with the ilium on either side by well-developed joints covered by smooth cartilage, permitting a rocking motion on a horizontal axis passing through the middle (second vertebra) of the sacrum. These joints are held in place and protected by neighboring muscles and by very strong ligaments, which are less developed in front than behind. All the large movements of the trunk and lower limbs impose strains upon and cause motion in the iliac joints.[1] The motion at these joints is increased during pregnancy, parturition, and menstruation, and may become so excessive as to cause much pain across the

[1] The term "iliac" joint is proposed instead of the awkward and inaccurate "sacro-iliac synchondrosis."

sacrum, and disability in standing and walking; this looseness and disability may persist. Congestion, soreness, and looseness may accompany chronic congestion of the female pelvic organs, owing to the close relation of the blood and nerve supply.

It is important to realize that sacro-iliac affections are not confined to the pregnant state nor to women, but that these structures are subject to the same injuries and disorders as other joints, and give rise to definite and characteristic symptoms. A large and important group of sacro-iliac affections are traumatic, and these are more common in men. Falls, blows, twists, or heavy lifting may strain, sprain, or displace one or both iliac joints, or the injury may be due to a continued strain, as prolonged recumbency during fevers, after fractures or surgical operations, or to the strain of a heavy pendulous abdomen, or of affections causing limping or an unequal distribution of stress, such as scoliosis, hip disease or ankylosis, and other affections of the lower extremity, or of bad postures favored by certain occupations. The hypotonus of neurasthenia may result in sacro-iliac incompetence and hyperesthesia. It is often difficult here, as in other organs, to decide how much of the difficulty is purely functional and how much is due to structural change. When sacro-iliac relaxation is present, it exerts an unfavorable effect on the neurasthenia, as do even comparatively slight disabilities in other organs. In general lack of vigor, without neurasthenia, the weakness of the tissues, particularly if combined with faulty dress (high heels) or faulty postures (hollow back, overstraight back, weak feet), may result

in sacro-iliac strain. Lastly, the iliac joints are also subject to the usual infections and diseases of the large articulations. Primary tuberculous infection is rare, but may occur; secondary tuberculous infection is more frequent. Septic or gonococcic infection may occur as a puerperal complication or at other times, and typhoid and other specific infections are known. When the joint is infected there may be a boggy swelling in its vicinity, and an abscess may occur, which often breaks inside the pelvis. Osteoarthritis of the iliac joint, usually compli-

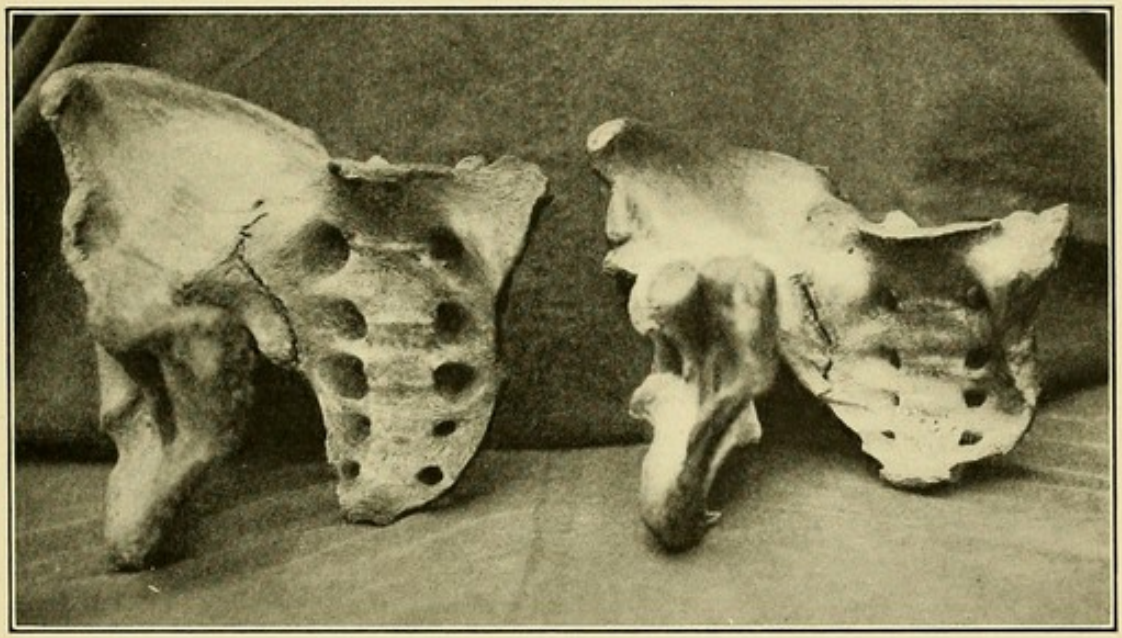


FIG. 127.—SYNOSTOSIS OF THE RIGHT SACRO-ILIAC JOINT FROM OSTEOARTHRITIS. The one at the left shows six sacral vertebræ. (The specimens are from Cornell Medical College.)

cating osteoarthritis of the spine, is not at all uncommon, and strains and injuries may result in local osteoarthritis, as in other joints. The osteophytes may cause a pseudo-sciatica or leg pain. The process often ends in ankylosis of the joint; such specimens are common in the museums (Fig. 127).

The **symptoms** are tenderness over the joint, pain near the joint or across the sacrum or lower back, and referred pain due to pressure on the important nerves passing

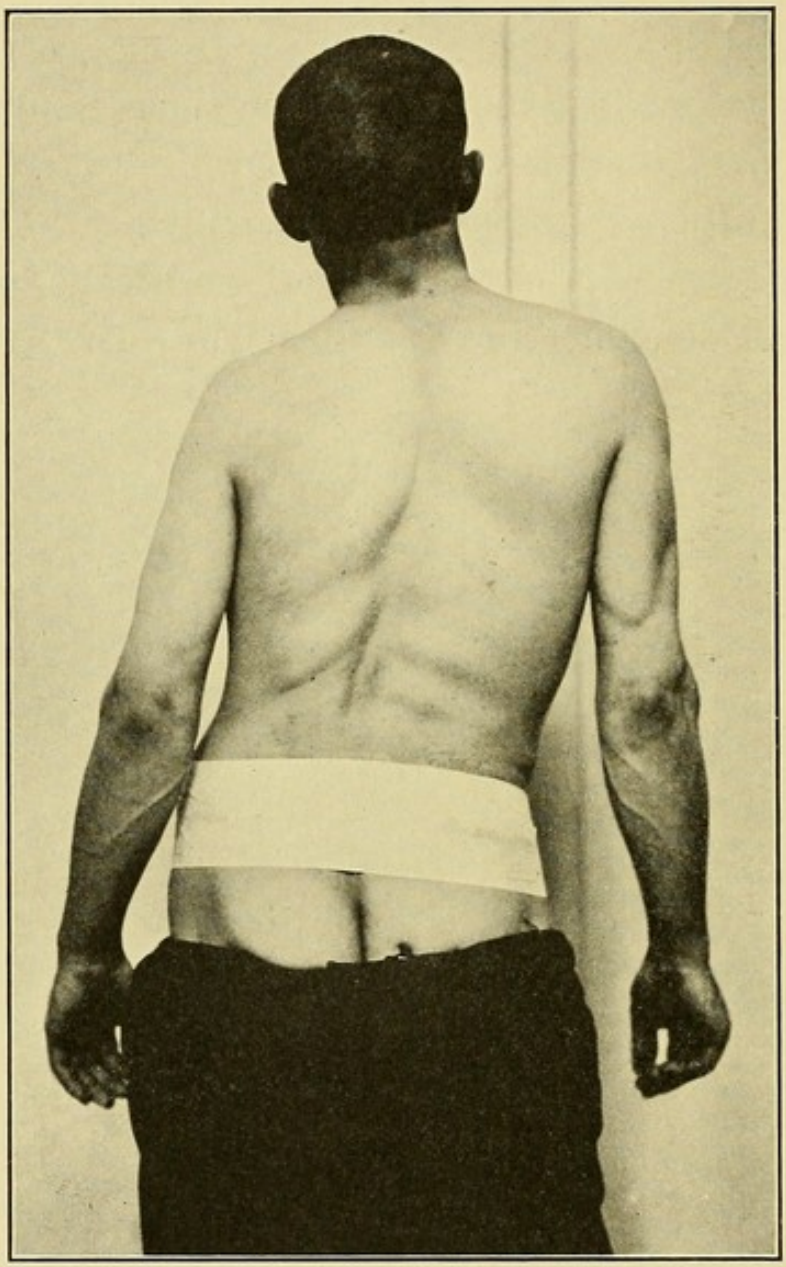


FIG. 128.—STRAIN OF LEFT SACRO-ILIAC JOINT WITH DEVIATION OF TRUNK TO RIGHT FROM A SNEEZE SIX WEEKS BEFORE. Pelvic strapping with adhesive plaster.

in front of the joint, namely certain cords of the lumbar and sacral plexus. The pains may be referred down the leg, to the gluteal region, to the hip, or to the region of

the iliac fossa and groin. Pain or discomfort may be felt in standing, sitting, and lying, and is aggravated when the patient changes from one posture to another. Pain at or near the affected joint is elicited when the patient is recumbent by flexing either thigh with the knee straight; the amount of flexion in this posture is also limited, more on the affected side. Movements at the hip with the knee flexed are usually free. Forward stooping and lateral trunk movements—indeed, any movements putting a severe strain on the iliac joints—may be limited or impossible. The weight in standing is borne on the well leg, and lameness is often present. In cases of long standing there is atrophy of the leg to palpation, and sometimes to measurement. There is frequently a marked curvature of the spine, with the convexity toward the well side (Fig. 128).

Diagnosis.—Sacro-iliac affections may be acute or chronic, mild or severe; they often incapacitate the patient from work, and sometimes render him helpless for life. The milder cases may be obscure and lead to serious errors in diagnosis, but may usually be made out after careful study. The acute traumatic cases are to be distinguished from lumbago, muscular rheumatism, and sciatica. In sciatica the pain follows the sciatic distribution, and there is tenderness over the nerve trunk; the symptoms are often relieved by recumbency, which is not the case in sacro-iliac affections. A sciatica may be secondary to sacro-iliac disease or displacement. In lumbago and muscular rheumatism the pain, tenderness, and stiffness are in the lumbar region, and more diffused. Crick-in-the-back is an indefinite term which may be ap-

plied to lumbago or to sacro-iliac strain. Sacro-iliac affections may be mistaken for ovarian, tubal, or uterine affections, and the two not infrequently coexist and exert an unfavorable reciprocal influence; the same may be said of neurasthenia. The lower abdominal and inguinal pains sometimes present in sacro-iliac affections have been mistaken for gall-stone colic and for chronic appendicitis. Chronic cases may be mistaken for disease of the hip or lumbar spine, but in hip disease motion at the hip is always limited, and there are usually malpositions of the thigh, a characteristic gait, and often shortening of the limb. In disease of the lumbar spine there is stiffness of that region, and often a projection, but osteoarthritis of the lumbar spine and of the iliac joints often coexist.

The **treatment** consists in pelvic support by a belt or corset, snugly adjusted above the trochanters. Strapping the pelvis just above the trochanters by several strips of two-inch zinc-oxid adhesive plaster, reaching beyond the anterior spines, will often give speedy and marked relief, which is of considerable diagnostic value. A wide webbing belt, fastened by one or two buckles in front, may be used; to prevent slipping upward it may be attached to the lower end of a long corset, and held down by garters. Often a long plaster jacket closely applied to the pelvis will be required. It is usually possible to relieve the pain and enable the patient to resume work. Occasionally a disability which has lasted for years will disappear as if by magic under pelvic support. Chronic uterine or ovarian disease and neurasthenia should be treated if present. Sacro-iliac

displacement may require reduction by special postures or manipulations, with or without anesthesia, before support is applied.

DEFORMITIES OF THE LOWER EXTREMITY

General Remarks

The structure of the lower extremity is more massive than that of the upper, and is adapted to support and propulsion; traces only of prehension remain. In the absence of active disease the disabilities of the lower limb—malposition, weakness, stiffness, and shortening—are of importance in the order given. A stiff hip in good posture, even if combined with some shortening, makes an exceedingly serviceable leg; the same may be said of the knee and ankle. A much flexed thigh or knee or extended ankle makes a very poor leg, even with motion and no actual shortening. The principal orthopedic aim in the management of affections of the lower extremity should be to prevent or correct deformity at the major joints, and thus retain or restore the supporting function of the legs. No matter how helpless a leg may be, it may always be straightened and braced or stiffened so that very fair locomotion is possible, provided the least affected leg is strong enough to stand on. In some cases where both legs are used as props, locomotion with or without crutches is still possible. If the fact be borne in mind that the fundamental function of the human leg is that of support, very few parts will be found to be indispensable. This is still further emphasized by the assumption of the function of the damaged part by other

structures. If one hip is stiff, the motion which properly belongs to it is so distributed between the lumbar spine, iliac joints, well hip, and knees, that if the posture of the thigh is good the loss is hardly felt in walking. In sitting and stooping, however, the embarrassment is considerable, as the necessary wide range of hip motion cannot be fully compensated. In total paralysis of the quadriceps good locomotion without artificial support is often possible, either by mechanically locking the knee back like a carpenter's rule, or by extension of the femur on the pelvis through contraction of the glutei, which, when the foot is on the ground, necessarily extends the knee; the danger in these methods of locomotion is that the knee may become hyperextended. In amputation the supporting power of the stump and of the rest of the limb is to be largely considered. Many amputations, especially of the foot, leave a stump affording poor support, and are therefore unserviceable. The best posture for a stiff hip is with a flexion and abduction of ten to fifteen degrees; for the knee, also, slight flexion is desirable, but on account of the danger of increase of flexion the knee is usually put up straight after an excision; the foot may drop slightly below a right angle in order to allow for the heel of the boot, but abduction and eversion should be avoided.

Deformities of the Hip

Congenital dislocation of the femoral head is the commonest congenital dislocation; it is six times more frequent in girls than in boys, and is oftener single than bilateral. The subjects of this deformity are, in the large majority

of cases, otherwise perfectly formed and without inherited tendency, though exceptions to both of these statements occur.

Etiology.—In a few cases there is a general looseness of the ligamentous structures of the body. Rare instances are due to trauma at birth; these are, strictly speaking, not congenital but acquired dislocations. The large majority of the cases seem to be due to a forced posture of the lower limbs *in utero* due to scanty amniotic fluid or other causes. In posterior dislocations the thighs are kept flexed and adducted, and the heads are forced against the posterior superior part of the capsule, which gradually yields and allows the head to slip out of the socket; in many cases, however, the dislocation is anterior or superior. In the female the acetabulum is placed farther to the side, thus favoring luxation.

Pathological Anatomy.—With the femoral head displaced, the acetabulum is not fully developed, but remains shallow, narrow, and of irregular shape; the upper rim is especially defective. The changes in the joint structure are slight at birth, but increase with age, and more rapidly after the child begins to walk. Some authorities state that the dislocation is at first upward, and that it changes by degrees into the posterior displacement. There is always an acetabulum in approximately its normal location (Fig. 129). Sherman, who advocated arthrotomy and incision of the capsular stricture as a routine measure, states that the acetabulum is nearly always sufficiently capacious to retain the replaced head without the necessity of enlargement. The head is usually larger than the acetabulum, and more or less flat-

tened or deformed; the neck is usually anteverted so as to evert the limb. The ligamentum teres may be lengthened, enlarged, or absent. The capsule in time becomes

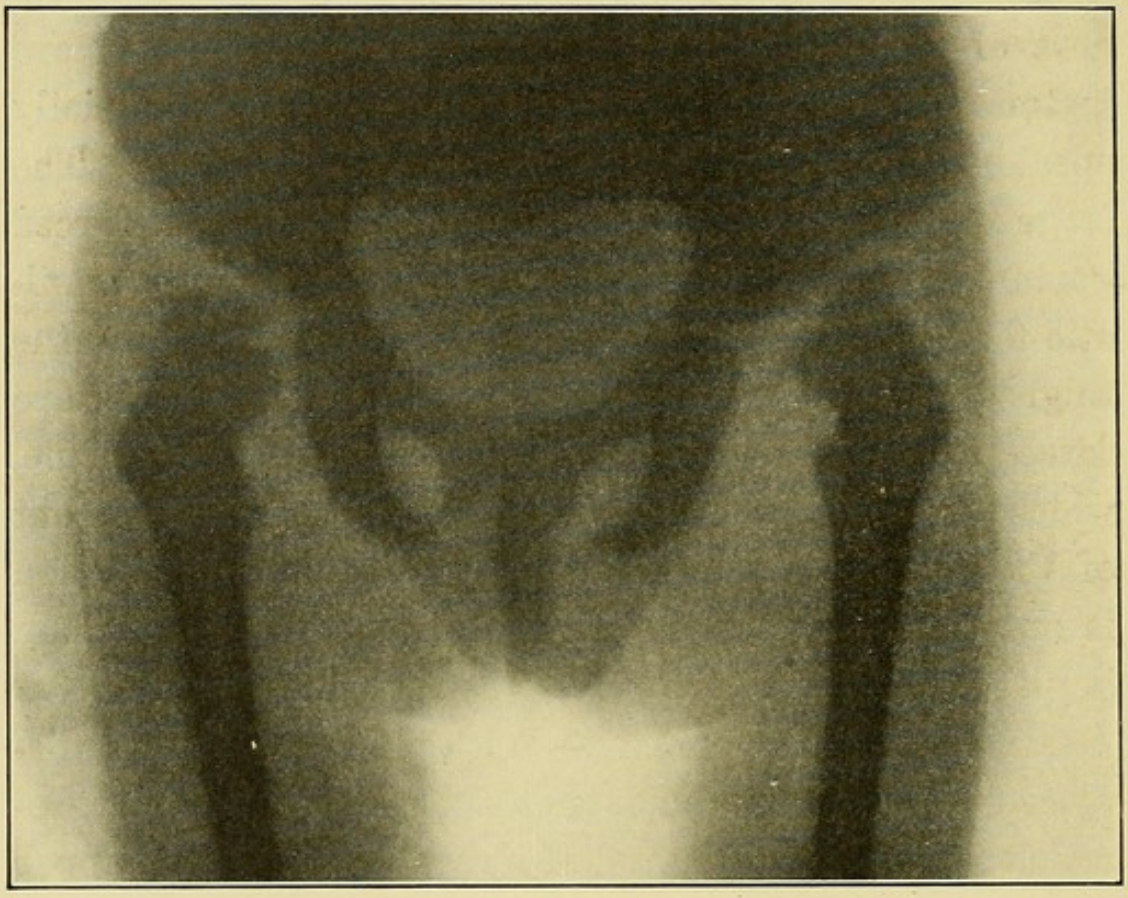


Fig. 129.—Congenital Posterior Superior Dislocation of the Right Hip in a Girl of Four. This was easily reduced under ether; the head remained in the socket after three months' retention in plaster.

elongated and thickened; if there is much displacement the upper part is wrapped about the head like a hood, while the lower part is drawn over the acetabulum, forming a pocket or hymen; the part between is constricted (hour-glass contraction), and may be adherent to the parts to which it is applied. The pelvis is atrophied on the affected side in old cases.

The pelvi-trochanteric muscles, whose direction crosses that of the femur, are lengthened and atrophied. The

adductors and pelvi-crural muscles running parallel to the femur are shortened. Even in the older cases there is seldom much shortening of the limb, except that due to the displacement. In some of the very old cases the head may rub through the capsule, and form a near-throsis.

Symptoms.—The first symptom to attract attention is usually a painless lameness when the child begins to walk. This is usually about eighteen months of age, sometimes later. If one-sided, the instability and displacement (shortening) of the leg cause an unsteadiness or limp on the affected side. The shortening and upward displacement of the trochanter are slight at first, often not over a quarter to half an inch, but increase with the stretching of the capsule, until in children of eight or ten it may amount to two inches or more (Fig. 130). The trochanter is prominent on the luxated

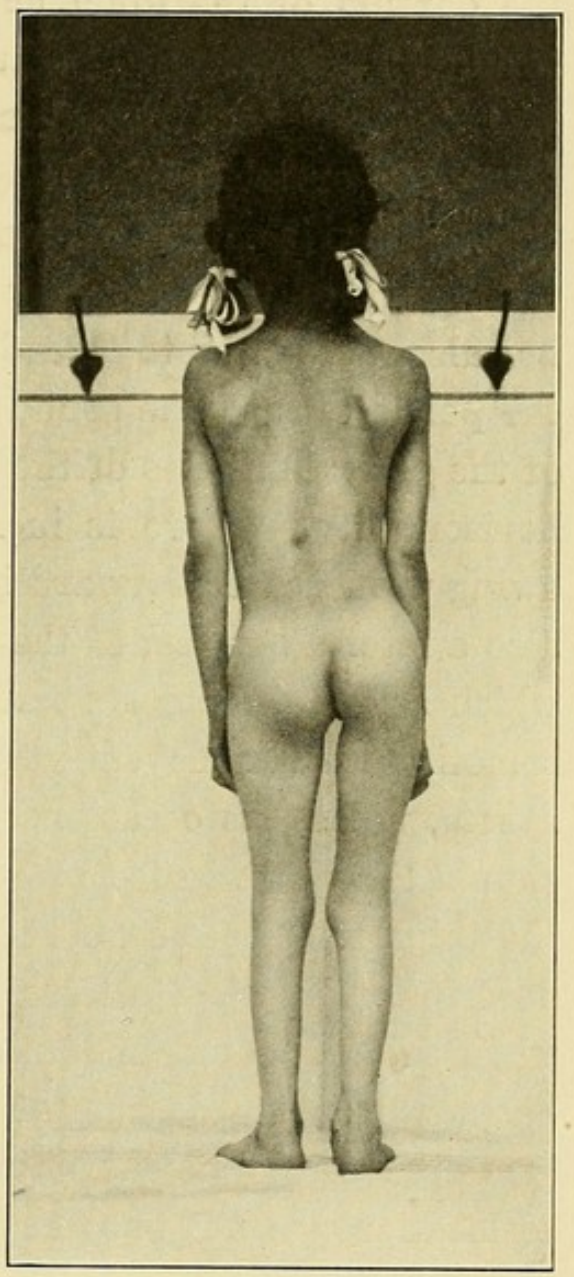


Fig. 130.—Congenital Posterior Dislocation of the Left Hip in a Girl of Eight. Left trochanter 1¼ inches high, and the left leg is short by the same amount. Notice compensatory spinal bending without rotation.

side, and rises above Nélaton's line by the amount of the shortening. If with the child lying on its back the leg is grasped above the knee and the thigh flexed, adducted, and rotated, the head may be felt moving on the dorsum of the ilium under the fingers of the free hand. In the extended posture the trochanter and femoral head may be forced up and down on the pelvis (pumping or telescoping).

The limp is caused not only by this telescoping, when the weight of the body is put upon the dislocated hip, but also, according to Trendelenburg, by the sagging of the pelvis toward the sound side, owing to the inability of the gluteal muscles of the affected side to preserve its horizontality. There is increased lordosis in standing owing to increased forward inclination of the pelvis, and also a lateral bending of the spine toward the short side, which seldom becomes a fixed scoliosis. Abduction and sometimes other movements are limited, but there is no spasm, unless, as occasionally happens, the luxated hip should become infected or irritated. In the older cases the thigh may become flexed and adducted. The above description applies to the majority of the cases, which, when brought for examination, are luxated upward and backward on the dorsum of the ilium.

Cases of persistent anterior, and of supracotyloid, dislocation are not uncommon. In the former the head is felt below or to the outer side of the anterior superior spine of the ilium. This position is much more stable than in the posterior dislocation; there is less telescoping, less lameness and disability, and less tendency to increase of shortening, and as the weight is carried over

or in front of the acetabulum there is no lordosis. In an anomalous case of anterior displacement reduced by the writer, the child was born with the foot behind the

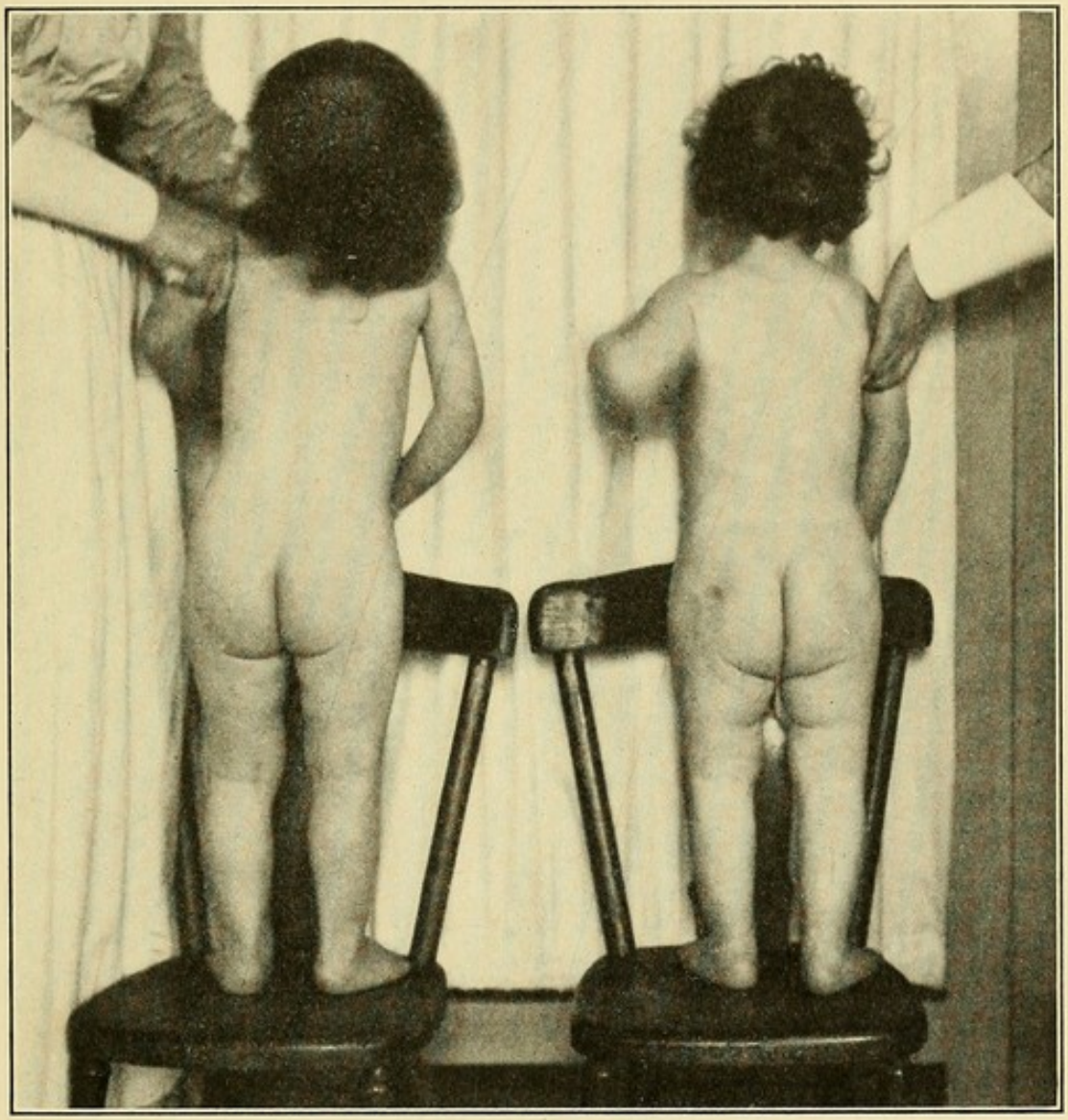


FIG. 131.—THE CHILD TO THE LEFT IS A GIRL THREE YEARS OLD; SHE HAS AN ANTERIOR DISLOCATION OF THE RIGHT HIP. THE BOY TO THE RIGHT, TWO YEARS OLD, HAS A BILATERAL UPWARD DISLOCATION.

opposite buttock, and there was paralysis with permanent flexion of the knee, pes equinus, and interference with the growth of the leg, probably from a birth injury to the sacral plexus. In certain of the supracotyloid cases

the head easily passes to the dorsum when the thigh is flexed (Fig. 131).

In bilateral dislocation of the hip the symptoms are present on both sides. If the displacement is equal the legs will be of equal length, and the shortening is measured by the displacement of the trochanters above Nélaton's line. Not infrequently one hip is more displaced than the other, and there is then a difference in the length of the legs. It is also to be remarked that the skiagram may reveal a narrow rim or a slight subluxation on the side opposite to the luxated hip in apparently unilateral cases. Such hips may slip out during the treatment of the luxated side. Viewed from in front or behind, the legs seem short and the hips abnormally broad. Lordosis is more pronounced than in unilateral dislocation, and the disability is greater. Abduction is more restricted. In a case of bilateral supracotyloid dislocation in a girl of twelve, the legs were crossed above the knees—scissors deformity—and progression took place

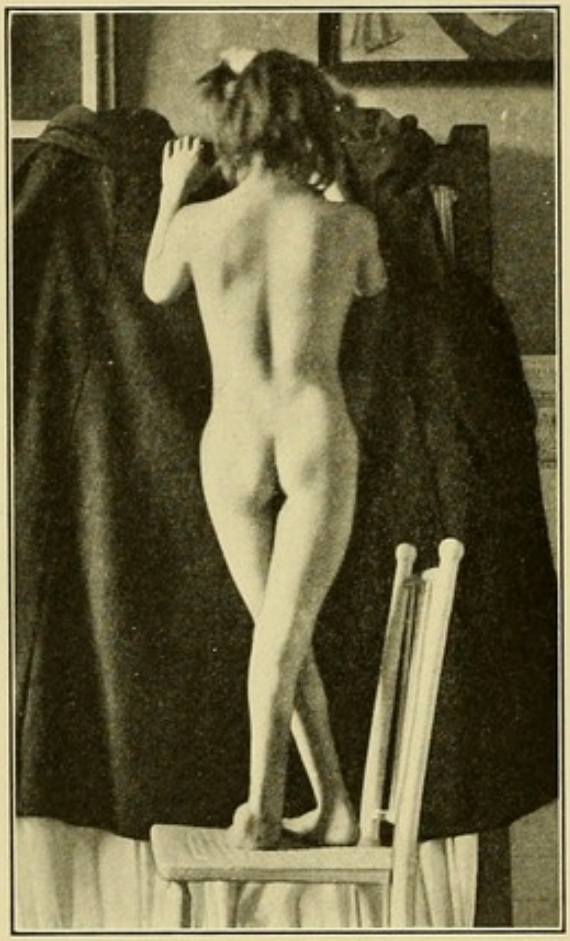


FIG. 132.—CONGENITAL UPWARD DISLOCATION OF BOTH HIPS; CONGENITAL RIGHT PES VARUS, LEFT PES VALGUS; GIRL OF TWELVE.

in this posture (Fig. 132). The ordinary gait of the bilateral cases is waddling, and very characteristic.

These children are usually well and lively, and are always able to walk; they seldom suffer much discomfort; as they grow older, however, and become heavier, the strain on the capsular ligaments becomes greater, abduction becomes more restricted, and disability increases. About puberty, or soon after, more or less pain about the hip and thigh is complained of, and the distance which the patient can walk is progressively curtailed until, in adult life, short distances may be accomplished with difficulty.

The DIAGNOSIS is seldom made until the child begins to walk, as pain is absent, and the slight displacement is usually unnoticed. In spite of the persistent and characteristic lameness many children are not brought to the physician's attention until they are quite large. From the symptoms mentioned the diagnosis is usually not difficult; obscure cases are cleared up by a good skiagram, which should always be taken as a matter of record. The combination of high, prominent trochanter, loose joint, and palpable head is found only in luxation; the history and other features will determine whether the luxation be paralytic, pathological, traumatic, or congenital. One should bear in mind the somewhat different symptoms of an anterior or superior displacement. In severe paralysis of the hip muscles after poliomyelitis, the head occasionally slips out. In such cases there is extreme looseness and wasting of all the tissues, and the hip can be easily slipped in and out of the socket with little force and no pain. In suppurative coxitis of in-

fants the head is often entirely destroyed, and the gait, looseness, and position of the trochanters indicate femoral displacement. The head of the femur cannot be felt, as it is lacking, and there is often the scar of an old sinus. In coxa vara the head is not palpable and the joint is not loose. In rachitic curvature of the upper end of the femur the gait may be waddling and the general appearance suggestive of congenital luxation, but the femora are bowed, marked signs of rickets are present, and the heads are in their sockets.

The PROGNOSIS of untreated cases as to improvement is bad; the tendency is for the displacement and disability to markedly increase as the patient gets older and heavier. Under proper treatment substantial improvement is effected in the large majority of cases, while in many the result is practically perfect. The bilateral cases are much more difficult, and in them the results are less perfect than in the unilateral.

TREATMENT was palliative until the labors of Paci, Schede, Hoffa, and Lorenz made the replacement of the dislocated femoral head a standard surgical procedure. Paci accomplished by leverage manipulations a transposition of the femoral head, giving improved position and function. Schede, after preliminary traction, sometimes obtained a true reduction by forcible mechanical traction under anesthesia. Hoffa enlarged the acetabulum by means of a large excavator through an open incision, and replaced the head. This operation was adopted with slight modifications by Lorenz, who was afterwards led to perfect bloodless reposition on account of some fatalities, and the stiffness often following the

open operation. Bloodless replacement, variously modified, is now the standard treatment for one-sided cases under ten and bilateral cases under eight. The older the case the more difficult the manipulation and the more uncertain the result, though the difficulty depends more upon rigidity of the tissues and the amount of the displacement than upon the age. Some of the older dislocations occasionally slip into place with great ease, as in the case of a girl of eight recently reduced by the writer. Treatment may be begun as soon as the diagnosis is made, but it is doubtful if there is any real advantage in replacing the dislocation before the age of two or three years, as the splint is soiled by the baby and the femoral head is not readily retained in position by the delicate tissues. When there is much rigidity and displacement preliminary traction in bed, with a weight of ten to twenty pounds for two or three weeks, makes the reposition much less difficult, and is frequently indispensable. In very difficult cases it is recommended to divide the adductor magnus at its insertion (Bradford) and the hamstrings, either before or at the operation, though this is seldom necessary.

The technic employed by Lorenz during his American trip in 1903–4 was as follows: The patient being anesthetized and placed in the dorsal decubitus on a flat pad, the pelvis was seized and steadied by an assistant while the operator flexed the affected thigh to ninety degrees and made continuous forcible abduction. This caused the adductor tendons to stand out like rigid cords; these were then sharply struck by the ulnar border of the hand or by the fist, in order to tear the retracted muscles. After

abduction had been carried beyond the frontal plane, an effort was made to pry the head of the femur into the socket by leverage over the fist or over the wedge. This was often successful and reduction was announced by an audible and palpable shock. If the displacement was not reduced by abduction and leverage, and especially if the upward displacement was great, a sheet was folded diagonally, the ends tied together, and passed under the opposite groin and over an upper corner of the table. With an assistant still steadying the pelvis, the displaced leg was grasped and pulled downward with some abduction and rotation; reduction sometimes occurred during this maneuver (Schede's method), but usually after the trochanter had been sufficiently brought down, the reduction followed over the thumb, fist, or wedge in forced abduction. The signs of reduction are a sudden jar, an audible click, the diminished prominence of the trochanter, the disappearance of the hollow in the groin, and its replacement by a hard body, the anterior portion of the head of the femur. After reduction the thigh tends to remain in abduction and flexion, and the hamstrings are retracted and prevent full extension at the knee unless forcibly stretched. When the flexion or the abduction is diminished the head slips out with a jar and click, but is easily replaced. By dislocating the head over the posterior superior and inferior borders of the acetabulum, these may be palpated and their development estimated. The stability of the reposition may be estimated from the development of the superior and posterior portions of the rim, and from the amount by which the flexion may be lessened without causing dislocation.

Once the head of the femur is in its socket, this is enlarged and the contracted anterior portion of the capsule stretched by repeated movements of rotation and circumduction of the flexed and abducted thigh; abduction is also increased to well beyond the frontal plane. Also the hamstrings are stretched by extending the knee, the child is placed on the well side, and the knee is flexed so that the foot lies in front of the shoulder, and hyperextended to the limit of motion. If both hips are dislocated the abductors are stretched simultaneously, one side is completely reduced in the manner above described and the other side is reduced afterwards by similar manipulations at the same sitting. After reduction the thigh is retained in right-angled flexion and hyperabduction by a short, thick, narrow spica encircling the pelvis and reaching to the knee, cut out in front and behind to prevent soiling. When the displacement is bilateral the spica includes both thighs to the knee, and the patient is placed in the "frog position." Lorenz recommended that the patient should be made to walk in a few days, with the idea that such efforts would force the replaced head deeper into the acetabulum, stimulate its development, and thus increase the stability of the reposition. He advised that the first spica remain six months, that the flexion and abduction should then be reduced, and a second spica applied in this secondary position, to be worn three months, followed by more spicas if necessary. After the removal of the last spica much attention was given to massage and to movements of flexion and extension in the plane of abduction, movements of hyperextension, and other movements to

strengthen the muscles previously lengthened and which oppose redislocation. The results of this treatment were excellent with anatomical replacement in about one quarter, anterior transposition with improved function in about one half, and poor in the remainder. The force used in the resistant cases was very great; serious accidents followed in several instances, and minor complications, such as anterior crural palsy, in many. Further experience has led the writer to modify this technic in the following particulars. In all difficult cases preliminary traction to the point of toleration was used for several weeks. Pounding the adductors is omitted; they yield to continuous stretching. Movements of extreme flexion and extension are also omitted, and only moderate force is employed. Rather than injure the patient, it is better to be satisfied with getting the head of the femur near the acetabulum and put the thigh up on flexion and abduction, as though reduced, when at a second attempt later on it may slip in easily. Nevertheless, a moderate amount of force will usually prove successful at the first attempt in cases suited to the bloodless method. Ridlon reduces the displacement by flexing the thigh until it is in contact with the abdomen, grasping the displaced head between the thumb and fingers of the free hand, and guiding it into the socket during forced abduction and outward rotation of the thigh.

Besides the methods of replacement of Lorenz and Schede already mentioned, there are others that may be tried, especially that of Schanz, which consists in flexing the adducted thigh on the abdomen and pulling sharply upward toward the opposite shoulder, the pelvis being

held by an assistant. The methods of Schede and Schanz depend upon traction rather than leverage for the reduction of the displacement; Calot of Berck has worked out a manual traction and propulsion method, and a plan of management which differs widely from the Lorenzian, and has given him and others, including the writer, most satisfactory results. He recommends three maneuvers for reduction, which are to be patiently tried in succession if necessary.

(1) While an assistant fixes the pelvis, flex the thigh and knee to a right angle; pull up on the thigh grasped near the knee with one hand, and at the same time push up behind the trochanter with the thumb of the other. In more difficult cases an assistant pulls up the thigh with both hands while the operator presses upon the trochanter with both thumbs. Four thumbs even may press upon the trochanter. While the leg is pulled it may be slightly rotated or circumducted. This maneuver succeeds within ten to fifteen minutes in most cases.

(2) The second maneuver is like the first, but a slow gradual abduction is added, the trochanter being pushed into place by the thumbs as before. This combines traction, propulsion, and leverage.

(3) In the third movement the patient is placed on the well side, and the flexed thigh is placed in extreme adduction, and the trochanter pressed and pulled into place as before.

To these may be added (4) the similar maneuver of Gwilym Davis, who places the child on the face, with the pelvis resting on a sand bag and the affected leg hanging down beside the table, and pushes down upon the tro-

chanter with the closed hands, the operator's weight assisting. An assistant gradually abducts the thigh; aiding the forward movement by traction improves the method. Reduction by these methods is less dramatic than by the method of leverage; there is less shock and click, and sometimes none at all. When reduction is effected the trochanter sinks or crunches away from the pressing thumbs into the depths like the yielding of a piano key to the push of the finger (Calot). Once reduced, the signs are the same as after reduction by the leverage method. After reduction by one of these methods the adductors are stretched and the thigh is placed

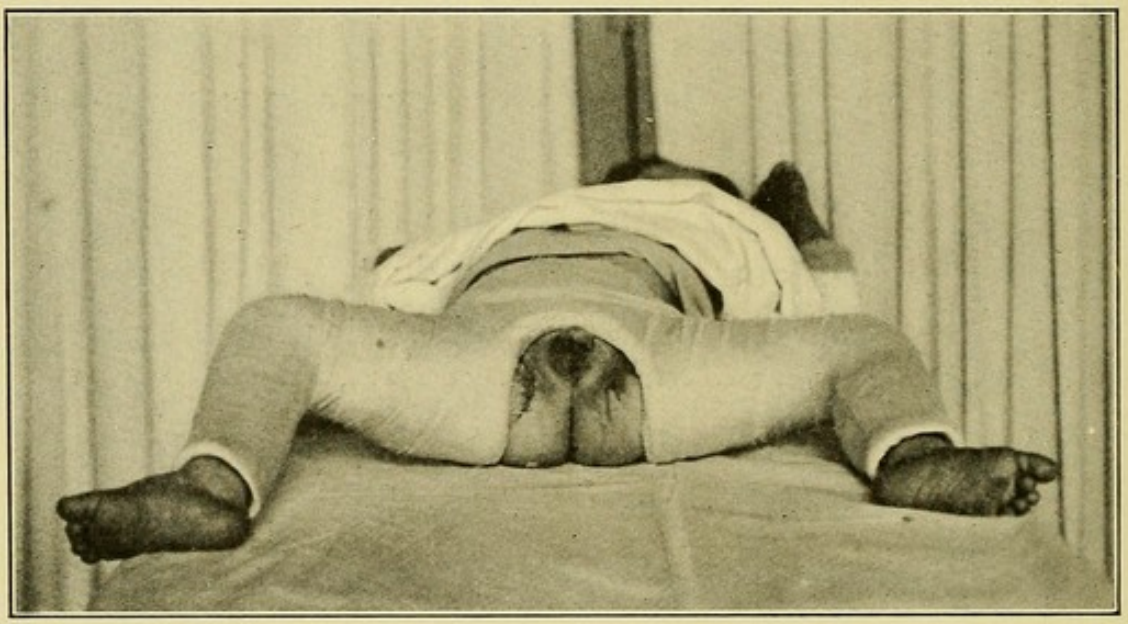


FIG. 133.—CONGENITAL DISLOCATION OF HIPS; MANUAL REPLACEMENT AND PLASTER ACCORDING TO CALOT AT POST-GRADUATE HOSPITAL. Photograph taken two days after the operation; notice ecchymosis in groins.

at seventy degrees flexion and seventy degrees abduction, as in this position much more of the head is in contact with the acetabulum than in extreme flexion and abduction, and the risk of anterior luxation is less (Fig. 133).

Calot recommends a long spica to include the foot, no walking, to change the position under anesthesia to moderate abduction, no flexion, and inversion after three and

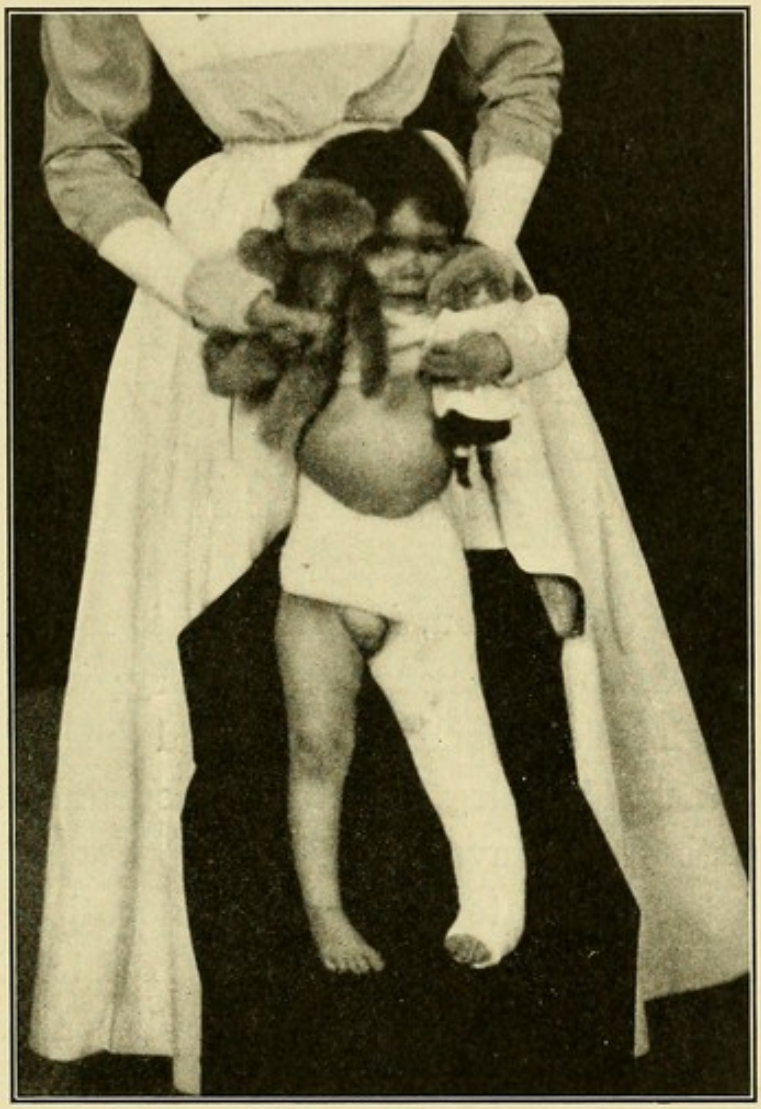


Fig. 134.—Left Congenital Hip Dislocation; Last Posture; Abduction with Inversion.

a half months, and to apply another long spica (Fig. 134). This is left on two months, when, if the reduction is stable, it may be removed and the limb allowed to come back into position as the patient lies in bed. Since using this technic the writer has had markedly better results and no accidents.

When the deformity is too rigid to be safely reduced by manipulation, the open operation, as perfected by Hoffa and Lorenz, may be used. This consists in opening the joint through an incision in front of the great trochanter (Hoffa) or at the outer border of the tensor fasciæ latæ, deepening the acetabulum by a large excavator and placing the femoral head in the deepened socket. This operation is often severe, and sometimes results in stiffness, but may give very satisfactory results in difficult cases. Sherman, of San Francisco, advocates opening the joint at any age, dividing the capsular stricture, and replacing the head without deepening the acetabulum; he reports excellent results.

In anterior dislocation, if the joint is firm and locomotion is good, no treatment is necessary; if function is poor, the thigh is flexed and adducted and the head pushed down and back. The leg is put up in semiflexion, moderate abduction, and inversion.

In the case of bilateral upward dislocation with extreme adduction, and cross-legged progression in a girl of twelve, the deformity was overcome by an osteotomy below the trochanter minor on each side, and the result was excellent.

In certain old, irreducible or relapsing cases Hoffa advises excision of the head, denudation of a spot above the acetabulum, against which the sawn neck is to be placed with the leg abducted. This often gives good stability and freedom by the formation of fibrous adhesions or of a pseudo-arthrosis. Where the head can be drawn down to the level of the acetabulum, Albee's shelf

operation (see osteoarthritis of the hip, p. 299) would seem to be indicated.

Coxa Vara.—The axis of the neck of the femur should, in the adult, cut that of the shaft at about one hundred and thirty degrees; when this angle is markedly smaller, the trochanter is raised, the leg is shortened, and abduction of the thigh is diminished. This condition is known as (cervical) coxa vara, and may be congenital or due to trauma, to rickets, to overweighting, or to other causes (Figs. 135 and 136). In another set of cases, usually flabby adolescents of rapid growth, the deformity is due to a yielding at the epiphyseal line; the head of the femur seems to slide down and back on the neck, while the latter keeps its proper direction (epiphyseal coxa vara) (Fig. 137). The genesis of the deformity is similar to that of the flat-foot and knock-knee of adolescence, with which it is often associated. As in the other static deformities of adolescence, it is not known whether the softening is specific or the exaggeration of a normal condition. The onset is usually slow and painless, but the deformity may appear suddenly after a slight fall or moderate injury. Pain may appear fairly early, and may increase in intensity, with limping and restriction of hip motion, especially in abduction and inversion, but often also in flexion. Hip motions may be painful if pushed to the limit, and there may be slight spasm during the active stages of the process. The trochanter is prominent. In the epiphyseal cases elevation of the trochanter and shortening of the leg may be slight or absent. The head is usually carried backward (convexity of neck forward) as well

as downward, so that the feet are everted and the plane of flexion is deflected outward. If the deformity is severe the thigh becomes adducted, and the apparent

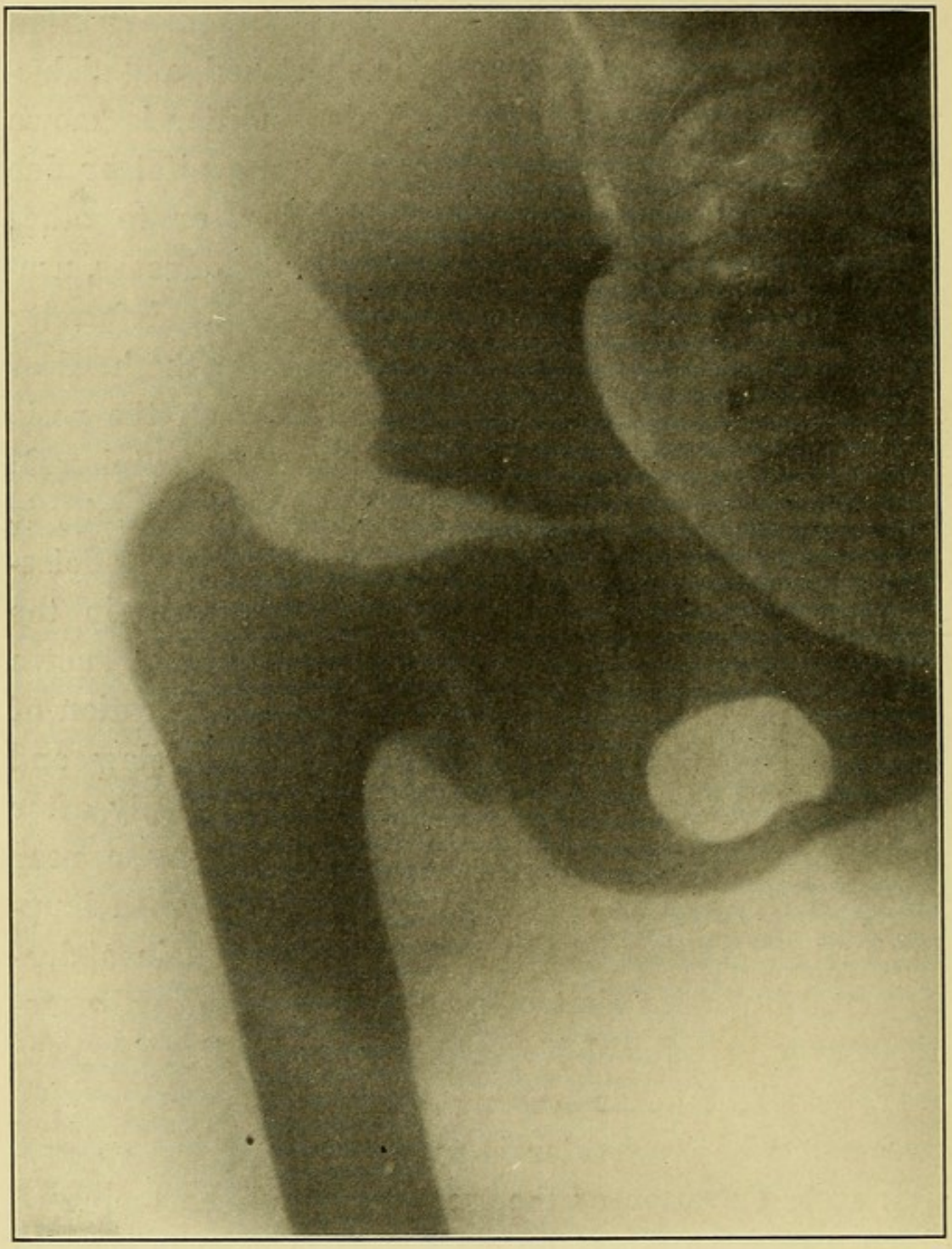


Fig. 135.—Cervical Coxa Vara in a Girl of Eight; Lameness of One Year's Duration. (Hospital for the Ruptured and Crippled.)

shortening is greater than the real. Later the shape of the head may be changed. The condition may exist

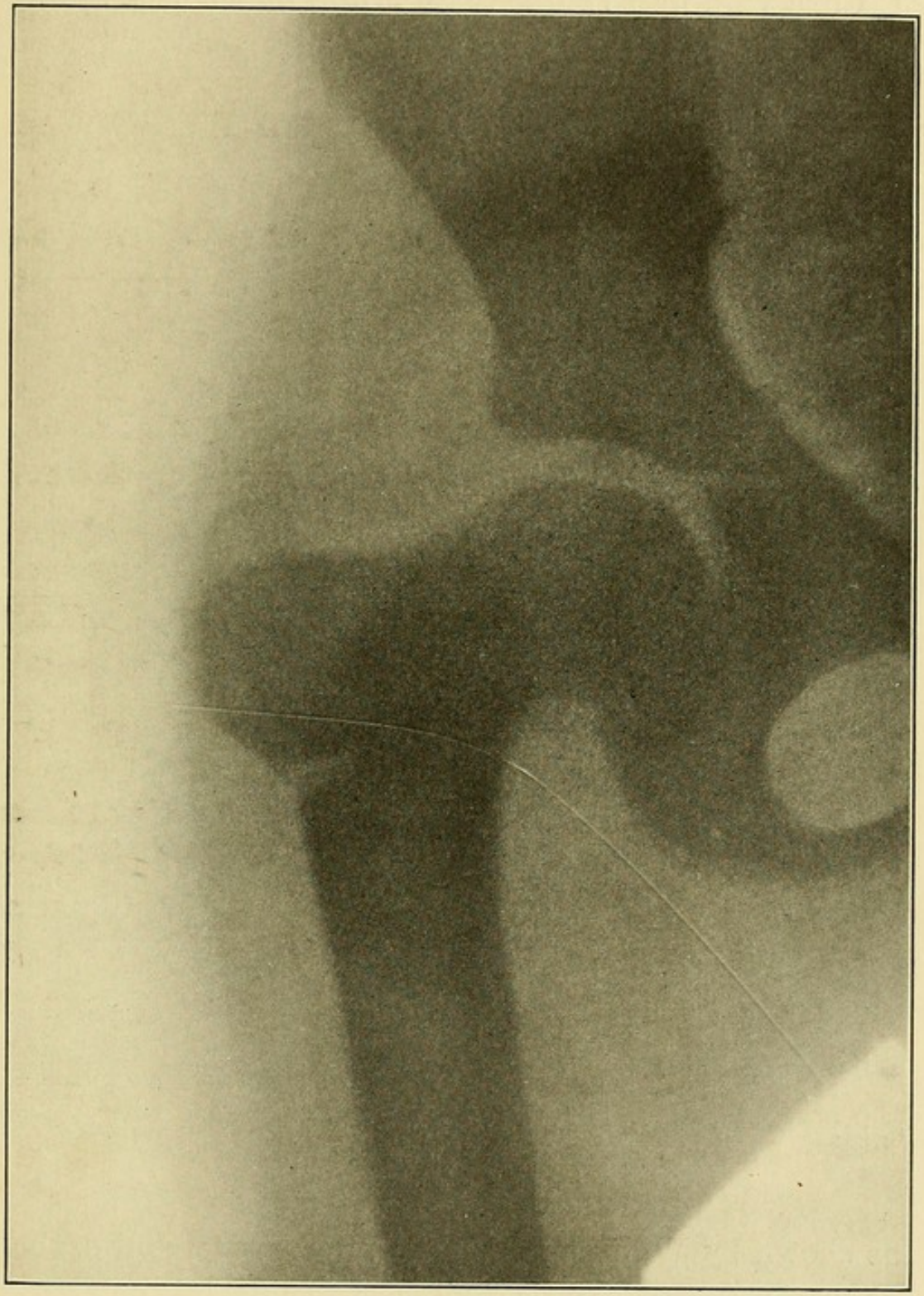


Fig. 136.—Same Case Two Months after Removal of Wedge Below Trochanter by Whitman. (Hospital for the Ruptured and Crippled.)

on both sides, when lordosis and a waddling gait are observed.

Coxa vara may be due to an injury of the neck at any age. Fracture of the neck of the femur in young children,

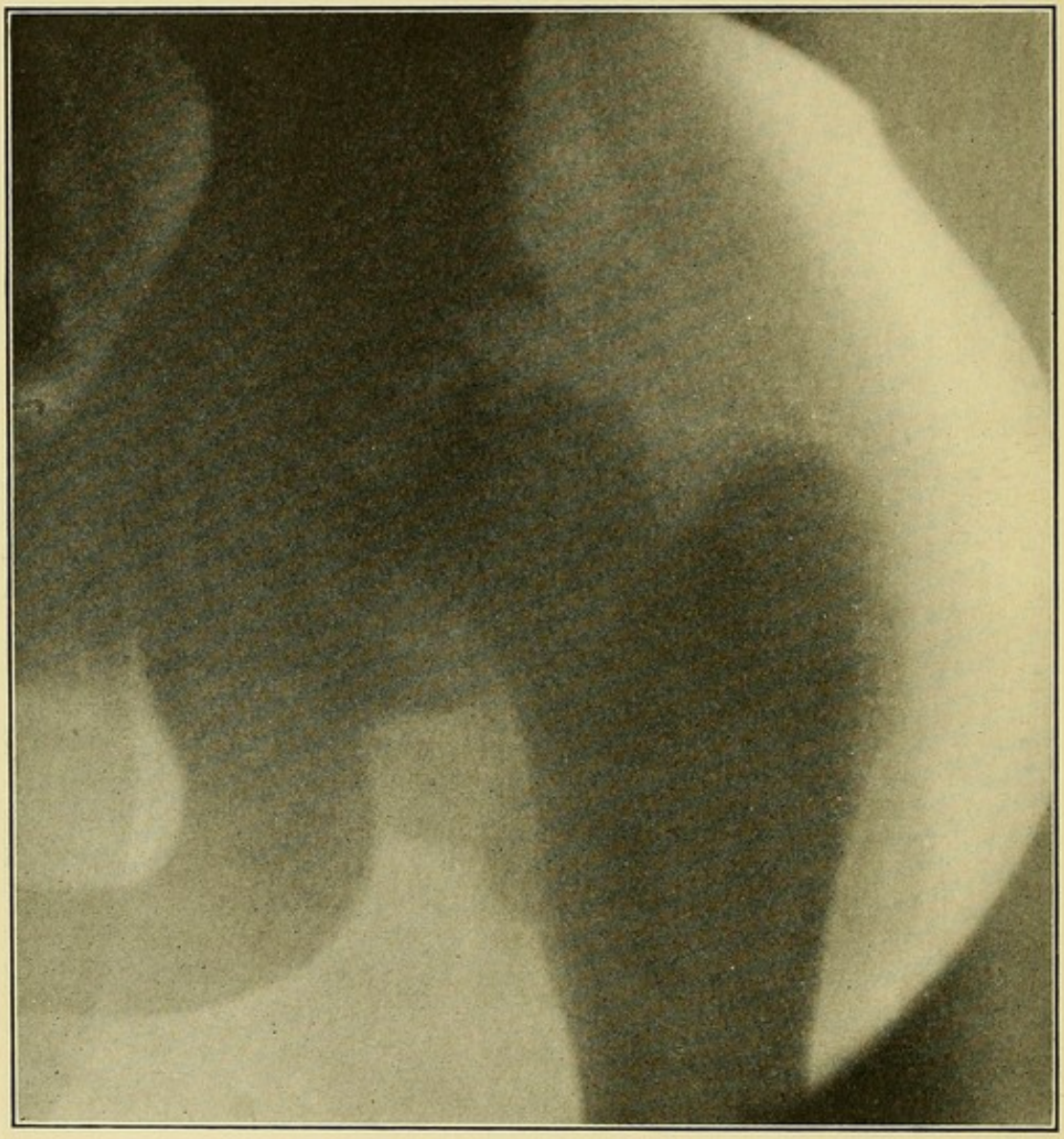


FIG. 137.—EPIPHYSEAL COXA VARA (BILATERAL) IN A BOY OF FOURTEEN; THE ANGLE OF THE NECK IS UNCHANGED.

as shown by Whitman, is by no means rare, and usually gives rise to a traumatic coxa vara. In flabby adolescents of the coxa vara type slight falls may produce a fracture

or acute bending of the neck. In adults, also, the union of a fractured femoral neck usually leaves a permanent coxa vara. This deformity should be prevented by using Whitman's abduction treatment. (See page 302.)

The diagnosis from congenital dislocation is not difficult; in coxa vara the head is in the socket, and there is no pumping. In certain cases, accompanied by much pain and stiffness, it may be difficult to exclude coxitis without a skiagram, which should always be taken; the history is also important.

In unilateral cases of moderate degree, especially where a fair amount of abduction is present, the patient should be put on crutches, with a long traction hip splint and a high shoe on the well foot to relieve the hip of weight bearing, and attention should be paid to the general nutrition; the bilateral cases should be kept off the feet entirely. This treatment proves successful in many of the early cases.

When the deformity has developed rapidly and the thigh is permanently adducted, forcible abduction and retention in plaster may correct the deformity if the case is seen early. In cases of serious, permanent deformity, where the bone is hard, an osteotomy should be done below the greater trochanter, and the leg should be put up in a long plaster spica in extreme abduction. A linear osteotomy is often sufficient, but a wedge should be removed, if necessary.

Coxa valga is the opposite deformity, where the neck-shaft angle is increased, the leg is lengthened, and the trochanter depressed. It may occur in cases of infantile paralysis, or during other affections, where the leg

hangs suspended for a long time. It is not practically important.

Paralytic and Spastic Deformities at the Hip.—After poliomyelitis, if all the hip muscles are paralyzed, there may be a loose joint with relaxed capsule. For this a long splint may be applied with a hip band, to control rotation. A much commoner deformity is thigh flexion (usually with abduction), from the adaptation of the anterior hip muscles and ligaments to the sitting posture. With this deformity, when the patient stands the front of the pelvis is pulled downward by the shortened structures, producing marked lordosis. This contraction cannot be stretched out, and the shortened tissues should be divided subcutaneously if the deformity is moderate, through an open cut, if severe. The structures cut are the tensor fasciæ latæ, the fascia lata including the iliotibial band arising from the front of the iliac crest, the sartorius, and the rectus, or as many of these as may be necessary to get good correction. The thigh, leg, and pelvis are then put up in a long plaster spica, with moderate overcorrection of the flexion and abduction, for from four to six weeks; after this a brace to hold the foot, leg, and hip in position is applied, if necessary.

Occasionally the head of the femur slips out posteriorly, producing a paralytic dislocation. The head usually slips back and forth into and out of the socket on slight manipulation, and without pain or much resistance. In severe cases it may be kept in place by stitching a fold in the capsule, or by excising a piece of it. The capsule may be so thin, however, as to make this procedure unsuccessful; in that case, only refreshing the joint sur-

faces to produce a stiff joint will keep the head of the femur from slipping.

Spastic adduction of the hip, usually on both sides, is due to cerebral paraplegia or diplegia. There is strong spasm of the adductors, causing the knees to rub together or the legs to cross, often with inversion. Stretching is often unsatisfactory; the deformity may be overcome, but it recurs. The same is true of tenotomy of the adductors unless the overcorrection is severe and the fixation long continued. Robert Jones excises an inch or two of the contracted adductors between long-jawed clamps. After this operation, if the legs are widely separated by a double spica or other means for six or eight weeks the deformity does not recur, though the adductors resume their function.

For the inversion of spastic palsy and of hemiplegia, Gibney excises the tensor fasciæ latæ, retaining the leg in a long spica in outward rotation for six weeks.

Diseases of the Hip-Joint

Tuberculous hip disease, coxitis tuberculosa, comprises about two fifths of all tuberculous joint disease; about ninety per cent of all hip infections in children are tuberculous. Hip tuberculosis may complicate spinal or other joint tuberculosis, or be complicated by them, but the large majority of cases are solitary as far as tuberculous bone disease is concerned. Double hip disease is rare, and should lead to a careful investigation of the underlying cause, which may be pus, syphilis, or arthritis deformans. The disease is commonest in delicate and poorly nourished children, but may occur at any age. It may

occur one to four months after an injury of moderate severity, also after measles, whooping cough, and other acute infectious diseases.

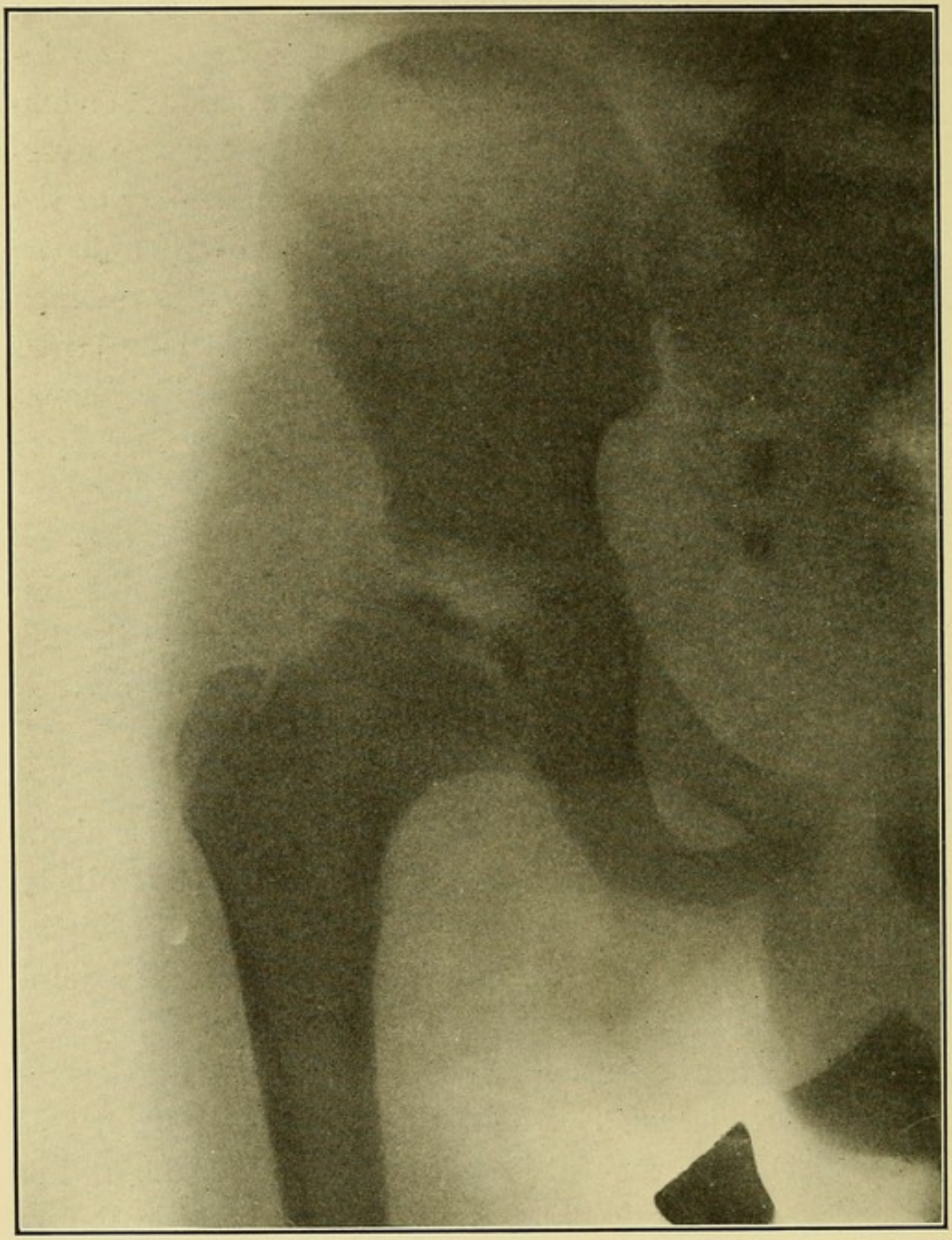


FIG. 138 *A*.—TUBERCULOSIS OF HIP; SLIGHT LAMENESS, NO PAIN, LITTLE SPASM, SIX MONTHS; ONE-HALF INCH SHORTENING; BOY OF SEVEN. (Hospital for the Ruptured and Crippled.)

Pathological Anatomy.—The tuberculous focus is usually a secondary infection by way of the blood from

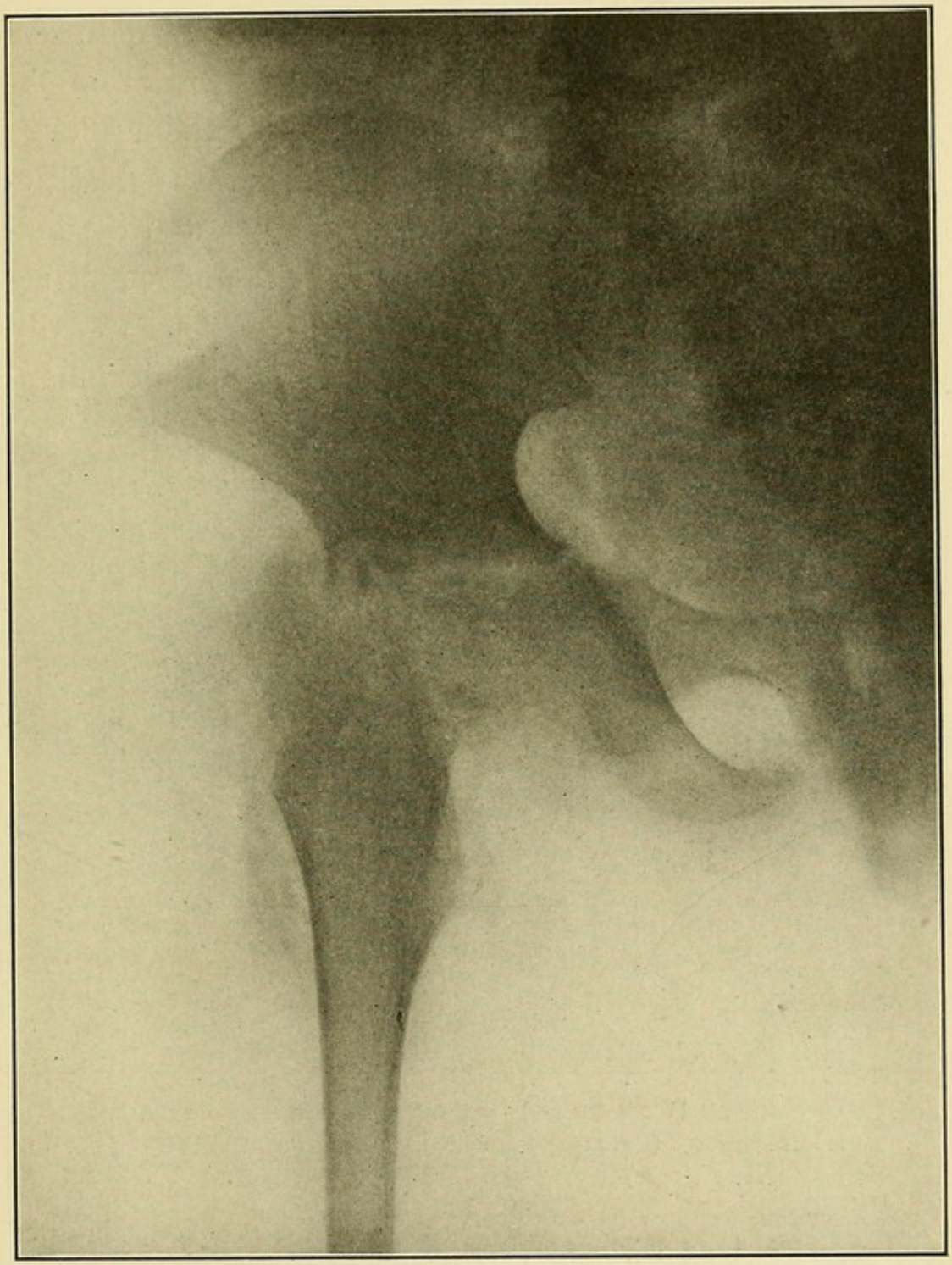


Fig. 138 *B*.—Tuberculosis of Hip after Measles; Disintegration of Acetabulum and Head of Femur; Atrophy of Leg and Pelvic Bones; Boy of Six. (Hospital for the Ruptured and Crippled.)

diseased abdominal or thoracic glands (or other organs). These are often not evident clinically, and usually cause no trouble if the joint disease is cured. The process usually begins as isolated or multiple foci or diffuse infiltration in the cancellous tissue of the femoral epiphysis or in the acetabulum; some authorities claim a large percentage of primary synovial infection. The destructive process spreads by softening, caseation, and the formation of ichor pockets (cold abscesses) and small sequestra; cicatrization may occur at any stage. Usually the cartilage is perforated and tuberculous material infects the joint, causing pulpy degeneration of the synovial membrane and ulceration of the joint structures

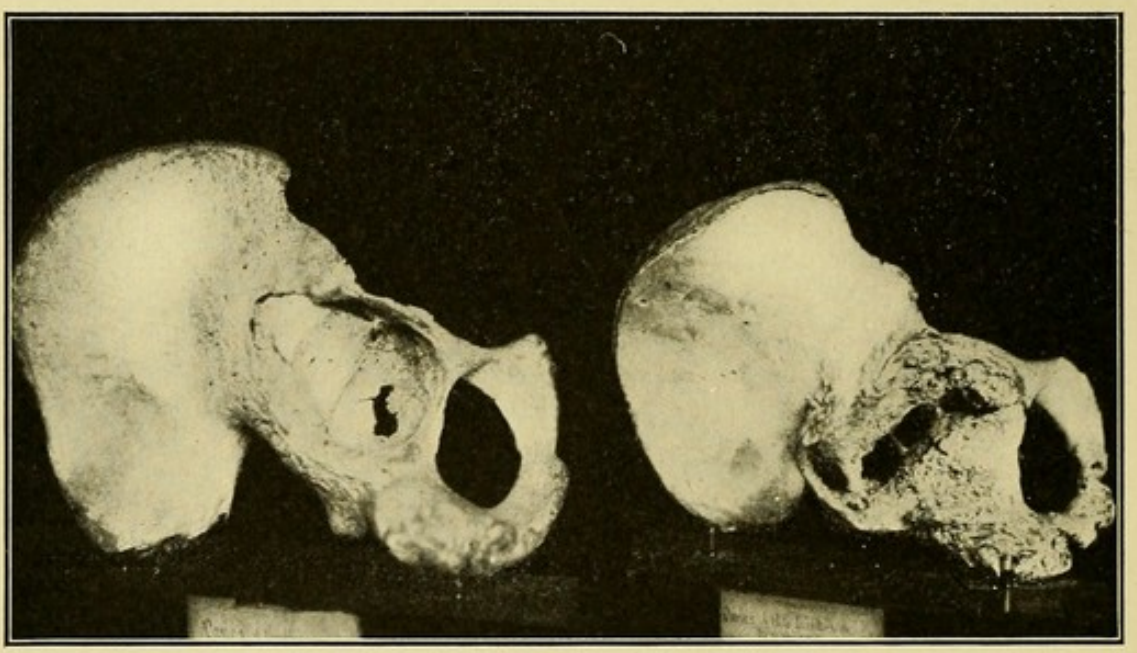


FIG. 139.—EROSION (WANDERING) OF ACETABULUM FROM TUBERCULOSIS OF THE HIP-JOINT. (From specimens in the College of Physicians and Surgeons, New York.)

(Figs. 138 *A* and 138 *B*). The acetabulum is gradually enlarged upward and backward (wandering acetabulum) (Fig. 139), and it and the head are eroded by the tubercu-

lous process, aggravated by the pressure of muscle spasm and weight bearing, and the grinding of hip motion. In

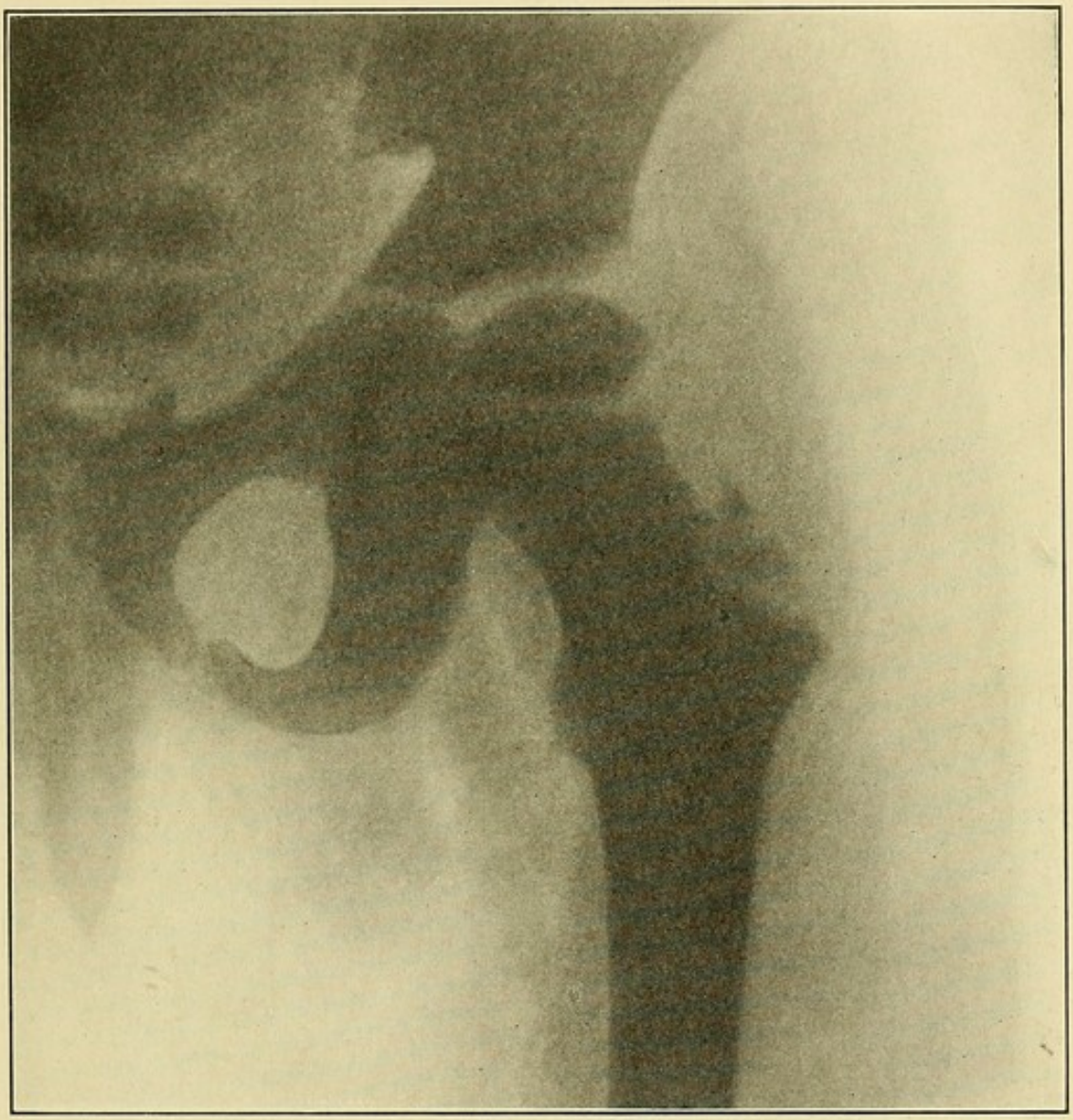


FIG. 140.—TUBERCULOSIS OF TROCHANTER WITHOUT INVOLVEMENT OF THE HIP-JOINT; LOCAL PAIN, TENDERNESS, AND SWELLING EIGHT MONTHS. (Hospital for the Ruptured and Crippled.)

rare cases the focus is in the great trochanter or neck, where it may break outside the joint or be removed (Figs. 140, 141, and 142). In severe cases the head may become dislocated upward and backward, or be entirely absorbed, or may lie in the joint as a sequestrum. The process ends

in fibrous contraction and adhesions, and much more rarely in bony ankylosis (Fig. 143); all the bony as well as the soft parts of the limb and corresponding half of the pelvis become wasted and are retarded in growth. All the bones of the limb are finally smaller, shorter, and more brittle than those of the well side; the sound limb may be abnormally large and muscular from overuse. Ichor pocket (cold abscess) formation is common; such pockets may present in the gluteal region, but are more common in front of the thigh or at the outer or inner side; they occasionally break through the acetabulum into the pelvis. They sometimes disappear without treatment, more often after aspiration; usually they open spontaneously or are incised, in order to avoid extensive burrowing and multiple sinuses. Abscesses and sinuses infected with pus microbes may cause sepsis

FIG. 141.—DISEASE OF GREAT TROCHANTER. (From specimen in Royal College of Surgeons. Phelps.)

with fever, and long-continued profuse suppuration may cause waxy degeneration of the viscera, including the kidneys. A certain percentage of cases, with or without ichor pockets, succumb to pulmonary tuberculosis, tuberculous meningitis, and acute miliary tuberculosis.

Symptoms.—The invasion is usually insidious; in a fair percentage of cases a slight or moderate injury is

Fig. 142.—Tuberculosis of Femoral Neck and Top of Trochanter. Moderate pain, lameness and atrophy after a fall five months before; severe limping two months; three-quarter inch shortening. Curetment by Whitman. (Hospital for the Ruptured and Crippled.)

followed in one to four months by lameness, usually painless at first. This lameness may be slight, and is usually intermittent; it may last, with the intermissions, two to six months before pain is complained of. The lameness

is characteristic, and indicates soreness and an avoidance of weight bearing and of full hip motion, particularly full extension. Pain often appears as restlessness

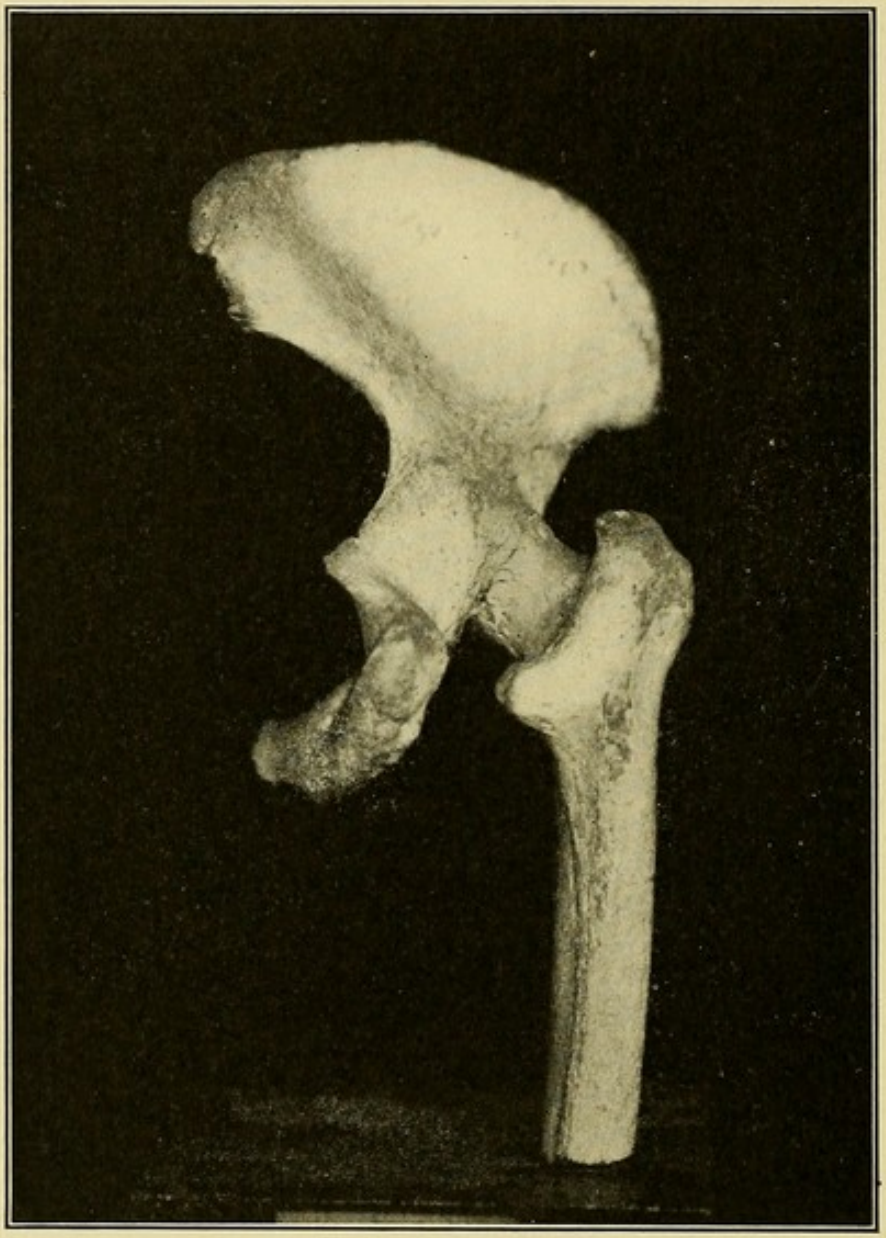


Fig. 143.—Bony Ankylosis of the Hip-joint.
(From specimen in the College of Physicians and Surgeons.)

or starting and crying at night, followed by acute pain in the groin or knee, which may become agonizing and may prevent locomotion. In many cases, however, particu-

larly when the hip is protected, pain is never severe, and in some cases it is absent. More constant and charac-

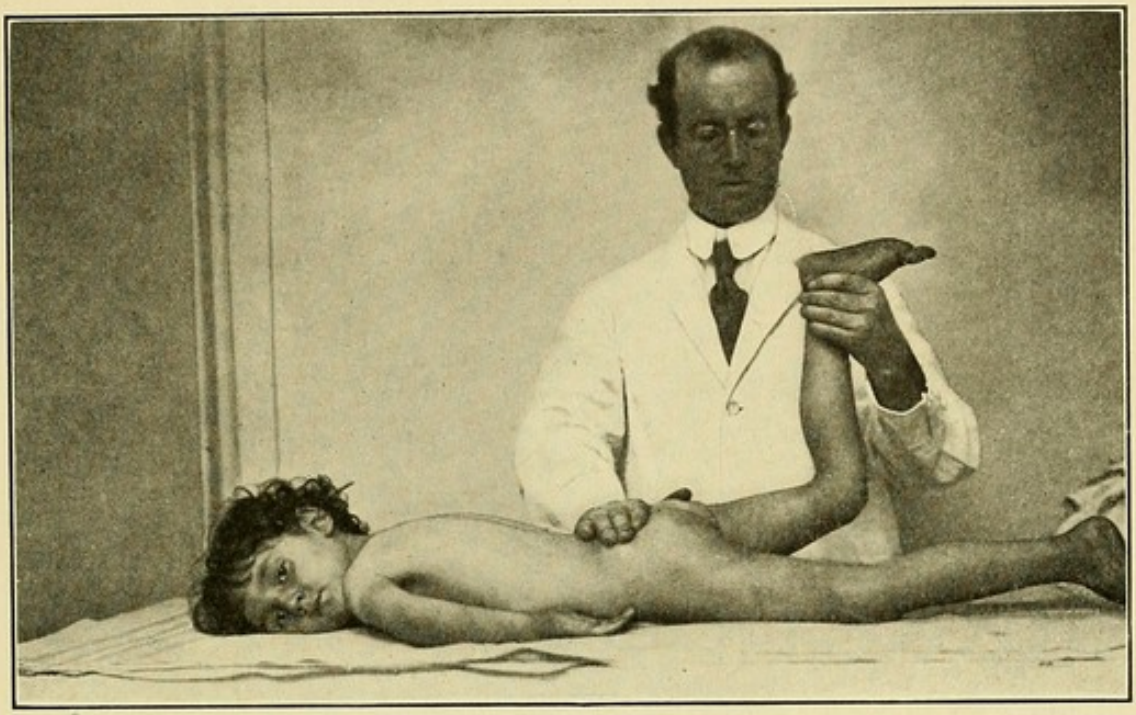


Fig. 144.—Testing Hyperextension at the Hip; the Right Side is Normal.

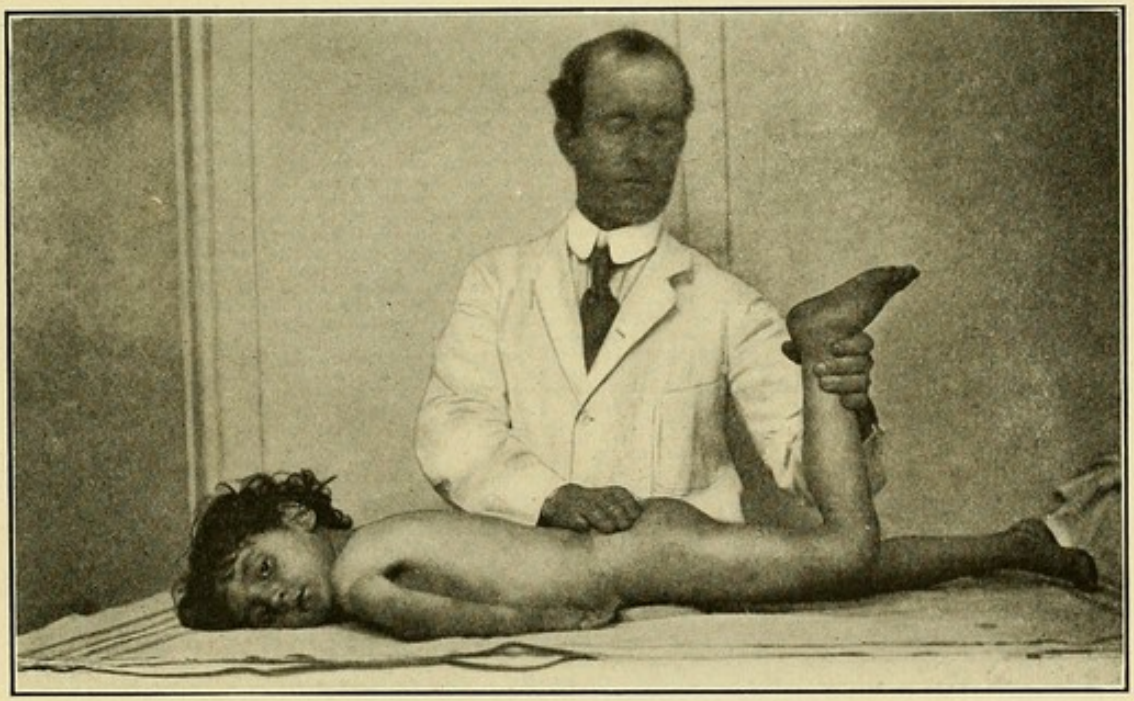


Fig. 145.—Testing Hyperextension at the Hip; the Left Side is Limited; Case of Beginning Hip Tuberculosis. (Posed by Strang.)

teristic of joint involvement than either pain or lameness is reflex muscular spasm, which limits passive hip motion by jerky contractions. This may usually be found even in the intervals of pain and lameness. When the patient lies on the face, with the knee flexed, and the hip is tested for motion in rotation and hyperextension, these, and particularly the latter, will always be found somewhat limited in extent even in early cases, and usually by jerky contractions (Figs. 144 and 145). As the disease progresses the thigh assumes certain characteristic postures. In most early cases the thigh is abducted, flexed, and everted, either to relieve intercapsular tension, as a result of reflex spasm, or to spare the leg (Fig. 146). This posture may become extreme and may per-

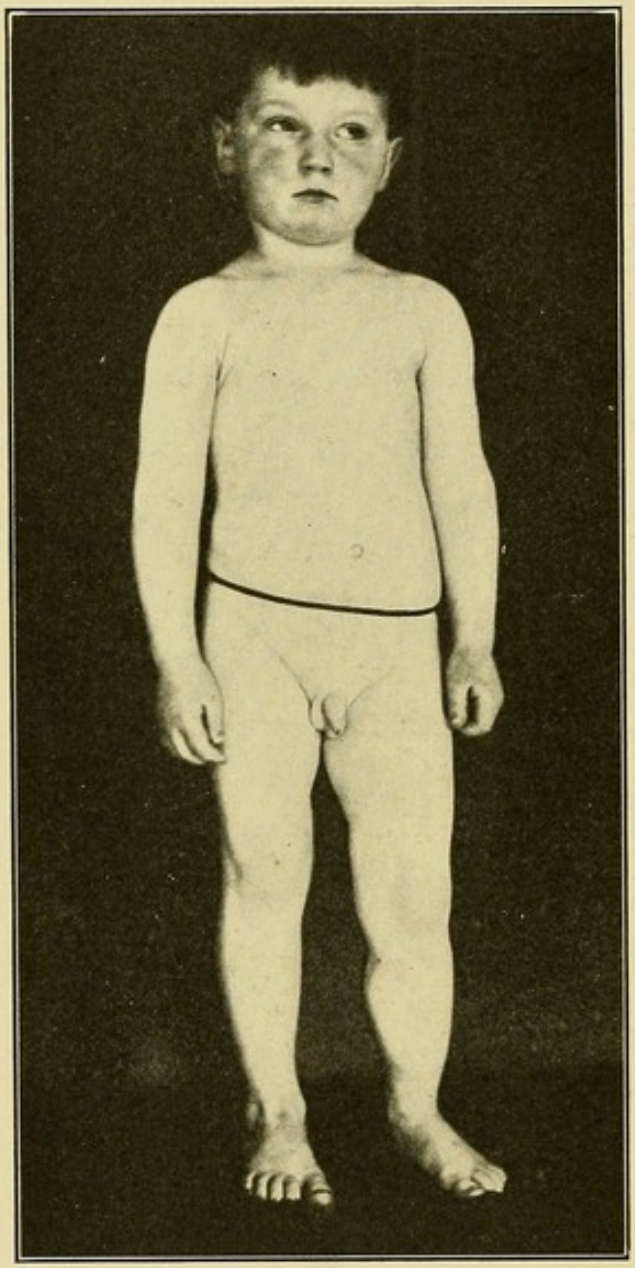


FIG. 146.—BEGINNING DISEASE AT LEFT HIP-JOINT, SHOWING ABDUCTION AND EVERSION; WEIGHT IS BORNE ON THE RIGHT LEG.

sist; in it the affected limb is apparently longer. In most untreated cases the flexion increases, and abduction changes to adduction as the case progresses. In such cases the affected limb is apparently and usually

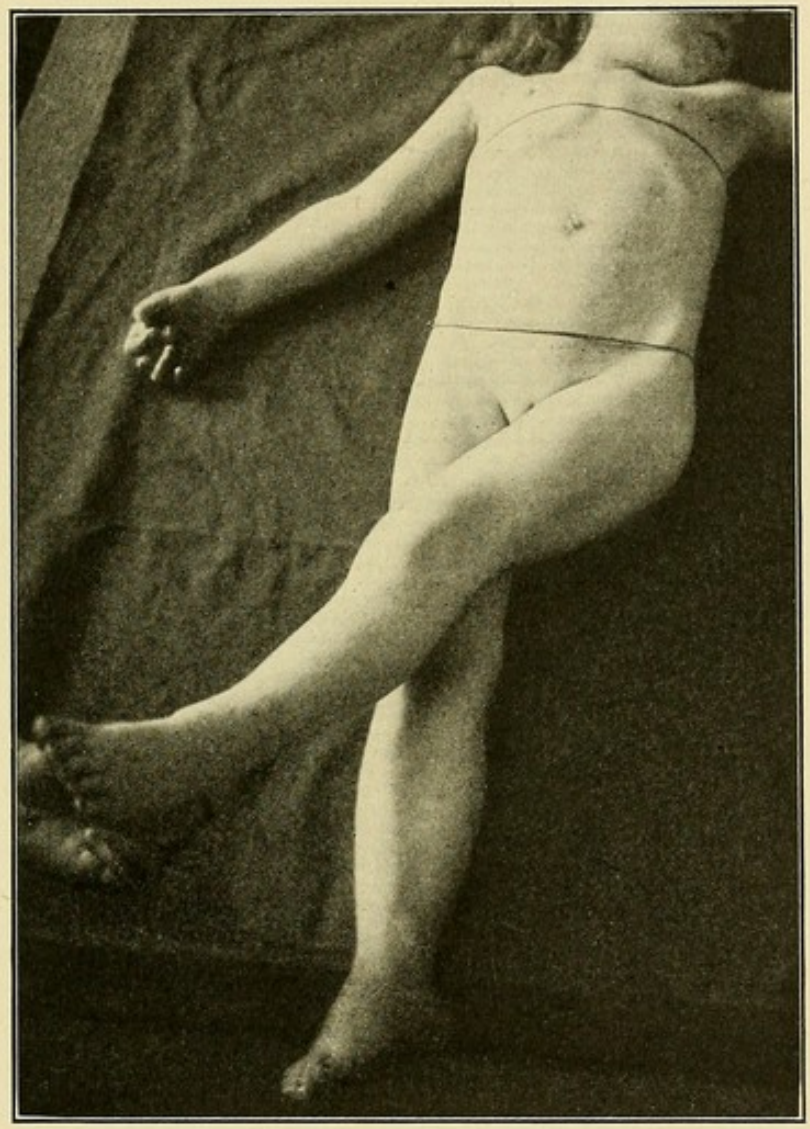


Fig. 147.—Adduction and Flexion at Left Hip Unmasked by Bringing Pelvis Level, and Back to Table. (Phelps.)

actually shorter. Adduction may appear early, and may be combined with either eversion or inversion (Fig. 147). The lateral malpositions cause compensatory lateral bending of the spine, but seldom true rotary lateral

curvature; thigh flexion produces lordosis, when the thigh is brought down (Fig. 150). As the disease progresses, pain, spasm, stiffness (Figs. 148 and 149), and limping become more marked, until the joint is locked, and walking is no longer possible from malposition or sensitiveness. When in this sensitive and helpless condition every movement may cause pain and the patient dreads to be touched; he often presses upon the dorsum of the foot of the affected side with the well foot to prevent motion and to produce traction, which also gives relief when given by hand, by a machine, or by a weight. In long-standing cases atrophy is marked and the malpositions become fixed from adaptation to posture, from

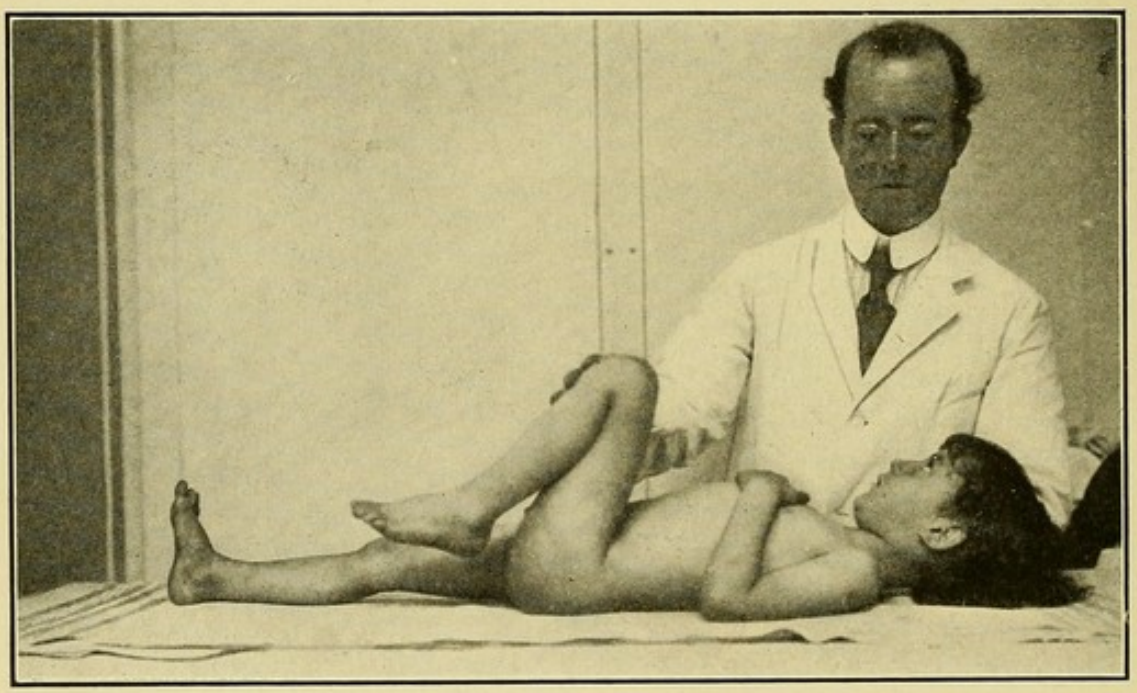


Fig. 148.—Testing Flexion of Left Leg.

adhesions, from displacement, and in a few cases from synostosis; the knee often becomes flexed and the foot dropped. In most cases considerable real shortening finally results from upward and backward displacement

due to erosion of the head and acetabulum. In addition to the shortening from this cause, which may amount to an inch or more, there is often in juvenile disease of long standing considerable shortening due to retarded

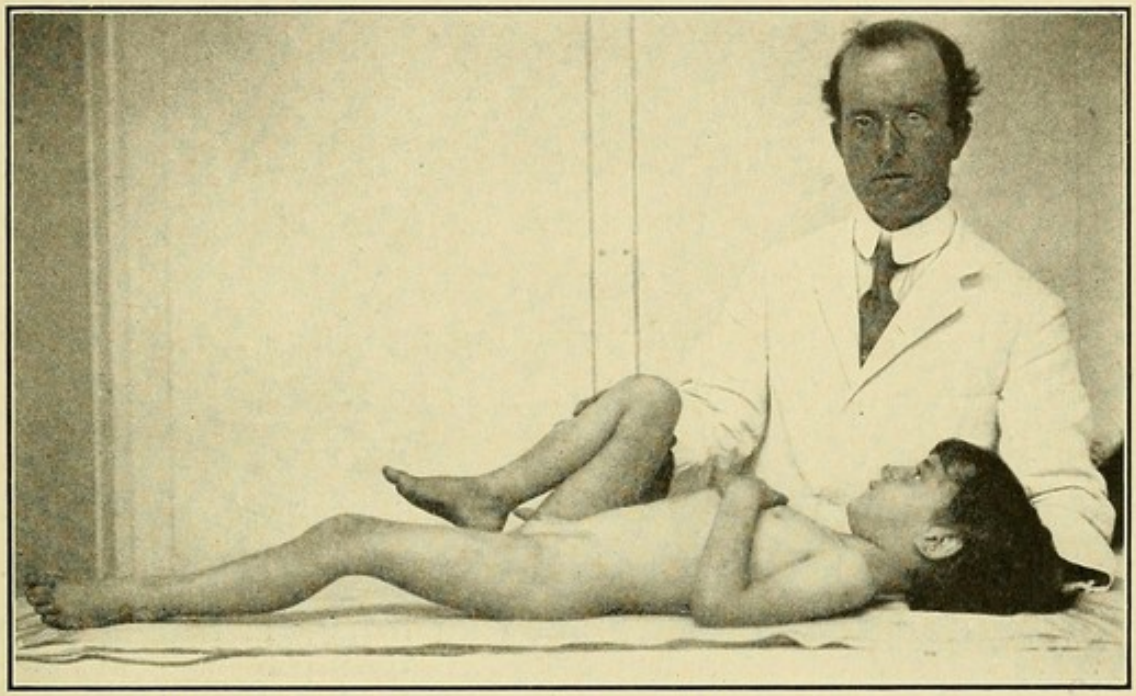


Fig. 149.—Testing Extension of Left Leg. (Posed by Strang.)

growth; this affects the whole limb and the affected side of the pelvis, and in the course of several years may amount to two or three inches, or more. The tibia alone may be an inch or more, and the foot nearly or quite an inch, shorter than its mate. In a few cases growth in length does not seem to be affected. In about one fifth of the treated cases ichor pockets develop. Pallor, emaciation, and loss of appetite are common after the earliest stages, but fever above 99.5° is rare, unless infection by pus microbes has occurred.

The diagnosis as to location is easy when the disease is pronounced; early cases are usually brought on account of lameness. Children should be entirely undressed

and their gait and movements studied; the hip should then be systematically tested in walking, standing, recumbency, and procumbency, for posture, motion, and muscular spasm; the length and circumference of the limbs should be measured, and the position of the great trochanter tested with reference to Nélaton's line; this line is drawn by a string from the anterior superior iliac spine to the tuberosity of the ischium, and the normal trochanter does not rise above it. The joint should also be palpated for tenderness, tension, and swelling, but forcible movements and pounding upon the sole or other violent means to elicit pain are to be condemned. While implication of the hip-joint is usually readily made out, it is often not so easy to establish the pathological diagnosis. A tuberculin test is sometimes helpful. Disability following directly upon an injury is usually due to lesion of the parts, such as sprain, or fracture of the neck of the femur.

Acute invasion, with high fever, pain, local tenderness, and thickening, is usually due to osteomyelitis of the upper end of the shaft. In cachectic infants a fluctuating joint, with fever, often denotes a suppurative arthritis. In middle-aged and elderly people a stiff and painful affection of the hip, coming on slowly with no tendency to suppurate, is usually senile osteoarthritis. Lameness and elevation of the trochanter, coming on slowly with pain and some stiffness, particularly limitation of abduction and inversion in flabby youths, may be due to coxa vara.

Congenital dislocation of the hip and infantile paralysis should not be mistaken for hip disease, though the

writer has known a case of paralysis to be treated for a year for hip tuberculosis. Many hip infections are not easily distinguished clinically from tuberculosis, and one is obliged to rely largely on the history of preceding disease. A considerable number of cases of hip infection in youths and young adults are gonorrheal.

The absence of joint spasm, the freedom of all movements except extension and internal rotation, and the presence of Pott's disease will serve to distinguish psoas contraction. In sacro-iliac disease, passive hip motions with the knee flexed are usually free. Skiagraphy frequently, and aspiration occasionally, may aid in the diagnosis.

The TREATMENT, as in other tuberculous affections, is by general invigoration and by enforced rest and protection to the joint. The joint must be immobilized and relieved of weight bearing, and protected against spasm and other injury. If the patient is old enough to lie still, traction in bed by means of a weight and pulley, with or without a traction splint, is the treatment of choice for a month or two until pain and spasm are relieved. If the leg is flexed, it should be elevated on an inclined plane, and traction made in the line of the deformity (Figs. 150 and 151). With this precaution, traction in bed nearly always affords prompt relief to the pain, and more slowly brings the leg into good position. Five to eight pounds are usually sufficient for a child. If pain and spasm are not relieved by recumbency, with traction properly applied, there is either tension from fluid in the joint or the disease is in part extra-articular. In very young children the best first dressing is a long plaster-of-Paris spica, put

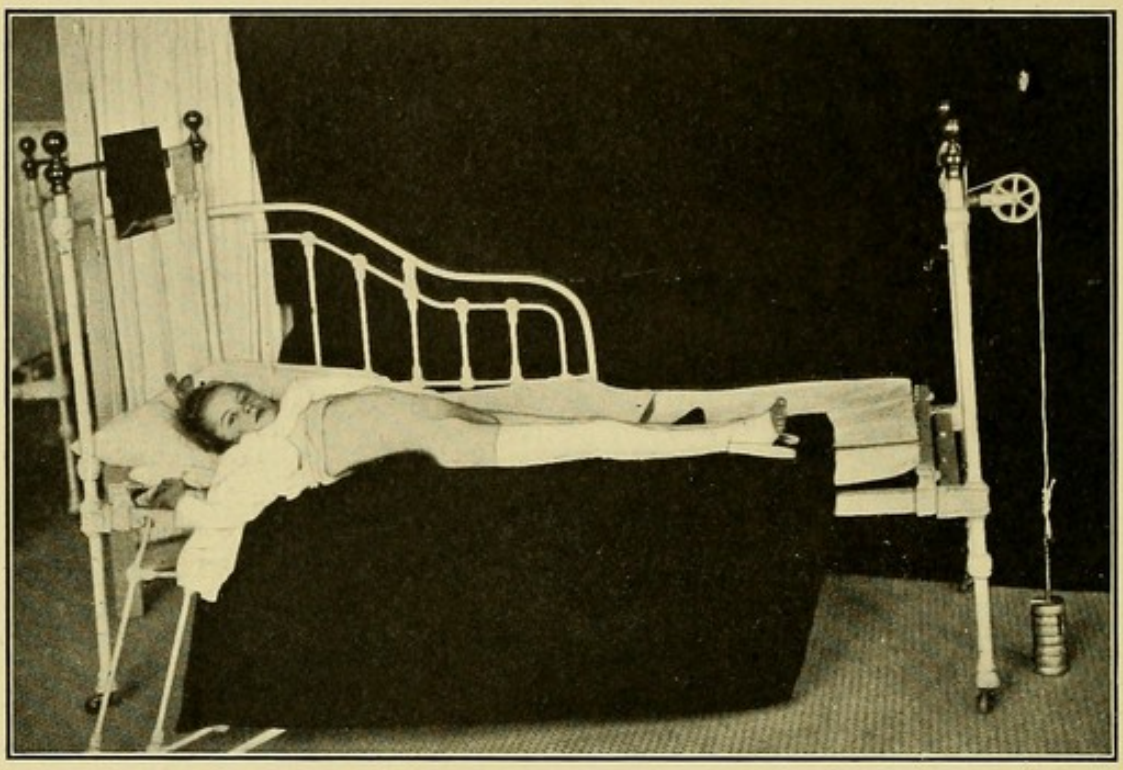


Fig. 150.—Case of Hip Tuberculosis Prepared for Traction in Bed. Note lordosis.

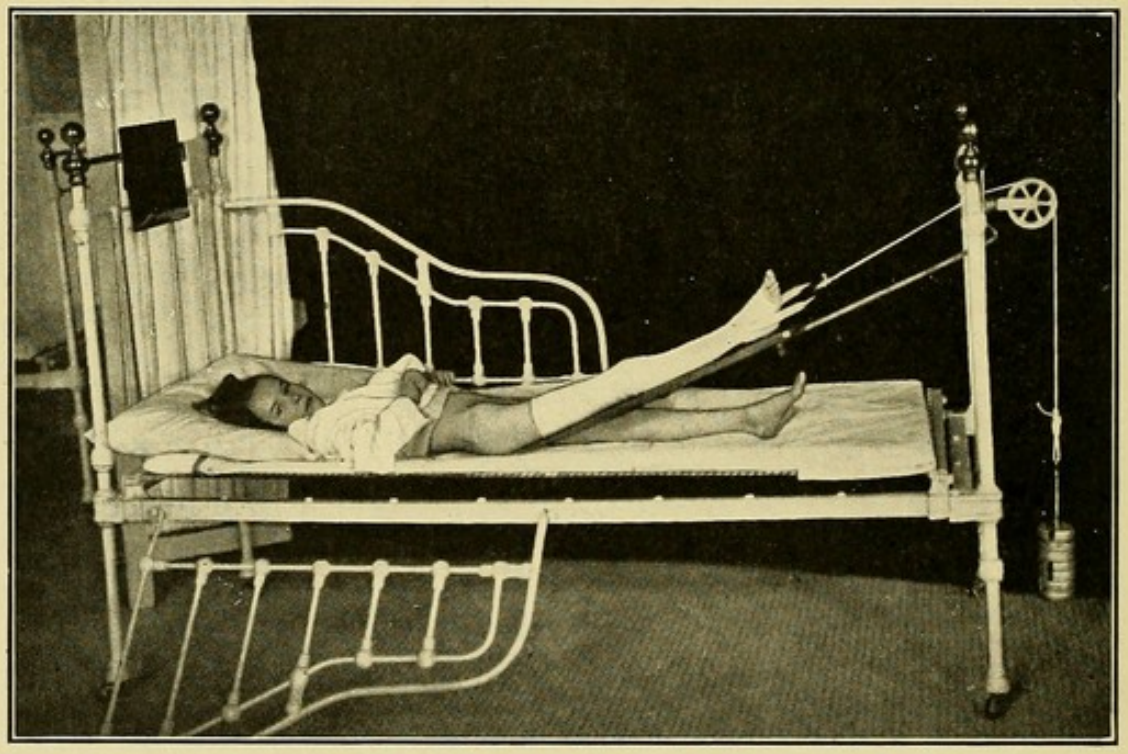


Fig. 151.—Traction in Bed with Weight and Pulley; Post-graduate Hospital. Note disappearance of lordosis when leg is elevated.

on with traction of the leg, reaching from the ensiform cartilage to the toes, and snugly grasping the pelvis. In dispensary cases without marked deformity, the long plaster spica may take the place of traction in bed.

When the acute symptoms have subsided, or before, a rigid immobilizing and traction splint with a thoracic attachment should be fitted, and worn day and night. Perineal straps, to furnish countertraction and to carry the weight of the body, are attached to the hip band (C. F. Taylor), or the weight may be borne on a padded ring (Phelps) (Fig. 152). The splint is longer than the limb by two and a half inches, and its lower end rests on the ground; it is attached by straps to the buckles of the adhesive plaster, which has previously been applied to the leg. A ratchet is convenient for adjustment, but if the straps are kept tight and a weight is attached to the splint at night, it is not essential. The adhesive plaster should be applied to the top of the thigh, and the knee should

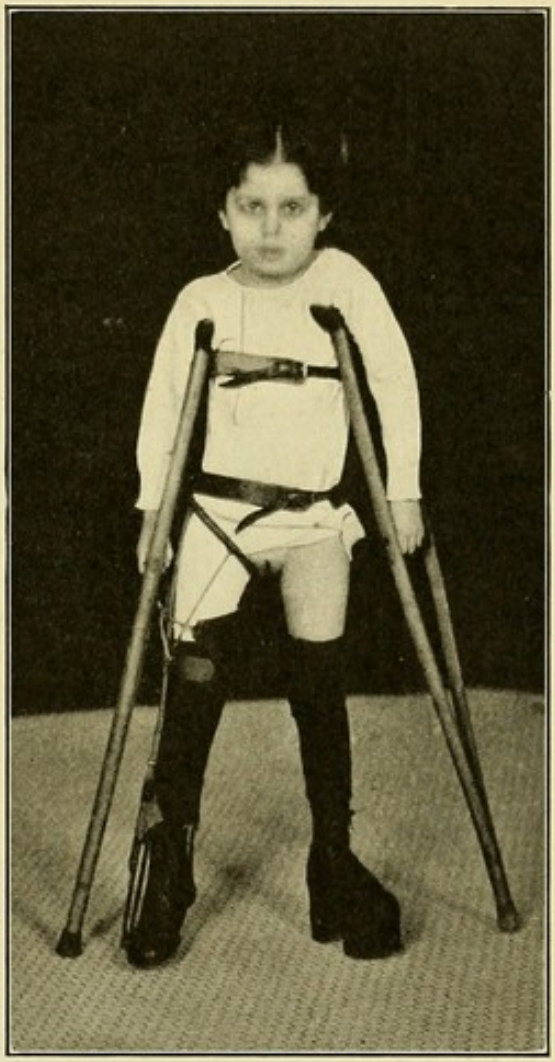


Fig. 152.—Phelps's Hip-splint, with Crutches and High Shoe on Well Foot, as Used at the Post-Graduate Hospital.

be supported behind, in order to prevent relaxation and recurvature (Fig. 153). The child wears a two-and-one-half-inch cork sole on the well foot, and the use

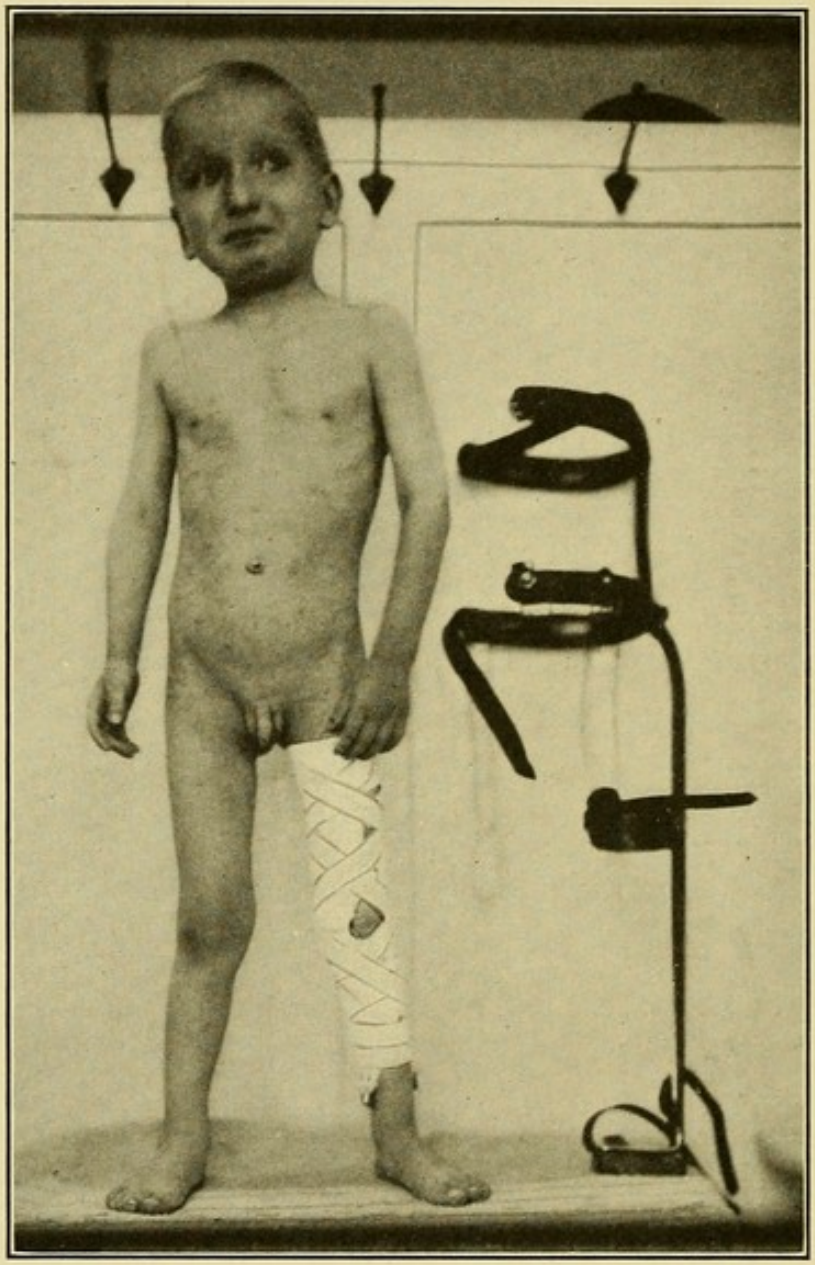


FIG. 153.—METHOD OF APPLYING ADHESIVE PLASTER FOR HIP TRACTION. Fixation and suspension splint used at the Hospital for Ruptured and Crippled.

of crutches, at least during the acute stage, is desirable; exercise should be greatly limited and jolting avoided.

Particular attention is paid throughout the treatment to the prevention and correction of deformity. Under

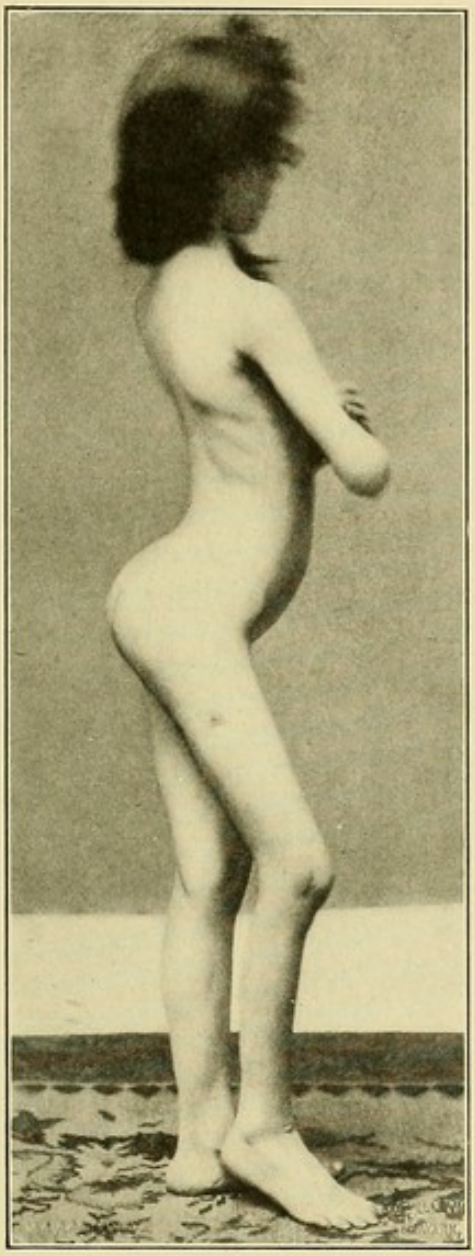


Fig. 154.—Fibrous Ankylosis of the Right Hip at a Right Angle.

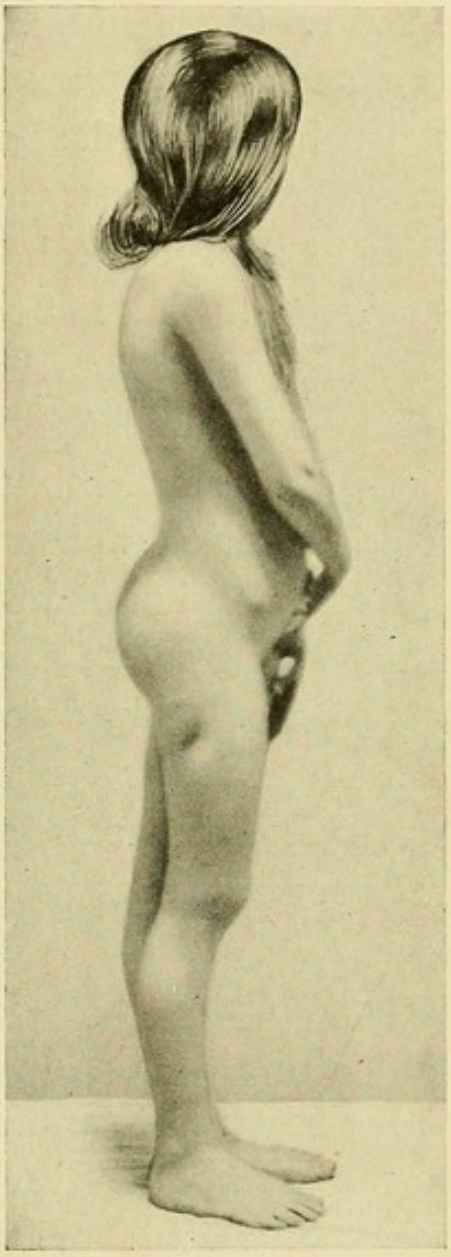


Fig. 155.—Same Patient as Fig. 154. Result after manipulation under ether.

careful management serious deformity should not occur, but, when present, it should be corrected. The deviations due to muscular spasm disappear under anesthesia,

and may usually be stretched out by traction in bed. In the later stages, a year or more after the subsidence of acute symptoms, fibrous adhesions may be carefully broken up under anesthesia, flexion and adduction overcome, and the leg placed in extension and moderate abduction in a long plaster spica (Figs. 154 and 155). In correcting these cases the pelvis may be fixed by extreme flexion of the sound thigh, or by a temporary short spica reaching to the knee of the well side (Dollinger). Owing to the atrophy of the femur a fracture is easily produced, unless the manipulations are made slowly, and with care. If a fracture should occur near the joint, the opportunity should be utilized to correct the deformity by placing the thigh in extension and abduction, and retaining the posture by a long spica; usually no harm results. After the correction of a hip deformity the long spica should be worn for eight or ten weeks; it is then replaced by a short spica, high sole, and crutches, which may be renewed several times until the hip is stable in the posture of choice.

Gant's Osteotomy.—In stiff, cured cases, with adduction and flexion, the deformity should be corrected and the leg restored to usefulness by a subcutaneous linear osteotomy just below the trochanter minor (Gant). This operation, which should be postponed until sinuses are healed, is not difficult or dangerous, and gives excellent results, often adding two or three inches to the effective length of the leg. The operation may be done through an open incision, if preferred. The subcutaneous operation is as follows: The anesthetized patient is placed on the well side, with a sand bag between the thighs as

high up as possible, and a sharp osteotome one quarter to three eighths inch wide is pushed through the skin to the bone in the axis of the femur. After the periosteum is divided the edge of the osteotome is turned across the

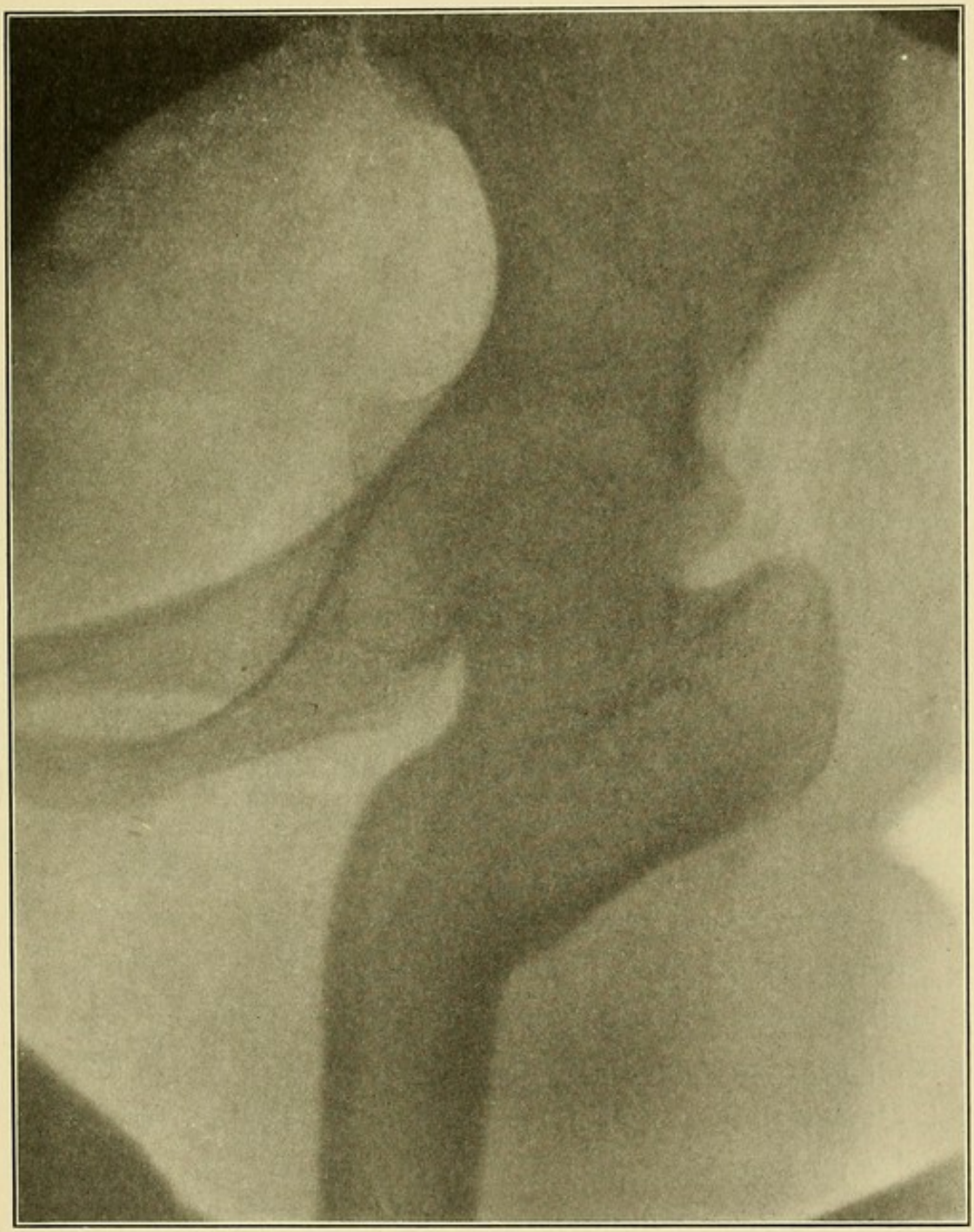


FIG. 156. — RESULT AFTER GANT'S OSTEOTOMY (ALBEE) FOR PERMANENT ADDUCTION OF THE THIGH. Girl of sixteen whose coxitis was cured without mechanical treatment.

axis of the femur, and the shaft divided by blows of a mallet for two thirds or three quarters of its extent. The osteotome is then withdrawn, the femur fractured, and the thigh brought into extension and abduction; one catgut suture closes the tiny wound, and a gauze and cotton dressing and long plaster spica are applied. The after treatment is the same as after manual correction (Fig. 156).

A few early cases of coxitis, thought to be tuberculous, recover in a year or less; in many of these the diagnosis is doubtful. In most really tuberculous cases several years of mechanical support will be required. When convalescence is established the thoracic attachment may be removed, the toes may be allowed to touch the ground, a jointed supporting splint may be applied, or the child may be allowed to walk in a short spica, grasping the pelvis and extending only to the knee. When the time comes to discontinue support, the splint should be at first left off at night and later gradually discontinued during the day. Some patients are kept far too long in splints, while in others the splints are removed too early; either error is a costly one, and the matter is one for careful consideration and ripe judgment.

Ichor pockets, so long as they are not infected, are usually harmless; for this reason they should be treated with great conservatism. When small they should be let alone; they sometimes disappear. If they increase in size and threaten to burrow, they should be aspirated through a large needle, and this should be repeated at intervals of a week or two; a fair number disappear under this treatment. If in spite of aspiration

they increase and require treatment, they may be aseptically incised and drained, and left open or sutured. Many contract, and heal at once or after discharging for a longer or shorter time, especially if fresh air, feeding, and joint rest are attended to. Others burrow in spite of care, and finally end in one or many more or less infected sinuses, which are often troublesome, and may be dangerous. Multiple and intractable sinuses are apt to result from disease of the shaft or pelvis, complicating the original trouble. Sinuses should not be allowed to pocket, and should freely drain the site of disease. The washing and injection of pockets and sinuses, except to clean up a pus infection, is usually useless and often harmful, though an occasional small injection of a saturated solution of iodoform in ether or a ten-per-cent emulsion of iodoform in pure glycerin into old sinuses is sometimes advantageous. The scraping out of pockets has given very bad results in practice. When extensively undermined, it is sometimes necessary to lay open these cysts by long incisions, and allow them to granulate. As a rule, if the general and local treatment is well attended to, the less uninfected pockets are interfered with the better; when infected they should be freely opened, washed out, and kept aseptic. The bismuth-vaselin injections are beneficial in many cases of pockets and sinuses (see General Part).

Operative Treatment.—After extensive trial, early excisions and erasions for tuberculous joint disease have been abandoned in children; they are now reserved for cases in which conservative treatment has failed, and are indicated in only a small percentage. Statistics show

a mortality from the operation or from the disease after operation of nearly one half. In those who recover, the limb is often very poor. In adults, excision is often the

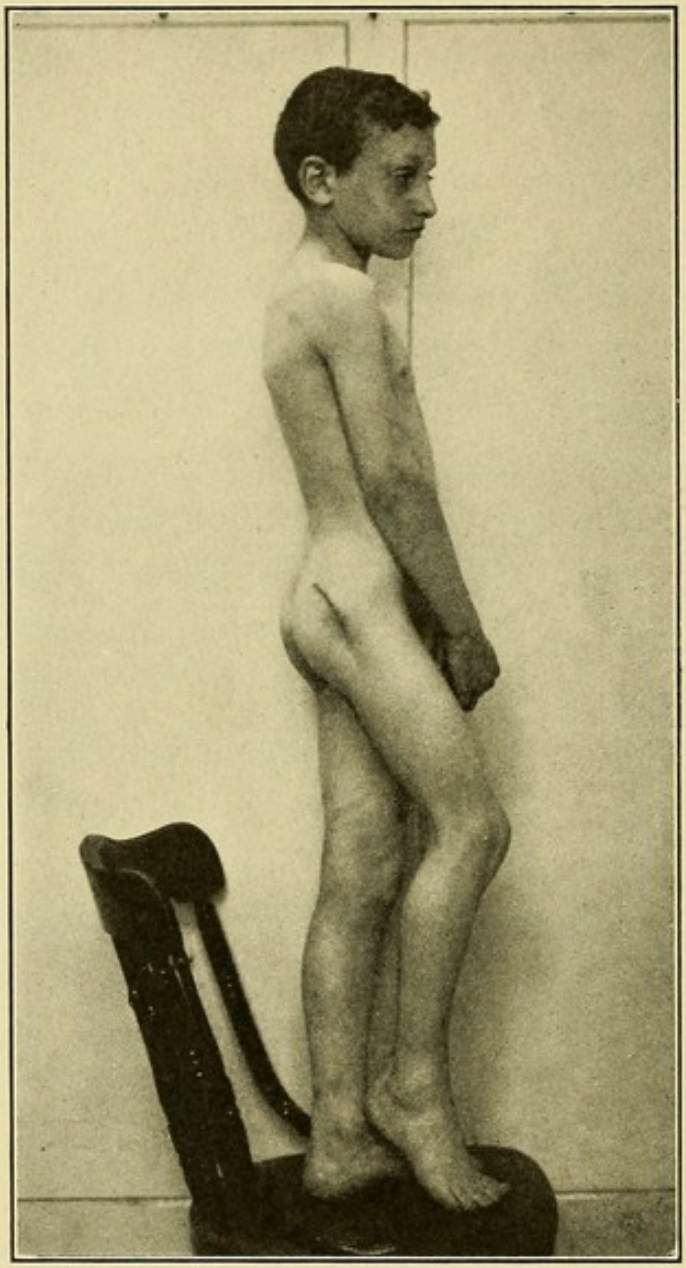


FIG. 157.—RESULT AFTER EXCISION OF THE HIP; BOY OF TWELVE; CURE WITH FLEXION AND SHORTENING. The flexion should be corrected.

operation of choice, and frequently gives excellent results. As the patient is usually in poor condition, it is important to do the operation quickly. An ample

incision is made from above the acetabulum to below the trochanter and into the joint, the capsule is separated, the neck or trochanter is quickly chiseled off, and the head removed with the forceps. Diseased bone is scraped out with the curette, and as much as possible of the diseased capsule is removed by curved scissors. The joint is washed out with hot saline and packed tightly for twenty-four hours, then down to bone only, and healing is by granulation; sinuses often persist (Fig. 157).

Prognosis.—Many untreated or neglected cases of tuberculous coxitis succumb after a longer or shorter period to tuberculous and septic accidents, waxy degeneration, renal involvement, prolonged suppuration, or exhaustion. In others, after the disease has run its course, the patient is left in fairly good general condition, but with a stiff, flexed, adducted, inverted, and shortened leg, rendering locomotion difficult or impossible (Fig. 158). In females, the deformity may be a bar to marriage and maternity. These deformities, no matter how severe or of how long standing, may be corrected by Gant's osteotomy, as already described. In hygienically and mechanically treated cases the suffering and mortality are diminished, the complications are less serious, and the final usefulness of the limb greater. The large majority recover with a competent limb, many with excellent motion. Unless the leg is left in good posture, the result is not to be considered satisfactory. Relapses are possible, even after many years, from sickness or injury, owing to the freeing of encapsulated bacteria, but this only occurs in a small proportion.

Infections of the hip-joint may be produced by pus cocci and other microbes, such as gonococci, pneumococci, and

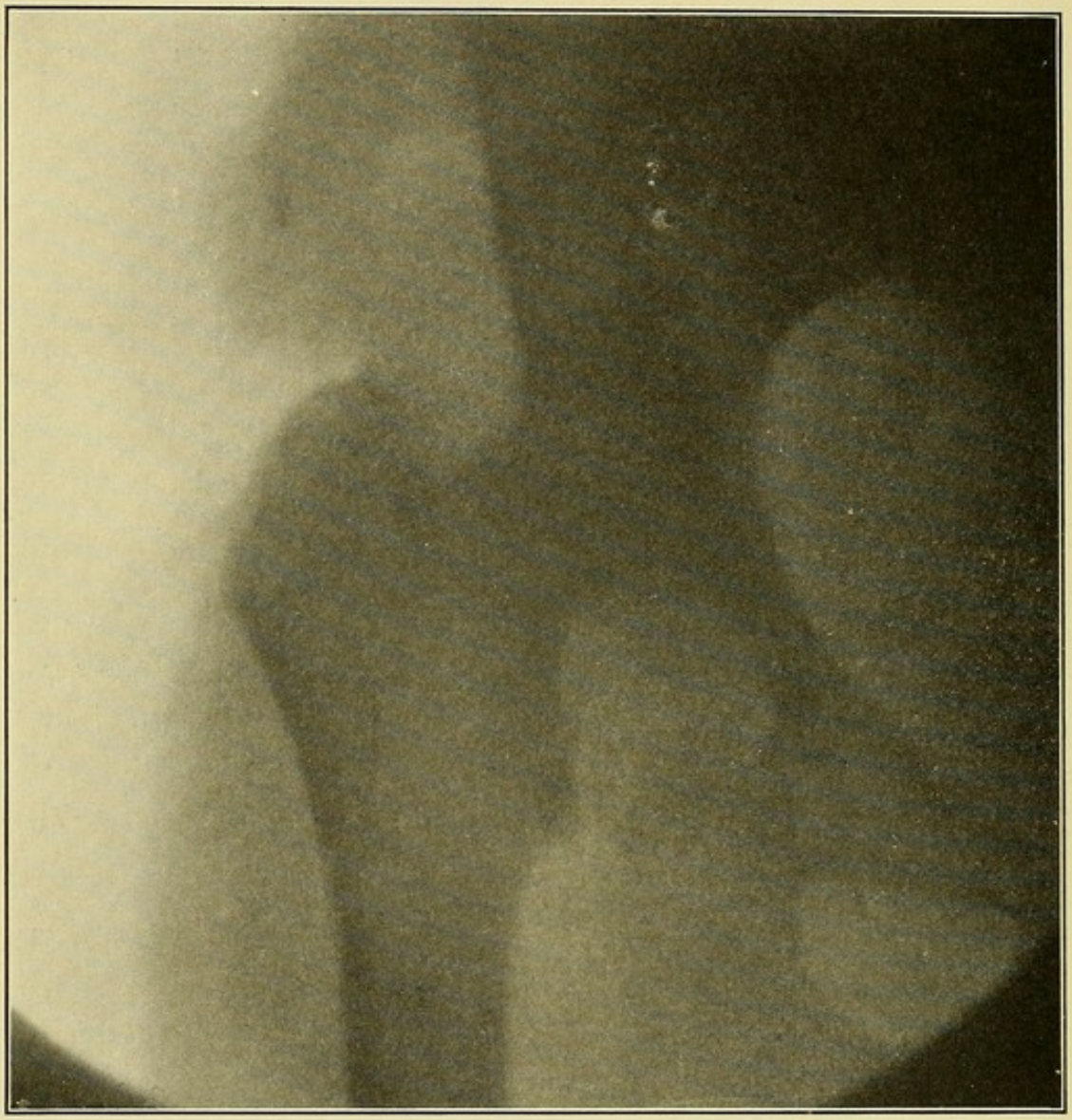


FIG. 158. — NATURAL CURE OF COXITIS. Disease at ten; extensive sinuses closed after one year. At twenty there were extreme flexion and adduction, which was corrected mechanically by C. F. Taylor. The skiagram taken at fifty-three shows excellent posture, disappearance of head and upward displacement. There is shortening of three inches, over ninety degrees of motion, and excellent function.

typhoid bacilli; these sometimes cause suppuration, at other times effusion or adhesive inflammation. The infection is usually brought by the blood current from some

local focus, but may arise from contiguity or from direct infection. The symptoms of pus infection, which may be primarily synovial or osteal, are acute and severe; after confirmation of the diagnosis by aspiration, purulent synovitis requires aseptic incision, irrigation of the joint, and drainage; bone operations will be required in the osteal form.

Bacterial products may produce joint irritation without suppuration, but with pain, tenderness, swelling, stiffness, and disability lasting a longer or shorter time. Such cases were formerly called rheumatic, but may often be traced to a definite source of infection, such as the tonsils or alimentary canal, and are amenable to treatment. The toxemia should be combated if still present, and its source eradicated or sterilized; during the active stages the affected joints should be put at rest by recumbency, and, if necessary, by traction and splints. During the stage of convalescence general tonic measures and local stimulation by vibration, massage, heat, electricity, and graduated exercise may be employed, and the protected or limited use of the joint favored by special apparatus, which enable the patient to walk without strain or injury to the weakened part.

The SUPPURATIVE COXITIS (EPIPHYSITIS) OF INFANCY usually occurs during the first year, and is often fatal unless prompt surgical relief is afforded. The head of the femur may be destroyed, or it may have to be removed, and the patient in such cases recovers with a loose joint and upward displacement of the femur (Fig. 159).

Gonorrheal coxitis is not uncommon in young adults. Many of these patients seem perfectly healthy, and no source of infection is found until the genito-urinary condition and history are investigated. Other joints may

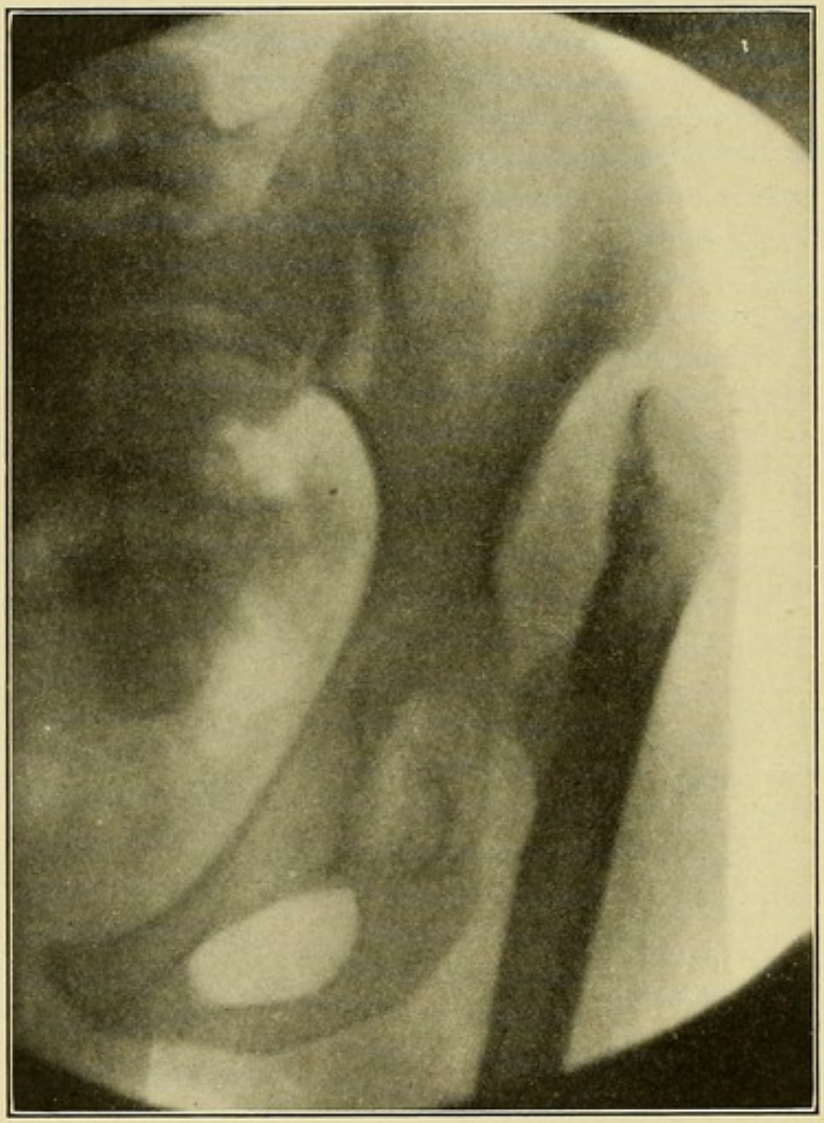


Fig. 159.—Disappearance of Head and Neck of Femur from Suppurative Arthritis at One and a Half Years. Boy of Six.

or may not be affected. The coxitis often causes great suffering and disability, which may oblige the patient to go to bed. With proper treatment of the source of infection, rest, and traction, the affection usually goes on

to recovery in far less time and with less local damage than do the tuberculous cases. Stiffness not infrequently follows, and it is important to keep the thigh extended and abducted. If the patient recovers with ankylosis and deformity, they may be rectified by a forcible stretching or an osteotomy.

Arthritis deformans is usually polyarticular, particularly affecting the phalangeal joints, but often involves one hip or both, and other large joints. It is characterized by atrophy of bone cartilage and soft parts, joint stiffness, and deformation. The general management of the condition is described in the general section (p. 45), and one should not take too pessimistic a view. Some cases do not progress far, others are arrested by treatment, while nearly all are susceptible of improvement. The local treatment by rest and prevention of deformity in the active stage, and by stimulation and correction of deformity in the stage of convalescence, gives gratifying, and sometimes brilliant, results. The plight of patients with both hips or other major joints stiff is, indeed, a sad one, and in such cases the attempt may be made to mobilize the joints by judicious and not too strenuous manipulation. If this fails, a flap of fat and fascia may be introduced into the joint (Murphy), or the attempt may be made to obtain a pseudarthrosis.

Osteoarthritis of the Hip and Senile Coxitis.—There is a lesion, often monarticular, which frequently attacks the hip, especially in middle life or beyond, which causes pain, stiffness, and lameness usually without constitutional symptoms, and which may make walking very

difficult or impossible. It usually comes on slowly, sometimes after an injury, and is characterized by the wear-

FIG. 160.—OSTEOARTHRITIS OF THE HIP, ANTERIOR VIEW EXCEPT SPECIMEN TO RIGHT, WHICH IS SEEN FROM BEHIND. (From specimens in Cornell Medical College.)

ing away of the weight-bearing parts of the joint and the formation of osteophytes around the periphery.

The head often becomes cylindrical, limiting motion to flexion and extension, the plan of which may be deflected (Fig. 160). There is no tendency to suppuration. The thigh usually becomes flexed and adducted.

The affection may also be polyarticular, when the lumbar spine, iliac joints, hips, and knees are specially liable to involvement, though the small joints are not immune. In a few cases striking benefit has been obtained by the use of deep vibration about the hip-joint. As the condition is much aggravated by friction and pressure, the use of a short spica and crutches, or of a jointed supporting splint, after preliminary traction in bed, is sometimes of great benefit, and the disease may be arrested. In some cases the suffering, malposition, and disability are so great as to justify a radical operation.

The head of the femur and the roof of the acetabulum may be chiseled flat and brought together (Albee), in order to give a firm and stable ankylosis in good posture; this has worked admirably in eight cases in which it has been tried.

Albee's Operation.—The hip is reached by an anterior incision five inches long from the anterior superior spine of the ilium, downward along the inner border of the sartorius muscle, which is retracted outward. The muscles and deep structures are separated by blunt dissection. The iliacus and the rectus femoris muscles are retracted inward. Osteophytes about the acetabulum, if numerous, should be turned aside with the soft tissues adherent to them, on account of their bone-forming possibilities. The joint, which is often obscured

by these bony excrescences, should be definitely located before the partial removal of the head is begun. With the leg adducted, about one half of the upper hemisphere of the head of the femur is removed *in situ* with a large chisel through a plane nearly parallel to the long axis of its neck. With the same instrument the acetabulum

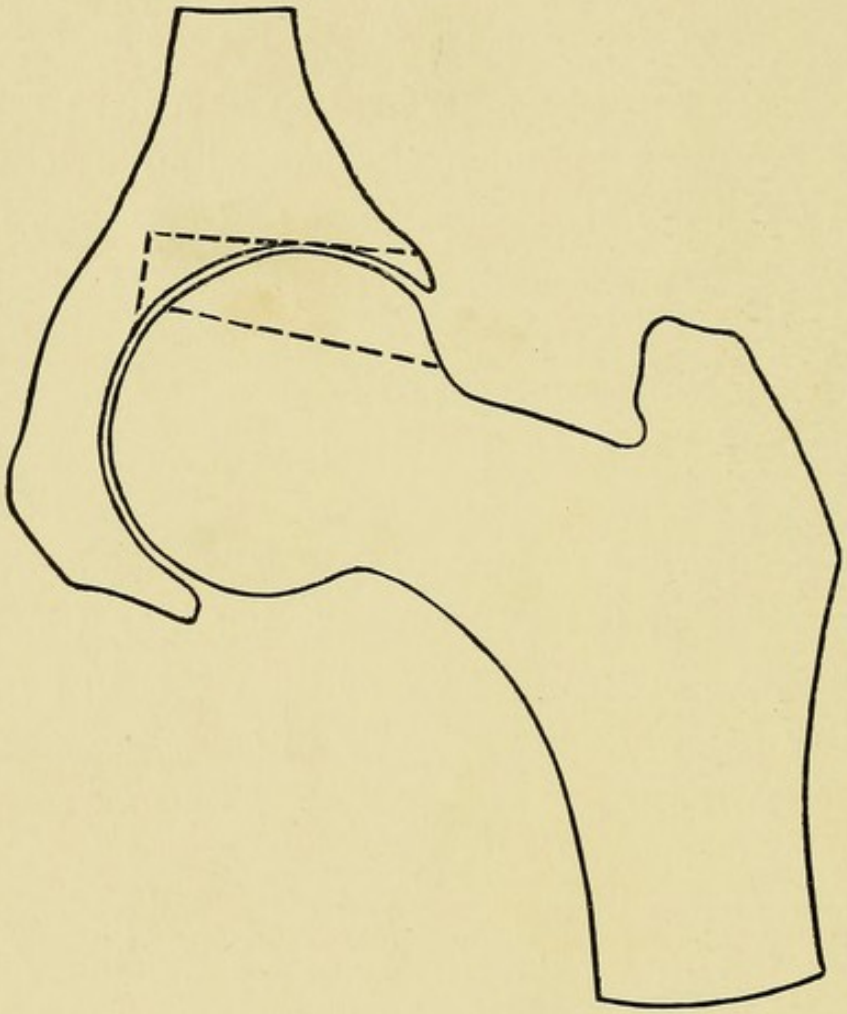


FIG. 161.—DIAGRAM OF ALBEE'S OPERATION. The broken lines indicate the amount of bone to be removed. It is removed from the head and the acetabulum in different planes, in order to secure the desired abduction of the thigh when the bone surfaces are brought together.

is transformed into a flat roof, against which the fresh surface of the head is brought into firm contact by abduction of the thigh. In order to prevent slipping, the

acetabular roof slopes slightly outward (Figs. 161 and 162). The capsule and soft tissues are sutured while the leg is held in strong abduction. If this position is pre-

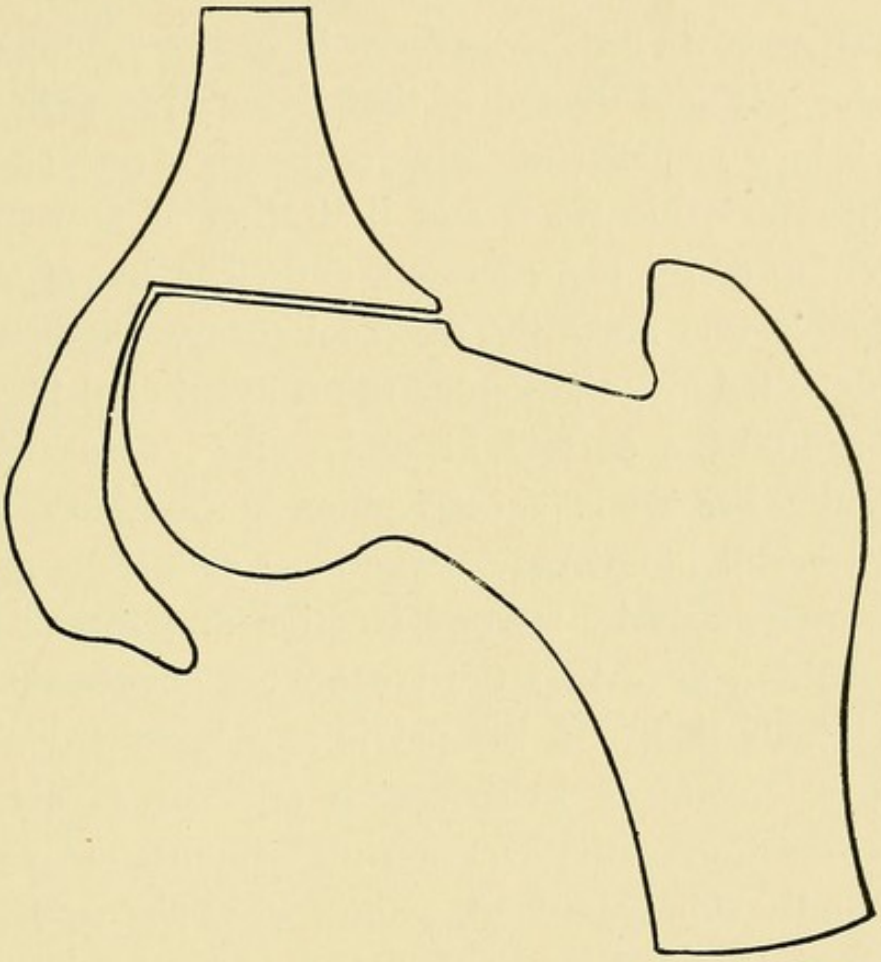


FIG. 162.—DIAGRAM OF ALBEE'S OPERATION. Apposition of the cut surfaces after the removal of the bone from the head and the acetabulum.

vented by contractures of the adductor muscles, tenotomies of those muscles may be necessary. The leg is finally put up in a spica, from axilla to toes, in a position of marked abduction. The patient should be kept in bed for three weeks. A short spica can usually be applied at the end of the fifth week, which should be retained six weeks.

DEFORMITIES OF THE LEG

Neck of Femur

Fracture of the neck of the femur is such a common cause of deformity and disability that it requires notice here. This injury is unfortunately frequently overlooked, but the disability, hip pain, and limitation of motion, with shortening of the leg, eversion, and elevation of the trochanter, should make the diagnosis easy, whether crepitus is elicited or not. Under the conventional treatment with sand bags or weight and pulley, deformity and shortening are the rule, bony union is the exception, and a fatal result is not rare. The bone should be replaced under anesthesia by manual traction and forced abduction, making sure that the trochanter is brought down to Nélaton's line, and the pelvis and leg should be put up in a long spica in extension and forced abduction with correction of the eversion (Whitman). Many cases unite under this treatment. The forced abduction treatment may be tried in the first three months, but in the older cases it is often best to enter the hip-joint through an anterior incision on the inner edge of the tensor fasciæ latæ, freshen the edges of the fracture, place the fragments in position, unite the periosteum by sutures or nail them by a steel drill or nail driven through the trochanter. The wound is sutured, but the nail should be removed through a small incision at the end of four weeks. If the proximal fragment is small it is better to remove it, freshen the acetabulum and the neck, and place the neck in the acetabulum, put the pelvis and leg in a

plaster spica in abduction, and try to get ankylosis or adhesions sufficient to keep it in place; or an operation may be done similar to Albee's for senile coxitis. Good results are also reported from spiking without arthrotomy, and from arthrotomy without nailing. The leg should always be put up in forced abduction.

Affections of the Shaft of the Femur

Congenital.—The femur may be congenitally absent, deformed, or short (Fig. 163). If there is a shortening of about an inch in one femur in a young child, with no other objective signs, and no history of disease or injury, the case is probably one of congenital shortening (phocomelia). In such cases motion is free, the head of the femur is in the acetabulum, the trochanter may not be elevated, and the leg is normally developed. The only symptoms are a slight limp if the shortening is considerable, and an inclination of the pelvis to the short side, with consequent bending of the spine. The difference in the length of the limbs should be made up by a cork sole on the shoe of the short side. If the femur is a mere rudiment, walking may still be possible if a Thomas knee splint is applied equal in length to the other extremity and taking the weight on the ring.

Unequal Growth of the Limbs.—Differences in length of the lower limbs not due to disease or deformity, and amounting to one quarter or half an inch, are not infrequently found, particularly in scoliotic girls; the left leg is usually the shorter. It is not known which long bone is most affected. There is usually a bending of the lower spine toward the short side, which in the

younger cases wholly or largely disappears when the difference is made up by placing some flat object of equal thickness, like a magazine or thin board, under

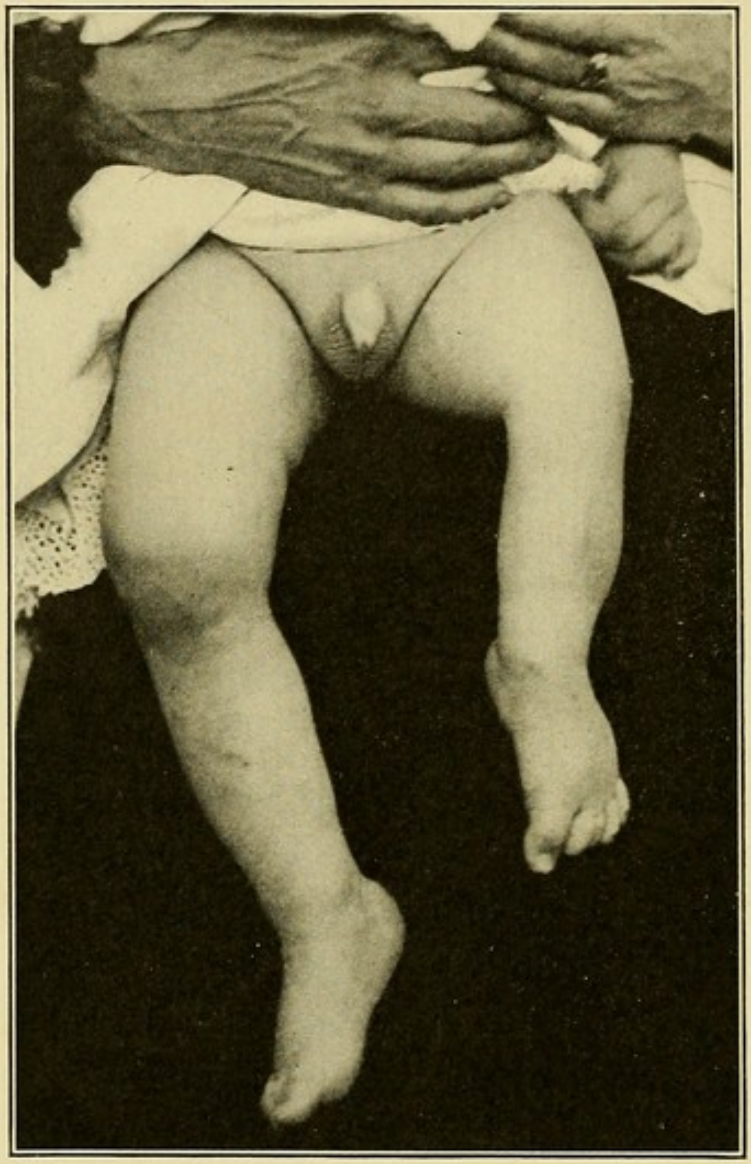


FIG. 163.—CONGENITALLY SHORT LEG (PHOCOMELIA) IN A BABY FOURTEEN MONTHS OLD; THE SHORTENING IS PARTICULARLY MARKED IN THE FEMUR.

the short limb. The compensatory bending does not usually result in severe fixed curvatures, but these sometimes occur. The curvature is not always toward the side of the short limb. It is difficult to assign any cause for this difference except *unequal growth*, though some

cases may be due to slight poliomyelitis. During the growing period the difference should be equalized by a corresponding thickness of cork under the shoe. Excessive growth of one leg (macromelia) also occurs; such legs are larger as well as longer.

Osteomyelitis of the shaft is commonest at the ends of the diaphysis (metaphysis) and during the period of growth; the hip and knee are frequently involved by contiguity or perforation. This accident should be prevented by early diagnosis and timely operative interference. The circumscribed form of osteomyelitis is sometimes called bone abscess; it may be acute, but is occasionally very chronic, and may run its course without suppuration, and producing a cavity with thickened walls containing fluid, which may be sterile. Such a lesion is called a *quiet bone abscess*, or *Brodie's abscess*. It is sometimes difficult to distinguish from a benign bone cyst, which, however, is more regular in outline, is often lined with smooth membrane, and is not inclosed in thickened bone. A large part or the whole of the shaft may be involved from the start. In such cases the shaft should be converted into a gutter by chiseling away its outer wall, or, if the shaft is already dead, it should be removed; both operations should be done under the periosteum.

Sarcoma may occur at either end of the femur or in the middle. It prefers the more rapidly growing end of a long bone. When it involves the middle of the shaft it is usually of the round or spindle-celled, periosteal type, which is more malignant than the giant-celled, medullary type (Fig. 30). Sarcoma at the ends of the

long bones may simulate or provoke joint disease. Skiagraphy often assists the diagnosis, but excision and pathological examination of a piece of the tumor is frequently necessary. The treatment is excision through healthy tissue or at the proximal joint. Injections of the mixed toxins of erysipelas and bacillus prodigiosus (Coley) have been successful in a few cases, some of them inoperable.

Benign cysts of the femur are rare. They usually occur in youths, and at the upper end of the shaft (Fig. 29). They are of regular outline, filled with clear sterile fluid, and lined with smooth walls (membrane); surrounding bone is not thickened. If extensive they may lead to spontaneous fracture, which, however, usually unites under proper splinting. Such bone cysts are benign, and heal kindly when scraped out.

Bowed Femur.—The femur often becomes bowed, usually outward and forward, in rickets, and also in Paget's disease (Fig. 57). As this deformity is not disabling, and is not noticeable under the clothing, it is usually left untreated.

Flexed Femur.—In flexion of the knee, occurring after excision, the bending is sometimes in the shaft just above the condyles. It may be corrected by a cuneiform osteotomy. See remarks on the treatment of flexed knee.

Deformities of the Knee

Congenital Deformities

Congenital flexion is occasionally noticed in babies; it may occur on one or both sides. In the light and middle

grades it yields to daily stretching (Fig. 164). The severe forms may be associated with pes calcaneus, and may be very resistant, sometimes requiring tenotomy of the hamstrings, forcible stretching, and retentive apparatus.

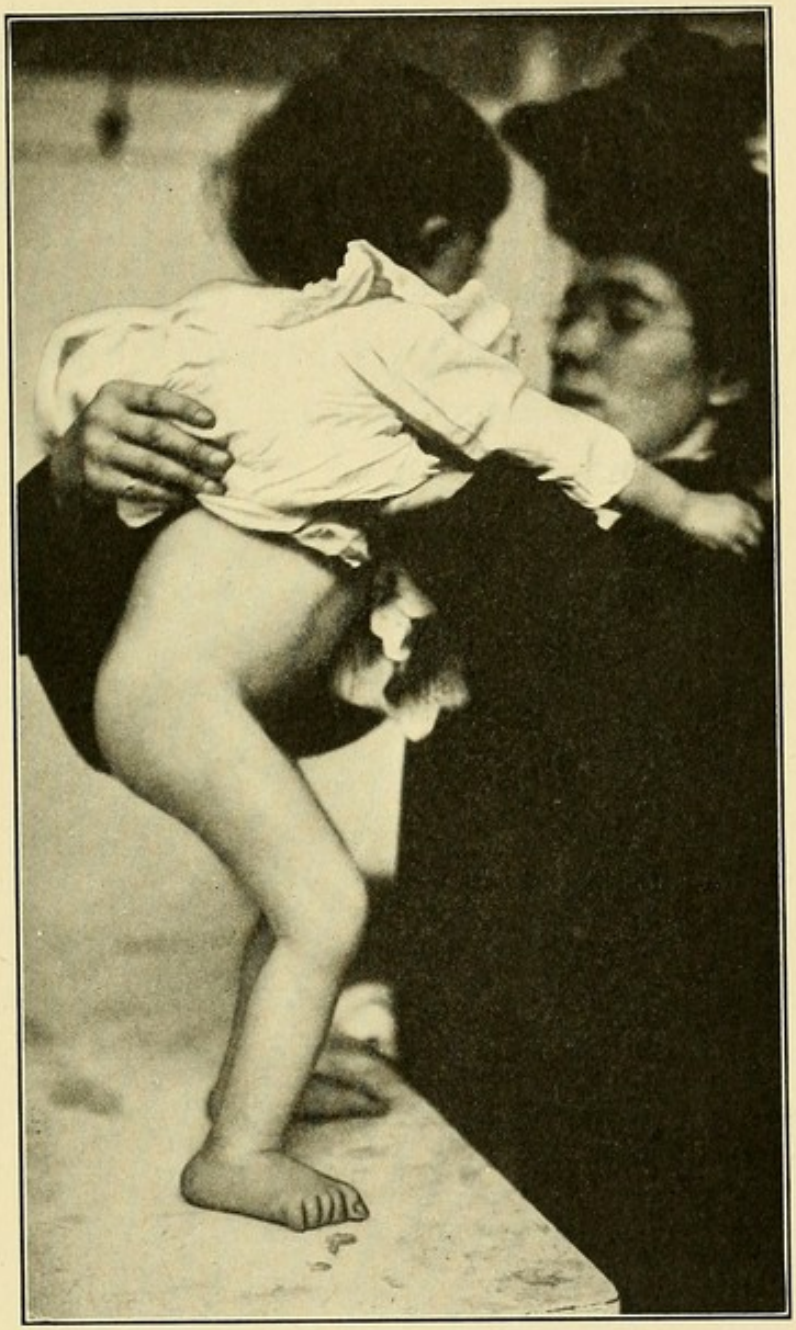


FIG. 164.—CONGENITAL FLEXION OF KNEES IN A CHILD OF TWO.

A snapping or clicking knee is occasionally seen in young babies. There appears to be laxity of the ligaments;

this permitted a partial dislocation of the tibia outward in a recent case. The laxity may be congenital. Bandaging, strapping, or splinting usually overcomes the difficulty.

Congenital Hyperextension of the Knee. (*Congenital genu recurvatum. Congenital absence of the patella. Congenital dislocation of the knee.*)

In this affection the baby is usually born breech first, with the thighs flexed on the abdomen, the knees hyperextended, and the feet beside the face; unilateral cases also occur; the deformity is evidently due to uterine pressure on the extended knee or knees; there is sometimes ligamentous laxity of a number of joints. The tibia is displaced forward on the condyles, the knee is lax, permitting lateral and sliding movements, and the patella is often not palpable in the first few months; it can usually be felt before the end of the first year, but may remain small. The hyperextension of the knee is often considerable, and it may be impossible to bring the leg back beyond a straight line. Popliteal creases may be absent, and creases may be present in front of the knee; the femoral condyles are abnormally prominent in the popliteal space. Unless the legs are held in position and gradually flexed by strapping the child to a frame bent under the knees, or by other appliances, the child may have difficulty in walking and loose knees. This condition is a rare cause of knock-knee. By preventing extension and displacement and gradually increasing the flexion, the deformity may be overcome; after some years, during which a jointed supporting splint may be worn, the knees become practically normal.

Acquired Deformities

Acquired genu recurvatum is due to stretching of the posterior ligament of the knee-joint when motion is not sufficiently checked by the hamstring muscles. In a mild degree it is often seen in loose-jointed and delicate children, and it is common in inveterate pes equinus and equino-varus; also after poliomyelitis affecting the knee flexors, especially when the heel cord is contracted (Fig. 31). It frequently occurs in the hypotonus of locomotor ataxia, and of coxitis, and especially in the latter affection if traction is made from adhesive strips applied only below the knee, and when hyperextension is not prevented by a steel band behind the knee. In the paralytic forms of genu recurvatum, and in that complicating locomotor ataxia, apparatus should be adjusted to prevent lateral motion and to keep the knee slightly flexed. The bending in the rachitic form is usually below the knee-joint.

Bursitis About the Knee.—A knowledge of the location of the bursæ about the knee is necessary in order to differentiate knee affections and treat them properly. It should be remembered that a bursa may be irritated by repeated trauma, and is liable to the various infections to which serous membranes are subject.

Prepatellar bursitis, or housemaid's knee, is usually due to working in the kneeling posture, as scrubwomen are obliged to do. It appears as a large, rounded, tense swelling in front of the patella, and is usually filled with a gelatinous fluid. It sometimes suppurates. The ordinary form may be treated by extirpation of the sac, or

by incising it with a tenotone, squeezing out the jelly, making multiple scarifications inside the sac with the tenotome (Hoffman) and applying firm compression. When pus is present the sac should be opened, irrigated, curetted, or dissected out and dressed. Prepatellar bursitis should not be confounded with tuberculosis of the patella.

Pretibial Bursitis.—The pretibial bursa lies between the front of the tibia and the ligamentum patella; when distended, it projects either side of the latter, and appears as a tense, elastic, or fluctuating swelling. It is often affected in diseases of the knee-joint, but it is not infrequently involved without affecting the knee. If filled with pus, it should be evacuated, disinfected, and scraped, otherwise rest and strapping are usually sufficient. Enlargement either side of the ligamentum patellæ may also be caused by hypertrophied synovial fringes below the patella.

Pretubercular Bursitis.—There is in some individuals a small bursa in front of the tibial tubercle, which may become inflamed after injury or otherwise, and give rise to a small, tense swelling, which may be unilateral or bilateral, and which may cause pain, especially on going upstairs. This condition may persist for a long time, and give rise to a permanent enlargement of the tubercle. The treatment is painting with iodin, strapping, and rest; stair climbing is particularly harmful. Prompt relief is usually afforded by such treatment.

Many of these cases in adolescents are due to a diastasis or fracture of the tubercular epiphysis (Osgood), a narrow tongue of bone jutting down from the upper

tibial epiphysis. In such cases pain, swelling, tenderness, and disability about the tibial tubercle comes on suddenly after a fall or blow. A lateral skiagram of the knee will clearly show a fracture or diastasis, if present. Soreness and disability may persist for some time unless the knee is immobilized for three or four weeks.

The **bursæ under the hamstring tendons** sometimes become distended or inflamed, and may require tapping and compression or more vigorous treatment.

Accidents to the Patella and its Ligaments.—The quadriceps tendon may be torn above the patella, and may require suture.

The ligamentum patellæ may be torn from its tubercle, and may require a couple of stitches to reattach it. Fractures of the patella are common, and, unless operated, the union is usually by ligament, sometimes with a large separation. Function, however, is often good. If one is a master of asepsis, it is good practice to make a transverse incision a few days after the fracture, turn out the clots, and unite the fibrous tissue at either side and at the edges of the patella by chromicized gut. A suture through the bone is usually unnecessary. In all of these injuries the leg should be kept in full extension by a back splint or by a plaster-of-Paris bandage.

Slipping Patella.—The patella, after once being dislocated, may acquire the habit of slipping, usually to the outer side. This may occur in knock-knee, when it is often sufficient to correct the deformity. When due to other causes, the ligamentum patellæ may be exposed by longitudinal incision; it is then split to its insertion in the tubercle of the tibia; the half of the tendon toward

which the patella slips is then cut off at its insertion, pulled under the half which still remains attached, and sutured to the periosteum near the tubercle on the opposite side (Goldthwait). This pulls the patella away from the side toward which it slips. This is much simpler than Krogius's operation (Kocher), and seems to be equally effective.

Tuberculosis of the Patella.—The patella is often diseased in tuberculosis of the knee, but the process may also begin in the patella. It is very important to recognize this early, as by a timely scraping operation or, if need be, by excision of the patella, infection of the joint may be avoided.

The symptoms are pain in, and swelling in front of, the patella; this swelling may contain serum, with flocculi and tuberculous débris; the anterior surface of the patella may be felt to be eroded, or erosion may be revealed by a skiagram. Extirpation of the patella does not interfere with extension of the knee if the fascia at either side is sutured together in the median line.

Ankylosis of the Patella.—The patella may become united to the articular groove of the femur after an infection of the knee-joint. If it has become ankylosed while the knee was flexed, it stops extension, and its adherence in any position removes all voluntary extension and flexion; any motion which may be present will be due to laxity of the ligamentum patellæ. The ankylosis may be fibrous, when it may permit rocking, or bony, when the patella is absolutely fixed. When the patella is adherent there is usually, but not always, more or less adherence between the tibia and femur. If the knee-

joint is stiff in extension, adhesion of the patella is of no importance. If the knee is flexed, it may be straightened after the patella is loosened. This may be done by inserting an osteotome between the patella and femur, either subcutaneously or through an open incision. There is a probability of readherence after correcting the flexion, and if motion is sought, the detachment should be effected through an open incision at the side of the patella. Cargile membrane should be placed between the patella and the femur and passive motion begun in ten days; an alternative would be to excise the patella, and sew the fascia together in the median line.

Knock-knee (*in-knee, genu valgum*) is usually a rachitic deformity, but the mild grades may be due simply to static conditions in delicate or otherwise normal children. Knock-knee may be due to other causes, and often follows tuberculosis of the knee and infantile paralysis. It frequently occurs in adolescents who stand too much or carry heavy loads.

The deformity may be principally in the femoral condyles, or principally at the upper end of the tibia, or equally in both. When the knee is flexed the knock-knee may disappear. The knee is usually somewhat loose, from stretching of the internal lateral ligament; the feet are turned out, unless instinctively turned forward or in, as a protection to the weak inner side of the knee and foot. Weak feet regularly accompany rachitic and static knock-knees, and aggravate the difficulty. Knock-knee is usually bilateral, but it may occur on one side only, or be paired with a bow-leg on the opposite side. Anterior curvature of the tibia is often found with knock-

knee (Fig. 165); it is possible for knock-knees and bow-legs to exist in the same individual, and to be combined

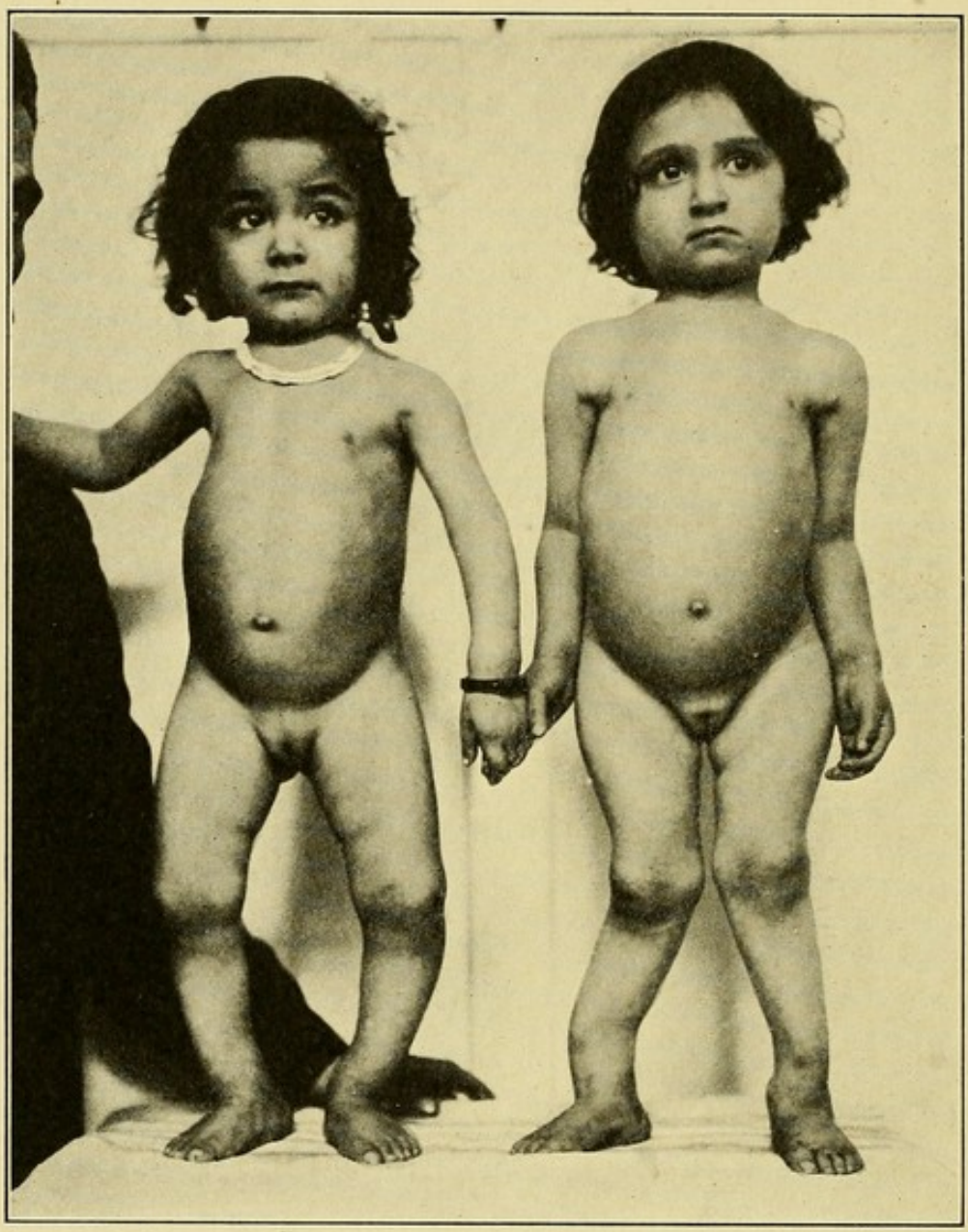


FIG. 165.—RACHITIC BOW-LEGS AND KNOCK-KNEES. The children show the stigmata of rickets, and the child with knock-knees also has anterior bow-legs.

with anterior curves of the tibiæ, and also of the femora. With knock-knees, the knees rub together in walking and the feet are not properly placed; the gait is stiff and

awkward, and in extreme forms walking may be almost impossible. For purposes of record the bare legs of the child are laid on a large piece of paper, with the inner border of the knees in contact, and a pencil tracing of the inner border of the legs is taken; this gives the angle of deviation, and the separation of the ankles. By comparing this record with others taken subsequently, the progress of the case may be noted with exactness.

Treatment.—With an ankle separation of two inches or less in young children, the shoes may be raised one quarter inch on the inner border, which inverts the foot, throws the weight on its outer border, and relieves the inner border of the foot and the inner side of the knee of strain. The child should be encouraged to toe in. In addition, the diet should be regulated, particularly if the child is rachitic, and it should be kept wholly or in part off its feet. Bicycle and pony riding are permissible. In deformities of medium grade in children under four, the Thomas knock-knee braces, when worn for a year or more, are often effective (Fig. 166). Braces which are jointed at the knee are ineffectual. In the severe cases the legs must be straightened by an operation; in children one may choose between osteoclasis and osteotomy; both give excellent results. For *subcutaneous osteotomy* the patient is anesthetized, and placed on the side with the leg to be operated uppermost and a sand bag under the inner side of the femur. An assistant steadies the flexed leg, while the operator grasps the femur between the left thumb and forefinger above the condyles and pushes the sharp osteotome, its edge parallel with the shaft and corner first, through the

skin, and down to the bone a finger's breadth above the external condyle (Fig. 167). After cutting the periosteum, the osteotome is rotated ninety degrees to bring the edge across the axis of the shaft, and two thirds or three quarters of the shaft is divided by blows of the mallet, the chisel being directed toward the center of

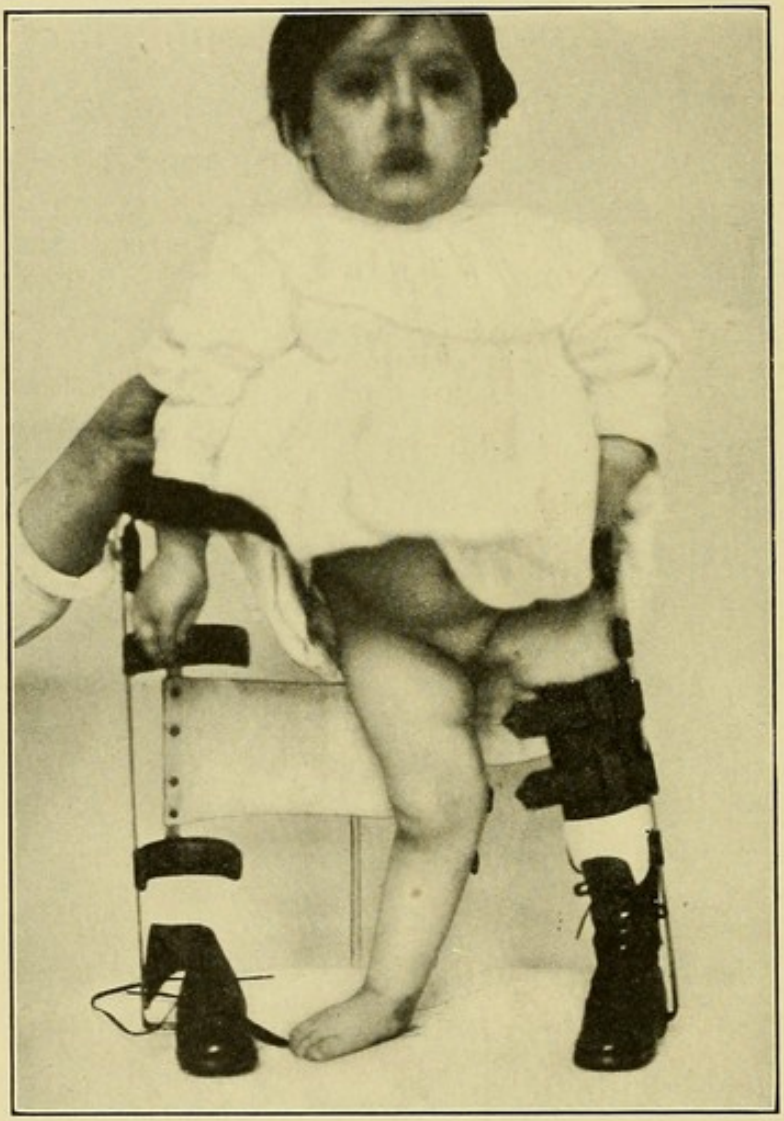


FIG. 166.—THOMAS'S KNOCK-KNEE SPLINTS WITH PELVIC HALF-BANDS ADDED.

the shaft; one should be careful to divide the cortex for more than half the circumference. The fracture is then completed by hand or over the wooden wedge, the de-

formity somewhat overcorrected, one suture inserted, and the leg placed in a long spica from waist to toes. If the operation is upon both sides the spica is double,

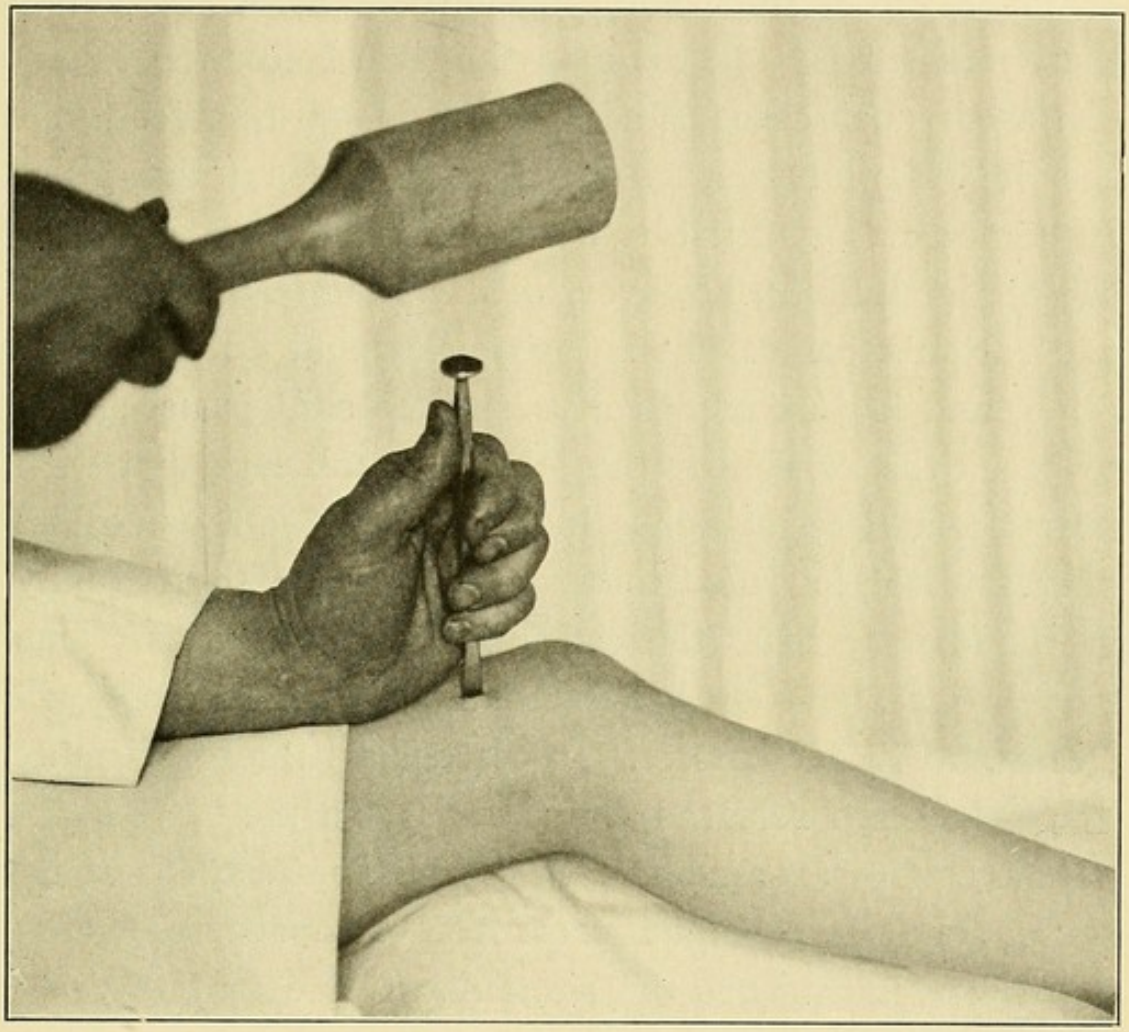


FIG. 167.—SUBCUTANEOUS OSTEOTOMY ABOVE THE CONDYLES FOR KNOCK-KNEE. The figure shows the proper posture of the hands for driving the osteotome through the bone; the osteotome is not yet turned at right angles to the shaft of the femur, as it should be before the bone is attacked. Note size and shape of osteotome (compare Fig. 199), and potato-masher used as a mallet.

and for convenience the legs should be somewhat abducted; the spica may be reënforced by a bar or other support below the knees. The final appearance in the splints should be one of slight bow-legs. This operation from the outer side is known as MacCormac's; it is some-

what preferable to Macewen's operation from the inner side. Either operation may be done through an open cut, if preferred. In cases where the deformity is moderate or where the bending is largely below the knee, the operation may be done on the tibia below the tuberosities; in such cases the correction is more perfect, and the plaster splint reaches only from the toes to the groin. In adolescents and adults osteotomy is the operation of choice; in children, however, with a good osteoclast such as Grattan's, osteoclasis is the quicker and simpler operation, and is just as effective. Some skill is necessary to break the bone near the joint in small legs, but with practice, and by bringing the plunger of the osteoclast nearer to the bar next to the joint, clean fractures may be made very near the condyles or tuberosities. One may break above or below (Blanchard) the knees, according to the deformity. In osteoclasis the screw must be worked and released very quickly, as the tissues are not harmed by extreme pressure if momentary, but easily slough under prolonged pressure. The overcorrection and the splinting are the same as after osteotomy.

For **genu varum** see Bow-legs.

Paralytic and Spastic Deformities of the Knee.—After poliomyelitis with partial or complete paralysis of the flexors and quadriceps, if the patient walks by locking the knee back mechanically, or if the knee is forced back by a tight heel-cord, a grave recurvature may develop from stretching of the posterior ligament. If the knee flexors are active, and particularly if the patient has been for a long time confined to the sitting posture, there may be permanent flexion of the knee from adaptive shorten-

ing. In many severe cases the flexion will be combined with subluxation of the tibia backward, knock-knee, and outward rotation of the leg—the same deformities that develop in tuberculous gonitis and other chronic inflammations. In many of the paralytic cases the biceps is active, and may help to produce the knock-knee and outward rotation by its contraction. The subluxation is due to the pull of the hamstrings in the flexed posture. In spastic palsy there is also a strong tendency to knee flexion, which, however, may be temporarily overcome by stretching.

In the adaptive flexions the knee may be straightened under anesthesia, with tenotomy of the hamstrings when necessary. The biceps most often needs division, and the insertion of the ilio-tibial band which lies in front of it. The biceps should be divided through an open cut or hooked up through a small incision in order not to injure the external popliteal nerve which lies directly internal to it. The internal popliteal nerve may also stand out as a tense cord near the middle of the popliteal space when the contracted knee is stretched. The posterior part of the lateral ligaments may present a strong obstacle to correction, and may be divided subcutaneously, taking care not to injure the external popliteal nerve. After full correction the leg is put up in plaster-of-Paris from the toes to the groin for from four to six weeks, during which time a two-barred, straight supporting splint is prepared. This splint may be either without a joint at the knee, so that the knee is held continuously in extension, or it may have a snap joint, making it stiff in extension when walking, and allowing it to bend by

touching a release when the patient desires to sit. In many cases, however, even when there is little power in the quadriceps, a brace with a free joint, giving lateral support and to prevent hyperextension, is sufficient.

If the sartorius and hamstrings are active, they may be transplanted into the paralyzed quadriceps tendon; or an arthrodesis may be done to produce ankylosis. Neither of these operations is indicated if the patient is satisfied to wear a proper supporting apparatus. When there is a flail-joint without antero-posterior or lateral stability, arthrodesis is the best operation, though it is not difficult to hold such a knee in proper posture for locomotion by a removable splint or brace.

Spastic contracture, if severe, should be relieved by tenotomy of the hamstrings and correction, since the deformity recurs if simple stretching is employed, and tenotomy exercises a favorable effect upon the spasm.

Acute synovitis is often due to a blow, fall, twist, or strain of the knee. It is characterized by pain, tenderness, and effusion, with varying amounts of stiffness and local heat. The effusion may be detected by the fluctuation above and below the patella, and by the ballottement of the latter. The principal dangers are aggravation of the condition by traumatic insults and the infection of the synovial cavity by pus or other pathogenic microbes, which happens oftener if the knee is used. Acute synovitis may also occur from the pinching of an hypertrophied synovial villus, or from the impaction of a floating body or a displaced semilunar cartilage. Synovitis or a passive hydrops may be secondary to many pathological conditions.

The joint should be strapped or bandaged and put at rest in a fixation splint. If the process is mild the patient may go about on crutches; if severe, he should be put to bed, and mild traction added. With adequate protection a simple synovitis should recover in three to six weeks. Obstinate cases often prove to be infected with pus, gonorrheal or other germs. Aspiration of the fluid under full asepsis may prove useful for diagnosis.

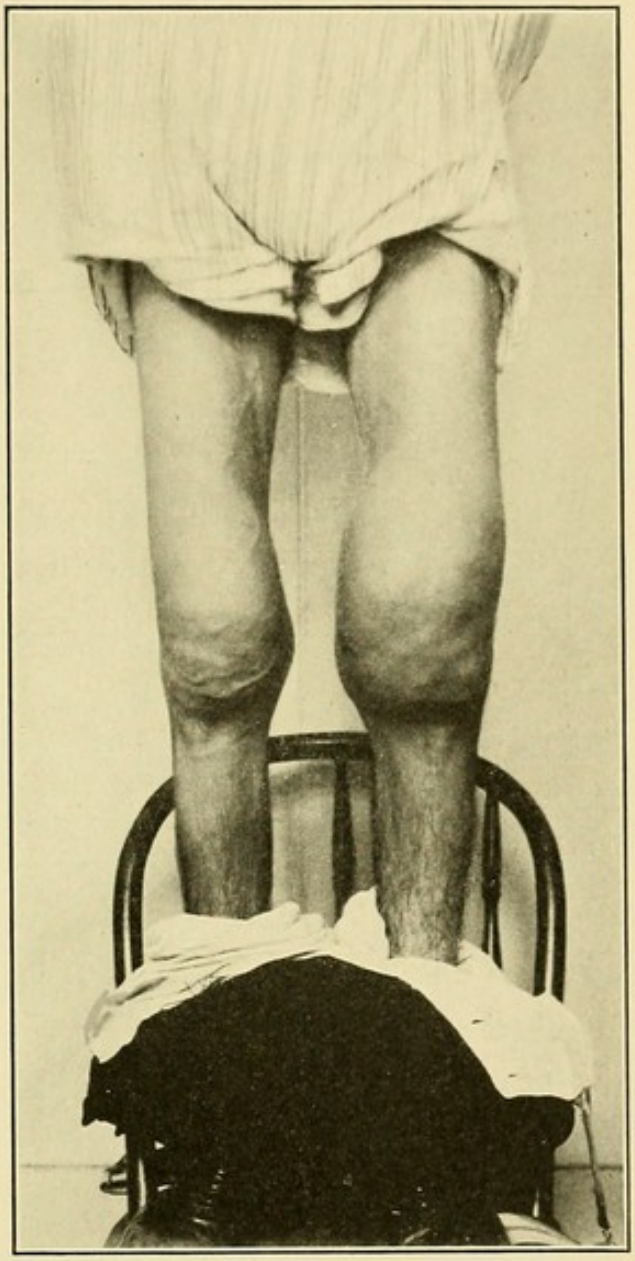


FIG. 168.—CHRONIC HYDROPS OF BOTH KNEES; DURATION, TEN YEARS WITH VARYING INTENSITY; ANKLES HAVE ALSO BEEN AFFECTED; MAN OF TWENTY-THREE.

Intermittent hydrops is a rare condition of unknown causation, in which effusion into the joint occurs at regular intervals of a few days to a few weeks, each attack passing off in a few days.

Chronic hydrops of one or both knees may persist, sometimes with remissions, many years. Common

causes are tuberculosis and syphilis, but some cases are difficult to account for (Fig. 168).

Gonitis Tuberculosa (*White Swelling*).—The knee is the largest joint in the body, and one of the most accessible. After the spine and hip, it is the most frequent articular seat of tuberculous infection. Its large size and exposed position make it easy to examine, and its extended leverage makes it readily splinted and controlled. Tuberculous gonitis is commonest in children, but may occur at any age.

Pathological Anatomy.—Infection comes by way of the blood, and may be synovial or osteal; the latter is the more common. In osteal infection there is a focus (Fig. 14), wedge-shaped infarct, or diffuse infiltration, which leads to flabby granulations, causing bone softening in the neighborhood, and which may progress to caseation, the formation of small sequestra or ichor cysts (cold abscesses), or may cicatrize at any stage. The surrounding bone undergoes expansion, and the neighboring epiphyseal cartilage is stimulated, causing increased growth in length. As the granulations or fluids work toward the articular cartilage, the latter becomes detached or perforated, and the synovial membrane becomes secondarily infected; the changes and symptoms of chronic tuberculous synovitis are thus added to those of tuberculous epiphysitis. In a considerable number of cases the synovial membrane is primarily affected, and undergoes extensive thickening and pulpy degeneration, with more or less effusion of serum and deposit of fibrin. Such a condition may last for years with mild symptoms, and without affecting cartilage or bone. Cartilage is

very resistant to infection; it derives its nutrition from underlying bone, and may atrophy or become detached if this is diseased. So long as it rests upon sound bone it presents a formidable barrier to the spread of disease from the interior of the joint to the bone (Nathan).

Symptoms.—The invasion is usually insidious and progress slow. Lameness and swelling are first noticed;

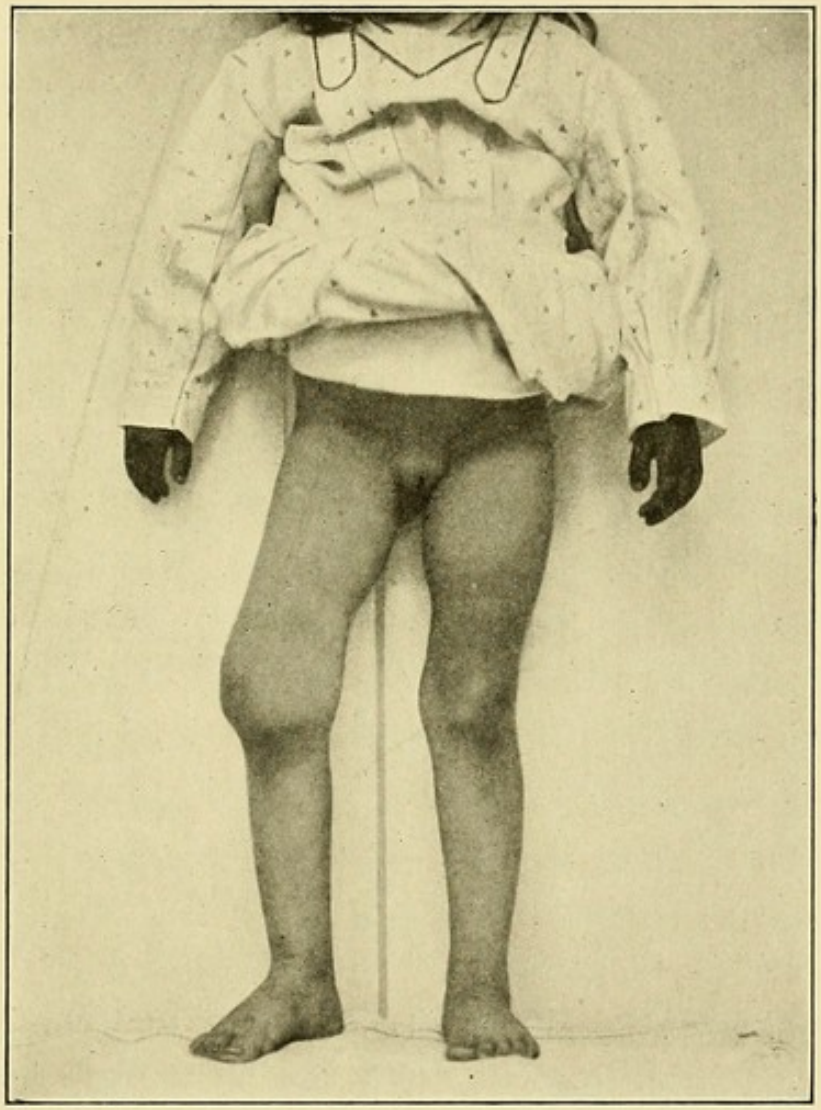


Fig. 169.—Tuberculous Osteitis of the Right Knee, of Two Years' Duration in a Girl of Five; No Mechanical Treatment.

pain may be absent for some time. The swelling is due to joint effusion and bony and synovial thickening, and tends

to obliterate the landmarks of the knee in front and at the sides; it is often described as a fusiform swelling (Fig. 169). The skin is usually pale and thickened. The knee is invariably somewhat flexed and motion is limited; as the disease progresses, flexion and stiffness increase and knock-knee and eversion of the leg are usually added; the process may end in ankylosis, and the patella may also become adherent. Sinuses often form, leading into the joint or into the bone focus. When the knee is examined it is found to be enlarged in all its measurements, and if the disease is osteal the condyles are thickened and enlarged. It is, however, sometimes impossible to decide without a skiagram whether there is bony thickening or not on account of the thickening of the synovial membrane and overlying parts. There may or may not be effusion into the joint, with floating of the patella, at the time of the examination. One or more tender areas may usually be found in the femoral condyles, or more rarely in the tibial tuberosities. The tuberculous process in the epiphysis stimulates the bones to increased growth in length, and the affected leg is regularly from one quarter to one inch longer during the active stage of the disease. This fact is of considerable diagnostic importance. The increased length is usually mostly in the femur. While increased growth is taking place near the knee, other parts of the limb are retarded in growth, and a time is usually reached when the measurements of the two limbs are equal. When this is the case, however, the femur is usually longer and the tibia shorter than the corresponding bones of the well side. After many years, if the disease has been severe, atrophy preponderates,

and the final result may be a limb shorter than its fellow by one or more inches.

Chronic tuberculous synovitis occurs oftener in adolescents and young adults; its progress is slower, and there is usually less pain, stiffness, and disability. The swelling, which is partly due to effusion and partly to thickening of the synovial membrane and overlying tissues, may be very great. More or less soft crepitus may be present. The underlying bone may seem to be enlarged when it is not.

The PROGNOSIS for cases seen early and carefully treated is good; the majority recover with a stiff knee, a good posture, and a serviceable leg. Many die from septic and tuberculous accidents, if neglected, and many others, after years of suffering, recover with disabling deformity.

DIAGNOSIS.—Pus joints should be carefully distinguished, especially in young babies; they have a more rapid invasion, and are accompanied by fever and local heat, and other acute symptoms both local and constitutional. Syphilitic, gonorrheal, and other infections, and effusions of blood must also be differentiated.

Arthritis deformans and osteoarthritis are usually polyarticular, and never suppurate; they are rare in children.

TREATMENT.—Tonic and fresh-air treatment is indicated, and the diseased joint should be relieved of motion and weight by an immobilizing splint and crutches. Splints, whether of plaster or other material, should include the foot and reach to the groin. Many splints are made far too short. An excellent immobilizing ap-

paratus, which at the same time suspends the limb and thus takes off all weight, is the Thomas splint, which is

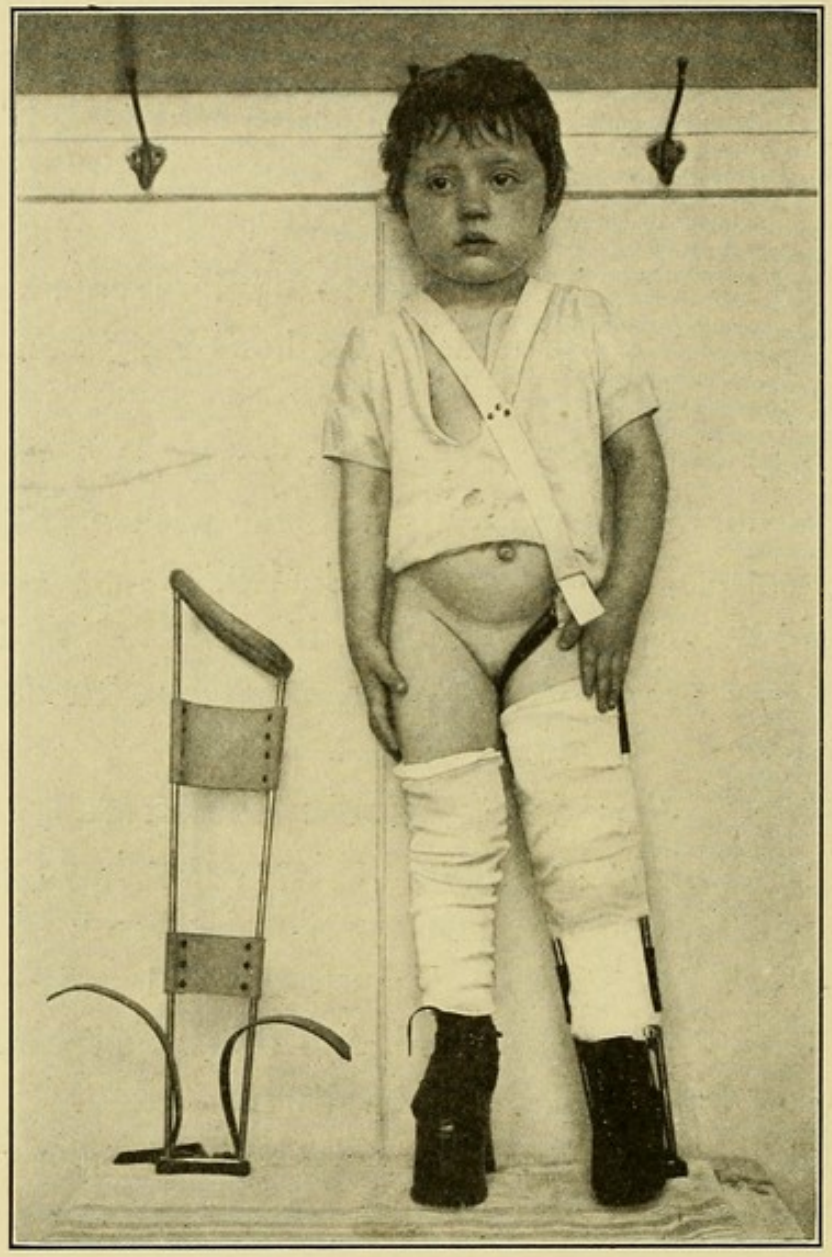


FIG. 170.—THOMAS'S SPLINT FOR SUSPENDING AND IMMOBILIZING THE KNEE. When the splint is buckled to adhesive plaster placed below the knee, shoulder straps are unnecessary, and a certain amount of traction may be exerted.

two and a half to three inches longer than the limb, and takes the weight on a padded ring (Fig. 170). It is worn with two-and-a-half- to three-inch cork sole in the

shoe of the well side. Immobilization and protection must usually be continued for several years before cure is accomplished.

There is a better chance at the knee than in most joints to localize the focus by a skiagram while it is still extra-articular, and excise it. This can occasionally be done, and the joint saved from serious damage. After

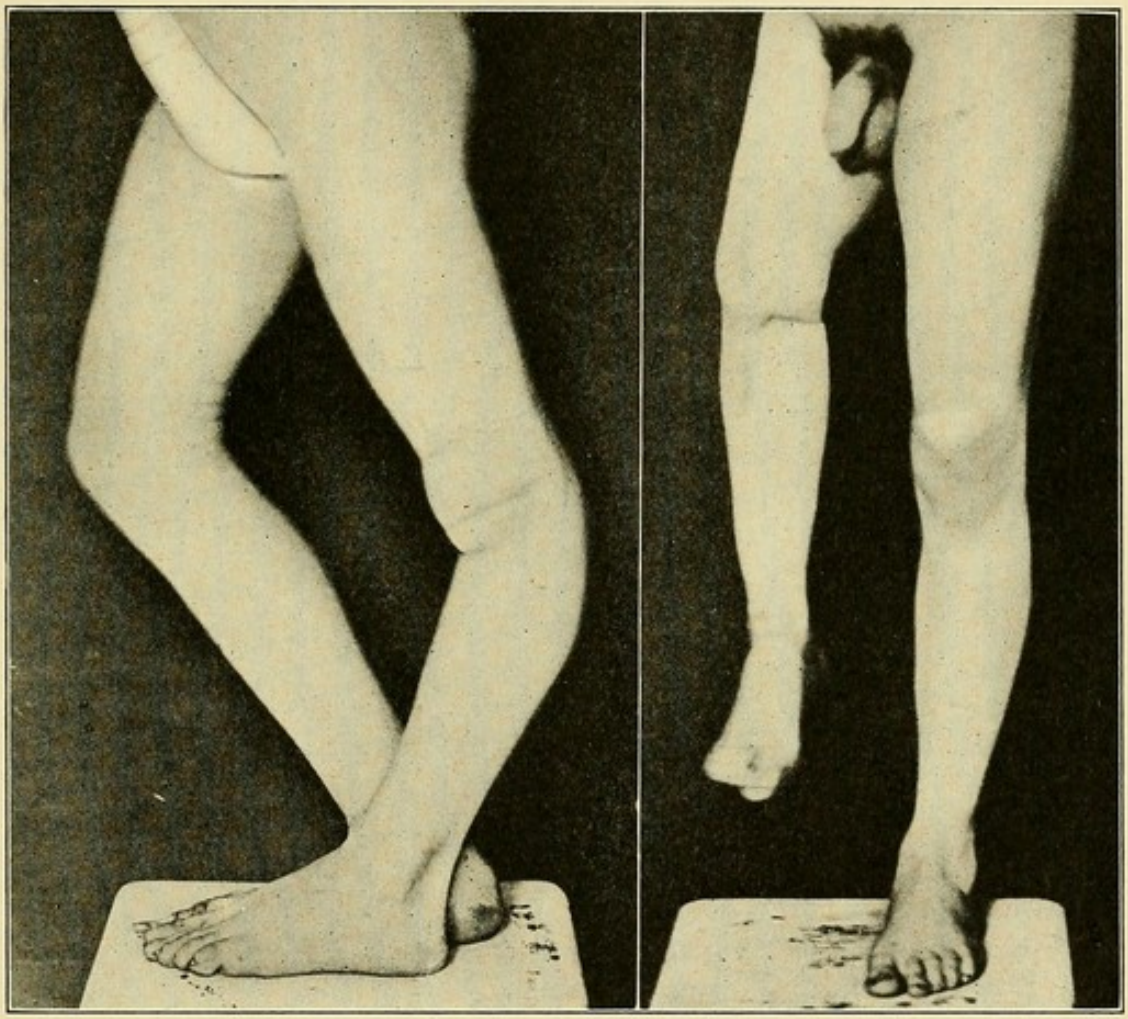


Fig. 171. Fig. 172.

Figs. 171 and 172.—Results after Early Excision of the Knee. The patient at the right has ten inches shortening.

the joint is infected, however, the operations of erasion and excision are unsatisfactory in children on account of the difficulty in removing all diseased tissue, the seri-

ous interference with growth, which may amount to eight or ten inches, or even more, and to the liability to flexion and other deformities years after the operation (Figs. 171, 172, and 173). These objections to the operation are so serious that it should not be done in children under fifteen except as a life-saving measure, when it is often preferable to amputation. In adults it may be much more freely employed, and is often the treatment of choice, even in fairly early cases.

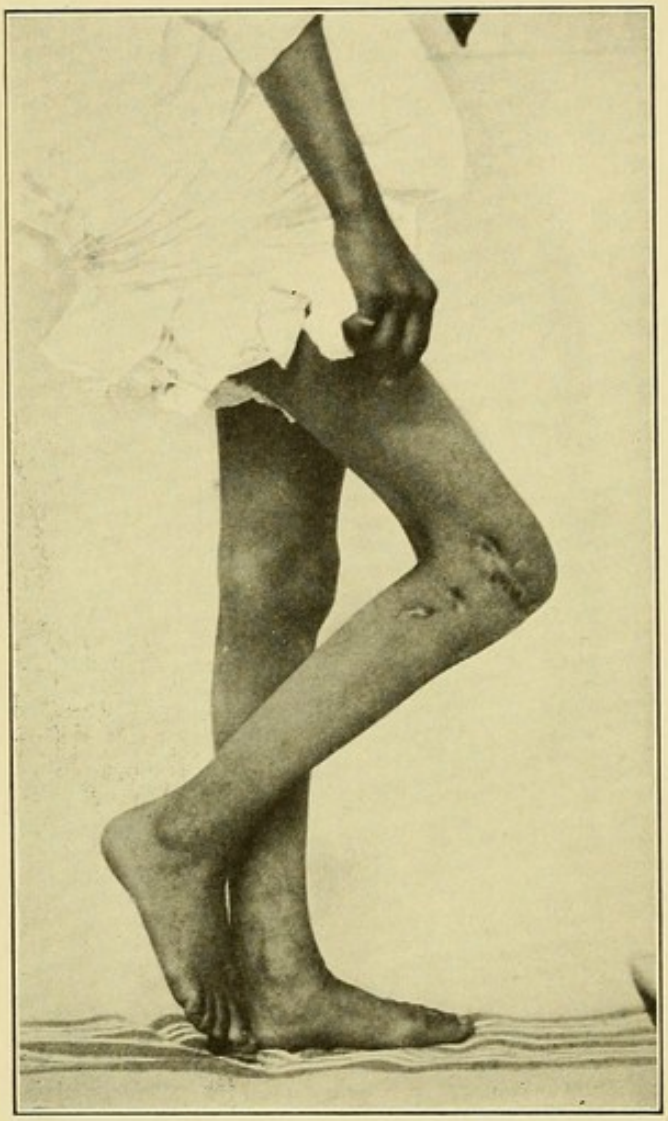


FIG. 173.—ANKYLOSIS WITH RIGHT ANGLE DEFORMITY AFTER EXCISION AT FIVE YEARS OF AGE; THE KNEE WAS SPLINTED FOR SEVEN MONTHS AFTER THE OPERATION; THE GIRL IS NOW TWELVE.

The synovial cases may be benefited by arthrotomy, to release fluid and cut out synovial fringes, but without scraping; in inveterate cases the entire hypertrophied synovial membrane may be removed by an arthrectomy. The knee should be carefully splinted for a year or more after operations. Bier's congestion treatment may be used in addition to

mechanical protection and rest. The results of such treatment, however, in tuberculous disease do not appear to be markedly better than from orthopedic treatment alone.

Treatment of Deformities

Flexion deformity occurring during the active stage of the disease may be overcome by traction in bed or by gradually straightening the splint. Care should be taken to pull the head of the tibia forward. If seen early, serious deformities will be prevented by proper splinting. Flexion in cured cases may be overcome by stretching fibrous adhesions under anesthesia, when Whitman's posture, the patient procumbent, is often advantageous. In other cases the Bradford-Goldthwait corrector, which slides the tibia forward on the femur as extension is made, gives excellent results. If the patella is adherent it may be chiseled free, subcutaneously or through an open incision.

Flexion and knock-knee with bony ankylosis, if the deformity is not too great, may be readily corrected by an osteotomy above the knee. Very severe deformities may require osteotomies both above and below, or a cuneiform excision of the ankylosed joint. If flexion is extreme, great care should be used to avoid splinters in the popliteal space, and to avoid strangling the popliteal vessels by too brusque a correction. In case of doubt the correction may be effected in steps. When there is much cicatricial tissue in the popliteal space, an anterior longitudinal incision should be employed. Recently it has been proposed to attempt to mobilize the ankylosed knee by opening the joint and interposing a fat and fascia flap

between the bone surfaces (arthroplasty); the results have not been brilliant.

Other Affections of the Knee

Gonorrheal infection of the knee may be mild or severe; the periarticular tissues are often much involved, and there is a great deal of swelling, and sometimes effusion. The disease may be monarticular or polyarticular, but does not, as a rule, involve many joints. Splinting is demanded in the acute stage, and symptomatic treatment, with special attention to the original focus. Gonorrheal and other specific infections are often followed by stiffness. Bier's congestion treatment may give striking results in the relief of pain.

Syphilis of the knee may be manifested as a chronic hydrops which may affect both knees, or as a gummatous involvement of the bone or synovial membrane. Antisyphilitic medication with very little local treatment will sometimes act almost like magic.

Pus infections of the knee may be synovial or osteal from an osteomyelitis of the neighboring bone ends. The symptoms are often acute and urgent. If pus in the joint is found by puncture, the joint should be opened, irrigated, and drained. If an osteomyelitis is found, and confirmed by the skiagraph, the diseased focus should be removed by an extra-articular operation as early as possible in order to prevent joint involvement.

The **knee may become infected** or inflamed, often with other joints, in the course of almost any acute infectious disease, and the treatment should be joint rest, and attention to the underlying cause. During convalescence the

articulation is slowly led back to use by apparatus, crutches, and devices, to permit partial or limited use, and by measures to promote joint nutrition. Deformities should be prevented, and if present, treated much as are those following tuberculosis.

Hemarthros. See Hemophilia, page 18.

Charcot's Knee (Fig. 174). See Trophic joints, page 70.

Arthritis deformans is usually polyarticular, with involvement of many joints, both small and large. Particular attention should be given to the underlying condition as laid down in the general section, and to the prevention of deformity by proper splinting. Formidable as this affection undoubtedly is, all cases are not of the severe type, and even in these very much can be effected by rational management.

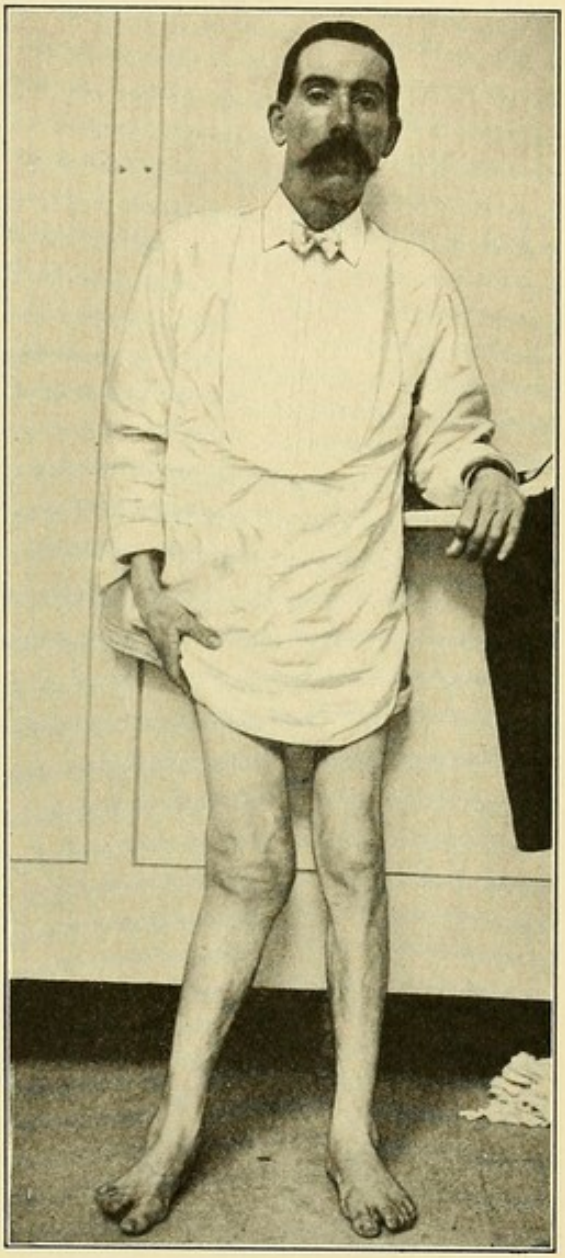


FIG. 174.—RIGHT CHARCOT KNEE IN A MAN OF THIRTY-EIGHT. Knee symptoms appeared two years before ataxia was noticed.

Osteoarthritis is particularly prone to involve one or both knees. It may develop after an injury or after the

strains imposed by an old deformity, such as knock-knee; many cases are due to senile changes; often the cause is unknown. The synovial membrane is often thickened, and may be tender in certain areas; there is often creaking of the joints on motion, easily felt and sometimes heard; motion is often restricted, and there may be points of tenderness located about the periphery of the joint; at these points bony enlargement may sometimes be made out by palpation, and frequently by skiagraphy; the knee may become flexed or otherwise deformed. The patient complains of pain, weakness, stiffness, and difficulty in walking and going upstairs. It should be said that large numbers of knee-joints creak more or less after the age of forty, and even before, in persons who are not conscious of any disability; creaking, unless severe or associated with other symptoms, is not necessarily indicative of present or impending knee trouble. Many cases of osteoarthritis of the knee are comparatively mild and self-limited, or recede under such simple treatment as strapping, bandaging, the high-frequency current, vibration, a knee cap or lacing, restriction of activity, and regulation of diet. For the severe cases with deformity, protective appliances are often of great value; operations are occasionally required. One should not mistake the knee pain often present in osteoarthritis of the hip and other hip affections for a knee symptom. In knee pain, the hip as well as the knee should always be examined.

Villous arthritis of the knee may be a primary affection produced according to Schüller by a specific microbe, or it may be secondary to osteoarthritis and various other

knee affections. Villous arthritis is characterized by hypertrophied villi and folds of synovial membrane, which sometimes cause swelling, and may be palpated either side of the patellar tendon or in the upper corners of the synovial sac. If one of these tabs is caught in the joint and pinched, sudden disability, pain, swelling, and effusion may follow. These usually pass off in a few days after rest, strapping, and bandaging, but are liable to recur. The hypertrophy is sometimes extreme, and the disability very serious. In some cases fat is deposited in and about the villi, which atrophy, leaving a **lipoma arborescens** free in or adjacent to the joint sac; lipomata may also develop after an injury. If the pain and disability are serious and refractory to mild measures, the joint may be aseptically opened and the hypertrophied villi or fatty tumors removed. If oozing is copious the joint may be washed out with hot saline solution. This operation, while undoubtedly successful under proper conditions, should not be lightly undertaken, nor at all unless the symptoms are of sufficient importance to demand it.

Floating Bodies (*Joint Mice*).—Hard or cartilaginous bodies are sometimes broken off from the edge of the joint or formed from villi or other tissues, and float free or attached by a pedicle, changing their position with the movements of the joint. They may be felt at times as a smooth, hard body or bodies slipping under the finger in certain definite localities. Unless pinched by the joint they may give rise to no symptoms, but when caught between the joint surfaces they may cause a sudden locking of the joint, pain, and disability, often followed by swell-

ing and effusion. These accidents recur at intervals. Such floating bodies require removal, which is often easily effected through a small opening. The operation should not begin until the floating body is felt under the skin, as otherwise it is sometimes very difficult to find it even through a large incision.

Displacement of the Semilunar Cartilage (*Internal Derangement of the Knee*).—A semilunar cartilage, usually the internal, may become bruised, torn, or displaced from a misstep or sudden twist of the knee. There is sudden acute pain, with locking of the knee, which may usually be worked loose; this is followed by pain, swelling (effusion), limitation of motion and disability, and there is tenderness over the cartilage; sometimes a projecting edge of cartilage may be felt or an increased joint interval; more often both are absent. Atrophy, especially of the quadriceps, is rapid and severe. Sometimes the displacement may be overcome by flexing and extending the knee under anesthesia while pressure is made over the cartilage. This should be followed by a compress and fixation for two weeks. Many cases, however, are refractory, and become chronic; the luxation may or may not be repeated at intervals, and there is pain, disability, tenderness, and atrophy. Some cases improve under strapping, bandaging, and the use of a knee cap or lacing, others under a jointed supporting splint (Shaffer). In a considerable number of cases all these measures fail, and the injured or displaced cartilage may require removal. It is usually sufficient to remove a triangular piece through a longitudinal incision. The absence of a part or the whole of a semi-

lunar cartilage does not interfere with good use of the knee.

Floating bodies, semilunar injuries, or displacement, and certain cases of enlarged villi may give rise to similar symptoms, and require careful study for differentiation.

Deformities of the Lower Leg (Knee to Ankle)

Congenital Defects of the Tibia and Fibula

The tibia or fibula may be defective or entirely absent; defects of the fibula are much more frequent than those of the tibia. If the defect is partial the lower extremity of the bone is usually the part which remains undeveloped. These defects are regularly associated with characteristic changes in the companion bone and in the foot.

With **absent fibula**, the tibia is short, thick, and bent at the junction of the middle and lower thirds; this bending may be very acute, and there is usually a furrow or dimple over this angle. This deformity has been called intrauterine fracture, which it usually is not. Muscles and tarsal bones may be absent or anomalous, especially on the fibular side. Toes and metatarsal bones are frequently absent, and when this is the case they fall away in order from the fibular side of the foot; if one toe is absent, it is the fifth; if two, the fifth and fourth, and so on (Fig. 175). The outer malleolus being absent, the foot is drawn into the equino-valgus posture, which is increased if the child walks. The whole limb is short, and the shortening may be partly in the femur; this shortening increases with age, and may ultimately

amount to five or six inches or more. The knee may be imperfectly formed, and is often somewhat flexed but is usually stable; there is no paralysis.

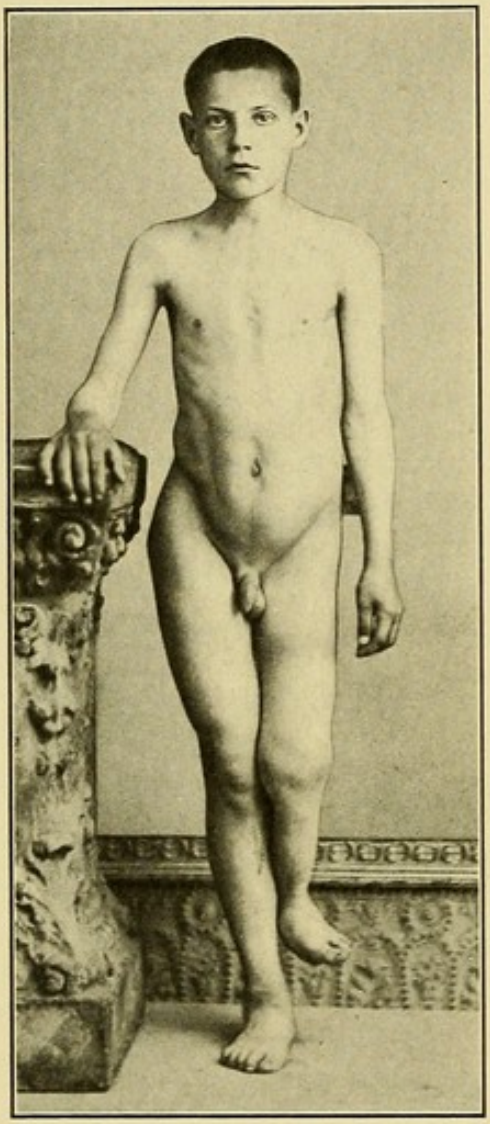


FIG. 175. — CONGENITAL ABSENCE OF LEFT FIBULA AND FOURTH AND FIFTH TOES.

The indication for treatment is to correct the malposition of the foot. This may be done in infants by tenotomy of the heel cord, manipulation, and retention in plaster, but correction is often difficult and relapse almost certain, on account of absence of the external malleolus. In older children, the ankle-joint may be opened by Kocher's fish-hook incision and an arthrodesis of the ankle performed. The writer has done this once with fair success.

In **absence of the tibia**, a very rare condition, the fibula is large, short, and bent, and the foot is in equino-varus. The knee-joint is unstable, as the fibula does not take the weight and moves in every direction. One or more toes and metatarsals are often wanting on the inner side of the foot. On account of its instability the leg is practically useless. The fibula may be implanted between the condyles, and united to the astragalus or os calcis.

Acquired Deformities of the Tibia and Fibula

In **bow-legs** and **genu varum,** or out-knee, the opposite deformity to knock-knee, the knee is carried outward by bending of the femur or tibia or both, or by a deformity of the condyles or tibial tuberosities. This deformity may be caused by injuries with outward displacement of

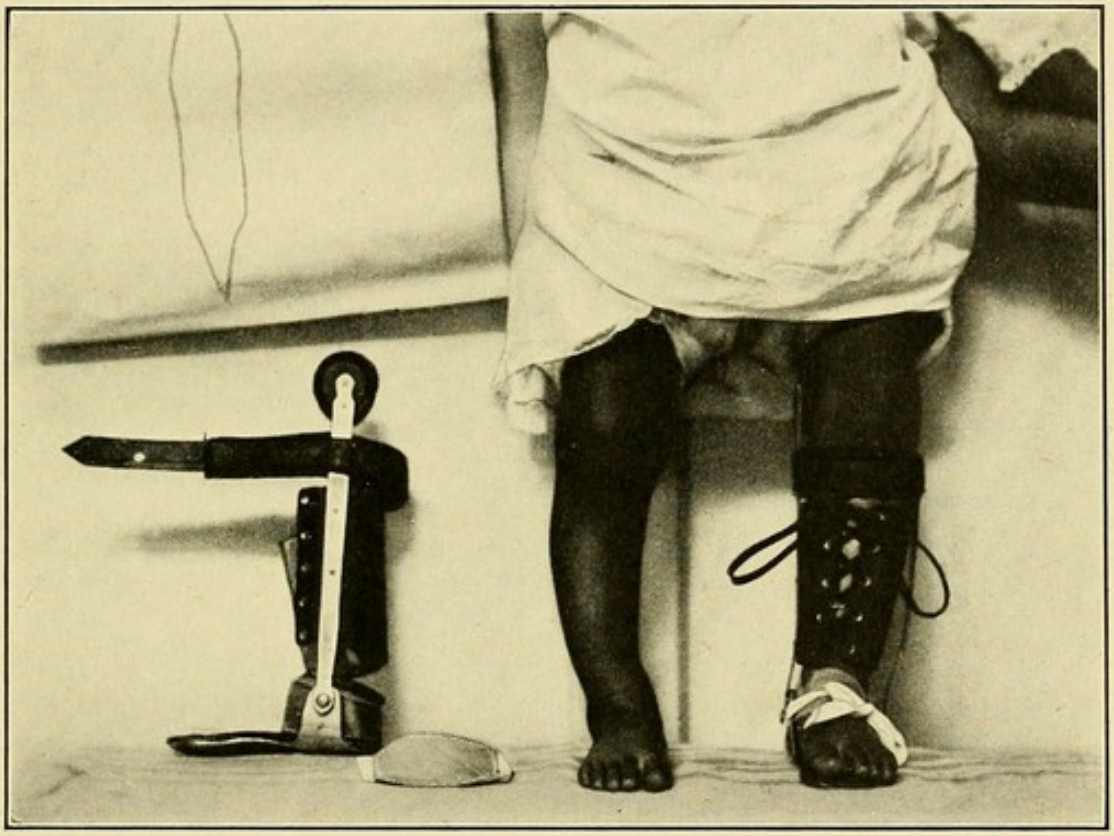


FIG. 176.—MODERATE BOW-LEGS IN CHILD OF TWO, WITH KNIGHT'S SPLINT. A pencil tracing of the deformity is shown at the upper left-hand corner.

the knee, or followed by a gradual yielding due to insufficient stability; it has been observed after excision of the knee in children. There is also a paralytic genu varum, due to relaxation of the external lateral ligament of the knee from continued strain. The commonest cause is undoubtedly rickets, and the yielding is oftenest mostly below the knee, which is the usual

bow-leg deformity. The greatest bending may take place just below the tibial tuberosities (Fig. 165), or at the junction of the middle and lower third (Fig. 176). Dane calls attention to the fact that the deviation of the leg bones is inward; if the inner borders of the knees are placed in contact the legs are crossed. The writer would emphasize the twist of the tibia inward, which always inverts the feet, and should be corrected at the operation. During active rickets bow-legged infants should not be allowed to walk, and should be treated for the rickets. To walking children under four, with

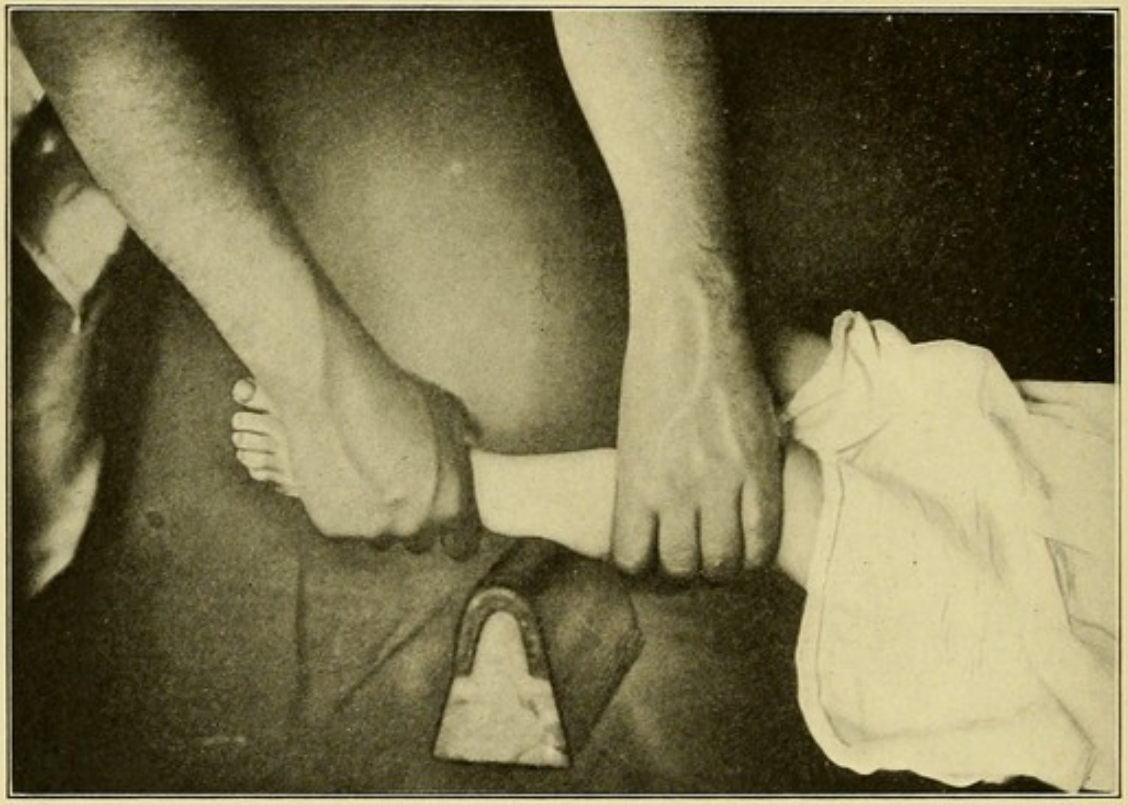


Fig. 177.—Manual Osteoclasis of Bow-leg Over Wooden Wedge.

moderate deformity, corrective braces may be applied, which should extend to the groin if the femora are much bowed. Such braces consist of two side bars as long as the leg, with a joint at the ankle, none at the knee, a foot

piece slipping into the shoe, and a lacing drawing the knee and leg toward the inner bar. When the deformity is mainly below the knee, the Knight bow-leg brace, similar in design but reaching to just above the inner con-

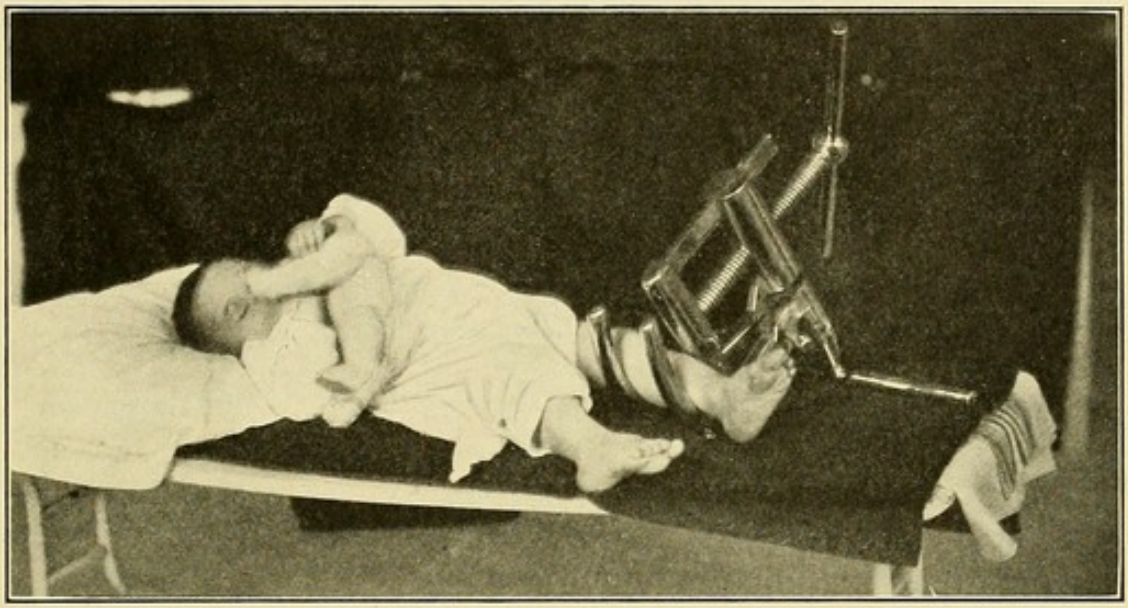


FIG. 178.—GRATTAN'S OSTEOCLAST APPLIED POR THE CORRECTION OF A BOW-LEG.

dyle on the inner side and to below the knee on the outer, is used (Fig. 176). The use of such appliances for a year or more often corrects the deformity. Indeed, there is considerable tendency to self-correction, especially in the milder cases. When the deformity is severe or the bones hard, even in children as young as three years, the most satisfactory treatment is correction after osteoclasis or osteotomy of the tibia. In young children, when the apex of the deformity is in the middle third of the bone, the leg may readily be broken over the block by the hands assisted by the weight of the body (Fig. 177). In older children, or when the fracture is to be near the knee or ankle, the osteoclast will do the work quickly and without injury (Fig. 178). Once the machine is adjusted

the plunger should be driven home and released with great rapidity, and if this is done there is no harmful bruising. After the fracture the deformity must be over-corrected and the feet twisted out, as they are always inverted from a twist in the tibia. The legs are put up in a slightly knock-kneed posture, in a plaster-of-Paris splint from the toes to the groin. The splint is left on six weeks, and renewed once or twice. The adolescent and older cases are best corrected by a subcutaneous osteotomy of the tibia at or above the apex of the curve. The technic is similar to that for knock-knee; the young cases may also be osteotomized, if preferred.

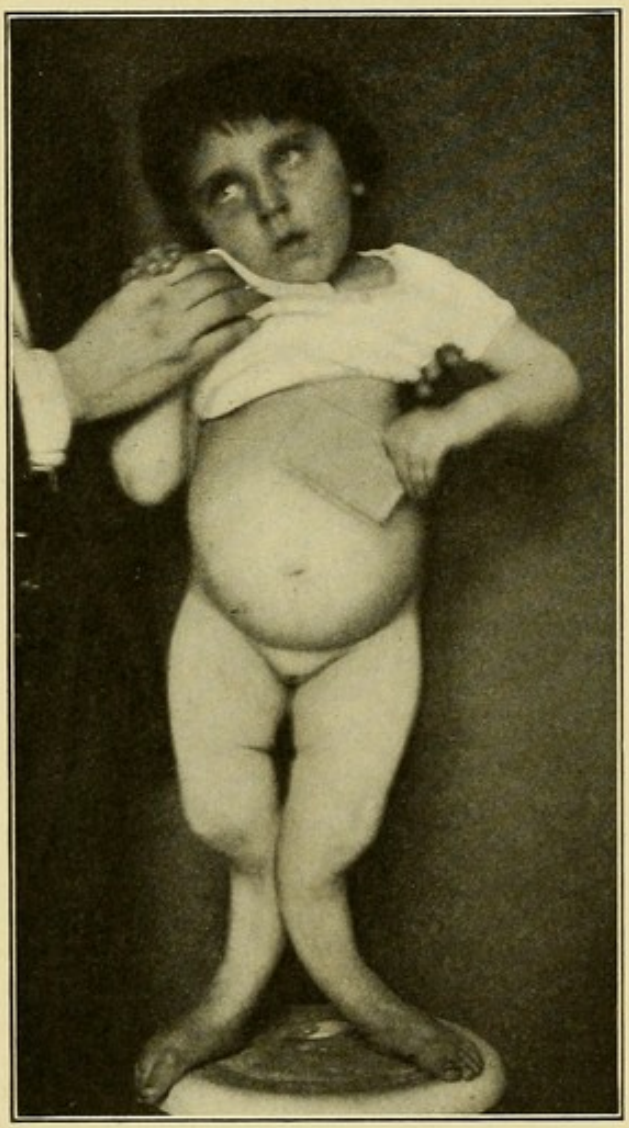


FIG. 179.—RACHITIC TIBIAL RECURVATURE WITH REVERSED BOW-LEGS. (Hospital for the Ruptured and Crippled.)

Anterior curvature of the tibia (*anterior bow-legs*), is often associated with bow-legs and knock-knees, especially the latter; all three may coexist (Fig. 165). It may be caused in rachitic children by sitting in a chair with the feet and lower legs hanging over. Most of the bend is in the lower

half, and it may be very sharp. Braces are usually useless, but the deformity is curable by osteoclasis or osteotomy. The tibia should be chiseled and broken from the inner side, as in bow-legs; afterwards the posterior angle is opened up by forcible manipulation, which tears the periosteum. When the tibia is straightened the leg is considerably lengthened, and if the deformity was severe the foot will be drawn down into the equinus posture by the relatively short heel cord. When this is the case the tendo Achillis should be cut and the foot brought up to a right angle. A plaster splint is then applied from the toes to the groin, taking care to retain the leg bones in good alignment by molding the plaster along the tibial crests.

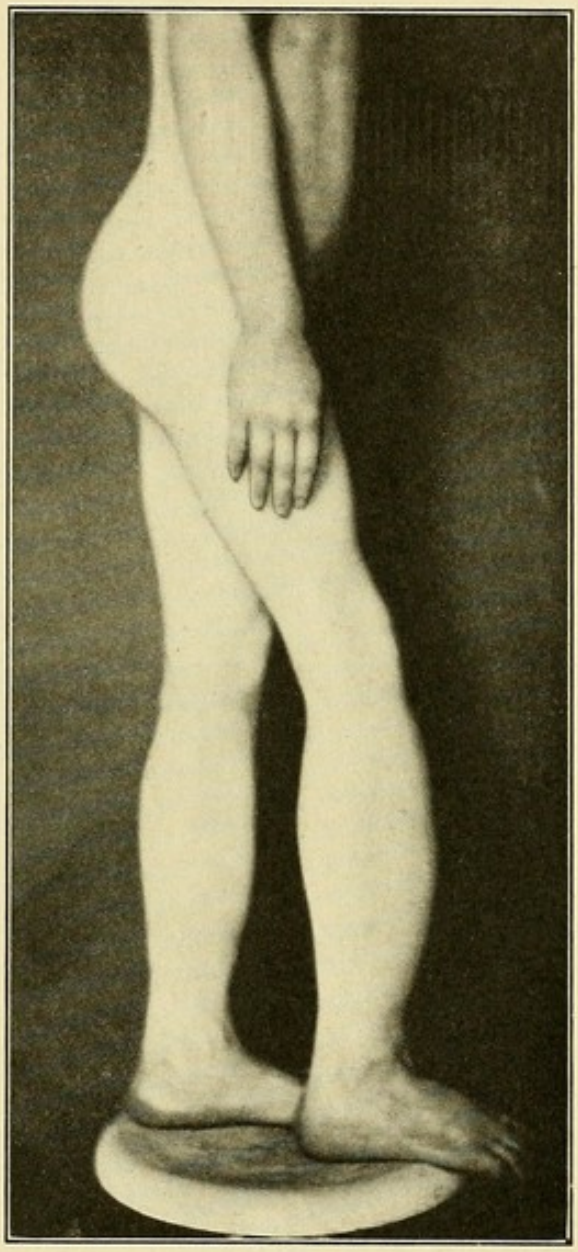


FIG. 180.—OSTEOPERIOSTITIS OF TIBIA (SABER-LEG); HEREDITARY SYPHILIS.

Rachitic recurvature at the upper tibial epiphysis is a rather uncommon deformity, but is occasionally seen in severe rickets (Fig. 179).

Several diseases of the tibia cause hypertrophy and anterior curvature of the bone; the principal ones are syphilis, ostitis deformans, and osteomyelitis.

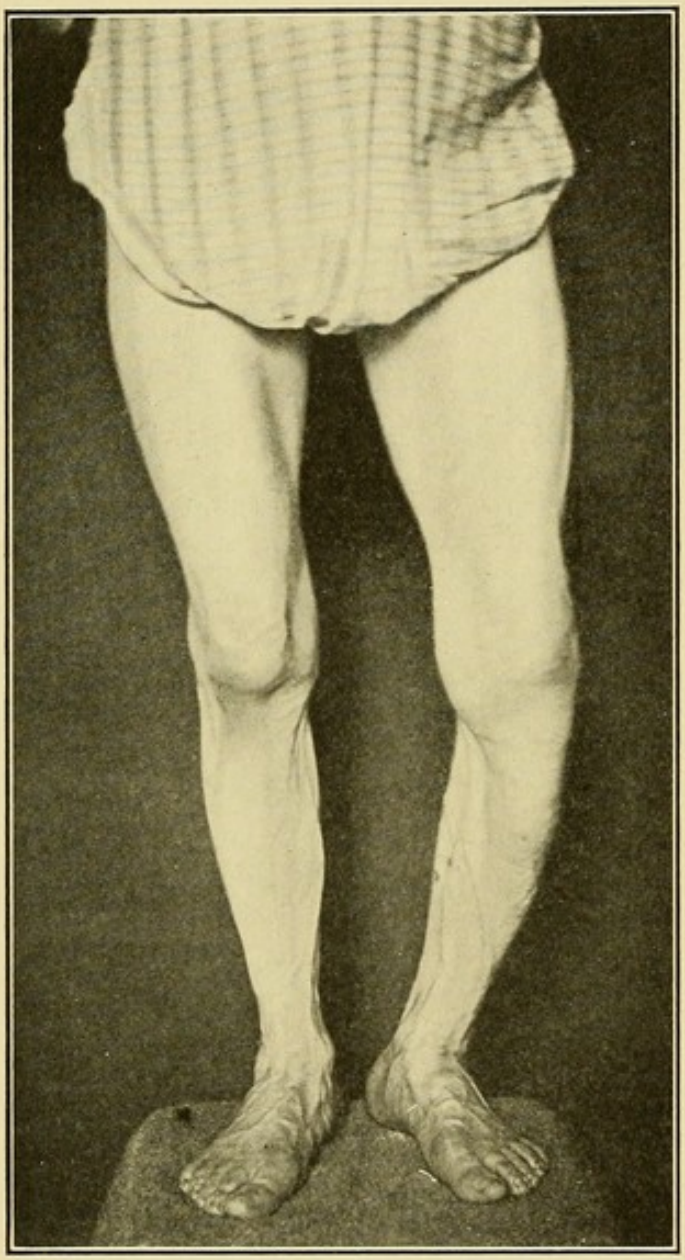


Fig. 181. — Osteitis Deformans of Tibia; Local Form.

In **syphilitic osteoperiostitis** the tibia is enlarged, elongated, curved, and sometimes flattened on one or both sides; the bone has a somewhat nodular surface, and is tender and painful (Fig. 180). There may be suppuration, but more often there is none. The process is checked by antisyphilitic treatment. It is commonest in the second decennium.

In **ostitis deformans** (*Paget's disease*) the tibia is often involved, either alone or with other bones. The affection comes on very slowly, with considerable pain in elderly people, and the tibia becomes much thickened, elongated, and curved (Fig. 181). There is no suppuration.

Osteomyelitis may affect either end of the tibia or the shaft. In the latter form the bone also becomes elongated, thickened, and curved (Fig. 182). It is commonest in children and adolescents. In a recent case, in a girl of twelve, the disease had existed about five years; there were numerous sinuses leading to sequestra, the tibia was three inches longer than its mate; as the fibula was not elongated, its attachment at the ankle forced the tibia to bend forward at its lower third. Diseased bone was removed and deformity corrected by subperiosteal resection of six inches of the shaft. New bone was formed, and the patient is making satisfactory progress.

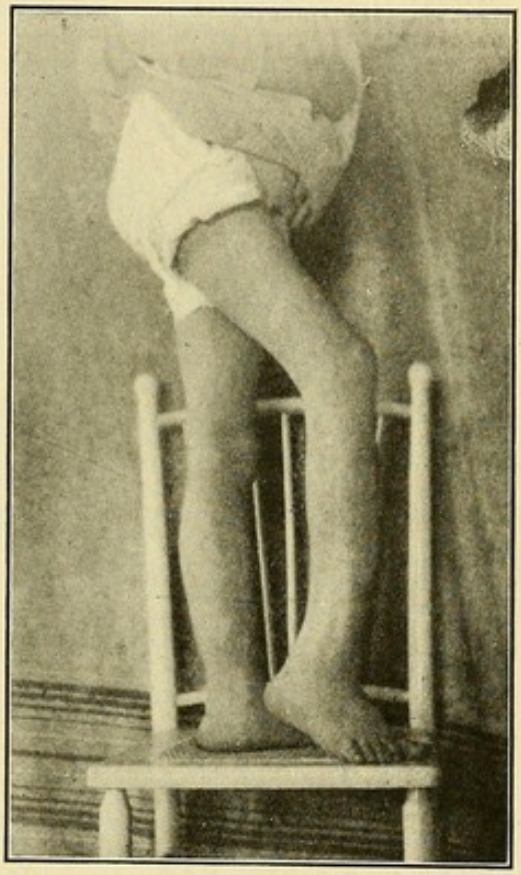


FIG. 182.—CHRONIC OSTEOMYELITIS OF RIGHT TIBIA, WHICH IS THREE INCHES LONGER THAN THE LEFT. Six inches of the shaft was resected subperiosteally, with regeneration of bone, and good recovery.

Tumors and Cysts.—The tibia is the frequent site of SARCOMA, especially near its upper end.

OSTEOCHONDROMATA sometimes develop from its lower end. The writer has seen a BENIGN CYST of the lower end of the tibia, which caused enlargement of the bone, but was painless and without constitutional symptoms; there was complete recovery after extirpation (Fig. 28).

Rupture of the plantaris tendon occurs mainly in adults. If when running or jumping a sudden stinging pain is felt in the calf, followed by tenderness, lameness, and swelling and ecchymosis at the side of the tendo Achillis, it is probable that the threadlike tendon of the vestigial plantaris muscle has been ruptured. This accident causes a good deal of pain and disability, necessitating the use of crutches and a light splint or strapping and bandage for four weeks; recovery is complete. Much suffering and delayed healing result, if the attempt is made to continue the use of the foot before healing has taken place.

Angina curis (*intermittent claudication, dysbasia angiosclerotica*) is due to arteriosclerosis of the posterior tibial artery; there may be hardening of other arteries or not. It occurs mostly in middle-aged men who are excessive smokers. It is characterized in its typical manifestation by the sudden onset of agonizing pain in the calf when walking; this may occur regularly after walking a certain short distance, and is so severe that it is impossible to proceed. After resting a few moments the pain recedes, but it is impossible to walk far. In typical cases the pain does not occur at other times. On examination it is found that the posterior tibial or dorsalis pedis pulse (or both) is diminished or absent. This may also be the case on the opposite side, even if no pain has been felt. Some of these cases later develop gangrene of the foot. Tobacco should be withdrawn and treatment for arteriosclerosis instituted. The attacks are said to be relieved in some instances by the use of the vibrator, the high-frequency current, and other means to improve the local circulation.

Varicose veins and varicose ulcers of the leg are not strictly orthopedic, but are both common and troublesome. The veins may be supported by strapping, bandaging (stockinet bandages are best), lacings, and elastic stockings, with relief to the patient, but can only be cured by extirpation.

Varicose ulcers are difficult to heal under the conventional treatment while the patient walks about, but heal readily under zinc-oxid adhesive-plaster strapping. The ulcer is covered and its edges drawn together by overlapping strips of one inch wide zinc-oxid adhesive, nearly encircling the leg. This dressing is to be renewed every second day, but no other treatment or restriction is required. It is astonishing how quickly ulcers which have resisted approved treatment for months or years will heal under this simple plan.

Deformities of the Ankle

Weak ankle (*in-ankle*) is that posture of weakness in which the inner malleolus descends and becomes prominent. It is often associated with the outtoeing, abducted, and everted foot, and also with knock-knee. The treatment is that of weak-foot, under which heading it is discussed.

Traumatic in-ankle is discussed under valgus.

Sprain of the ankle is a common injury which consists in the rupture of some of the fibers of the lateral ligament, usually the external, of the ankle-joint. Swelling, pain, tenderness, disability, and ecchymosis follow rapidly upon the injury, which is slow to recover under local applications or plaster-of-Paris splinting. Soreness and

lameness may persist for months. In injuries with great ecchymosis, fracture of the tip of the malleolus should be suspected, and a skiagraph taken.

The treatment by adhesive-plaster strapping, introduced into this country by Gibney and modified by Whitman, shortens the confinement and disability and gives excellent final results. The Whitman method is as follows: So soon as the patient is seen, two zinc-oxide plaster strips two inches wide and twenty-eight inches long are snugly applied to the sides of the leg beginning and ending below the knee, covering the malleoli, and passing under the heel. The foot is held by these plaster strips slightly toward the injured side. When the side straps are in place, strips of plaster one inch wide are wound from the ankle across the dorsum and under the foot, and again across the dorsum in the reverse direction, meeting the point of departure and continuing for several overlapping figure-of-eight turns with a few circular turns around the front of the foot. This covers the ankle and foot, except the heel, ball, and toes, with snugly applied overlapping turns of adhesive plaster. The side strips are held in place by turns above the ankle, and by spiral turns in both directions. The leg, ankle, and foot are then firmly and evenly bandaged from the toes to below the knee. This dressing prevents lateral strains and checks swelling, but does not prevent the use of the foot. Usually there is marked relief from pain, and if the patient is inclined to use the foot he may do so. It is probable that moderate use in the firm dressing acts as a kind of massage to assist drainage and promote circulation. Many patients walk without discomfort or

harmful effect so soon as it is applied. In most the disability is incredibly short and the cure rapid under this management. The dressing should be changed once a week, both for better support and because the skin may become irritated if the plaster remains too long. The plaster may be loosened with alcohol or benzine, and if the leg has been previously shaved the discomfort of stripping off the plaster will be diminished. Such a dressing should be worn for five or six weeks, and, if necessary, followed by a simple bandage. Since the introduction of this method the treatment of sprains has been both simple and satisfactory.

Tuberculosis of the ankle usually occurs as an infection from one of the neighboring bones, especially from the astragalus or lower end of the tibia (Fig. 183). In children this disease often recovers under immobilization of the foot and ankle with an ankle brace or with a gypsum splint, and suspension of the limb by crutches or a Thomas splint, and the usual tonic treatment for tuberculous affections. In some cases sinuses will appear which may heal under simple aseptic dressings or the occasional injection of a saturated solution of iodoform in ether or the bismuth-vaselin mixture. Sometimes, however, the ankle-joint may have to be opened and the diseased tissues removed, including the original focus; this often involves the removal of the astragalus. The location of the bone disease may be determined by skiagraphy. In adults the disease is more often secondary to or complicated with pulmonary or other visceral tuberculosis, and radical operations are frequently required.

A very simple but efficient method of treatment of

tuberculosis of the ankle-joint has lately been employed in Berlin by the advocates of the Bier method. A plaster-of-Paris cast is applied from the knee to the ankle sufficiently tight to cause slight congestion, but allowing free joint motion. The plaster is molded carefully about the tuberosities of the tibia; in it is imbedded a double up-

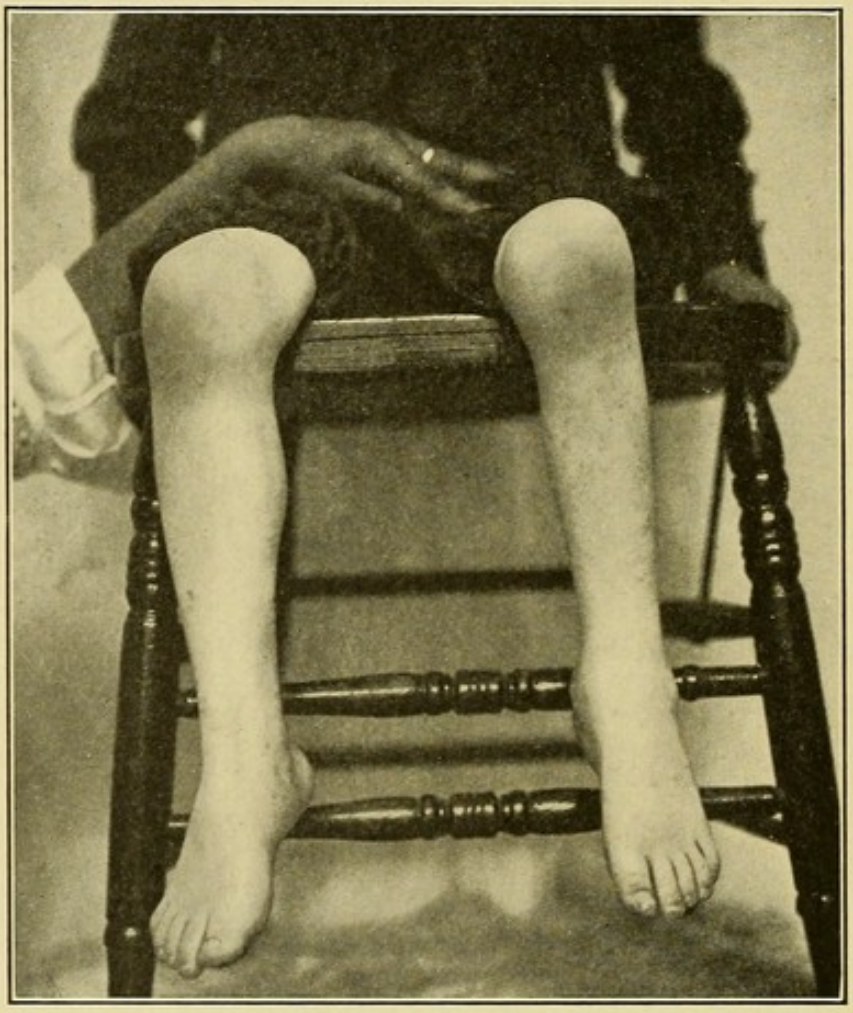


FIG. 183.—TUBERCULOSIS OF LEFT ANKLE; ONE YEAR'S DURATION. Note atrophy of leg and foot.

right iron support, which extends two inches below the foot, with a small foot plate to walk on. That the apparatus may be easily removed and reapplied, it has a lateral hinge on one side of the ankle-joint, and the

plaster is cut down the front and back, making two lateral halves (Ogilvy).

If the mechanical and hygienic management of the case can be carried out one should not consent to amputation so long as the circulation in the foot is good; an excision of diseased bone, in case of need, is preferable even if it has to be repeated, as ultimate cure frequently results.

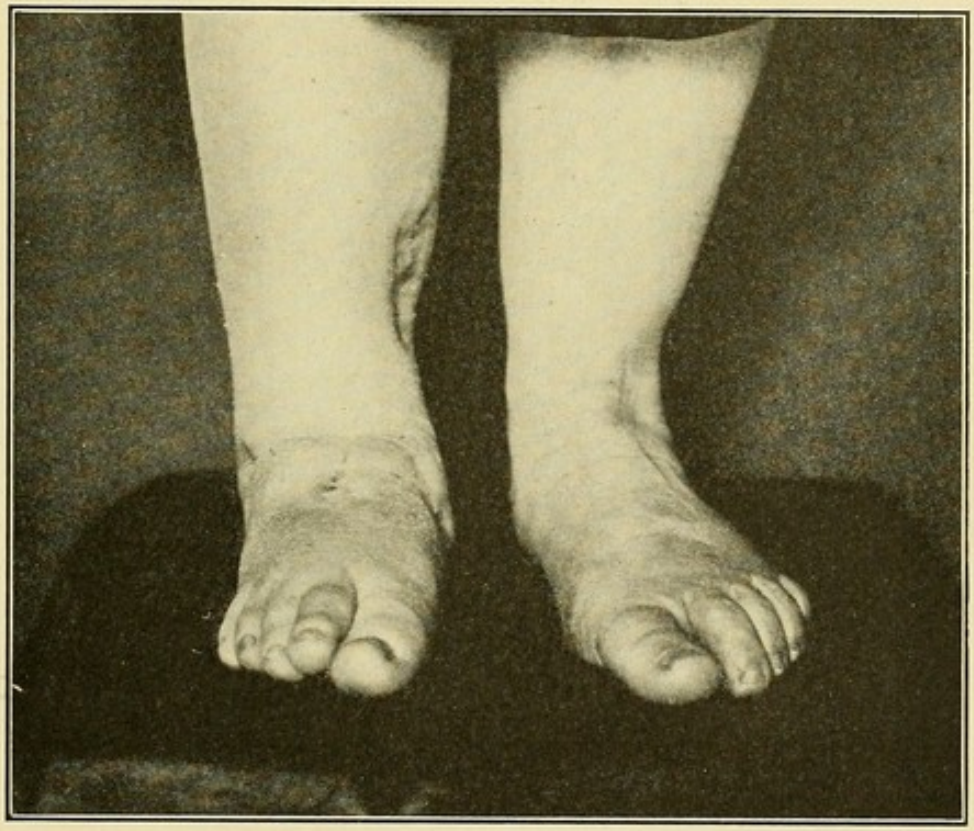


FIG. 184.—CURE AFTER TUBERCULOSIS OF RIGHT ANKLE AND TARSUS BY CONSERVATIVE OPERATIONS (GIBNEY) AT THE HOSPITAL FOR THE RUPTURED AND CRIPPLED, AND FRESH-AIR TREATMENT. This patient had been condemned to amputation.

The above remarks apply equally to tuberculosis of the tarsus, which is somewhat more serious and persistent owing to the complicated structure and multiple joints of the tarsus (Fig. 184). Cures are frequently obtained under conservative treatment, especially in children.

Deformities of the Foot

Physiological Anatomy of the Foot

The normal feet form a strong, flexible, and adjustable base for carrying the weight of the body. The natural foot is wedge-shaped, with the apex at the heel; this is well seen in babies and in primitive people who have never worn shoes (Fig. 185); nearly all shoe-wearing feet are more or less deformed. The foot is rigid at

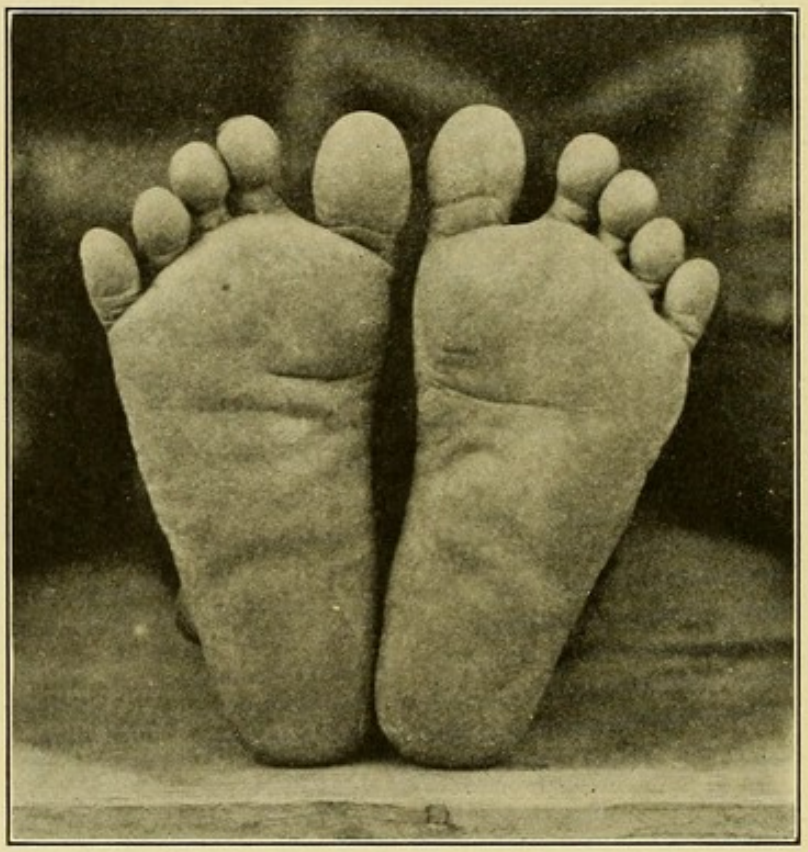


Fig. 185.—Feet of Negrito, Showing Natural Shape When Shoes have Never Been Worn. (Hoffmann.)

the heel, and relatively so along the outer border; the longitudinal arch at the inner side and the transverse arch across the ball should be flexible. The foot, including the toes, is naturally capable of considerable

movement, and even of prehensile power, but this is soon lost under restrictive coverings. It is desirable to keep

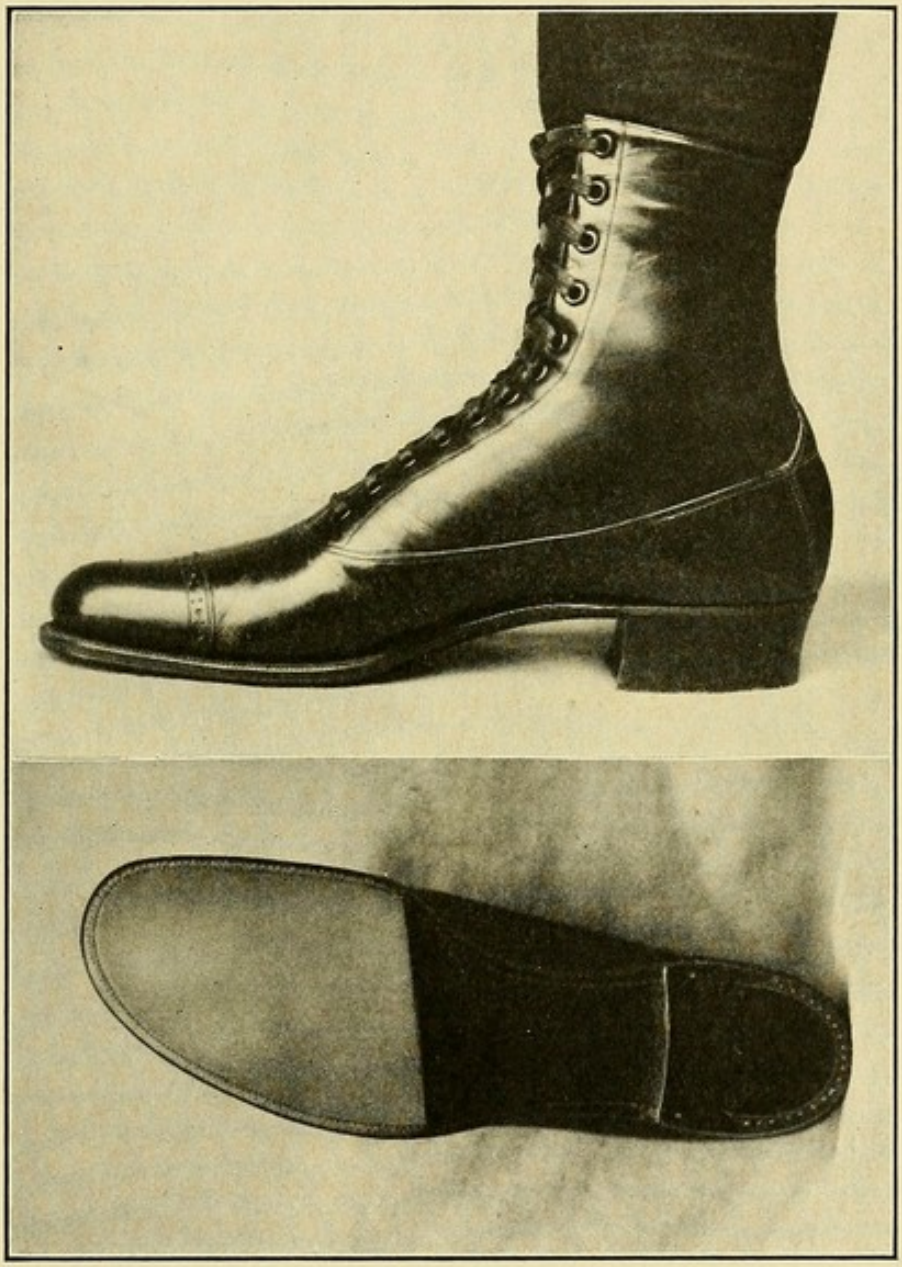


Fig. 186.—Walking Boot of Natural Shape.

babies barefooted until they begin to walk, and to encourage barefoot walking under suitable conditions. Sandals have the virtues of better ventilation and less restriction than shoes, and may be worn a part of the time. Shoes should be laced, and of the orthopedic or

natural shape—*i. e.*, straight on the inner side, broad across the ball, narrow and snug behind, but with a low, broad heel (Figs. 186 and 187). This shape should

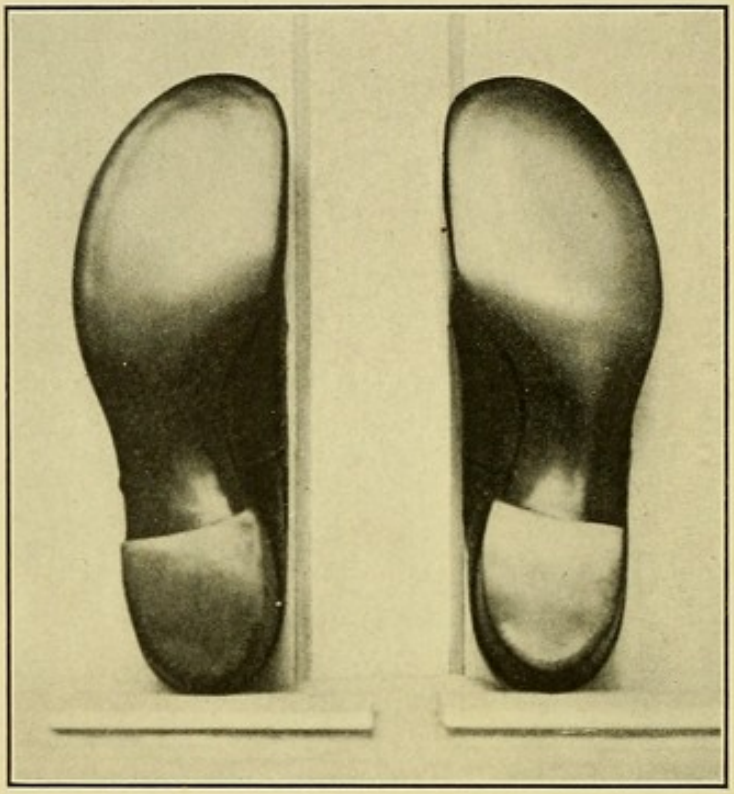


Fig. 187.—Orthopedic Shoes, Built to the Lines of the Normal Foot.

be retained at least for walking shoes in adult life. "Right and left" stockings, longer on the great toe side, are also desirable, but are hard to get.

The muscles which control the foot are situated between the knee and the ankle. Antero-posterior motion takes place mainly at the ankle, rotation and lateral motion mainly at the mid-tarsal joints. The foot is arched at the inner side, the scaphoid being the keystone; the heads of the metatarsals form a transverse arch, of which the pillars are the heads of the first and fifth metatarsals. Theoretically the foot is a tripod resting on the os calcis,

and the heads of the first and fifth metatarsals; practically the weight is borne in most feet on the heel, ball, and outer border. When the foot is in a normal condition, normally used, and supported by well-developed muscles, the inner border does not touch the supporting surface (Fig. 188). It is so balanced and constructed

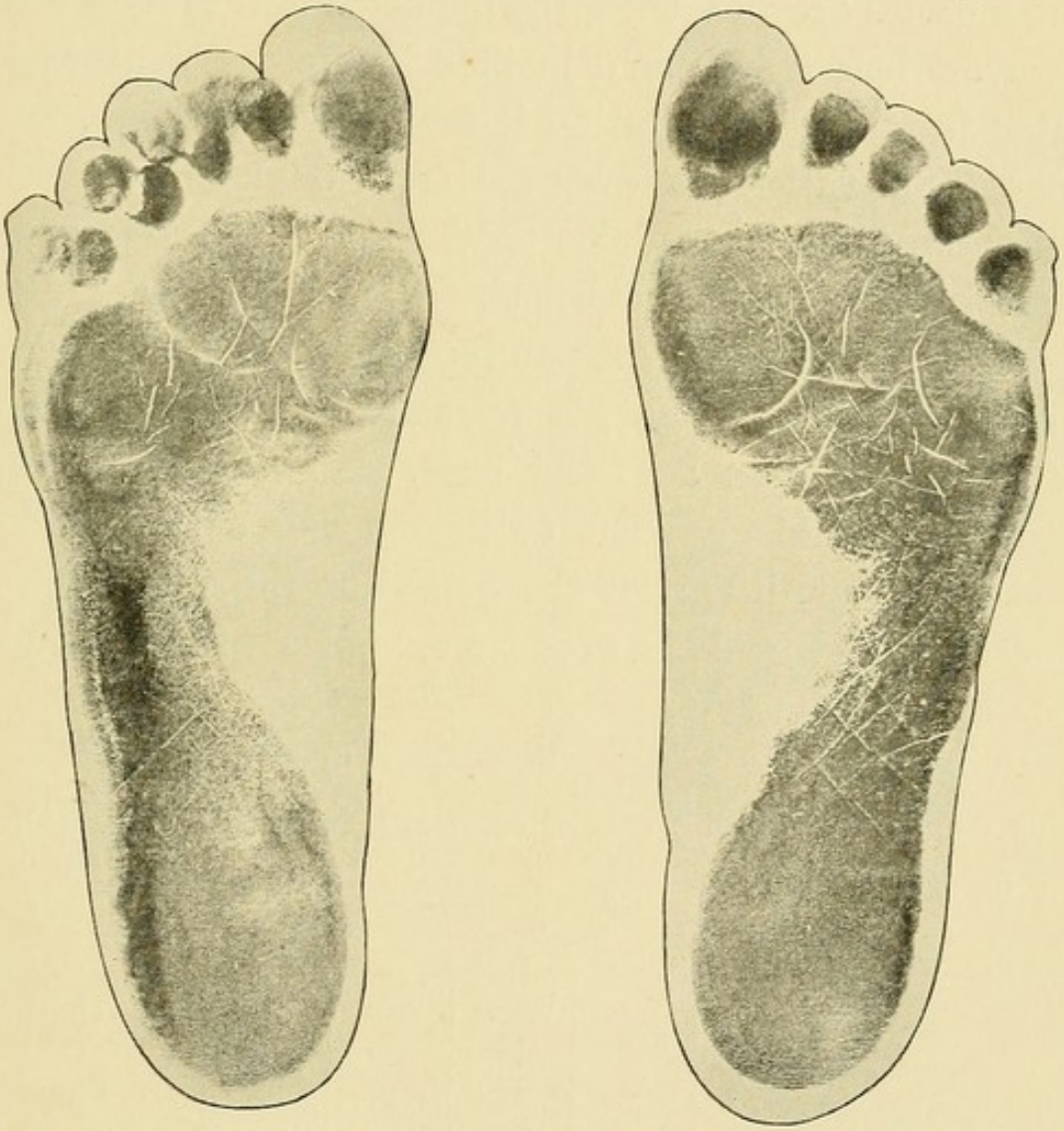


Fig. 188.—Sole Prints of Normal Feet; Boy Aged Six.

that diminished resistance or additional strain causes a yielding or sinking on the inner side; the inner malleolus sinks, moves backward, and becomes prominent, the arch

falls inward, the foot rolls outward, and its inner border becomes longer. This movement is equivalent to an outward rolling (eversion) of the foot with abduction of the forefoot; the foot also becomes broader across the ball under weight bearing. If standing is prolonged on hard surfaces, if the load is increased or the muscles are weakened, the abducted and everted foot recovers less readily and in time becomes a weak foot; later from added irritation it may become a rigid flat-foot. When the foot gives out from weakness or overweighting, it always yields on the inner, the vulnerable side, in the manner described.

Walking with the feet pointing forward (straight-foot or strong-foot walking), is physiological, graceful, and effective; it gives a strong base, an elastic step, and beauty of carriage. The outtoeing walk is stiff, ugly, and inefficient; it carries the weight on the heel, gives a bad base, and tends to produce or aggravate bad bodily postures.

The following table, modified from Whitman, shows the action of each muscle and its relative importance in each movement:

	Dorsal flexion	Plantar flexion	Adduction	Abduction	Eversion	Inversion
Tibialis anterior	1					1
Extensor hallucis longus	3					6
Exterior digitorum longus	2			3	3	
Peroneus brevis		6		2	2	
Peroneus longus		3		1	1	
Gastrocnemius and soleus		1	2			2
Tibialis posterior		4	1			3
Flexor hallucis longus		2	3			4
Flexor digitorum longus		5	4			5

Classification of Deformities

Deformities of the foot exemplify all the postures into which the foot can be placed. The lateral deformities are pes varus (adduction of the forefoot with rolling in), and pes valgus (abduction of the forefoot with rolling out). The antero-posterior deformities are pes equinus, when the foot is dropped, and pes calcaneus, when the foot is raised. When the forefoot is dropped at the mid-tarsal joints with elevation of the arch, the deformity is called cavus. The lateral and antero-posterior deformities are frequently combined; both equinus and calcaneus are often associated with cavus. For equal grades of deformity the valgus posture is more disabling than the varus.

Pes Varus and Equino-Varus.—Varus is usually combined with equinus, pure varus being exceedingly rare; the combination is called pes equino-varus, in which either the varus or equinus element may predominate.

Congenital equino-varus is the commonest form of club-foot, and one of the commonest congenital deformities. Like other congenital deformities, it is sometimes inherited or appears in several members of a family, but it is oftener isolated; it may be associated with other deformities, but usually occurs in children otherwise free from defect (Fig. 189). The deformity is due in most cases to adaptation to a cramped posture in utero under uterine pressure from deficiency of liquor amnii. It may be unilateral or bilateral or combined with a calcaneo-valgus on the other side; in rare instances club-foot is combined with club-hands, due to the same cause. The legs and feet of

club-footed babies a few days old usually drop back readily into a posture with flexed thighs and knees, in which the deformed feet are closely applied to the back of the

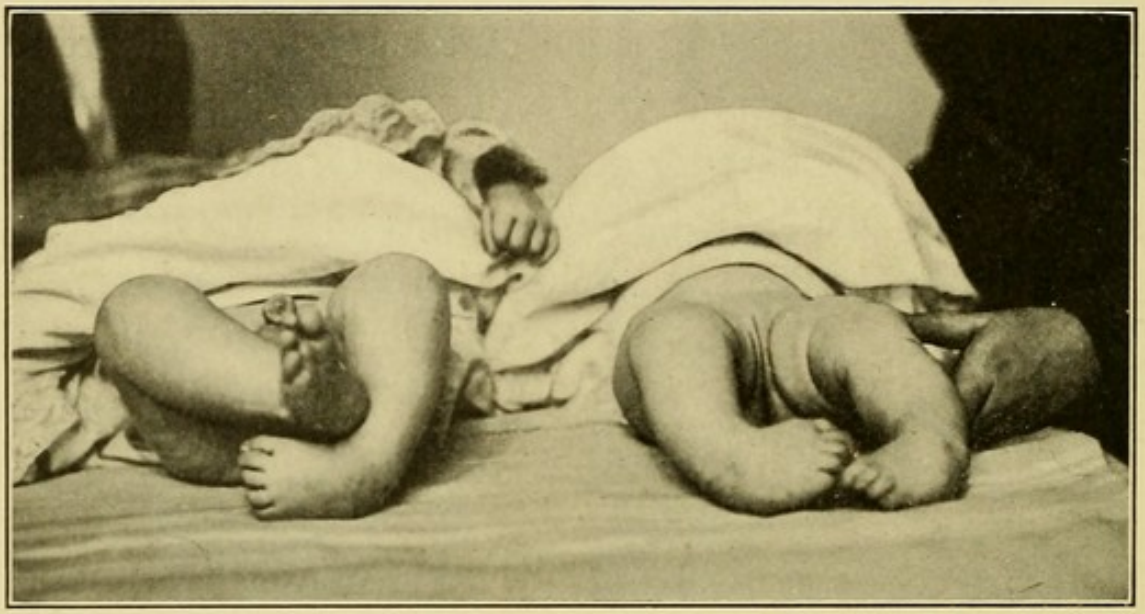


FIG. 189.—CONGENITAL PES EQUINO-VARUS. The baby to the left is two months old and has the deformity on his left side; the baby to the right is five months old and has both feet deformed.

thighs or, by crossing the legs, to the outer side of opposite knees; this is probably the forced posture of the last few months of intrauterine life. There is in the form under discussion no primary defect in the embryo and no paralysis; the foot has simply been shaped or molded to the posture forced upon it by its constricting envelope. The deformity is of all grades from very mild to very severe; when fully developed it presents the following elements: (1) Adduction of the forefoot (varus); (2) inversion of the foot; (3) inward rotation at the ankle; (4) dropping of the forefoot (cavus); (5) dropping of the foot at the ankle (equinus). The SYMPTOMS consist in the deformity and consequent stiffness, lameness, and disability. The leg muscles remain thin,

and after some years there may be some shortening from retarded growth; the foot, even when corrected, is usually shorter and smaller than normal. The child walks some months late, and if the feet have not been corrected, it walks on the outer side of the foot with the toes pointing inward; this aggravates the deformity, and the worst cases finally walk on the dorsum of the foot with the forefoot curled up, near the internal malleolus. These severe uncured cases, though common twenty years ago, are now seldom seen in this country. Walking on deformed feet produces a callus on the part of the foot receiving the pressure; it also strains the knee, causing hyperextension and lateral weakness.

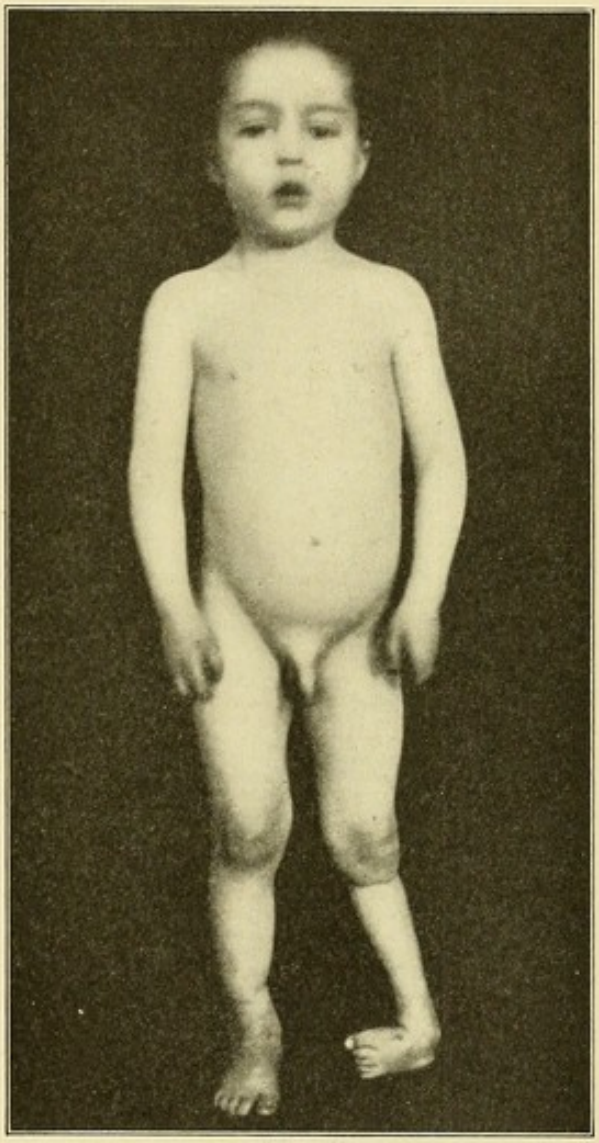


Fig. 190. — Untreated Case of Left Congenital Equino-varus in a Boy of Six; Notice the Congenital Constriction Below Left Knee and Above Right Ankle; Fingers are Also Deformed. (New York City Children's Hospital, Randall's Island.)

Prognosis. — It will appear from the above that the natural tendency of the affection, if uncorrected, is to get progressively worse, produce severe deformity,

and make correction painful and difficult (Figs. 190 and 191). Under mechanical and surgical treatment most early cases can be entirely corrected, and the severe and late cases greatly improved.

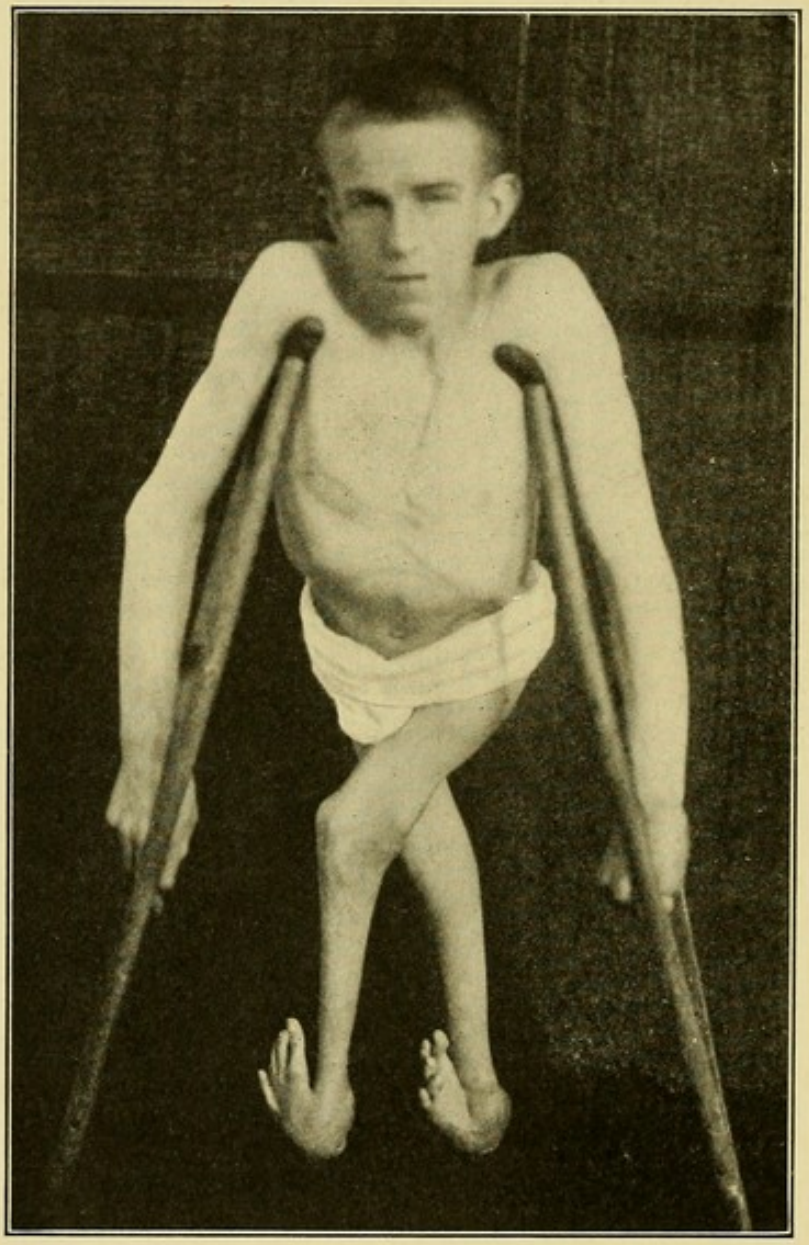


FIG. 191.—UNTREATED CASE OF BILATERAL CONGENITAL EQUINO-VARUS, SHOWING EXTREME DEGREE OF DEFORMITY IN A BOY OF SEVENTEEN. (New York City Children's Hospital, Randall's Island.)

The TREATMENT during the first two months of life should be confined to moderate manipulation to abduct

and evert the foot. At two months of age, if the baby is healthy, continuous mechanical pressure against the deformity may be made by metallic or plaster-of-Paris

Fig. 192.—The First Application of a Plaster-of-Paris Splint to the Unilateral Case Shown in Fig. 189. Showing the Correction Obtained at the First Dressing.

splints (Fig. 192). The foot is to be gradually unfolded or remolded by overcoming first the varus element, later the equinus. The foot may be allowed to drop and leverage applied by a splint on the inner side of the foot and leg. The Judson splint, made of a strip of brass with a half band at each end properly padded, and a free band applied to the outer ankle, may be securely strapped to the inner side of the foot and leg by adhesive plaster, and gradually straightened as the foot yields (Figs. 193 and 194). This may also be done by a plaster-of-Paris splint applied in the best posture of the foot and renewed

and straightened once a week. Violent stretchings are not necessary. When the foot has been pushed out into valgus, it will be found that the equinus element is diminished, and in some instances may be readily stretched out by hand or by corrective splints of plaster or steel. It is seldom necessary or wise to operate on a baby's foot during

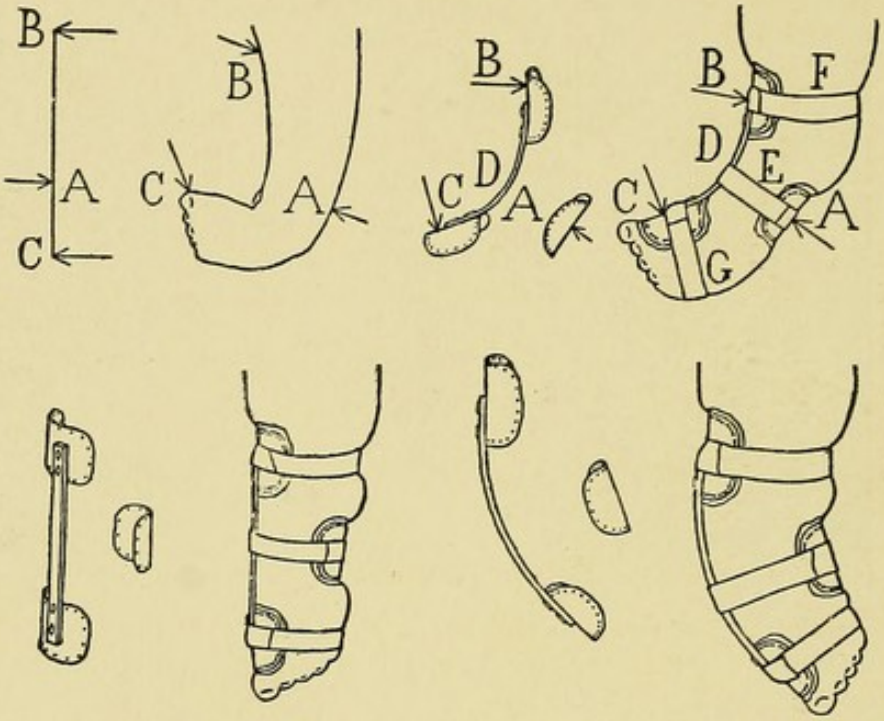


FIG. 193.—PROGRESSIVE CORRECTION OF THE VARUS DEFORMITY BY CONTINUOUS LEVERAGE APPLIED BY MEANS OF THE JUDSON SPLINT. (Judson.)

its first year, and it is practically always possible to overcome the varus deformity in a few months. If the equinus deformity is not overcome at the age of fifteen or eighteen months, it is best to cut the heel cord subcutaneously, manipulate the foot thoroughly, and put it up in overcorrection. After the foot is thoroughly corrected, rather somewhat overcorrected, the problem is to hold it until there is no tendency to relapse, and at the same time let the child walk. It is at this point that many experience difficulty. If the foot is well held, the

pressure of walking will assist the cure, whereas if the foot turns inside the splint, by ever so little, walking increases this tendency. The retention splint should be applied to the inner side of the foot and leg, support the foot by a sole piece, stopped at a right angle, and should be secured by strapping which is so arranged as not to interfere with the circulation. Such a splint is the C. F. Taylor club-foot brace, which slips into a laced shoe, and may be adjusted by bending the side bar (Fig. 195). The heel may be held down if desired by a strip of adhesive plaster applied to the inner side of the leg, and buckled to the back of the brace. This splint may also be used for correction, in which case the angle of the foot part is controlled by a screw stop at the ankle, and is at first applied in the equinus posture. Ratchets and

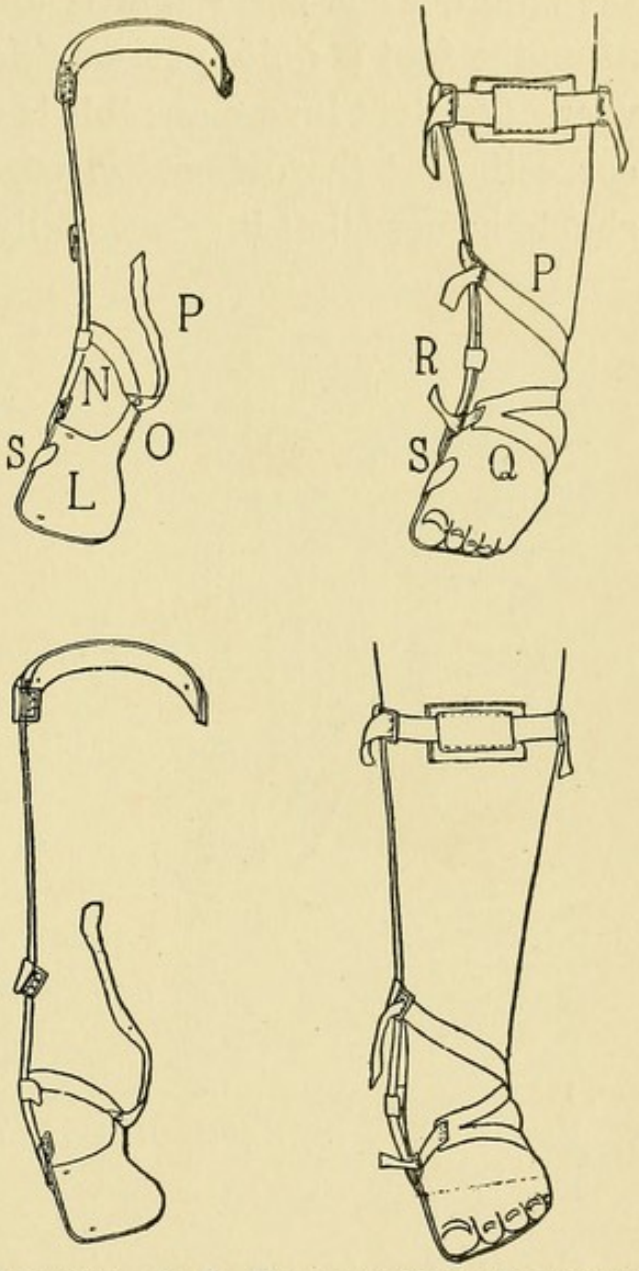


FIG. 194.—C. F. TAYLOR'S METHOD OF THE GRADUAL CORRECTION OF PES VARUS BY CONTINUOUS LEVERAGE, AS MODIFIED BY JUDSON. (Judson.)

complicated joints are unnecessary; the vital point is to hold the foot to the splint, otherwise the foot turns inside the splint, when correction is applied. In certain cases after the foot is quite presentable in shape, there may be very persistent inversion; this is usually due to imperfect correction of the deformity, when additional correction should be used, but is occasionally due to an inward twist

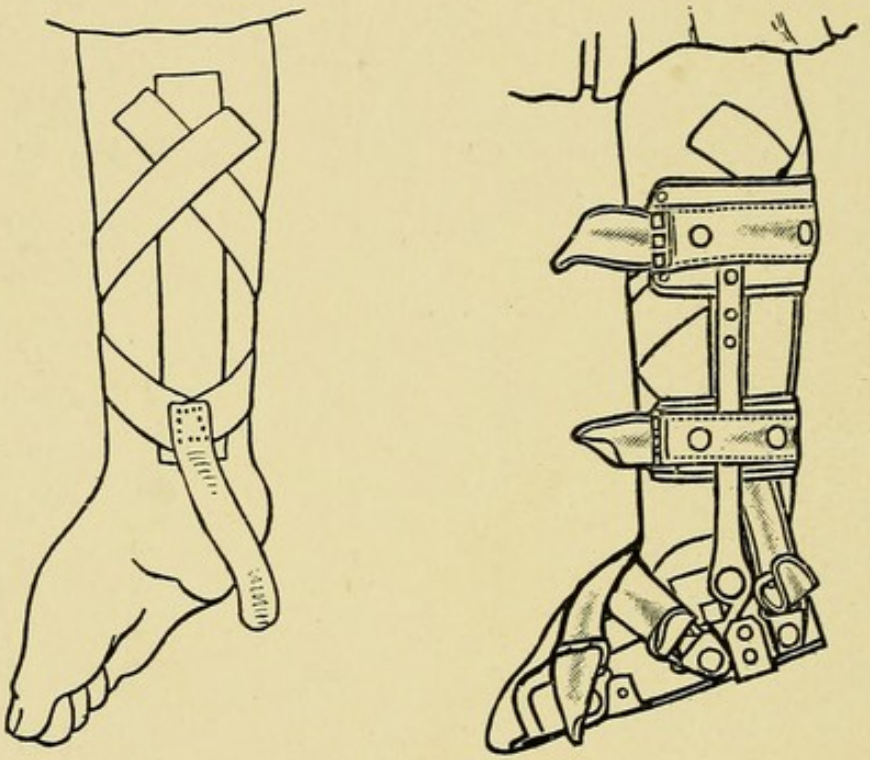


FIG. 195.—THE TAYLOR EQUINO-VARUS BRACE WITH ADHESIVE PLASTER FOR HOLDING DOWN THE HEEL. If used for retention the foot is stopped at a right angle.

of the tibia. A very effective splint for this annoying condition consists of the ankle brace already described attached by a steel band behind the calf to an outside bar with joints at the knee and hip, and to a hip band; this appliance forces the foot out and controls its direction (Fig. 196). Cases seen in the second to the fourth years of life and sometimes later may usually be corrected by mechan-

ical means, but much time and annoyance are saved by etherizing the child, cutting the plantar fascia and heel cord subcutaneously, and manipulating the foot thoroughly over the wooden wedge, or with the Thomas wrench (Fig. 197). Ten to twenty minutes of rather forcible manipulation should render the foot quite pliable, when it may be put up in plaster in overcorrection, and afterwards held by a splint. Many rigid cases in older children may be corrected by Phelps's operation of dividing all contracted tissues down to the bone through a cut running from in front of the internal malleolus two thirds of the way across the sole. Resisting ligaments should be divided even if the astragaloscaphoid joint is opened, the foot thoroughly manipulated, and the deformity overcorrected. The wound is covered with overlapping strips of sterile rubber tissue, and a large pad of shaken gauze, and the foot put up in plaster. The dressing may be kept on four weeks or more; the wound heals by granulation. Apparatus should be used to prevent recontraction. A V-shaped flap with the point opposite the head of the first metatarsal has been used by Jonas, with divi-

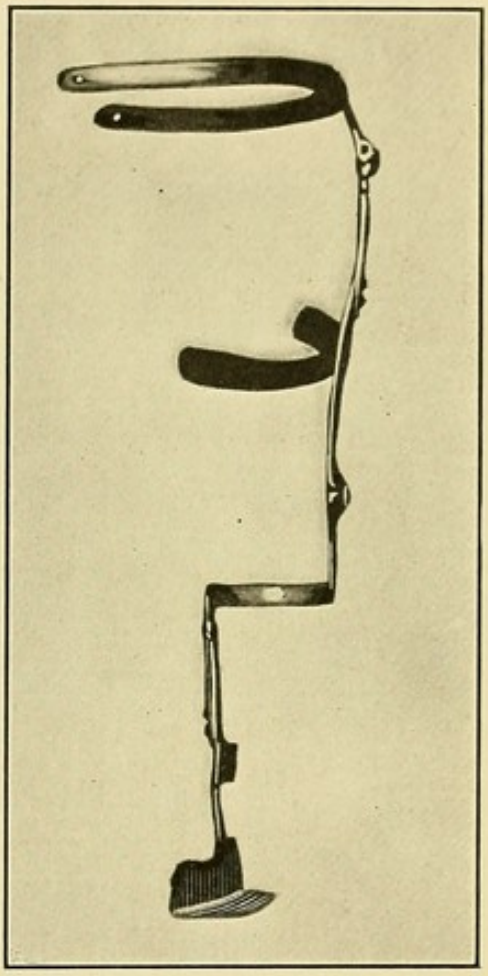


FIG. 196.—C. F. TAYLOR'S LONG CLUB-FOOT SPLINT, WITH PELVIC BAND FOR OUTWARD ROTATION OF THE FOOT.

sion of deep tissues according to Phelps, in order to cover the gap. Phelps's operation is unquestionably safe and effective when properly employed; it is unnecessary in young children. Many of the severe cases may be corrected by stretching with the Thomas wrench or other powerful instruments, preferably after prelim-

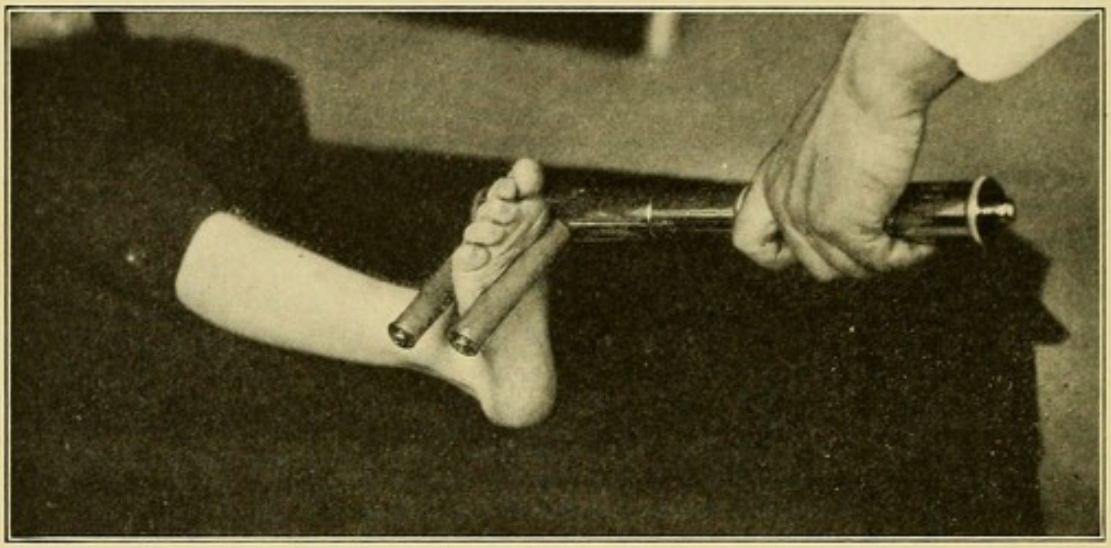


FIG. 197.—CORRECTION OF PES EQUINO-VARUS BY MEANS OF THE THOMAS WRENCH. Flat-foot and inversion may be overcome by an inward twist.

inary tenotomies. Schapps has recently devised a simple but powerful lever for this work (Fig. 212), and excellent pedoclasts have been shown by McKenzie and McCurdy. The skillful use of the means enumerated makes the removal of wedges of bone rarely advisable, though this may be safely done. When the deformed astragalus presents an obstacle to reduction its neck may be divided, or the whole astragalus may be removed. The foot needs to be held in position by a brace for a year or two after correction. When the brace is left off a slight tendency to inversion may be met by building the shoe up a quarter of an inch on the outer edge.

Paralytic congenital club-foot is caused by a spina bifida. The sensory and motor nerves may be permanently paralyzed with resulting club-foot. The paralysis may be complete or partial and is always permanent. The deformity may be corrected by the usual methods, but it should be borne in mind that on account of the sensory paralysis continuous pressure is badly borne, and sloughs are easily produced. For this reason operative correction is usually better than mechanical. The paralysis of course remains, and retentive apparatus is required.

The **pes equino-varus associated with absent tibia** has already been mentioned. The treatment is corrective arthrodesis with the lower end of the fibula. Pes equino-varus may be caused by shortening of the tibia from disease, by cicatricial and other contractions on the inner side of the foot and leg, by peroneal paralysis, and by spasm of the tibials.

There is no real **static varus** or **equino-varus,** except possibly in barefooted primitives, the condition popularly known as **pigeon-toes** being usually a compensatory or protective maneuver to ease the strain on an in-ankle or an in-knee; as such it should be inculcated and encouraged in these conditions. To forcibly turn the foot outward by braces or shoes aggravates the primary difficulty. Another cause of pigeon-toes is bow-legs; here the tibia invariably has a considerable inward twist, which is always revealed when the legs are placed on a flat surface with the patella pointing upward. This inward twist should be rectified when the bow-legs are corrected. The pigeon-toed gait is characteristic of spastic palsy and hemiplegia, the leg is rotated in from

the hip and turned in at the foot. Toeing-in is not usually a serious deformity, it does not, unless excessive, interfere with good use of the feet, and the tendency in the adaptive cases is toward a natural cure.

Paralytic equino-varus is a frequent sequela of poliomyelitis when the peroneal muscles are paralyzed and the tibials are active. In mild cases the foot may be held by an ankle brace with an outer T or ankle strap. The deformity may be corrected in severer cases by forcible manipulation or by tenotomies of the heel cord and plantar fascia, and if necessary of the tibials. In older patients tendon grafting or arthrodesis may be indicated. A part or the whole of the anterior tibial may be transferred to the outer side of the foot and attached to the head of the fifth metatarsal; or an arthrodesis may be done at the ankle and the calcaneo-cuboid joint with or without tendon grafting.

Pes equinus is rare as a **congenital** affection, but common as an **adaptive** or **paralytic** deformity. It is often combined with varus, and also with cavus. In cases of short leg from any cause, if the shortening is not compensated by a high sole, the foot is dropped and the weight is taken on the ball; when this has been done for some time the heel cord becomes permanently shortened. Shortening of the heel cord may also occur after long periods of recumbency, when the habitual posture of the feet is in equinus, and also from wearing high heels. Most women accustomed to wearing high heels have a moderate adaptive shortening of the heel cord. These women often cannot wear low-heeled shoes for this reason. In cases of weak and flat feet, although the foot

may be easily pushed up to a right angle and often beyond, if the foot is prevented from swinging into valgus, and dorsal flexion is made, the equinus becomes apparent. Such a condition is common in delicate and scoliotic children and adolescents. This condition has been called non-deforming club-foot (Shaffer), an obvious misnomer. If it requires a special name, that of pes equinus occultus or occult equinus is suggested, though it is no

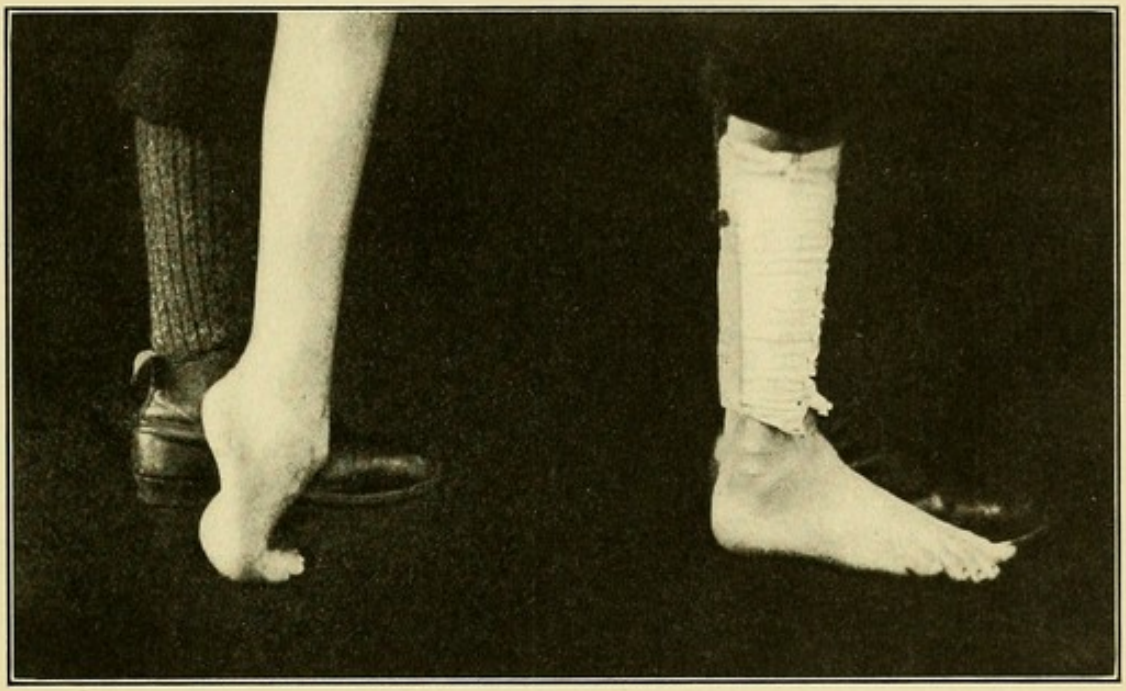


Fig. 198.—Paralytic Equinus From Hemiplegia, Before and After Achillotomy.

more hidden than mild degrees of many other deformities. Spastic and other forms of palsy are a common cause of equinus (Fig. 198). In cases of equinus secondary to a short leg one should not correct the equinus unless the leg can be lengthened or the patient is willing to wear a cork sole. It is not always necessary to correct degrees of equinus so mild as to be occult, but it is so difficult to stretch the obvious and older cases,

that it is far better to perform the simple operation of tenotomy of the heel cord. If preferred, this may be done under local anesthesia, always under aseptic conditions, but when much stretching is required a general anesthetic is better.

Achillotomy.—A small tenotome (Fig. 199) is inserted flatwise under the inner border of the tendo

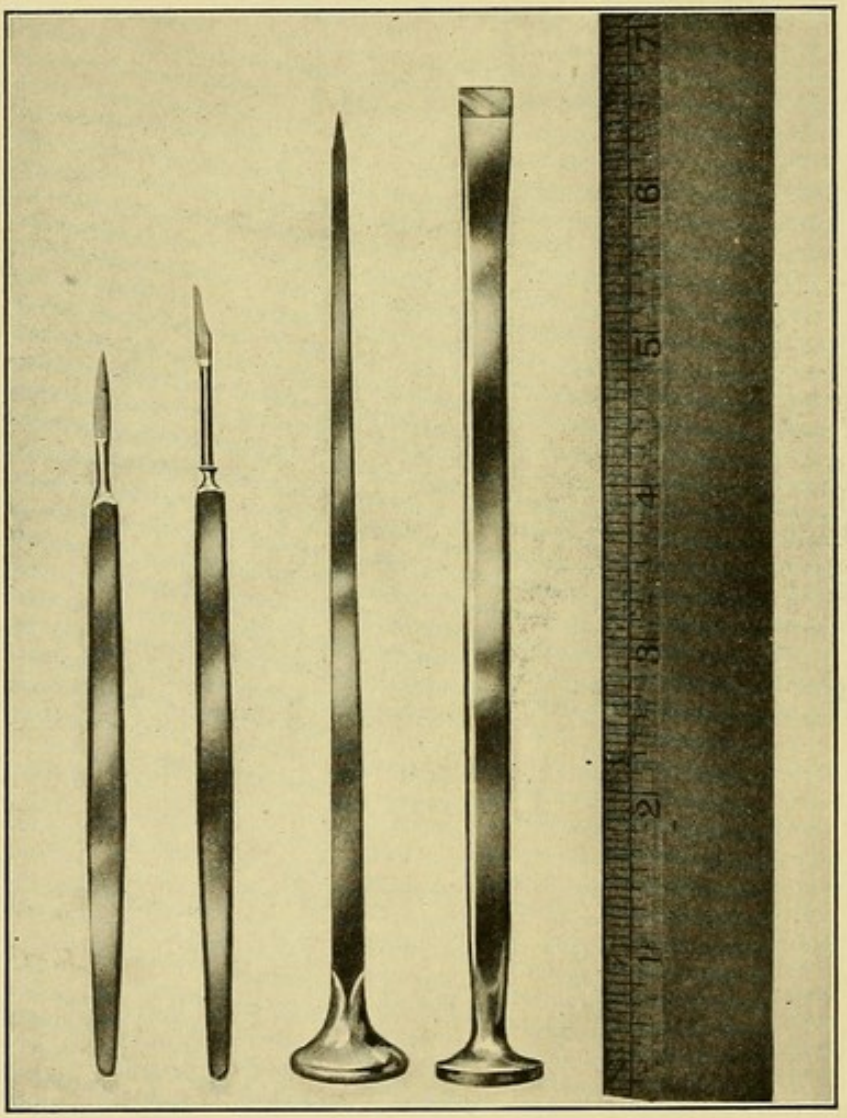


Fig. 199.—A, Tenotome with Rounded Edge, as Used at the Hospital for the Ruptured and Crippled, New York; B, Jones's Straight-edged Tenotome; C and D, Side and Front View of Vance's Osteotome, as Used at the Hospital for the Ruptured and Crippled.

Achillis three quarters of an inch above its insertion (Fig. 200). The edge of the tenotome is then turned toward the tendon, which is divided by a sawing motion, taking care not to buttonhole the skin. If the

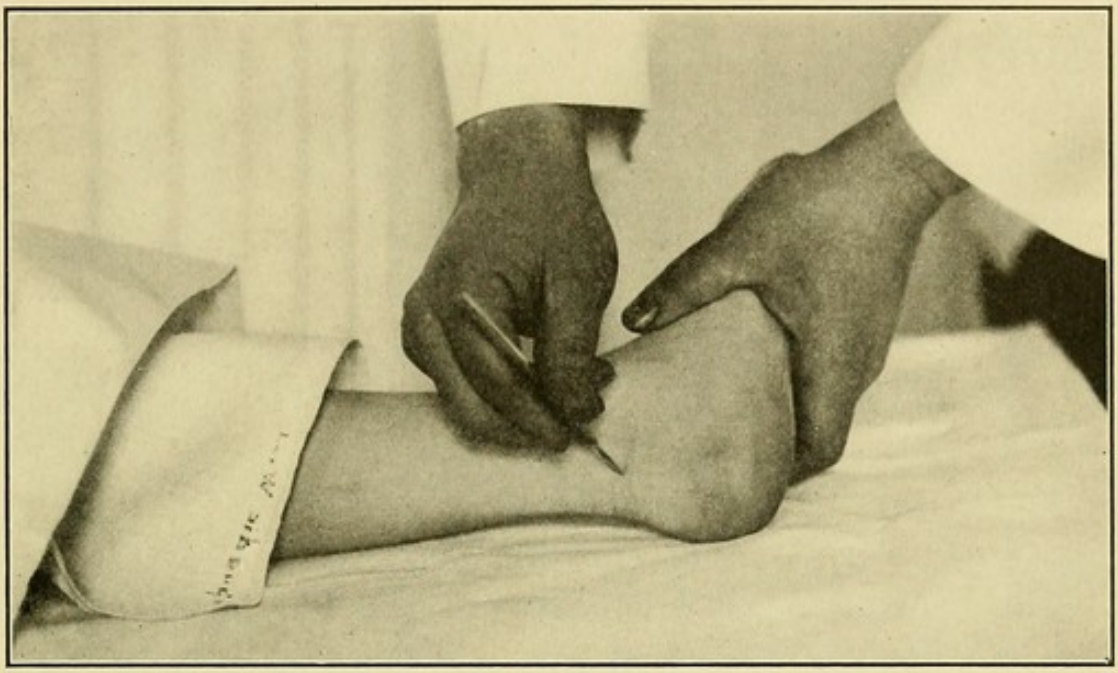


Fig. 200.—Subcutaneous Tenotomy of Heel Cord.

deformity is of long standing the posterior ligament of the ankle-joint and other structures may offer considerable resistance, and much force may be required to effect a correction. The heel cord may be lengthened by an oblique cut and suturing through an open incision or subcutaneously by splitting the tendon at two places an inch or two apart and cutting out in opposite directions; the tendon is then pulled apart by dorsal flexion of the foot. It is doubtful, however, if any operation is better than the simple subcutaneous tenotomy, since, if the foot is placed at rest, the tendon always unites firmly in six weeks. After the operation the deformity should be corrected at once, in congenital cases some-

what overcorrected, in paralytic cases slightly undercorrected, and the foot placed in plaster-of-Paris in the corrected posture.

Paralytic drop-foot (*equinus*), if of the flail variety, without resistance to dorsal flexion, may be held by a

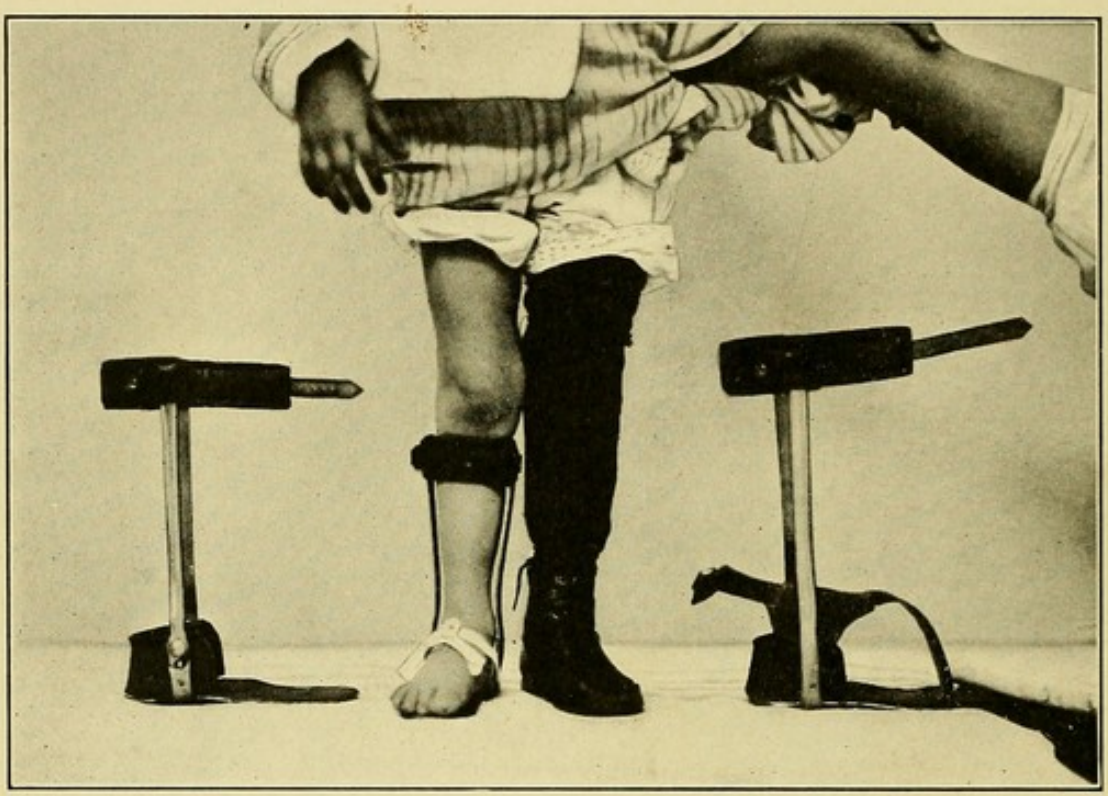


FIG. 201.—STIFF TWO-BAR ANKLE SPLINT SHOWN APPLIED, ALSO SEPARATE WITH VALGUS ANKLE-STRAP AT RIGHT. In the jointed splint at the left a stop prevents downward motion.

stiff two-bar ankle brace, worn inside the shoe (Fig. 201). If dorsal flexion is limited by the posterior leg muscles, the ankle brace may have a stop to prevent plantar flexion only, or it may be given limited motion by stops both ways. If there is a varus or valgus an outer or inner ankle strap may be added. The drop-foot may be overcome by shortening the anterior tendons, and as has been recently shown by suspending the foot by braided silk cords from the anterior surface of the

tibia. The lower part of the tibia is exposed and the silk woven into the periosteum up, across, and down for a couple of inches; the free ends hanging down are drawn under the skin and sutured to the periosteum, taking in a little bone at the sides of the scaphoid and cuboid through separate small incisions.

Pes valgus (*abducted and everted foot*) may be combined with calcaneus or with equinus; the latter condition has been described under equinus; the **congenital form,** usually combined with calcaneus, is not very rare, and is usually curable by manipulation. The foot is stretched down and in, and is retained in plaster in the equino-varus posture if the deformity is severe. Valgus frequently follows a **Pott's fracture,** which is accompanied by displacement of the foot outward and backward, and if not corrected at the time of the first dressing, the displacement may become permanent and cause serious disability. The foot should be drawn forward and put up in plaster-of-Paris somewhat inverted. When this is done, healing takes place without deformity. When the fracture has been allowed to heal in the valgus posture, it may require correction by refracture, or by an osteotomy above the ankle. Plimpton advocates the reproduction of the original fracture and the removal of redundant callus by operation, in order that the parts may be correctly adjusted; he reports excellent results.

Static valgus, the usual and normal result of the yielding of weakened structures, or of passably healthy structures to overweighting, is one of the commonest of deformities. In its milder forms it is known as "weak ankles" or "*weak feet*" (Whitman), and is very preva-

lent in New York children and in those adults who stand at their work; its distinguishing marks are prominence

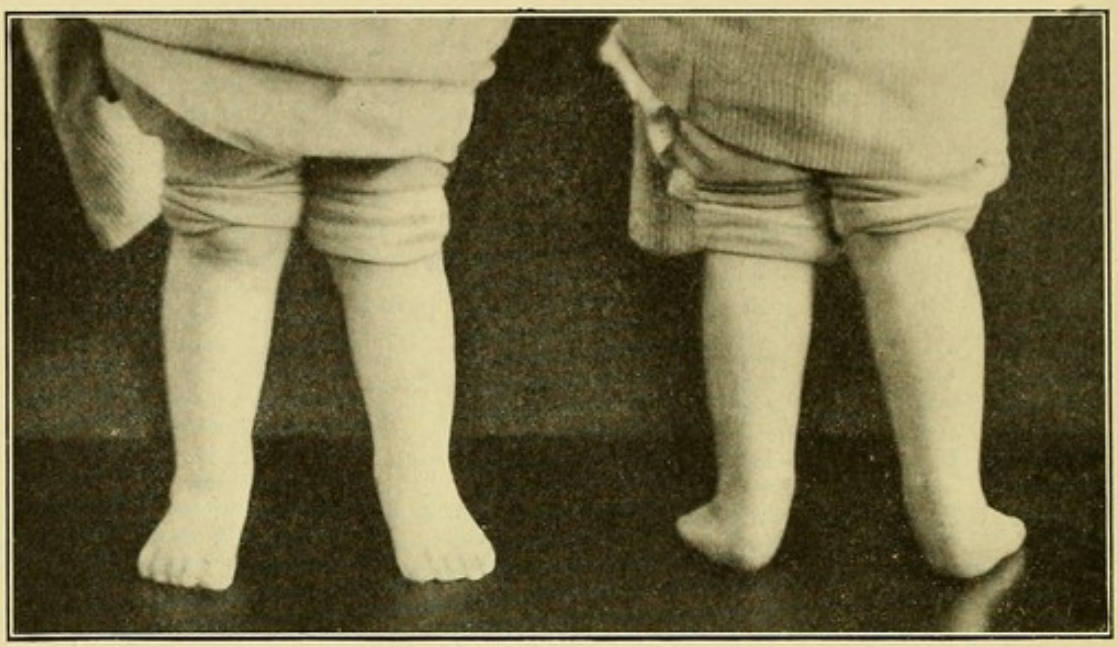


FIG. 202.—WEAK ANKLES AND KNOCK-KNEES IN A YOUNG CHILD. (Weigel.)

of the inner ankle and abduction and eversion of the feet (Figs. 202 and 203). An imprint of the foot may be taken by stepping on smoked paper, or by stepping

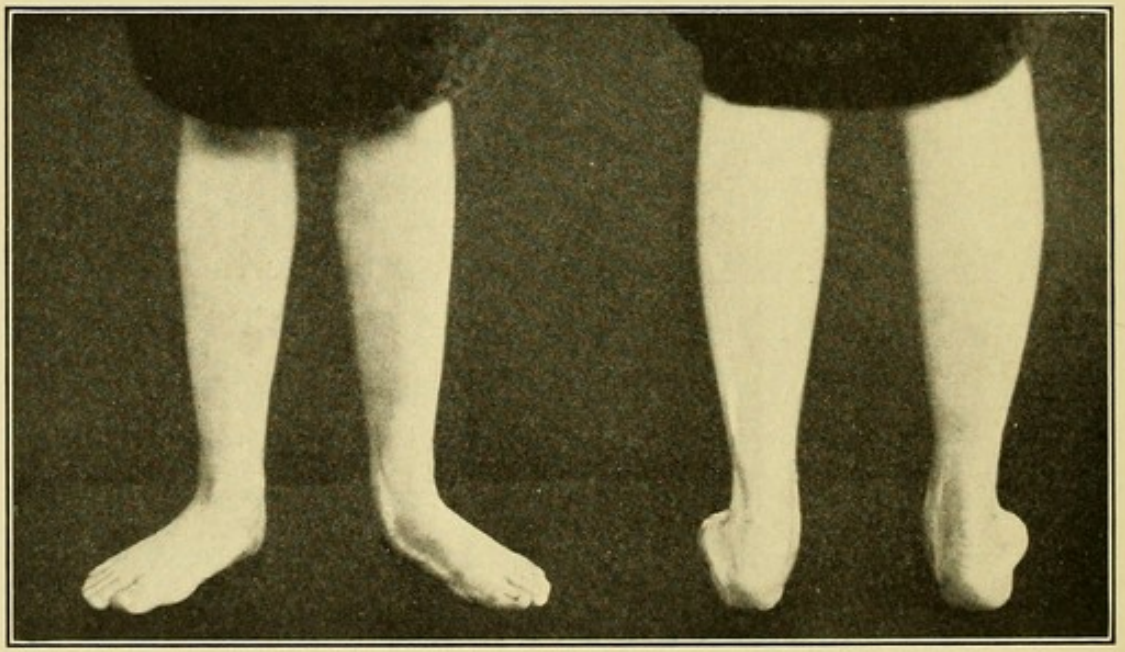


FIG. 203.—WEAK FEET FROM OUTTOEING. (Weigel.)

on a ground-glass plate or slate upon which printer's ink has been thinly rolled, and afterwards on paper; the impression may be fixed at once by a spray of siccative (Fig. 204). In Freiberg's method the sole is painted with the following solution:

Tr. ferri chloridi	50
Alcohol (80%)	45
Glycerin	5

The patient then steps upon a piece of thick paper or cardboard, after which the impression may be intensified by painting the card with a strong solution of tannic acid in alcohol (Fig. 188). Such impressions show the pressure-bearing surface of the sole. The feet toe out, the shoes are worn out on the inner edge, especially at the heel, and in walking the inelastic heel gait is used. In children there is seldom any pain; in adults there often is, both in the feet and in the legs.

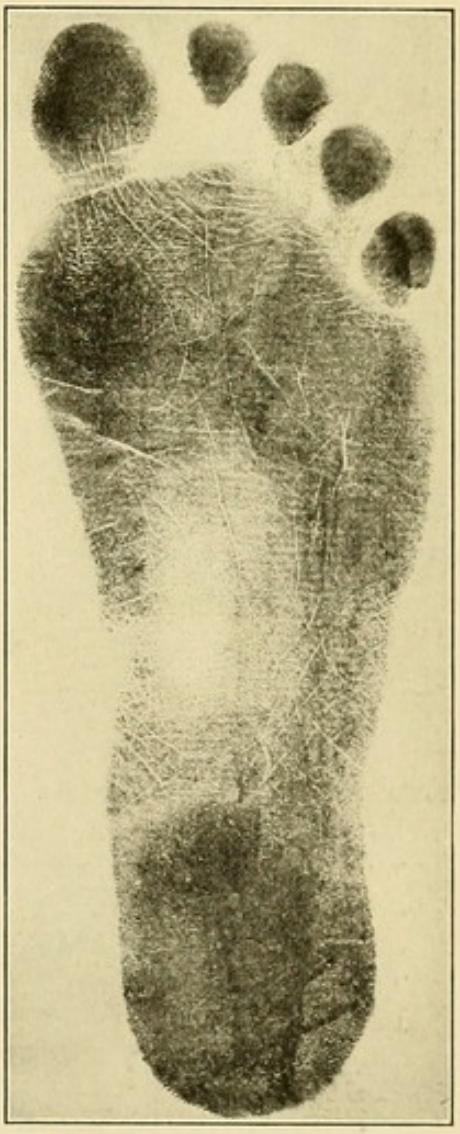


FIG. 204. — MODERATE FLAT-FOOT; PRINTER'S INK IMPRESSION. (Weigel.)

If the feet are flexible, the treatment is by exercises, proper shoes, and straight-foot walking. The shoes are of the natural or orthopedic

shape, built up a quarter of an inch or slightly less on the inner edge (Fig. 216); or the Thomas heel, which projects forward and inward like a buttress, may be used (Fig. 205). The exercises are to be practiced without shoes, and are designed to strengthen the adductors and invertors. They are as follows:

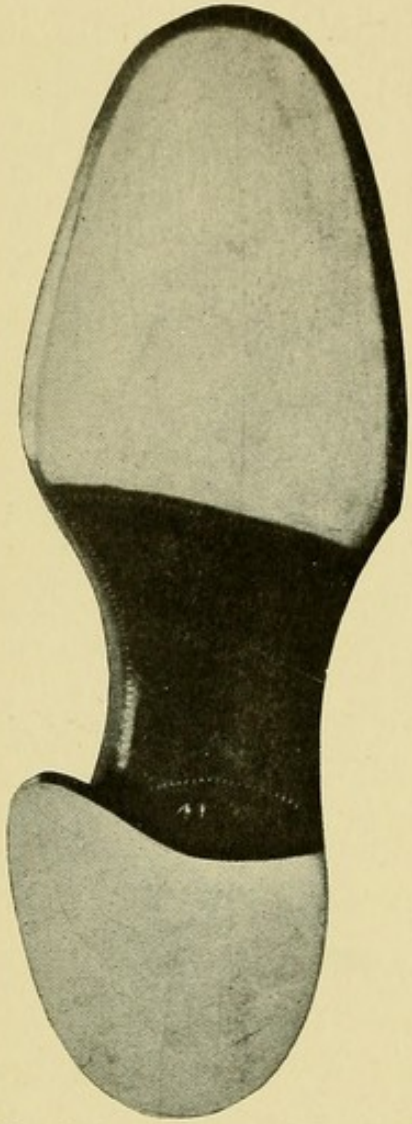


FIG. 205.—MODIFIED THOMAS HEEL EXTENDED FORWARD AND INWARD, THE MECHANICAL EQUIVALENT OF THE TURNED-IN GREAT TOE OF THE BAREFOOTED PRIMITIVE. (Cook.)

(1) Walking with heels raised and toes pointing inward.

(2) Walking on the external borders of feet; toes turned in.

(3) Sitting with legs supported and feet free, or with heels resting on floor; invert feet strongly, or grasp a large ball between the feet.

(4) And best; stand with feet turned in; quickly elevate heels; slowly come down on outer borders of feet. Repeat fifteen or twenty times morning and evening.

Osgood has devised a simple and effective apparatus for exercising the muscles controlling the foot and testing their strength.

In the atonic weak feet of adults, plates may sometimes be required, as it is difficult to get patients to persevere with the exercises.

Flat-foot.—Foot symptoms may come on slowly or develop suddenly in adult life, as in women not used to prolonged standing, who adopt some occupation like nursing which involves continuous standing. Many such begin to have pain and tenderness under the arch, and sometimes over the ankles, under the heel, and under the outer ankle bone a month or two after being put to work. Orthopedic shoes, built up on the inner side, if there is a tendency to weakness, and straight-foot standing and walking are usually preventive of trouble. When feet are painful, tender, and somewhat stiff, even if the arch has not fallen, they should be fitted with shoes built up on the inner side, be strapped in the varus posture, with or without a shaped felt pad under the arch, and be put at sedentary occupations for two or three weeks. The strapping is done by the method described for supporting a sprained ankle, except that the wide straps are started below the outer ankle and the foot drawn over into moderate varus (Fig. 206). If soreness subsides in a week or two, shoes and exercises will suffice; if soreness and disability persist, casts should be taken for foot plates. The casts are taken by mixing a thick plaster cream and pouring it into a pan or upon a thick piece of paper just as it begins to set. The feet anointed with vaselin are placed into this with the inner borders parallel and two inches apart, and pressed down about an inch into the plaster. The feet should be placed in the posture which the plates are designed to give them—that is, slightly inverted. The soft plaster is molded up about the feet with the fingers to give a correct outline. When the plaster is hard the feet are removed, and from this negative a posi-

tive is taken. The positive is shaped by scraping to distribute the pressure, and the outline of the plate is drawn upon it. To this modified cast the plate of sheet steel is fitted. The plate which has been found most useful

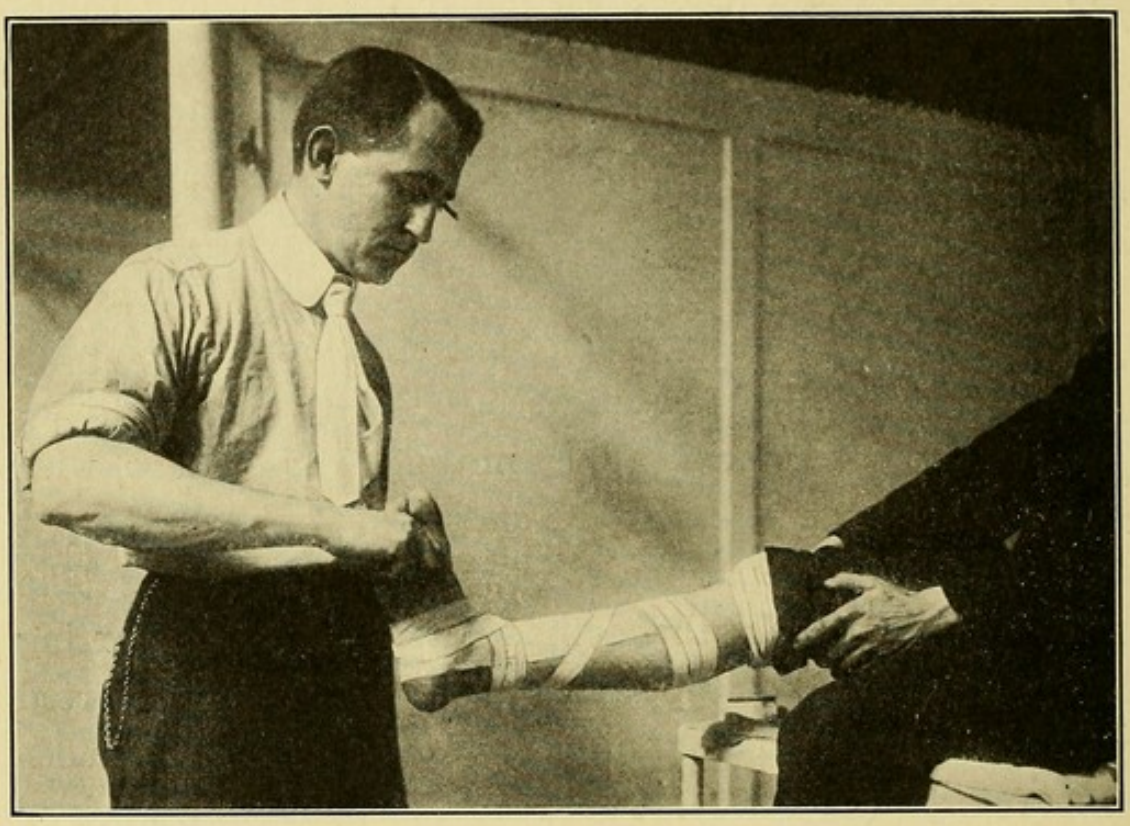


FIG. 206.—FLAT-FOOT STRAPPED IN THE POSTURE OF INVERSION. (Posed by Cilley.)

by the writer in mild and medium cases is a long plate without high flanges, reaching from the back of the heel to the heads of the metatarsal bones and arched well up in the inner side, especially under the scaphoid. Such a plate rests on the heel and the anterior edge. Its function is not only to hold up the arches, but also so to distribute the weight that the feet will be properly placed and undue strain prevented. Plates are worn inside orthopedic shoes. Corrective exercises and straight-foot walking should be practiced.

Rigid Flat-foot.—In cases not properly treated while the feet are breaking down, abduction and eversion increase, the arch sinks, and the os calcis swings to the inner side. The scaphoid and head of the astragalus slide down out of position or the ligaments yield, and the tarsal bones acquire new bearings and new points of pressure; this causes more or less irritation, soreness, muscular spasm, and finally adhesions and reshaping of the bones and articulations. We have, then, in the old rigid cases to deal with fixed subluxations of the inner tarsal bones (Fig. 207). The first step in the treatment is to reduce the subluxation and restore the foot to its nor-

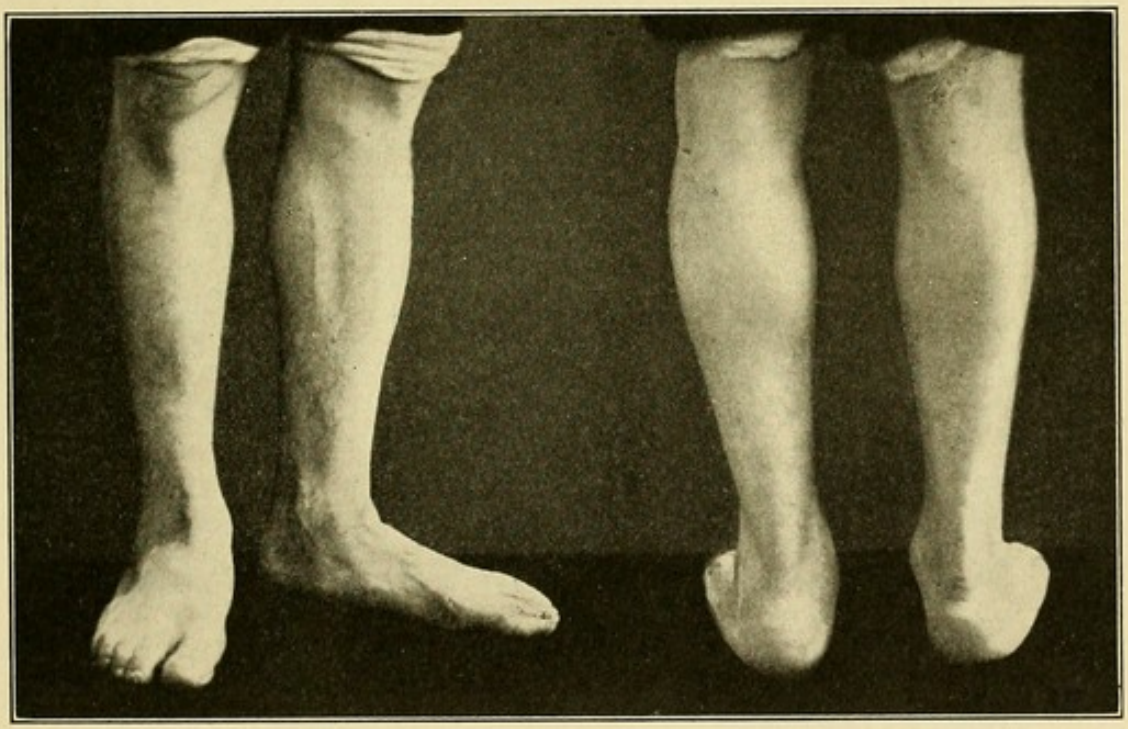


Fig. 207.—Rigid Flat-foot, both Sides. (Weigel.)

mal posture. It is useless to attempt to treat such patients with plates or otherwise until the posture and to some extent the flexibility of the feet has been restored. The patient should be anesthetized and the foot

manipulated, at first in plantar flexion, with the help of the block and Thomas wrench if necessary, and put up in plaster-of-Paris in adduction and inversion for three or four weeks. The correction will be much facilitated by section of the heel cord in certain cases. After removal of the plaster, casts should be taken for plates, which in these severe cases may often be of Whitman's shape with a large outer and inner flange (Fig. 208). The feet should be replaced in splints until the plates are applied. The patient should then have shoes fitted and walk about, practicing the foot exercises, and have the feet forcibly inverted to keep them flexible (Fig. 209). By such measures as these pain may be relieved, and the

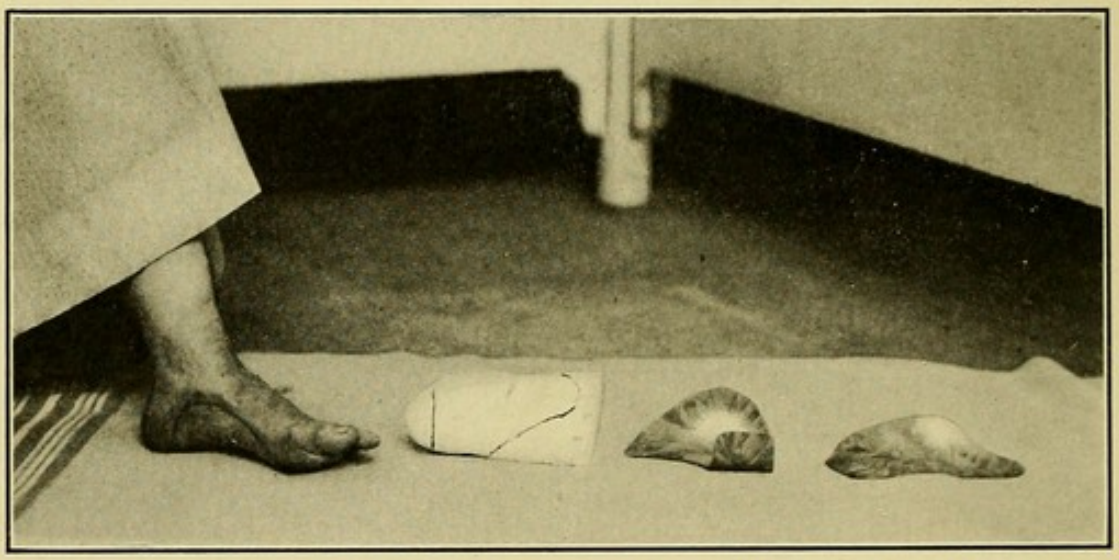


FIG. 208.—WHITMAN'S PLATE APPLIED TO FOOT: PLASTER CAST (POSITIVE) OF FOOT, MARKED FOR PLATE; WHITMAN'S PLATE, AND LONG PLATE, BOTH FACING TO LEFT.

patient enabled to walk. In many very painful and useless feet the arches are not noticeably flattened, and on the other hand many very flat feet are useful and painless. This is true in children who seldom have pain from flat feet, and also of those feet that have gone through

the painful stage, and have recovered with stiff and flat feet. Such feet in adults should not be disturbed, if doing good work, merely because the arch is flattened. In relapsing cases characterized by much spasm of the

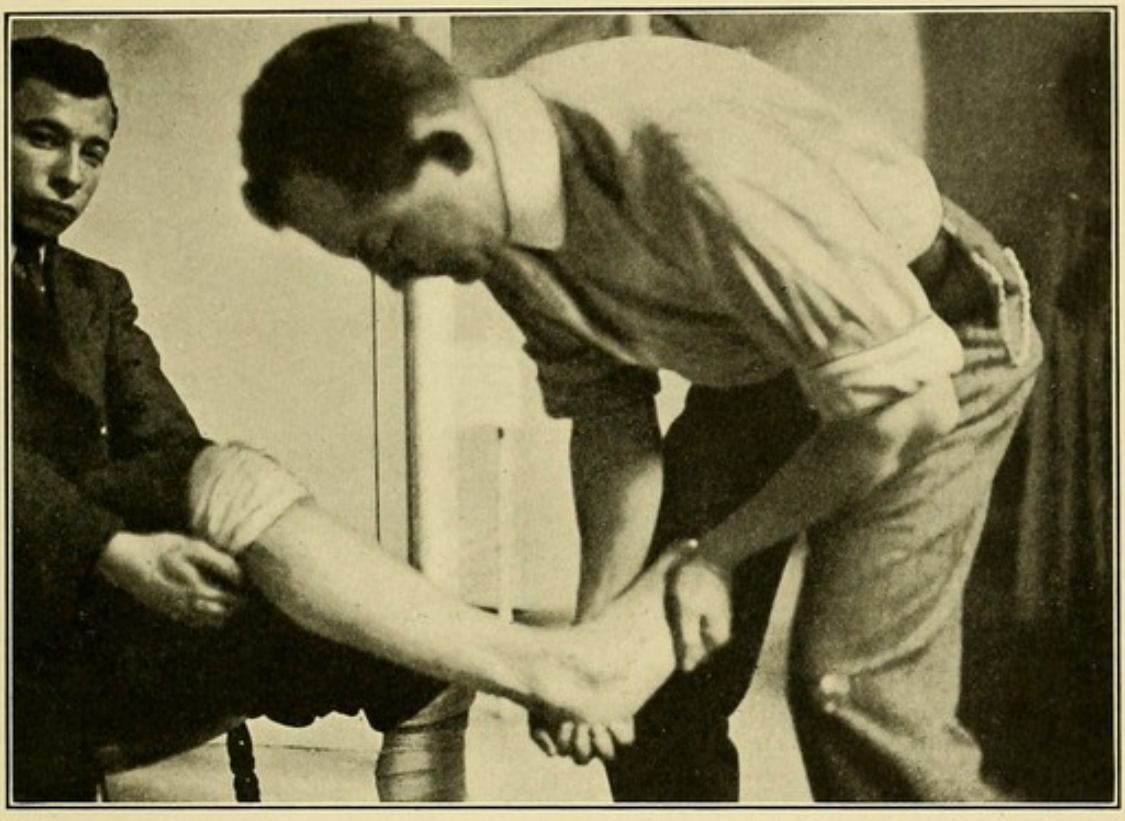


FIG. 209.—THE MANIPULATION OF FLAT-FOOT BY FORCED ADDUCTION AND INVERSION. (Posed by Cilley.)

peroneals, the tendons of these muscles may be hooked up through an incision behind the lower part of the fibula and one or two inches excised (Robert Jones). This does no harm, and is often helpful in obstinate cases. A few very flat and rigid cases are benefited by excising the scaphoid, which may be done through a longitudinal curved incision over its inner part. The foot is then corrected, the wound sewed up and dressed, and in three weeks a high arched plate is fitted. This sometimes gives good results in cases impossible to correct by manipula-

tion alone. Commercial foot plates so freely offered in shoe shops are usually inefficient. It should be remembered that many cases of mild weak and flat feet may be cured by proper shoes and corrective exercises alone. Plates are splints, and should not be prescribed in a routine manner nor left on indefinitely. Much attention should be paid to strengthening the foot with a view to leaving off the plates when they are no longer needed.

"Rheumatoid" and Infectious Flat-foot. — Flat-foot is often mistaken and treated for rheumatism, but flat and painful feet are a frequent complication of arthritis deformans. Such cases are much more difficult to relieve than simple static flat-foot. Weak or flat feet may also complicate various infections, particularly gonorrhea. These cases often resist the usual treatment, and in all obstinate cases in young adults, especially if unilateral, the possibility of gonorrheal infection should be investigated. Achillo-bursitis, tender enlargement of the os calcis, obstinate and painful swelling about the tarsus, and aggravated talalgia with exostoses are frequently gonorrheal. In such cases treatment of the primary focus is often of the greatest importance.

Paralytic valgus, due to paralysis of the tibial muscles, is very common, especially after poliomyelitis; it may be combined with shortening or lengthening of the heel cord. The mechanical treatment of paralytic valgus is by a two-bar ankle brace with an arched sole plate and foot lacing, worn inside the shoe. The ankle-joint may be stiff, limited, stopped up or down, or free according to the conditions. The ankle is drawn outward by a T strap on the inner side and buckled over the outer bar, or by a special

ankle strap. If much force is to be exerted a plate should be added at the outer side of the foot to make counter pressure. Such a brace may be constructed with one bar on the outer side, and this has the advantage of easier adjustment and greater compactness, but it has the disadvantage of wearing down at the joint and requiring more attention. Either arrangement may be combined with a leg brace. When the foot alone is to be treated the brace reaches to the upper part of the calf, where it is provided with a calf band or side plate and a wide strap and buckle, or a lacing. The severer cases may be improved by a tendon transference or an arthrodesis, or both. If the peroneal tendons are active, these may be cut off, brought over the foot, and attached to the anterior tibial or to the periosteum in front of its insertion, while the foot is inverted. It is also possible to reënforce the inverting power of the foot from the extensor hallucis and from a slip from the heel cord. Where all the muscles are weak, an arthrodesis of the ankle-joint, and if necessary of the astragalo-scaphoid joint, will give better results.

Dislocation of the peroneal tendons occurs in some cases of valgus; the tendons are dislocated forward and upward over the end of the internal malleolus. They may snap back and forth. If the annoyance is serious, a flap of periosteum may be raised from the fibula and sewed back over the replaced tendons, or a groove may be excavated behind the malleolus.

In **pes calcaneus** and **calcaneo-valgus** the foot is drawn upward or upward and outward, and the weight is borne on the heel. In the severe and long-standing cases the

forefoot may drop down, causing a cavus. As already described under valgus, the **congenital form** is not very rare, and the milder cases are harmless, as they usually recover spontaneously. The severer forms may require downward and inward manipulation of the foot and retention in plaster-of-Paris in the equino-varus posture. It is nearly always curable.

FIG. 210.—PARALYTIC CALCANEO-VALGUS AFTER POLIOMYELITIS.

The **paralytic form** is also not uncommon; in it the foot in front of the heel is useless, even if the toes can be

moved (Fig. 210). The weight is borne entirely on the heel, and the gait, provided there is fair power at the knee and hip, is that of a peg leg, with no spring or elasticity. Indeed the foot is worse than useless, as it is very much in the way. The deformity usually gets progressively worse, the os calcis becoming more vertical, the heel acquiring a thick callus, the midfoot becoming highly arched (cavus), and the forefoot a mere appendage (Fig. 211). The tendency to deformity may be checked by a stiff ankle brace to which the foot is strapped, and which transfers some of the weight in stepping from the sole to the front of the tibia below the knee. The wearing of such a support mitigates the disability and gives much relief. The patient, however, is

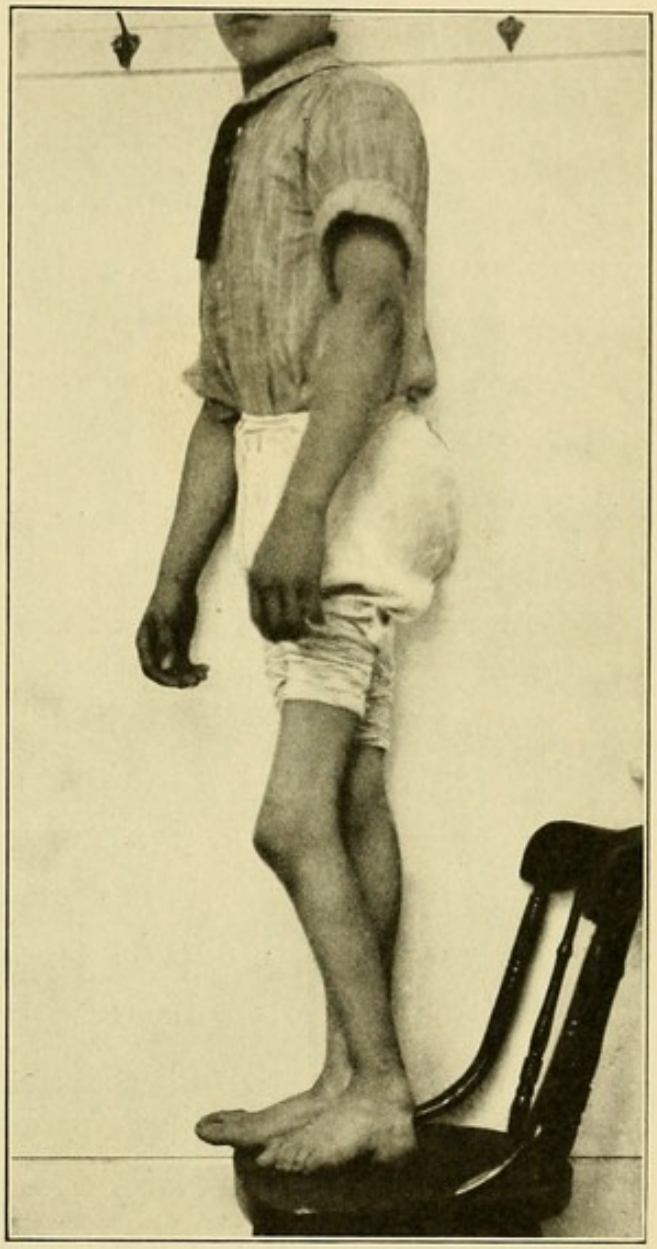


FIG. 211.—PES CALCANEO-CAVUS AND FLEXED KNEE IN A BOY OF SIXTEEN, FOLLOWING POLIOMYELITIS AT SIX MONTHS OF AGE.

obliged to wear it for life. Shortening of the heel cord alone, as advised by Willet, has not proved satisfactory.

The most satisfactory operation for severe paralytic calcaneo-valgus is arthrodesis with astragalectomy and dislocation of the foot backward, as advised by Whitman. The incision is Kocher's fish-hook incision, starting behind the fibula and curving under the external malleolus and over the dorsum of the foot to the astragalo-scaphoid joint. The peroneals are dissected free, cut off below, and drawn back. The flaps are dissected back under the tendons and the joint is entered in front of the external malleolus with scissors. Keeping close to the astragalus the ligaments which hold it are cut by the scissors one by one, as the foot is dislocated inward, the tendons and vessels on the dorsum being hooked up and pulled inward. The enucleation should not take much more than five minutes. The sustentaculum tali is then chiseled off and a corresponding place on the outer side of the os calcis is freshened, the joint cartilage of the tibia, malleoli, and os calcis are then removed and the tibia brought forward and placed with the malleoli in contact with the freshened sides of the os calcis, and the foot somewhat plantar flexed. The position should be stable. The peroneal tendons may be sutured to the os calcis. After closing and dressing the wound a plaster-of-Paris splint is applied. A brace should be worn for a year or more. The results of this operation are exceedingly good. Firm fibrous union in a good posture, and a much more shapely and useful foot are usually obtained.

Robert Jones has suggested an exceedingly ingenious

operation for pes calcaneus and calcaneo-valgus with cavus, which, however, requires two sittings. At the first a wedge of bone is removed from the inner side of the tarsus in front of the internal malleolus of such shape

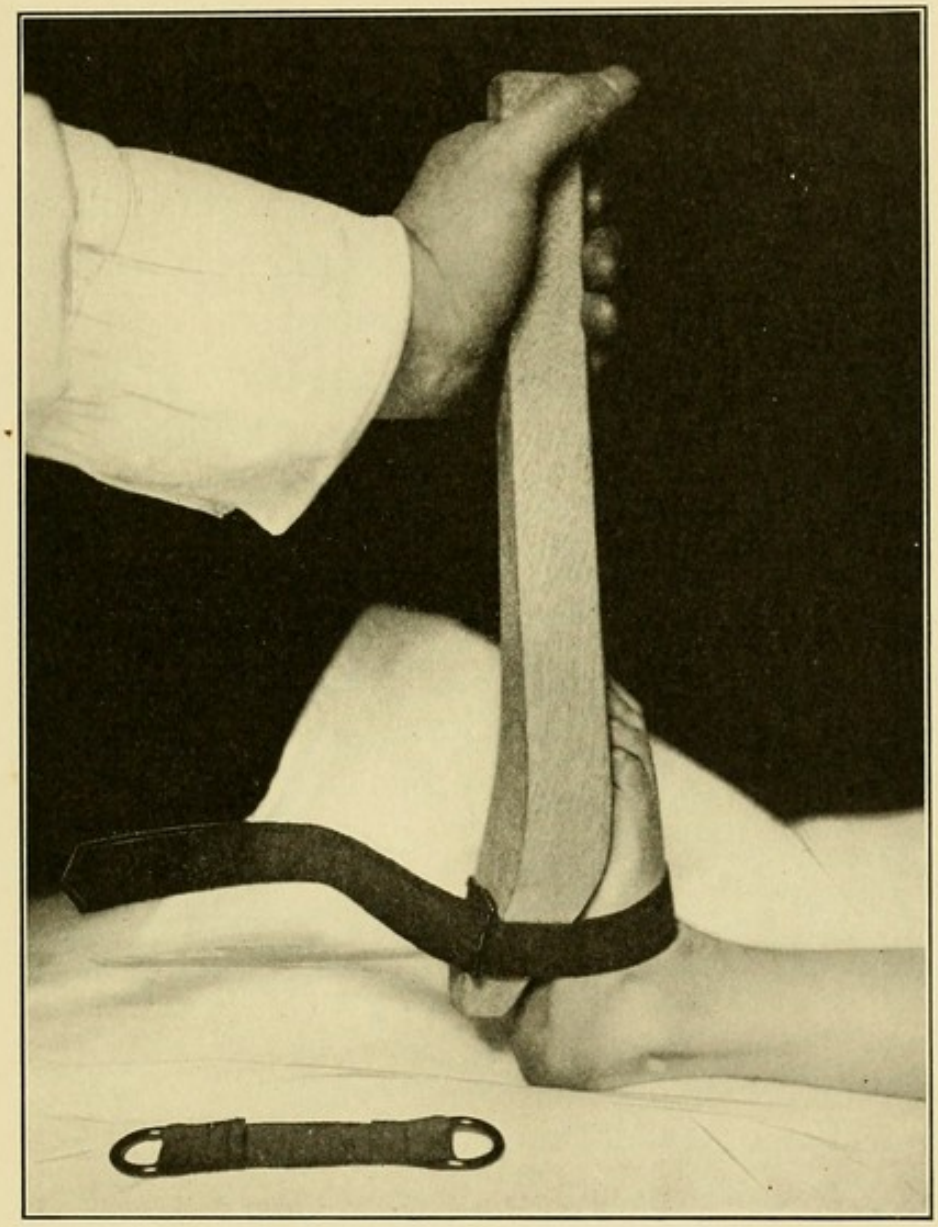


FIG. 212.—CORRECTION OF CAVUS DEFORMITY WITH SCHAPPS'S LEVER. This instrument may also be adjusted to stretch the heel cord, and for lateral action.

(base mesial and dorsal) as to correct the cavus and valgus. The wound is closed and dressed, and the foot

brought up in extreme dorsal flexion against the tibia and held in plaster four weeks. At the second operation the straightened foot is brought down into position and an arthrodesis of the ankle is done. This should fix the straightened foot at a right angle to the leg.

Pes Cavus (*Hollow foot*).—Some individuals have an exaggerated arch and bear weight only on the heel and ball. Cavus is a frequent complication of equinus, calcaneus, and varus. In most cases where the hollow foot is serious enough to cause trouble the best treatment is a subcutaneous division of the plantar fascia, forcible stretching with the wrench if necessary, and fixation in plaster (Fig. 212). In some cases of equinus combined with cavus, the correction of the cavus may overcome the deformity. In such cases it is a mistake to divide the heel cord, as the foot then goes up *en bloc* when dorsal flexed, making it difficult to stretch the cavus. Cavus is often a paralytic deformity.

In **flail-ankle** when all the muscles are paralyzed, the foot may be controlled by a supporting splint, or stiffened by an arthrodesis.

Affections of the Heel

Achillobursitis anterior involves the bursa between the back of the os calsis and the lower end of the tendo-Achillis near its insertion. The infection may be of any kind to which bursæ are subject, but is often gonorrheal; the bursa may also be irritated by a tight or rough shoe pressing or rubbing the back of the heel. There is a tender swelling near the insertion of the tendon, with pain from shoe pressure and on walking.

Applications of tincture of iodin, adhesive plaster strapping, bandaging, relief from shoe pressure, and rest will usually effect a cure. In a tuberculous or pus infection, the bursa will require to be scraped out.

Achillotenontitis is an inflammation of the tendon itself or its envelope; the lower part of the tendon is enlarged and tender. Similar measures will prove effective; rest and the avoidance of stairs should be emphasized. In bandaging it is well to place cotton pads either side of the tendon.

Talalgia and Osteophytes of the Os Calcis.—The os calcis is not infrequently the seat of *tuberculous disease*, which requires the treatment outlined under tuberculosis of the

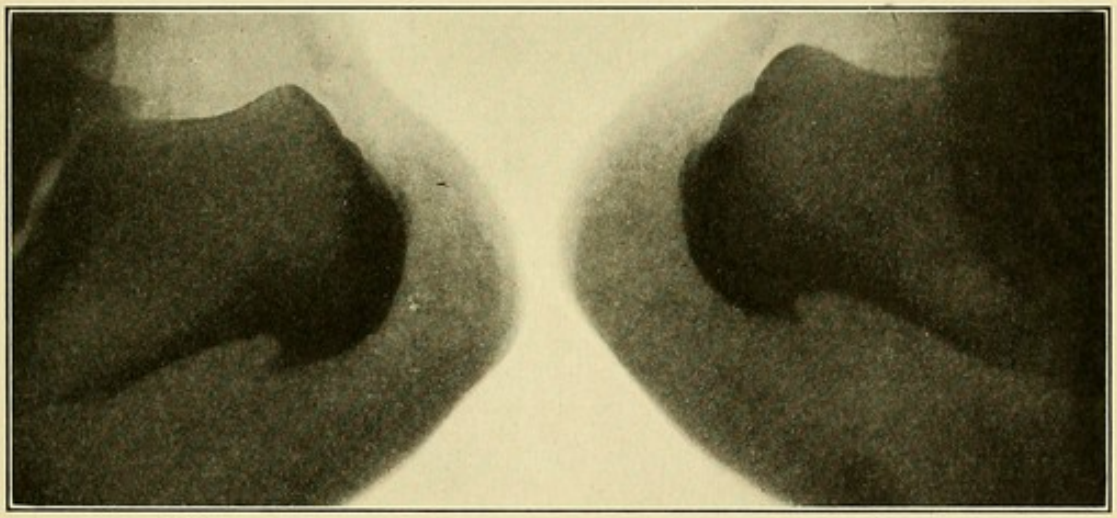


FIG. 213.—BONY SPUR ON BOTTOM OF OS CALCIS IN A WOMAN OF FORTY-SEVEN WITH OSTEO-ARTHRITIS. Relief after removal of spurs.

ankle-joint and tarsus. It is frequently the seat of gonorrheal infection, when it is often enlarged and tender to lateral and plantar pressure. A definite painful point over the tuberosity of the os calcis may be very persistent and troublesome, and skiagraphy shows that it is frequently caused by irritation *osteophytes*, and disappears

on their removal (Fig. 213). The best approach is probably by the U-shaped incision at the sides and back of the heel (Jones). This flap is turned down, the osteophytes removed, and the flap sutured back in place, leaving no scar on the sole. It should be borne in mind that even when osteophytes are shown, the symptoms frequently disappear under conservative treatment. This tender heel has been called *talalgia*, and has been said to be due to a bursitis. It is a frequent accompaniment of flat-foot, due no doubt to the irritation at the insertion of the plantar ligaments. It may sometimes be relieved by a piece of felt cut out in the middle like a corn plaster, or by a foot plate made unusually concave at the heel to relieve pressure. When the trouble is due to gonorrheal infection the trouble is likely to be diffused through the tarsus, or at least to cause swelling and tenderness about the astragalo-scaphoid joint.

Some *strains* and *wrenches* of the foot result in **acute tenosynovitis** of the extensor or other tendons. The affected tendons are tender and swollen and motion is painful. Rest, tincture of iodin locally, and a bandage usually effect a cure in a short time. **Injuries** of the foot, accompanied by much ecchymosis, or pain at a definite point on a bone, should be skiagraphed to ascertain whether fracture is present.

Hump-foot (Bradford) is caused by flexion at the first metatarso-cuneiform joint with enlargement of the bones on the dorsal surface. It is caused by short shoes with a high arch and tight vamp. Proper shoes, rest, and tincture of iodin usually cure the affection, which may be quite painful.

In **hollow claw-foot** there is a cavus combined with hyperextension of the proximal and flexion of the other segments of the toes; the condition is usually associated with paralysis of the interossei and lumbricals. In order to hold up the forefoot Sherman has devised the following ingenious but rather difficult operation: The deformity is corrected by subcutaneous tenotomy and stretching of the shortened parts, and the foot is put into a light plaster splint. Care should be taken to have the plantar surface of the splint thin. This is allowed to harden, cut away on the dorsum, and protected by gauze kerchiefs which had been placed about the foot. A large fenestra is then cut over the dorsum, and a large square flap is raised back from the base of the toes, exposing the extensor tendons; these are cut as far forward as possible, and raised. The periosteum over the ends of the metatarsals is incised, raised to either side, a chromicized gut suture with a long needle at each end passed through the tendon back of its cut end, and thus passed one on each side of the bone through the foot and plantar part of the splint, tightened, and tied over a gauze pad. This brings the cut end of the tendon tight to the denuded bone. Each tendon is treated this way in turn; then the flap is sutured in place and the dressing applied.

Ryerson has found that, by removing some bone from the dorsum of the metatarsals by a narrow chisel, the periosteum may be sutured over the cut end of the tendons by means of small, full-curved, round needles. He advised a looped stitch in the tendon. Both operations are reported to give excellent results; the forefoot is held up, and the toes straightened out with the splinting.

Weakness and falling of the anterior arch of the foot is a very common affection. It is often but not always associated with weakness of the longitudinal arch. In weakness of the anterior arch the ball of the foot is broadened, and the heads of all the metatarsals rest on the ground. Sometimes the middle metatarsals seem to receive more of the weight than the first and fifth, and large and painful calluses are formed under the middle of the ball of the foot. In other cases there may be a spot of exquisite tenderness under the fourth, third, or second metatarsal, and sudden attacks of severe pain running into the toe—**Morton's toe, metatarsalgia.** The most usual location is the fourth metatarsal and toe, and the trouble is not always associated with obvious weakness of the anterior arch; the cause is probably a neuritis of one or more nerve filaments, which are pinched by the heads of the metatarsals as they pass to the toe; in other cases there may be joint irritation. The attacks only occur when a shoe is worn, and it is characteristic that the pain is so great that the shoe is at once removed, no matter where the sufferer may be. Complete and instantaneous relief may sometimes be afforded by strapping a beveled felt pad, three eighths of an inch thick and an inch or more across, just behind the middle of the ball of the foot by a one-inch strip of adhesive plaster, encircling the foot behind the ball several times. This, if successful, may be replaced by a felt pad fixed to a thin leather lacing to be worn over the stocking, or by a pad of leather or hard felt just behind the ball of the foot in the sole of the shoe. The shoes should be of orthopedic shape, wide across the ball, and snug over the

instep, with heel an inch or more in height and shank well arched in front. Obstinate cases will require a long steel plate made from a cast of the foot and reaching from the back of the heel to the ball. The anterior part of the plate is arched from side to side, and raised at the front to support the metatarsals; the longitudinal arch may be supported or not as desired. Such plates may be used for weak anterior arches without Morton's toe, and indeed for many cases of weak feet. They will also prevent the formation of calluses on the ball of the foot by elevating the arch; should it be necessary to soften the callus or corns, collodion with ten per cent of salicylic acid, or the official collodium salicylatum compositum, is the best application.

Corns and **calluses** are always due to abnormal pressure, often from tight or badly shaped shoes. They may be softened and scraped away after applications of collodium salicylatum compositum (N. F.), but will recur unless pressure is removed by fitting shoes of natural shape. Soft corns due to pressure between the toes may be difficult to cure, unless shoes and stockings are discarded for a time, and the toes held apart by cotton pledgets.

Chilblains are due to poor circulation often from tight shoes. Easy shoes should be fitted, and wide cotton stockings substituted for woolen, or vice versa. Applications of tincture of iodin and nitrate of silver are sometimes useful, but are less important than proper foot coverings. Long sitting or standing with the feet on hard, cold floors is particularly harmful.

Deformities of the Toes

Congenital deformities occasionally occur. Absence of toes, metatarsals, and tarsal bones in connection with absent leg bones has already been mentioned. Redundancy, splitting, and fusion also occur (Fig. 214).

Fig. 214.—Six Digits on Each Extremity; Those on the Hands have been Removed; Child of Sixteen Months.

Gigantism of one or more toes with hypertrophy of the ball of the foot is sometimes seen, and the foot is sometimes so large and unwieldy that an amputation of the enlarged area may be advisable (Fig. 215).

The small toe may be drawn upward and mesialward upon the dorsum of the foot. This deformity may be corrected by strapping.

In *split-foot* or *lobster-foot* the metatarsus is split, each prong carrying one or more large and deformed digits.

Hallux valgus is a deviation of the great toe outward with enlargement about the metatarso-phalangeal joint. This enlargement is partly in the bursa and soft parts (bunion), and partly in the head of the first metatarsal. This deformity is largely the result of short and pointed shoes, and it destroys the value of the great toe as an inward strut or brace to oppose eversion of the foot. As it seems impossible to retain the supporting power of the great toe with the usual footgear, our only resource is to replace it by the elongated heel splayed inward (Thomas heel, Fig. 205), which replaces to a certain extent the function of the great toe. In moderate grades of hallux valgus orthopedic shoes straight on the inner side should be worn. The toe post, a thin piece of metal incorporated in the insole, may be worn between the great and second toe; this necessitates a digitated

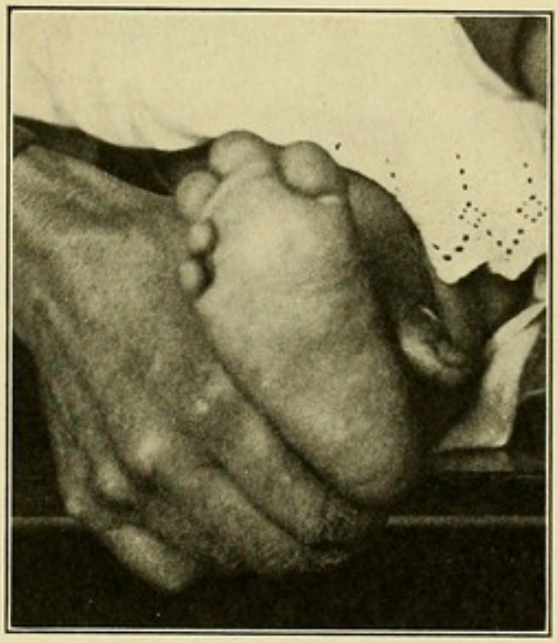


Fig. 215.—Congenital Hypertrophy of Second and Third Toes and Forefoot in a Baby.

stocking. A light splint to pull the toe inward to be worn at night is easier of adjustment and more manageable (Fig. 216). In severe cases an operation is necessary.

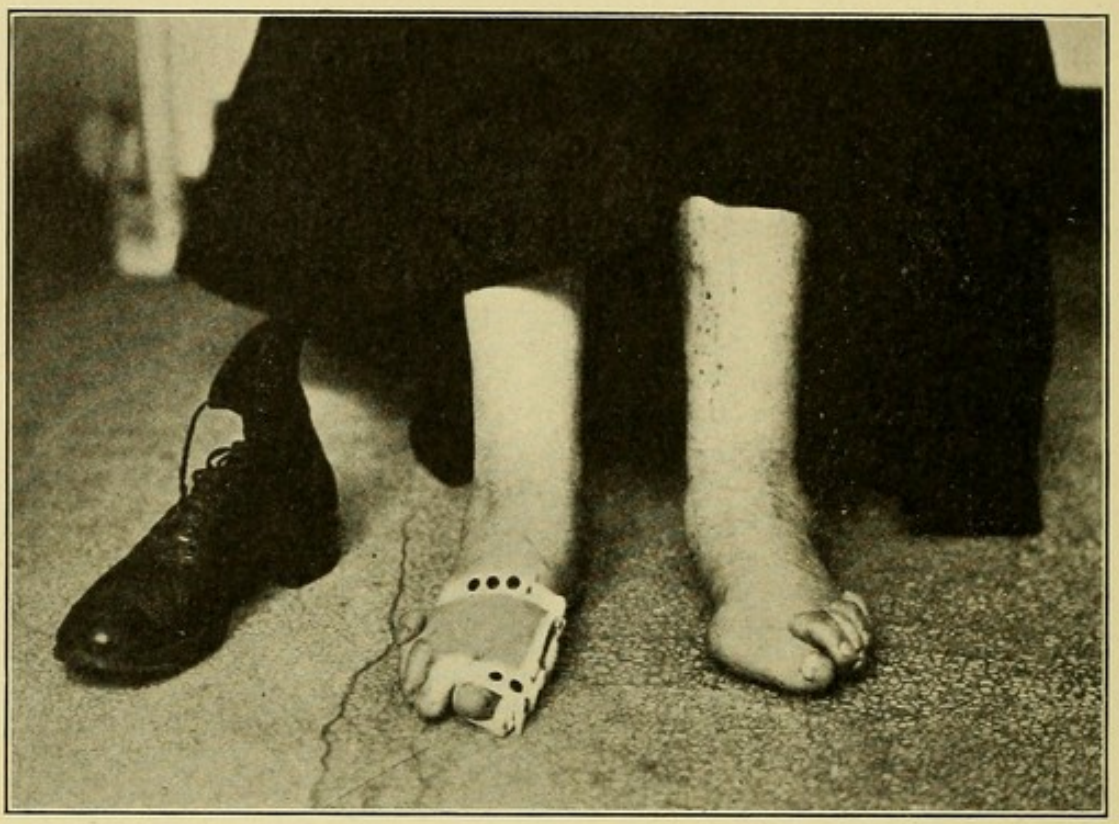


FIG. 216.—HALLUX VALGUS; THE TOE TO THE LEFT IS PARTIALLY CORRECTED BY A TOE SPLINT. The shoe is built up on the inner side for weak foot.

A great many have been proposed, but oblique excision of the head of the first metatarsal is as good as any, and gives excellent results. The incision is convex upward, and freely opens the joint at the mesial side of its upper surface. The head and neck of the metatarsal are stripped of periosteum and ligaments, and the head is cut off in a slanting direction with the bone forceps. The wound is sutured in two layers, and the toe is held in adduction by the dressings or a small splint. The loss of the head of the metatarsal does not interfere with the stability of the foot.

Hallux varus occasionally occurs as a congenital deformity, but is very common in primitive barefooted people, in whom the prehensile power of the toes is greatly developed. It also occurs as a complication of pes varus, and may be rather persistent after the club-foot is practically cured. The ordinary shoe of civilized life usually corrects this deformity.

In **hallux rigidus** the motion at the great toe-joint is much limited, and the joint is enlarged and painful. The skiagram shows disappearance of cartilage, and sometimes the presence of osteophytes. The process

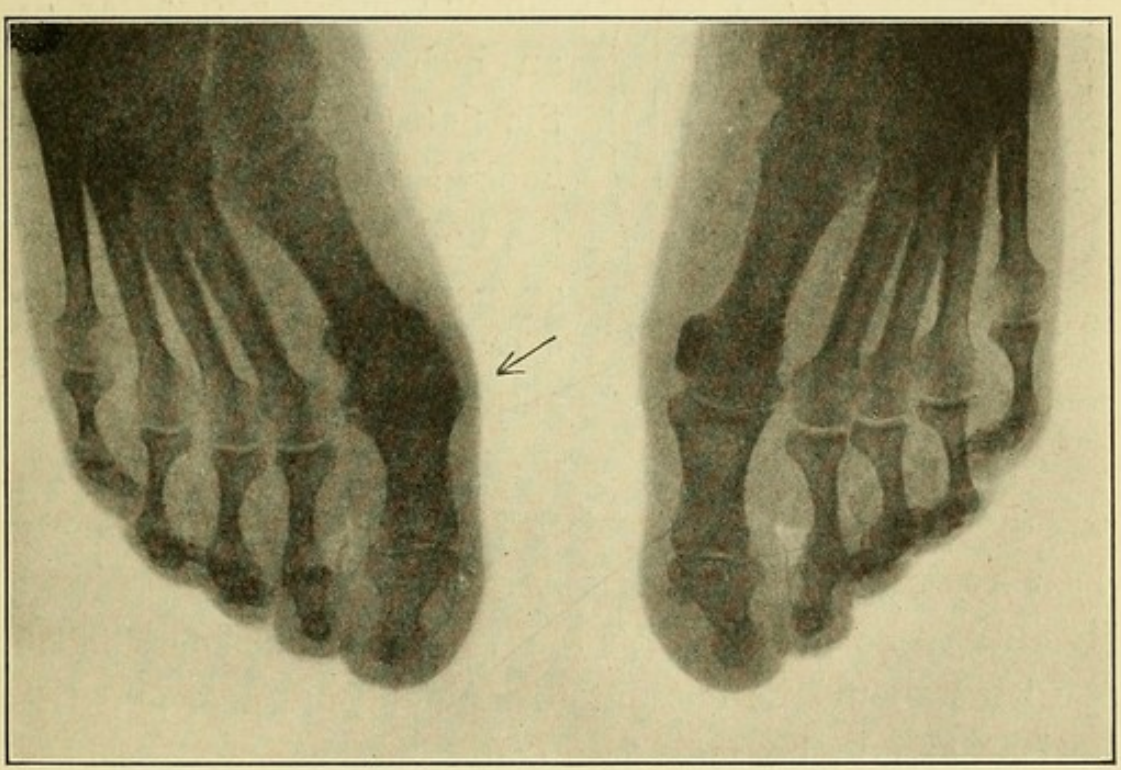


Fig. 217.—Hallux Rigidus of Seven Years' Duration in Man of Forty-five.

seems to be similar to arthritis deformans, and may be the result of an injury or of repeated insults (Fig. 217). Strapping, counter-irritation, and protection or splinting will sometimes effect a cure, but in certain cases it is

necessary to excise the joint. A convenient form of splint is a thin bar of steel slipped between the layers of the sole of the shoe.

Ingrown toe-nail is an exceedingly painful and disabling affection, for which many ingenious operations have been devised. They are all needless, as the trouble is always curable by protecting the soft parts from the edge of the nail. This may be done in mild cases by carefully tucking a strip of kid or a small piece of cotton under the nail at the side and in front. In granulating cases, a thin silver or aluminium hook, a quarter of an inch wide and bent on the flat (Fig. 218), may be hooked under the edge of the nail, protected by cotton or gauze, held in place by a strip of adhesive plaster, and allowed to remain some weeks. If properly adjusted, the granulations contract and heal, and the toe is soon restored to its normal condition. The granulations may be dusted with alum or aristol. The toe of the boot should be cut out to relieve pressure, and the patient should be seen frequently, to change dressings if soiled.

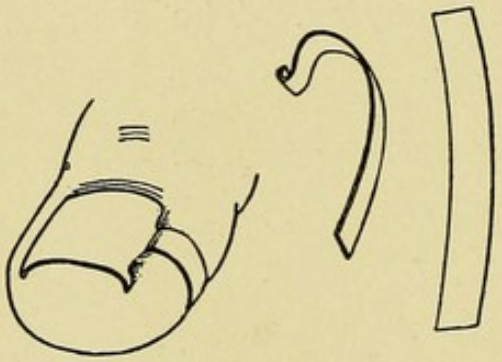


FIG. 218. — HOOK FOR INGROWN TOE-NAIL. (The author, in the *American Medico-Surgical Bulletin.*)

Hammer-toes are rather hard to manage; the affected toes are sharply flexed and rigid; if the deformity is slight, manipulation and small splints, or supporting the toe by adhesive plaster, is sufficient (Fig. 219). In severe cases excision of the joint and splinting the toe

straight until ankylosis takes place is the proper treatment. Hammer-toe of the first digit, or hallux flexus, may occur with flat-foot.

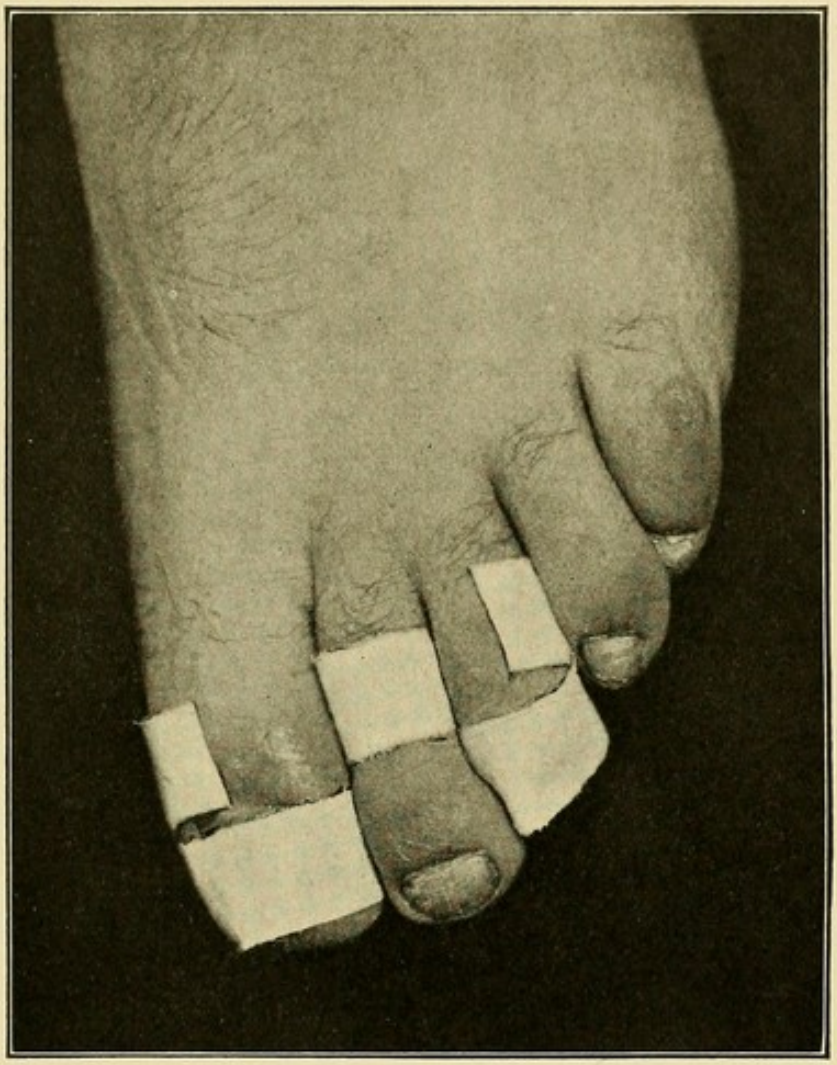


Fig. 219.—Correction of Mild Hammer-Toe by Adhesive Plaster. (Foote.)

The treatment of **trigger-toes** and slipping joints is usually by adhesive plaster strapping.

TECHNIC

TECHNIC

In former days the practice of orthopedic surgery was limited by some to splinting, by others to splinting and gymnastics, while the operating surgeon often believed that when he had finished with a crippled patient there was nothing further to be done. It has become increasingly evident, however, that in order to do justice to his art the orthopedic surgeon must be master of its mechanical, gymnastic and surgical aspects. As gymnastic and operative technic, so far as they come within the scope of this work, have already been given, this section contains an outline of mechanical principles, and the details of construction of such apparatus as will be found most serviceable in general practice.

The bodily framework is composed of a series of levers—the long bones, moving on each other at the joints, actuated by the muscles or by outside forces, and checked by muscles, ligaments, and the conformation of the parts.

In orthopedic work it is often necessary to control motion and pressure at certain joints, to progressively change the posture of a limb, or to fix it in the posture of choice.

LOCAL PRESSURE AND MOTION

Pressure may be increased by bandaging, strapping, or laced or elastic appliances encircling the parts. Such procedures give additional support to weak or swollen parts and hasten the absorption of simple effusions; if placed about a joint, they also restrict motion. The rubber bandage, applied according to Bier, increases pressure in the parts beneath it, and causes congestion in the parts peripheral to it.

Pressure may be diminished by quiescence, recumbency, suspension, and traction.

Motion may be increased by exercise and manipulations.

It may be **restricted** or **abolished** by voluntary or enforced quiescence, recumbency, or splints. These different elements enter in varying degree into the conception denoted by the term protection.

BANDAGING AND STRAPPING

Some of these topics are treated in the general and special parts of this volume; it will suffice here to discuss certain practical aspects of bandaging, strapping, splinting, and traction.

Bandages may be used to keep dressings, padding, adhesive plaster or splints in place, and to protect the skin; or they may act like a stronger and tenser skin to produce local compression as in a joint effusion. When used for compression, muslin, flannel, or canton flannel bandages are much better than gauze. In applying bandages the reverse is seldom used; the fullness left by changing

the direction is turned under as a dart. When much compression is desired, the bandage is drawn tighter, and it is often well to fill out hollow or soft spaces with cotton. If a bandage is to remain long, it may be retained in place by spiral strips of narrow adhesive plaster or by stitching; compression bandages, however, usually require daily reapplication.

In bandaging the whole leg to protect the adhesive plaster for the hip splint, three circular turns are made above the ankle to protect the skin from the buckles; the leg is then covered to the groin with ascending figure-of-eight turns; these are covered to the buckles by a descending spiral. The end and each turn are then stitched in place. Such a bandage will prevent the plaster from slipping, and will remain smoothly in place for a month or two; it should not be applied so tightly as to cause swelling of the foot.

In using a retention bandage of few turns, it is sometimes more stable if a turn is passed through a slit in the preceding turn at the crossing (split bandage, Griffith).

Strapping with adhesive-plaster strips, which may be applied in overlapping series like clapboards, or criss-cross, or both, one layer over the other, affords even better support than a bandage. The best material for this purpose is zinc-oxid adhesive plaster from one to two inches wide. The strips may encircle small parts like the finger or wrist, but should go only three quarters around the knee or leg. Depressions may be filled in, and the whole should be covered with a bandage.

Strapping may also be applied over a well-fitting bandage to increase the effect.

The strapping of joints, particularly of sprains, of flat-foot in inversion (Fig. 205), and of varicose ulcers and inflamed veins, as described in the special part, gives very satisfactory results. Fractures of the ribs and sprains of the back may often be sufficiently supported by adhesive strips two inches wide, either imbricated or criss-crossed. When mild compression is to be used for a long time, it may be applied by means of a light canvas lacing or an elastic covering fitted to the part. Diachylon plaster on moleskin and zinc-oxid adhesive are much used as a basis for traction, and the latter to secure splints to the limb or to fasten split splints together. It is well to cover with a bandage. Adhesive strips doubled lengthwise or folded in from the edge may serve as improvised straps. If it is desired that a part of the adhesive surface should not adhere, as in strapping a toe down or up (Fig. 219), the exposed part of the strip may be covered with a separate piece of the plaster. Strips of adhesive are often used to retain dressings. Adhesive plaster may be used to cover or line the exposed parts of steel splints; a few circular turns will keep a strap from slipping on a bar. Strapping over a joint, like bandaging, restricts motion.

SPLINTING IN GENERAL

Splints are used to fix joints in the posture of choice or to control pressure and the amount and direction of motion. Fixation may be combined with suspension or

traction. The underlying principles for splinting injured or diseased joints or parts are:

(*a*) Repair takes place better when injured or diseased parts are at rest, at least in the early stages. Locomotion is often undesirable.

(*b*) Healing or healed joints may be used in part before they should be intrusted with full function.

The underlying **indications** for splinting paralyzed or paretic parts are:

(*a*) Paralyzed or paretic parts are best placed for recovery of strength if the paralyzed muscle groups are relaxed (shortened). Nothing so weakens a paretic muscle as continuous stretching.

(*b*) Locomotion is desirable as a general and local tonic, and is often possible, if the weak leg is made stable, by splinting loose or insecure joints.

Contractions of many kinds may be gradually corrected by progressively modifying the splint leverage.

The following **mechanical principles** involved in fixation splinting are for the most part fairly obvious; they are nevertheless frequently violated in practice.

(1) A fixation splint or lever must have sufficient weight and stiffness for the work in hand; rigidity is usually important.

(2) A splint should work from a definite fixed point; the firmer the grasp the more definite the effect.

(3) The longer the splint the greater the effect for a given pressure.

(4) With a given adjustment, a splint will be more efficient under a moderate strain, as in quiescence, than under a heavy strain, as under active motion or shaking.

(5) In splinting, pressure and counter-pressure must be opposite and equal.

Or more briefly, a splint must start somewhere, go somewhere, and do something on the way; the means employed must be adequate for the results desired.

Stiffness.—The splint should be made of suitable material and weight, the latter proportionate to the weight and activity of the patient, and so distributed as to resist the strains put upon it. Splints are frequently too heavy, and often too light or not stiff enough.

Base and grasp are fundamental, and are much modified by the fact that the body is not only a combination of levers, but that these are constructed of and covered by living tissues, which modify to a certain extent the working conditions.

(*a*) The bony levers cannot be directly seized for immobilization, but are acted on through layers of tissue which are often thick and soft. To hold the femur is somewhat like trying to hold a broomstick inside of a pillow. For this reason splints must be accurately and snugly fitted.

(*b*) Continuous pressure on a point, line, or small surface, especially when the soft parts are thin, will produce ulceration. The points where pressure falls must be clearly recognized, and chosen with some reference to their abiiity to bear pressure. Sharp projections like the spinous processes, the olecranon, the back of the heel, the patella, and the malleoli, should be protected from pressure. The splint should also be so broad and so well fitted at its bearing points that pressure will be evenly distributed over a comparatively large surface.

Padding is principally useful in that it distributes pressure and ensures a more accurate fit. It should always be remembered that, in order to relieve a point of pressure, the pressure about it or at some neighboring surface must be increased (the principle of the corn plaster).

(*c*) A splint must not be applied so tightly that it will interfere with peripheral circulation, causing swelling and necrosis; that is, circular constriction should be avoided.

Bearing these mechanical limitations of bodily structure in mind, the splint is held to its proper base by being applied over a bent joint (knee, elbow, ankle), or by being molded or fitted above prominent parts, as the trochanters and iliac crests, in spinal splints, by suspension from adhesive plaster applied to the skin (hip-splints), by attachment to webbing suspended over the shoulders (Thomas's knee splint), by being held on by bandages, adhesive, or a laced shoe. In all these methods the shaping and molding of the splint so that it will receive support from or be steadied by the bony prominences is very important, and in the case of plaster-of-Paris splints encircling the part, may be alone sufficient.

The grasp of the splint must be firm or the part to be fixed will slip or twist over it or inside it. Much complexity of apparatus would have been avoided if the matter of grasp had been sufficiently studied. The proper placing of webbing or adhesive or other grasping appliances in a club-foot brace renders all screws and ratchets unnecessary. Without proper grasp the foot inevitably twists out of its splint, no matter how cleverly con-

structed. The case is similar and far more difficult in scoliosis.

Length.—The fixation splint should be as long as circumstances permit in order to increase the leverage. Too short splints fail to immobilize, as sufficient pressure to fix the part cannot be borne. The rule is to prolong

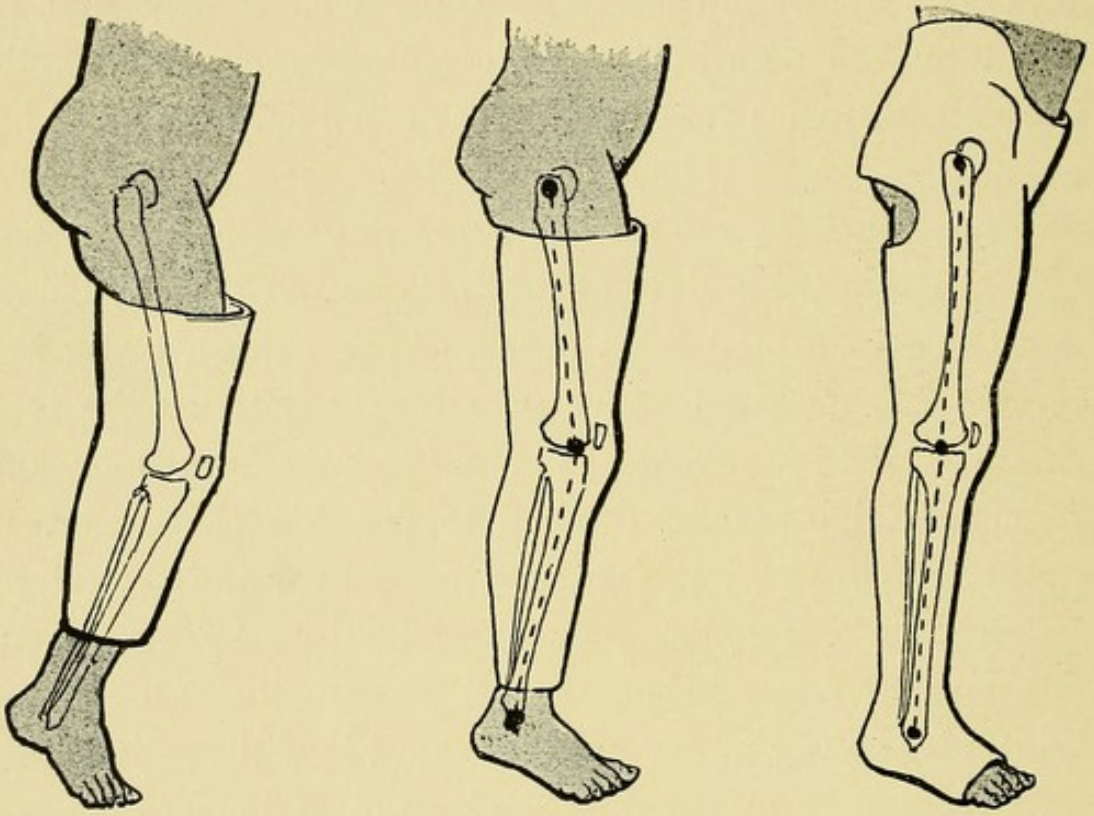


Fig. 220.—Illustrating Greater Efficiency of Long and Carefully Fitted Splints. (Calot.)

the splint at least to near the neighboring joints, and to include them, if necessary. To fix the ankle, the splint should reach from the toes to below the knee; to fix the knee, from the ankle to the groin, or, better, from the toes to the lumbar spine (Fig. 220).

Quiescence or recumbency is often a great aid to splinting, and sometimes essential for a certain period.

It is also necessary to consider the different motions

at each joint or point of fracture, and how each is to be influenced by splinting. For instance, rotation at the hip may be controlled by a splint having at its upper end a band grasping the pelvis, and at its lower end a foot-piece holding the foot. Such an appliance, however, does not control hip flexion and extension, or lateral motion. When diseased or after a fracture, even a hinge-joint, like the ankle, knee, or elbow, may require fixation in all directions.

Pressure and Counter-pressure.—The greatest help in the technic of fixation or joint control is a clear apprehension of the elementary mechanics of the problem, and a definite plan for applying force within the tolerance of the patient, to produce the desired result. The basic principle in leverage technic, and the one that helps one most to obtain a clear and definite conception of splint action in a special case, is, perhaps, Principle 5; pressure and counter-pressure are opposite in direction and equal in amount.

Material.—Fixation splints may be made of plaster-of-Paris, celluloid, pasteboard, wood, stiffened felt, paper, or leather, gutta-percha, mild steel wire, bars, or tubing, brass, aluminium, or other material. They are secured by enveloping the limb, by bandaging, strapping, lacings, or straps and buckles, and are kept from slipping or twisting by the means already described.

Plaster-of-Paris is the best plastic material for splints molded to the body, on account of its quick setting, lightness, and porosity. Plaster-of-Paris splints are made of crinoline bandages from two and a half to five inches wide and four to six yards long, into which

dental plaster has been rubbed. The *crinoline* should run thirty to thirty-five threads to the inch, and may be starched, but should not be stiffened with dextrine or glue, which delay the setting. The crinoline may be obtained in pieces thirty inches wide and twenty-four yards long; the kind marked "Vigilant" is used at the Hospital for the Ruptured and Crippled. In order to avoid frayed edges, threads should be pulled at the proper width for the bandage desired, and the material cut in the space of the pulled thread.

Plaster-of-Paris is pulverized gypsum which has been calcined at 350° to drive off water. It becomes inert if exposed to moisture or cold, but may be restored by heating again. The dental casting plaster is the best for bandages, but good results are often obtained from cheaper plaster bought in bulk; the latter is as good as any for filling casts. Plaster should be kept in tin receptacles in a warm, dry place. Good plaster will set in from five to eight minutes, and the addition of salt, alum, or sulphate of potash to the water is unnecessary and undesirable, since it weakens the splint. The addition of one-twentieth part of Portland cement (Meisenbach) strengthens the bandage, which may be made lighter if this small proportion of cement is added.

In *making* the *bandage* the strip of crinoline is loosely rolled and placed on a board, and the plaster rubbed in by hand or scraped in by a straight-edged knife or stick. It is important that neither too much nor too little plaster be used; the proper amount is just enough to thinly cover the meshes of the crinoline. As the bandage is finished it is *loosely* rolled up. If rolled

tight the water will not penetrate sufficiently to moisten the bandage. The bandages may be prepared by a bandage machine, but are hardly so good. Commercial plaster bandages are for the most part unsatisfactory.

Applying the Bandage.—The part to which the bandage is to be applied is stripped, and covered with stockinette tubing or a thin layer of cotton wadding, which has previously been cut into wide strips and rolled into bandage form; absorbent cotton may be used, but is not so good. The padding is made thicker over the points of pressure and about bony prominences, in order to distribute the pressure, and is applied beyond the ends of the splint. The cotton may be held in place by a snug gauze or muslin bandage, or this may be omitted.

For jackets, spicas, and large splints, five-inch bandages should be used; for feet and smaller splints, two-and-a-half to four-inch bandages. A pail of tepid water is provided, in which the bandage is placed until it is thoroughly soaked; it is well to place the bandage carefully on end and to wait until the water ceases to bubble; it is then taken out and squeezed at both ends, to express superfluous water without dislodging the plaster, and to work with the bandages fairly wet, especially for the first layers. As each bandage is removed from the water it is replaced by another, which soaks while the operator is working. The operator rapidly applies the wet bandage in spiral, figure-of-eight, or criss-cross turns, folding in darts of redundant material, or changing the direction by bringing the bandage back on itself and returning in the direction of choice; if preferred, the bandage may be cut. The bandage should be applied with a snug,

even pressure, so that the shape of the part is preserved; each bandage should overlap the preceding about two thirds. It is a common mistake of beginners to apply the turns too loosely, so that the part inside the padding is not firmly grasped. The bandage may be quite snugly applied, provided the pressure is uniformly distributed and does not form a constriction at any one part. As the turns are applied they should be briskly rubbed in order to cause the different layers to fuse into one mass. The method of application is freely varied to suit the conformation of the part. By making zigzag short turns of the bandage on itself over weak parts, like the groin or knee-joint, the splint may be strengthened without adding greatly to its weight. This may also be accomplished by placing strips of bass-wood splinting, or strips of tin or thin steel, properly shaped by bending with the hands, between the layers of plaster. When the bandage begins to set it becomes warm, and should then be molded so as to grasp the parts, and be given its final shape, in which it should be held without finger dents until it is hard. After the splint is finished the ends are trimmed with the scissors or a sharp knife, and if the splint is to be laced, it is cut down the front, sprung open, and removed from the part and bandaged together, to be dried for a day at about 300°; the edges are then covered with adhesive plaster, kid, or buckskin, and hooks are attached to strips of leather, which are sewed either side of the fissure. The splint may then be sprung open, replaced, and laced up. In ordinary work this is not often desirable, except for plaster corsets. It is usually better not to split the splint, and to apply a new one when a change

of posture, inspection of the limb, or removal of the splint is necessary.

Removal.—After completion of a fixed splint, it is well to make a straight cut through two thirds of the thickness of the plaster down the front before the plaster

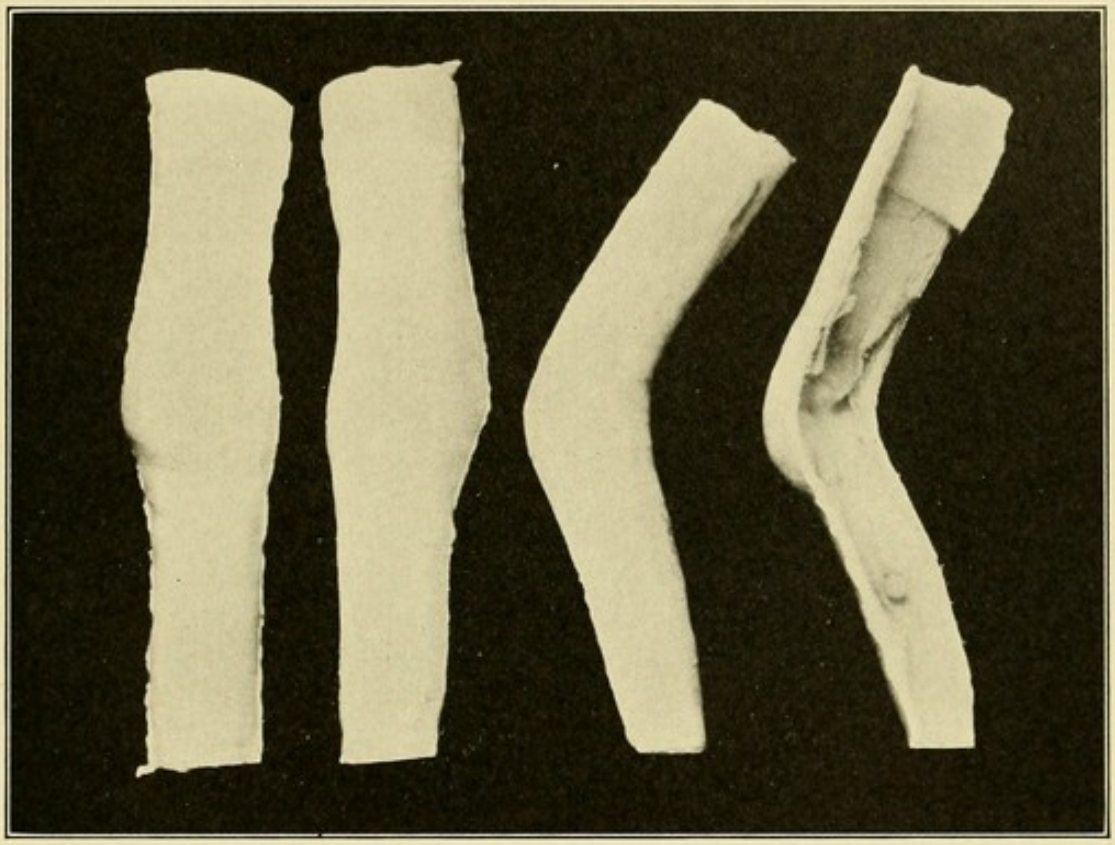


Fig. 221.—Plaster Splints Cut into Anterior and Posterior Halves.

is dry. This very much facilitates the removal of the splint without damaging it. Better still is it often to make two cuts, one at each side of the front. When the splint is to be removed the cuts are completed and the splint falls into an anterior and a posterior half, allowing the part to be removed without strain, and without damage to the splint, which may be replaced, strapped together, and used again (Fig. 221). When a splint is to be used and thrown away, the cutting off is facilitated

by wetting the plaster with warm water along the strip to be cut, which may be easily done by applying strips of wet gauze or cotton. The plaster may be cut down dry by cutting a V-shaped groove with a sharp knife. A

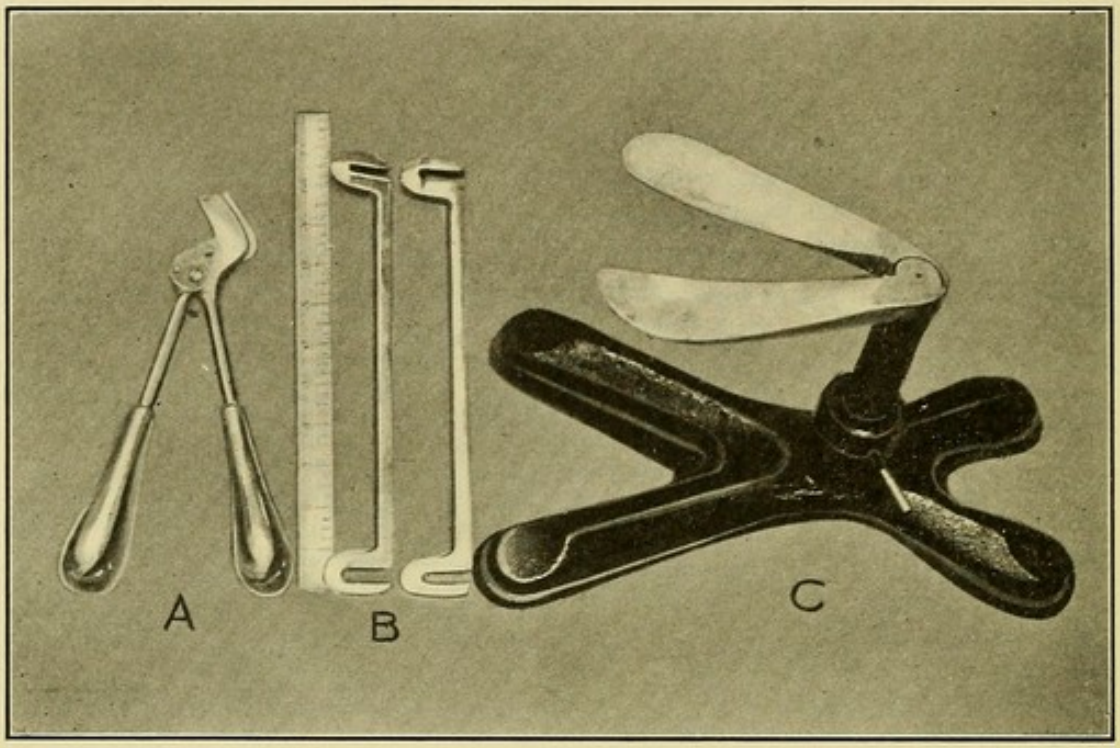


FIG. 222.—A. STILLÉ'S PLASTER CUTTER. B. HOOKS FOR BENDING STEEL BARS. C. SCHULTZE'S HIP-REST.

good knife for this purpose is a cloth cutter's knife with replaceable blades; it should be sharpened on a strip of emery paper after use. A number of saws and plaster cutters are in use, but the most practical is Stillé's plaster cutter (Fig. 222), working on the principle of a conductor's punch; the Swedish instrument is the best. It will readily cut plaster a quarter of an inch or more thick.

A bandage may be left under the splint next to the skin, with ends projecting, to be used for scratching the skin, especially with jackets and spicas (Lorenz). Win-

dows may be cut in plaster splints over sinuses or ulcers, in order to apply a dressing; or a splint may be interrupted and bracketed by steel brackets, incorporated into the plaster above and below a large sore or multiple sinuses.

Care should be taken to keep the splint clean and dry, to replace cotton that may have become wet or soiled, and to dust talcum powder or boracic acid under the edges. Spicas may be protected by a muslin bandage or by a stockinette cover. A foul odor or localized pain usually indicates a pressure sore, and the splint should be at once removed and readjusted. A plaster spica or jacket, if well cared for, will keep in good condition two or three months.

A plaster bandage, turned eight or ten times upon itself and rubbed down hard, may be applied to the forearm and hand, and used as a molded splint; or such a band may be used to reinforce a weak part—groin, back of pelvic part of spica, back of ankle, and sole of foot.

Instead of bandages, layers of crinoline cut to a pattern may be immersed in thick plaster cream, and applied to the part to be immobilized.

Plaster Casts.—Other materials which can be molded require so much time for setting and drying that they must be shaped over a cast of the part. A cast may be also used as a record or as a pattern to which steel bars or plates may be bent or hammered to fit (foot plates). Plaster-of-Paris, as it sets quickly and expands slightly when setting, is best suited for casts. A bandage cast is made by applying a plaster bandage to the part which has been previously oiled or powdered; a thin, narrow

strip of aluminium should be laid on the skin where the bandage is to be cut down. After the bandage is removed it is greased or powdered with talc on the inside, the cast is bandaged together, the end is stopped with cotton, or placed on a board, and enough plaster cream poured in to fill it. After this has hardened the shell is removed, leaving the mold of the part. If one side only of a part is desired, it is greased or powdered with talc, and placed horizontal, and to-and-fro turns of plaster bandage are made until a shell of about eight thicknesses have been obtained; after setting, the positive is taken as usual. This method is not very satisfactory for the hands and feet. Better results are obtained by molds taken directly with thick plaster cream, as in

Casts for Foot Plates.—An impression of the foot may be taken by pouring the thick plaster cream into a pan or upon a piece of thick paper, muslin, or sheet of cotton on the floor in front of the seated patient. The relaxed feet, previously oiled, are then placed in the plaster in the desired posture, and the plaster is heaped up about them and the top smoothed off with the finger. When the plaster is hard, the feet are removed and the positive taken. If the whole foot is desired, the mold is taken in two castings, while resting on its outer side, with the knee bent to favor relaxation and inversion. The plaster rests on a pad of cotton, covered with muslin, placed on a stool; the patient's relaxed foot is placed with the outer border upon the thick plaster cream, which is applied to about the mid line of the foot; the edge is smoothed with the finger and greased (Fig.

223). A second mixture of plaster cream is poured over the foot to complete the mold, which, when hard, comes off in two lateral halves. These are bandaged together and a positive taken. The shape of the plate is marked off on the positive, which may be shaved or scraped to make it more concave and narrower to fit the shoe. The shaving of the cast calls for considerable skill. The impression method is much simpler, and is just as good if the foot is pliable and properly placed. Negative casts of the feet and hands and other parts for record may be made in dorsal and plantar or palmar halves by placing a thread about the outer border of the part and pulling it so as to cut the plaster before it is hard. If the fingers and toes are in contact, or nearly so, it is not necessary to dip down between them with the thread.

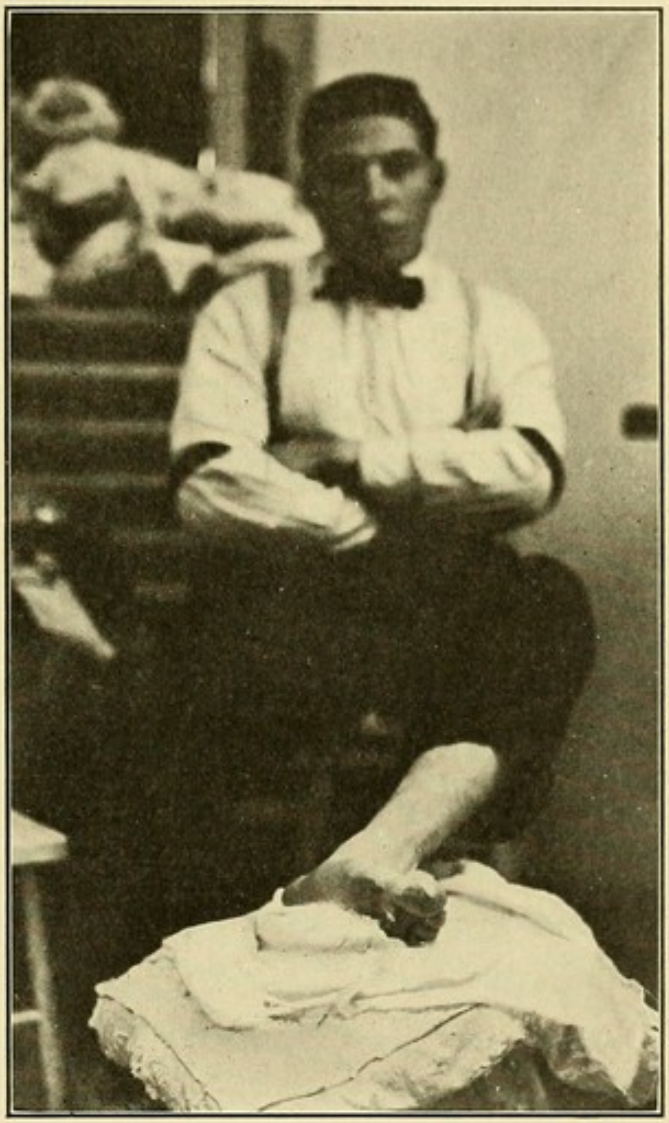


FIG. 223.—TAKING PLASTER CAST FOR A FOOT PLATE. (Whitman.) The cast is half done.

The *arch supports* (foot plates) which have been found most useful by the writer are the long plate without flanges and the Whitman plate (Fig. 208). The long plate is shaped to a cast of the sole from the end of the heel to the heads of the metatarsals, rising on the inner side to fit the longitudinal arch. When used for weakness of the anterior arch, or metatarsalgia, it is arched up behind the metatarsal heads and under the metatarsals. When used for weak foot or atonic flat-foot, the longitudinal arch receives more support, but the inner side is not arched up into a high lateral flange. If desired, both anterior and longitudinal arches may be supported. Fitted to a cast taken with the foot slightly inverted, this plate has given excellent results where the feet are not rigid.

Rigid flat-foot requires the Whitman plate with wide inner and outer flanges, after the foot has been mobilized. It reaches to the tubercle of the os calcis behind and to the head of the first metatarsal in front; the outer side of the front is usually cut away, but may be made sufficiently wide to give support to the anterior arch. The cast must be taken with the feet well inverted. Both plates are made of 18-gauge steel, cut to a paper pattern taken from the marked cast, and hammered at a red heat on a cast-iron last, and shaped to the plaster cast by hammering on a lead block. The plates should be tried on and worn, and any faults of fit corrected by bending with a wrench or pounding with a round-headed hammer on a lead anvil. They may be tinned or zincked, and are worn loose in the shoe. Excellent plates have been made of phosphor bronze

and other alloys, but they are somewhat thicker and heavier.

The plates are kept in place by a laced natural-shaped or orthopedic shoe, built up to one eighth to one quarter of an inch on its inner side, if required. If the foot slides over too much to the outer side, which seldom occurs with proper shoes, a strip of thin piano felt three quarters of an inch wide and three inches or more long is placed under the lining of the outer side of the shoe, the front of the strip reaching to just behind the head of the fifth metatarsal.

Celluloid splints and jackets are made by soaking stockinette or gauze in a saturated solution of celluloid chips in acetone. The solution should be placed in a wide-mouthed bottle, which should be stirred from time to time and kept corked during the intervals. An under vest or piece of stockinette is drawn over the plaster cast and the celluloid solution is painted on two or three times with a brush; this is allowed to dry for several hours, when another under vest or a layer of gauze bandages is applied and treated as before. Four or five such layers are needed for a jacket; when finished, the jacket must dry for six days. If removed too soon, it will curl. The jacket, when finished, should be fitted, perforated, and trimmed. Celluloid splints are neat but difficult to make, and only moderately satisfactory. Celluloid and acetone are inflammable, and the fumes of the latter are toxic.

Leather splints and jackets are made of unfilled oak-tanned leather, cut after a pattern, thoroughly wet, and stretched over a plaster cast of the part. This wet

leather is tacked in place and bound to the cast by winding with cord or webbing. It takes several days to dry, after which it is stiffened by painting on hot bayberry wax until no more is absorbed. The splint or jacket is then provided with hooks and trimmed in the usual manner. Leather and celluloid splints may be reinforced with steel strips, if desired.

Removable fixation splints made of STEEL bars on either side of the leg, ending in a sole piece and provided with cross bands, straps, and buckles, and lined with leather, are very serviceable, especially in cases where exact control is required and where the brace is to be worn a long time. In many instances it is well to make such a splint with a joint, which is at first fixed, and in the later stages of the treatment may be given limited or full motion.

This is as good a place as any to say that the way an orthopedic surgeon handles his steel work is a pretty good indication of his quality. The man who sends his patients to an instrument maker with an order for a hip splint, back brace, or what not, gets and deserves to get very indifferent results. If the case is one for mechanical treatment, the mechanical indications should be carefully analyzed, and the apparatus planned down to the minutest details. It is not necessary or feasible for the surgeon to make his own steel apparatus, but it is indispensable that he should give the instrument maker exact directions. It is essential that orthopedic hospitals should have a machine shop and trained mechanics. If a surgeon does not have access to one of them, or has none of his own, he may still do excellent

work with an intelligent locksmith, gunsmith, or blacksmith and harness maker, provided he himself knows what he wishes. He need not be dominated by an instrument maker who has his own idea of what an apparatus should be, but a very inadequate conception of the indications for treatment in any particular case; this the surgeon should possess, and see to it that it is properly embodied in an appliance. The instrument maker will furnish what the surgeon demands, and if the surgeon has a clear conception of each problem presented, he will dominate the situation, as he should. As a rule, with some exceptions it is best to correct deformity by traction in bed, forcible manipulation, or surgery, before a permanent splint is applied. Many splints, particularly those for the fixation of infected joints, require to be worn day and night for months or years.

Elastic bands, levers with spring action, and axillary brace crutches are for the most part ineffective or unnecessary, and form no part of the equipment of the surgeon who does serious work; ratchets are seldom required.

Measurements.—To measure for a leg brace the patient is laid on his back on a large piece of smooth wrapping paper, and an outline of the leg is taken with a pencil; the sole is traced separately. The position of the ankle, knee, crotch, and, if a hip band is desired, of the anterior superior spine of the ilium are noted on the paper; and if the knee is bent, a side tracing is taken. The outline of the splint desired is drawn on the paper close to the tracing of the limb, and the circumferences at the crotch, knee, calf, and ankle are put down. The

position of the bands and the kind of joints desired are also noted. Such a tracing and such measurements, if correct, will give the instrument maker sufficient data from which to construct the splint.

Fitting.—Having studied the mechanical problem and selected and designed the proper splint to meet the condition, it is necessary that the splint should be accurately fitted to the patient. After the steel frame is made it should be tried on before it is polished, plated, or lined, and such alterations made as will enable it to grasp the leg closely, yet without undue pressure on any part. The bars may be bent with steel hooks or wrenches to relieve or increase pressure at any point (Fig. 222). The side bars may be bent on the flat (laterally) to improve the fit; the cross bands may be bent or straightened to approximate or separate the side bars, or where a single bar controls below the hip band this may be twisted to turn the foot in or out. Very slight changes often make a vast difference in the leverage, comfort, and efficiency of the apparatus; this is especially true of spinal splints. The splint should be adjusted until it fulfills its function without discomfort to the patient. Afterwards the fit or the leverage may be changed from time to time to meet changed conditions.

Finishing and Lining.—When the framework of the splint is finished it should be japanned, highly polished, blued, or nickel plated, lined with leather, and pads, straps, and buckles supplied where needed. While a neat appearance is desirable, sound structure is the essential, and many homemade or improvised splints render excellent service. Where there is much pressure the skin

should be bathed with alcohol daily, dried, and powdered with talcum or boracic acid.

Adjustable Fixation Splints.—It is often desirable to use a splint material that will permit of angular adjustment as deformity is corrected. When plaster is used, if it is desired to change the angle of fixation a new splint is applied. The most convenient material for such a splint is mild steel wire, bars or sheets; aluminium or brass may be used for small parts.

Strong STEEL WIRE may be readily bent to the size and shape desired, usually that of the outline of a solid splint for the part; the wire is made continuous by brazing the ends together. This wire skeleton may be covered with bandages and padded, and may be bent over the edge of a table to any angle, and the angle changed in an instant. It may be bandaged or strapped to the limb. For instance, a very serviceable ankle splint, if the leg is suspended, may be made of wire following the inner and outer borders of the sole of the foot and back of the leg, connected under the ball of the foot and behind the calf, and bent at the heel. This splint, covered by bandages which skip the heel, and padded, is light and extremely convenient when there are extensive dressings at or below the ankle. The angle at the heel may be changed at will. Similar splints may be devised for almost every part of the body, and almost every posture (Fig. 251). The wire or gas-pipe frame is such a splint for the entire body, with special support to the spine. Jones of Liverpool uses a concave splint of mild steel of different lengths, covered with felt, for routine splinting, instead of wood or plaster. These splints can be bent in an in-

stant over the edge of a chair or table to any desired angle, and are padded and bandaged to the limb. They give excellent service. It is often necessary to splint the flexed knee and gradually straighten it. This may be done in an emergency by making a posterior bar of flat steel bent to the proper angle, and furnished at each end with a steel half band. This may be padded and strapped or bandaged to the leg, and the angle straightened in an instant as desired. The ready-made splints of the shops are mostly unserviceable. Thin sheets of ALUMINIUM are easily cut with the shears to a pattern, with or without flanges, and are very serviceable for small parts, like fingers, toes, and the wrist. Phelps recommended the aluminium corset for spinal support. This is made by hammering sheet aluminium heated to dull red over a cast-iron form molded from a plaster cast. It is made in right and left halves, hinged behind on universal hinges, and provided with hooks and lacings in front. In spite of perforations they are very hot in summer, and, while they may be made serviceable, they have never seemed to the writer to equal the plaster or steel and leather appliances. Simple small splints like the Judson club-foot splint may be made of brass, which is easily adjusted by the fingers.

The preceding discussion applies to simple fixation splints, fixed or removable; the elements of suspension, traction, and limited joint mobility frequently complicate the mechanical problem.

Suspension.—It should be noted that the arm is already suspended. The following remarks apply to the lower limb. If it is desired that the limb shall be suspended

so that no weight is borne by the affected joint, resort may be had to crutches, or to modifications of the splint, which enable it to transmit the weight from the perineum to the ground direct. Two crutches should be used; one crutch, or a crutch and cane, are awkward combinations of no real service. In using crutches it is well to take the weight mainly upon the hands, for the continued pressure of the crutches upon the axillæ frequently produces crutch palsy. If it is important that the affected limb should never touch the ground, it is usually best to place a cork sole of one to two inches under the shoe of the well side. When partial use of the limb is permitted, the patient may walk between the crutches, gradually increasing the weight borne by the affected limb as it proceeds toward recovery. When two crutches are no longer needed, a stout cane with a comfortable handle, used on the well side, enables the patient to relieve the limb of about half the pressure. In the alternative plan of combining suspension with the fixation or protective apparatus, the splint is made rigid, is carried two and a half inches below the foot, and a cork sole of this height is added to the shoe of the well side. The apparatus is provided at its upper part either with a rigid hip band carrying strong perineal straps, or with a padded steel ring, upon which the ischium rests. The Taylor hip splint and its modifications belong to the former class, the Thomas knee splint and Phelps hip splint to the latter. In either case the leg hangs suspended from the perineum (ischium), and all the leg joints are relieved of weight bearing and external pressure. It is possible to accomplish a similar result by

applying plaster splints while traction is made on the limb, and molding the plaster carefully to bony parts like the tibial tuberosities (for the ankle), and pelvis and perineum for the instep and knee; but it is usually easier and better for the patient to use a crutch with a plaster splint, and let the leg hang.

Traction or continuous pulling of the leg was devised with the idea of relieving not only the pressure due to the weight bearing, but also that due to local muscular spasm. When properly applied it is extremely serviceable during the acute stage of many joint infections. In hip tuberculosis particularly, intense suffering may frequently be instantly relieved by pulling the leg with the hand (manual traction). The relief persists so long as the traction is kept up, and as it is not possible to do this very long by hand, adhesive plasters are applied to the leg, which are fastened by buckles to a stirrup carrying a cord passing over a pulley to a weight, the patient being in bed. It has been shown experimentally that the surfaces of the hip-joint may be separated by traction; in most instances it suffices to relieve the pressure. Lateral traction is unnecessary. The technic of weight and pulley traction in bed is simple, but important. The adhesive plasters should be evenly applied nearly to the groin; if they do not reach high enough, injurious strain comes upon the knee. If the thigh is flexed or adducted, the leg is placed upon an inclined plane, and the weight and pulley so arranged as to pull in the line of the deformity (Fig. 151); the knee should be slightly flexed. Symptoms are frequently aggravated by pulling against the hip deformity. As the muscles

gradually relax to the traction, the pulley is lowered until the pull is in line with the bed and the body. Five or six pounds in a sand or shot bag, flat iron, or brick is usually sufficient for a child; ten or twelve pounds for an adult. It is important that the feet should not touch the foot of the bed or the weight touch the floor; a metal bedstead is the most convenient, and should be long enough to allow six or eight inches space below the foot; the mattress should be hard to prevent sagging. If necessary, thin boards may be placed under the mattress. To prevent the patient from being drawn downward by the pull of the weight, the foot of the bed should be elevated six to eight inches, or the patient should have counter-traction from perineal straps attached to a frame or to the bed. At the Post-Graduate Hospital, in addition to raising the foot of the bed, a towel is pinned around the patient below the ribs, and the back of this is fastened to the head of the bed by a bandage; this plan works well in practice. For traction of the bent knee a double inclined plane may be used, or a curved rod may be passed lengthwise over the bed, from which traction may be applied upward and headwise above the knee and upward and footwise below the knee (to overcome backward subluxation), and downward and footwise from the knee to the ankle. Traction in bed is also useful to stretch contracted parts which are not infected, as in resistant cases of congenital hip dislocation. In the last class of cases two to four weeks are sufficient; in hip diseases, a few weeks to a few months. Head traction in bed or on a frame by means of a head-halter, and weight and pulley, is sometimes

advisable in cervical and upper dorsal disease of the spine, but it is probable that the traction does good in most cases by the incidental immobilization, as the effects of traction on the spine are usually best produced by leverage. Moderate traction may be applied to the hip by means of a close-fitting spica grasping the pelvis and condyles, and to the knee by a snug-fitting plaster splint grasping the thigh or pelvis and foot. The action of such an appliance is, however, uncertain and transitory, owing to the indefiniteness of the grasp, and consequent slipping of the part. Spinal traction by a protective appliance, like a plaster jacket and head spring, is likewise illusory, though such an apparatus may serve a good purpose by its leverage action.

Portative traction splints are usually made of a stiff, steel framework, properly lined and fastened by straps and buckles; they differ from the fixation apparatus, which also furnishes suspension by the introduction of a ratchet or other device by which a continuous pull is exerted. Suspension of the leg, indeed, provides traction by the weight of the leg, so long as the body is upright, and at night or when recumbent a weight may be attached to the limb. The traction may also be increased by tightening the straps by which the lower end of the apparatus is attached to the adhesive plasters, the upper end being fixed by a perineal ring or straps. In fact, a ratchet introduced at the side of the leg bar, as in the Taylor hip splint, has proved mainly useful in adjusting the brace, and it has been abundantly proven in practice that good fixation, suspension, and the simple adjustment of straps and buckles are sufficient in the

ambulatory stage of treatment without special traction devices. If more than this is required it is better to give the patient weight traction in bed for a few weeks, either with or without a hip splint, and let him get up on the fixation and suspension apparatus snugly strapped, and usually with crutches, after the muscular spasm, pain, and acute symptoms have abated.

Limited motion at certain stages or for certain conditions is frequently indicated when either fixation or free motion would be harmful, and it is often wise to permit motion in certain directions while preventing it in others. To introduce controllable motion an appliance, usually of steel and leather with proper strapping, is used, which resembles a fixation apparatus for the part except that it is provided with a joint or joints. It is especially to be remembered that a movable apparatus must be heavier and stronger than a simple fixation appliance, especially as it must bear the strain imposed by the body weight, which the other frequently does not. It must also conform to the rules for grasp, incidence of pressure, and length laid down for fixation appliances. A joint may be a simple lap joint made by joining the flat ends of two pieces of steel by a pin or pivot, or a fork or hinge joint, where one end of the bar passes between a fork in the other bar, the three flanges being pivoted together. Such joints are harder to make and are much more expensive, but if well made are more durable. A free joint is one without stops. A stop joint is one provided with stops to limit motion. For instance, a two-bar ankle brace may have no joints (fixation splint), or may have a joint permitting free antero-pos-

terior motion at the ankle, in which case it prevents lateral motion only; or it may have an up stop to prevent dorsal flexion (in calcaneus) or a down stop to prevent plantar flexion (in equinus), or both stops to limit antero-posterior motion in both directions (Fig. 224).

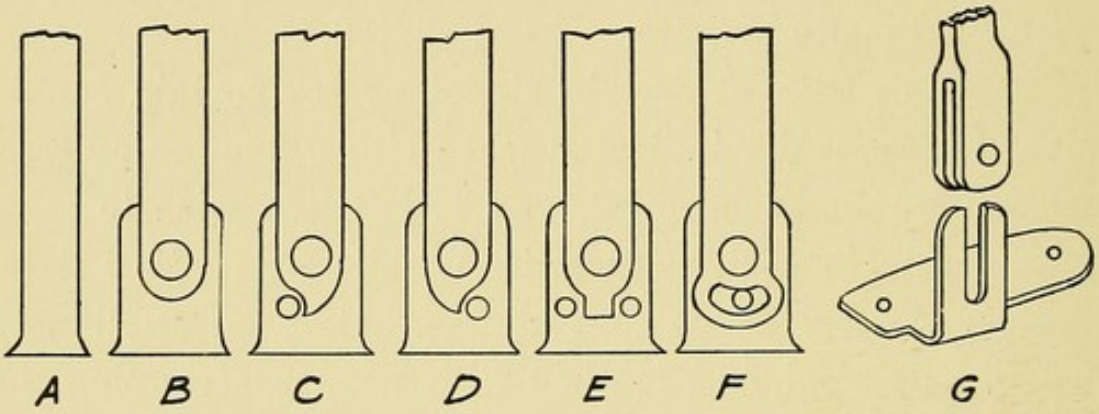


FIG. 224.—DIFFERENT SPLINT JOINTS AT ANKLE. A. No joint. B. Free joint. C. Down stopped joint. D. Up stopped joint. E. and F. Limited motion joint. G. Slip joint.

A stopped joint, especially when the stop is designed to resist the weight of the body, should be stronger than a free joint.

Snap joints are used to give fixation when standing and walking, and yet allow flexion when sitting (Fig. 225). They are used particularly in supporting splints for the knee, with quadriceps paralysis. A strong joint is made with a steel disc riveted to the lower bar on the inner side; this disc and the upper bar are perforated; a steel lever five or six inches long is pivoted to the upper segment of the splint on the outer side; the lower end of this bar is split, and carries a pin, pivoted in the fork, at right angles and fitting in the perforations of the side bar and disc. When the pin is in the holes, the brace is without joint motion; when the pin is with-

drawn from the hole in the disc by pressing on the upper end of the small lever, the knee may be bent at any desired angle; the pin snaps into place automatically from the outward pressure of a spring on the upper end of the lever, when the holes come opposite as the brace is straightened. Such a splint may be set at any angle, and motion may be limited by stops, if desired.

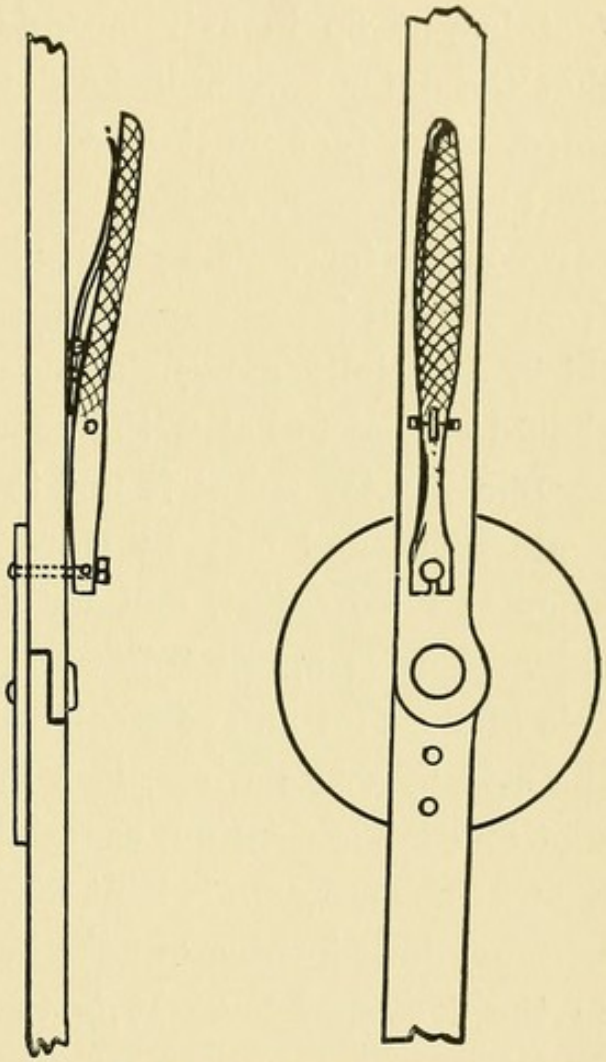


Fig. 225.—Snap Joint.

Having summarized the technic of the different splint materials, and the principles of the control of joint motion, the common problems presented by the major joints will be considered in order, from below upward.

SPLINTING—SPECIAL

Leg Splints.—The tarsus and ankle may be readily immobilized by a plaster-of-Paris splint extending from the toes to the top of the calf. Such a splint is usually applied over the dressings after operations on the foot.

The splint may be made removable by cutting it into an anterior and posterior gutter.

After the mobilization of a flat-foot under ether, the foot is put up in extreme adduction and inversion so that the outer border looks down and the toes point inward. The foot must be well padded, especially along the outer border, and strips of cotton must be placed between the toes. The plaster bandage should be applied from without inward across the sole, and the splint made thick, especially along the outer border of the foot; it should extend to below the knee.

If a plaster splint is not to be walked on, it may be made light, and may be worn with crutches or with a Thomas knee splint, and with a high sole on the well side. A wire splint following the back of the leg and sole of the foot and connected under the ball and behind the calf by cross wires, is a very serviceable brace for foot and ankle fixation, especially when there are dressings. Such a frame is bent to any desired angle, covered with bandage leaving out the heel, padded, and bandaged to the foot and leg. It is to be worn in bed or with crutches.

Two-bar Jointless Ankle Splint.—For long-continued ankle fixation the most satisfactory apparatus is the two-bar ankle splint made of a steel bar with a tongue forged forward at the middle; this is riveted by three rivets to a steel foot piece, and bent up on either side to form uprights; the uprights are connected behind the calf by a steel band an inch or more wide; the side bars are $\frac{9}{16}$ wide and 8 gauge. The foot piece is made from 15 to 16 gauge sheet steel to an outline of the

sole on paper, and may be made somewhat narrower and shorter than the outline to fit inside the shoe. The calf band and sole piece are lined with leather, which is riveted in place, and the splint is provided with a leather heel piece. It is kept in place by an ankle cross strap, or by a leather lacing, and by a strap and buckle at the top (Fig. 201).

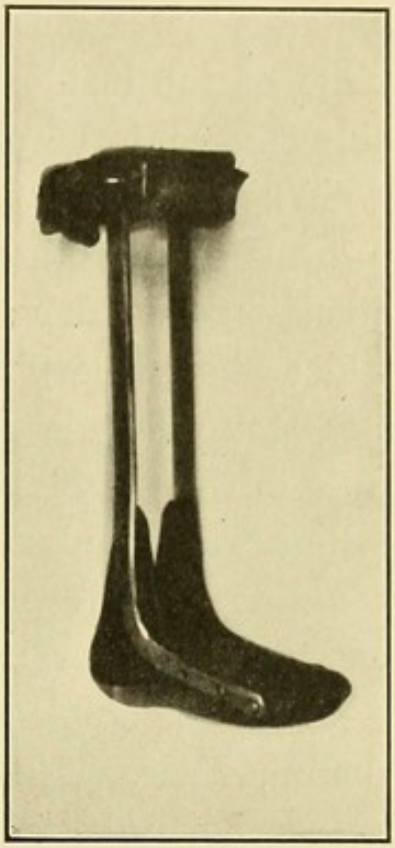


Fig. 226.—Whitman's Jointless Calcaneus Splint with Leather Sole, Preventing Dorsal Flexion of the Foot.

Whitman has devised a very simple and ingenious splint to prevent dorsal flexion of the foot (Fig. 226).

Retention and supporting splints for the ankle often must be worn for a long time, and when this is the case are usually made of steel, lined with leather, like the two-bar fixation splint just described. If only lateral support is required, the splint is constructed with a free lap joint in each bar at the ankle; the splint works better if this joint is placed below the anatomical ankle-joint; two inches above the sole plate is high enough for an adult, an inch and a half for a child. It is best to make all steel ankle braces, with a sole plate to be worn inside a laced shoe. Ankle splints made with the two bars jointed to a U piece riveted to the shank of the shoe, while sometimes sufficient for light support, are

usually unsatisfactory. In either an inside or outside brace the transverse turn of the U piece should be brought forward two inches for support to the sole plate, and to receive an anterior rivet. Better still, the foot plate of the inside brace should be forged with strong side flanges, to be pivoted to the side bars.

When motion is stopped in either direction, especially upward or in both directions (limited motion), the construction should be strong. The arrangement of stops which should be placed on both the inside and outside bar has already been explained (Fig. 224). If the ankle falls to the side, lateral support is needed. If the ankle falls inward (valgus), it should be supported on the inner side by a T-shaped or other ankle strap, buckling outside the outer bar; if it falls to the outer side, the strap should be placed on the outer side, buckling around the inner bar. When a strong pull is needed the counter pressure may be taken on an inner or outer padded side plate or flange. The foot may be inverted or everted by the pull of the ankle strap, and the action may be increased by bending the bars laterally. Flat steel bars may be bent by steel hooks such as those shown in Fig. 222, or by adjustable wrenches.

Correction Splints for the Foot.—While it is perfectly feasible to correct many feet deformities with apparatus, this need never be complicated. Experience has shown that severe and inveterate cases are more quickly and perfectly cured by forcible stretching, or by cutting contracted tissues under an anesthetic; when this is done the deformity in many instances recurs unless the foot is properly held by a suitable appliance for a sufficient

time. Infantile cases of congenital club-foot, even if severe, may usually be corrected by moderate and gradual manual stretching and retention with adhesive plaster or in a splint of plaster-of-Paris or other material, renewed or straightened from week to week. When plaster-of-Paris is used the foot should be well padded with cotton and stretched outward; no attempt should be made to correct the equinus until the varus is overcome. It is often well to run the plaster up above the slightly bent knee, and to apply the plaster bandage from within outward (across the sole), and pull the foot out by passing some of the turns directly up the outer side of the leg, and securing them by circular downward turns. Mold the plaster well about the ankle and rotate the foot out before it sets. It is often a help to push up on the sole with a short, thin board, to give the splint its final shape. Sometimes in fat babies the splint works down on the foot or drops off. This may be obviated by attaching adhesive plaster to the leg, turning the end back over the splint, and imbedding it. The plaster should be changed once a week; this is better than cutting the cast and gradually correcting, as practiced by Wolff. The toes should be watched for symptoms of constriction. The same result may be obtained by adhesive-plaster strapping in the light cases, or, even in severe ones, by using a light metal splint on the inner side of the foot and leg, which is at first bent to the deformity and afterwards straightened by the fingers as the deformity yields. This principle, laid down by C. F. Taylor, is embodied in the simple method of Judson, who used a small brass strip with a stout concave

band at each end, and an outer band which is strapped to the foot by adhesive plaster (Fig. 193).

The Taylor one-bar club-foot splint, now usually employed as a retention splint, may be used as a correction splint (Fig. 195) in a similar manner. It may be asked why not always make one-bar ankle braces? This was C. F. Taylor's practice, the bar running up the inner side for a varus, the outer for a valgus. These braces were

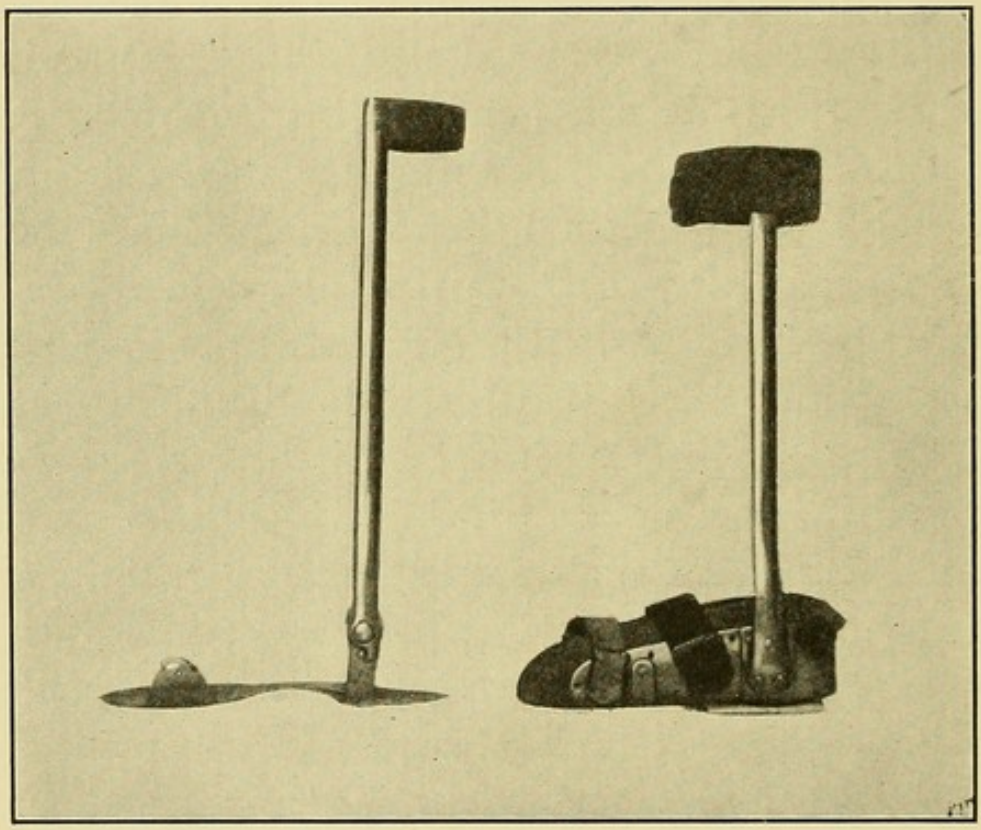


Fig. 227.—Varus Brace with Inner Side Plate or Lip.

provided with a sole plate, a side plate (or lip) (Fig. 227) for counter pressure, a down stop at the ankle, and special strapping, and gave excellent service. They take up less room in the shoe than the two-bar splint, and are more suitable for lateral adjustment. They must be made stronger and are more expensive, but the one seri-

ous objection is the rapid wear of the joint necessitating frequent repair. In certain cases, however, especially when lateral action is desired, they are, if well made, on the whole superior. When the Taylor club-foot brace is used for correction, the action is much intensified by holding the heel to the splint with adhesive plaster and a strap and buckle. With a suitable splint provided with proper strapping, leverage may be applied up to the toleration of the patient. In children much over a year old, except in mild cases, the division of the heel cord and plantar fascia has given better results than stretching in the hands of most surgeons.

Rotation of the leg cannot be entirely controlled at the foot, and if the straightened club-foot continues to point inward, as not infrequently happens, the inside bar retention splint should be attached by a band below the knee to a thigh piece and pelvic band, having free joints at the knee and hip. By reason of the grasp on the pelvis exercised by the pelvic band, the foot may be rotated outward at will by simply twisting the side bar (Fig. 196).

Knee splints for fixation are conveniently made of plaster; the splint may be made removable by cutting it into an anterior and posterior gutter, which may be strapped together (Fig. 221). Errors to be avoided are: too loose a splint and too short a splint (Fig. 220). It is well to mold the splint about the patella, and to flatten it behind the knee to ensure stability (Calot, see Fig. 228). It is often well to include the foot, which gives better fixation and prevents swelling; it is not often necessary to include the pelvis. Adjustable fixation splints

may be readily and cheaply made of a posterior wire frame, or of a posterior steel bar with half bands at the ends (page 424), provided with straps and buckles or

FIG. 228.—A. PLASTER SPLINT MOLDED ABOUT KNEE TO PREVENT ROTATION. B. UNMOLDED SPLINT PERMITS ROTATION. (Calot.)

bandaged in place. Either may be easily bent to any desired angle. If the knee is nearly straight and the patient goes about, the fixation splint should include the foot. Such splints are often needed for use on one or both legs, after infantile paralysis. Two side bars run the length of the leg, ending in a foot plate, as in the two-bar ankle brace, and having a wide steel band behind the calf and behind the upper part of the thigh; the outer bar should be an inch or more longer than the inner. Leather lining, straps, and a broad shaped or perforated pad over the knee, and a heel band complete the apparatus. If it is desired to control rotation, as often happens, the outer bar is attached to a steel pelvic band, and has a joint at the hip. The ankle may have a joint suitable to its needs, or no joint if it is desired to prevent motion; the foot plate fits inside the shoe (Fig. 229). This brace is simple, cheap, and efficient; its main disadvantage is the awkward posture in sitting with straight knees. It has, nevertheless, enabled many helpless patients to walk, and

hundreds have worn it for years without noticeable discomfort.

When in chronic disease of the knee-joint it is advisable to combine suspension with fixation, the *Thomas knee splint* is the most practical (Fig. 170). This consists in two $\frac{5}{16}$ to $\frac{3}{8}$ inch steel rods, of which the outer is about

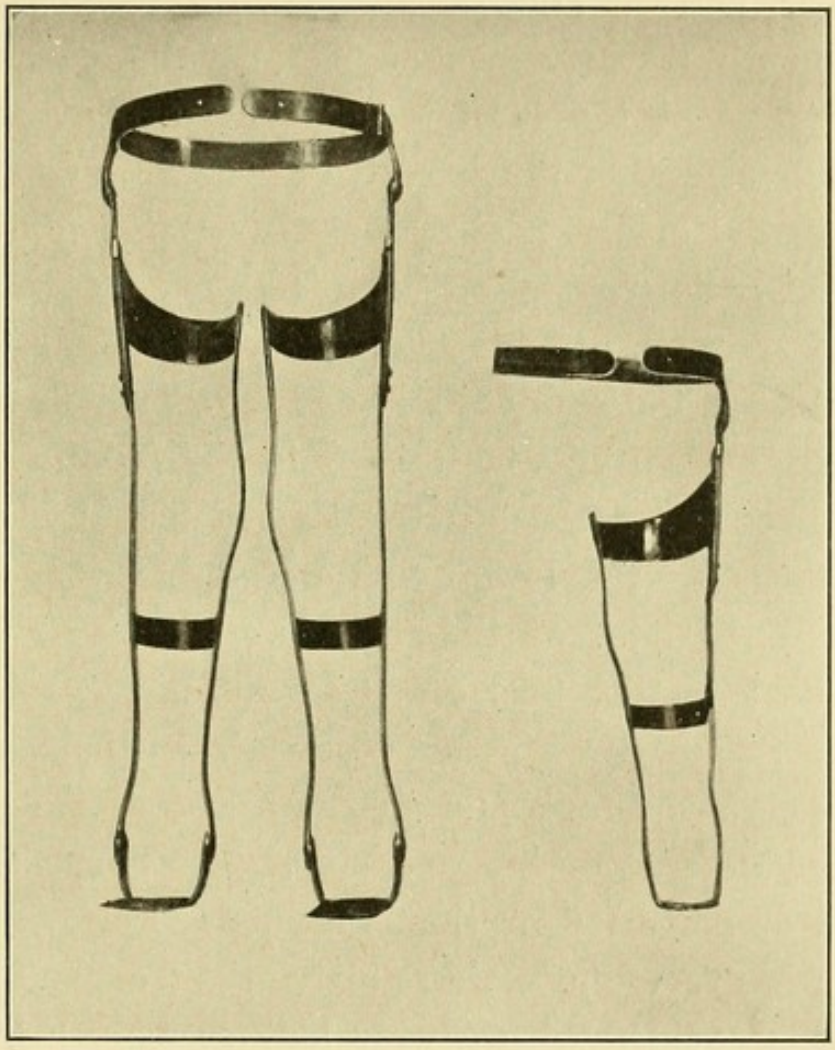


Fig. 229.—Steel Fixation Splints for the Knee with Pelvic Band to Control Rotation at the Hip.

three inches the longer, reaching from two and a half to three inches below the foot to the groin and top of the trochanter respectively. It is well to lap the side bars, and join them by screws, to provide for lengthening the

splint. The rods are inserted below into a cross bar, and brazed to a $\frac{5}{16}$-inch steel ring above at an angle of forty-five degrees. This ring is somewhat triangular, with rounded angles; the tuberosity of the ischium rests on the lower side, and transmits the weight of the body to the splint. The lower end is shod with thick leather or rubber, and the ring is padded with felt and covered with smooth leather. The splint usually carries two short straps at the lower end, which are attached to buckles terminating the adhesive plaster, applied to the leg below the knee. These plasters carry the splint, when the splint is not resting on the ground, and may be used to exert traction. If adhesive plaster is not used, as in ankle disease, the splint is suspended from the shoulders by webbing suspenders attached to the front and back of the ring. If desired, a third strap may be attached to the back of the lower end, which is fastened to a buckle at the back of the shoe to pull the heel down, and thus keep the toes off the ground. The Thomas brace is made with a space of two and a half to three inches below the foot, and a high sole to correspond is worn on the foot of the well side. The ring should be an inch or more longer than the inclined circumference of the thigh from the groin to above the trochanter. The bars are provided with a wide leather band behind the leg and thigh. The slipping of these bands may be prevented by winding half-inch adhesive plaster around the bar. The knee is kept back by many turns of a bandage, or by a fitted pad which buckles to the bars. If the knee is sore it is sometimes best to apply, for better fixation, a light plaster-of-Paris splint to the knee, to be worn

with the Thomas splint; but, as in other joints, if the process is very acute, it is best to put the patient to bed and apply weight and pulley traction for a few weeks until the acute symptoms subside. If flexion is not great the Thomas splint may be used to correct it; in this case the pressure falls on the back of the ring, on the band above the ankle, and on the front of the knee, where it must be well distributed. Traction often assists correction and may be applied in bed, or by tightening the buckles of the adhesive plaster; a ratchet is unnecessary.

In convalescent cases where fixation without full suspension is desired, the so-called *caliper splint* may be used. This consists in the Thomas splint, with the side bars separate below and the ends turned inward. These turned-in ends may be sprung apart like a caliper and inserted into a round hole bored in the heel, or, better, into a metal tube fastened to the sole of the shoe where it joins the heel; a strap above the ankle keeps the ends from springing apart. The splint is made the length of the leg, or slightly longer if it is desired to reduce the joint pressure.

Correction Splints for the Knee.—When it is desired to change the posture of the knee, or increase the range of motion, usually in extension, this may be done in cases suitable for brace treatment by using either a plaster-of-Paris or metal fixation splint, as already described, and changing the angle as the obstructing tissues relax (Fig. 230). When passive motions, massage, or vibration are also to be employed, the splint must be a removable one. It is often convenient, instead of bend-

ing a wire or bar, to have a splint with an adjustable joint, which may be fixed at the angle of choice. Recumbency and traction are often powerful aids to correction, especially in inflammatory conditions.

The correction of lateral deformity, especially in in-knee and out-knee, is a very common problem in mechan-

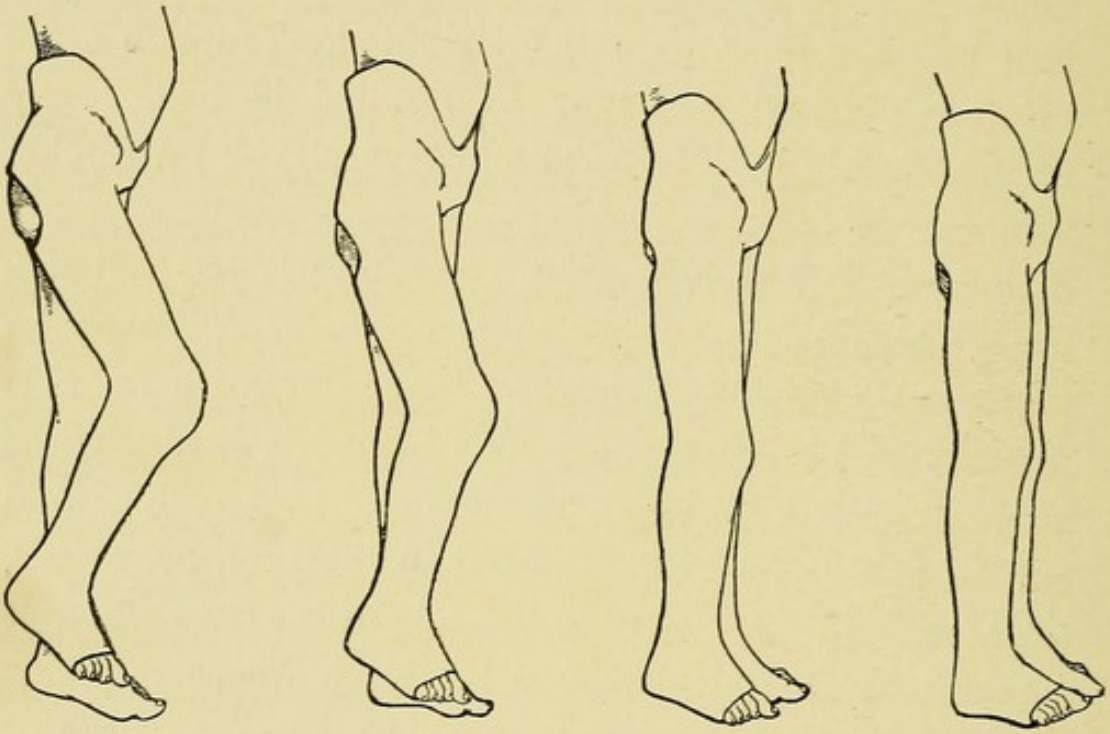


Fig. 230.—Correction of Knee Flexion by Successive Plaster Splints. (Calot.)

ical orthopedics. Only the younger and moderate cases of knock-knee are suitable for splint correction. *Knock-knee splints* with a movable knee-joint are worthless, since no lateral leverage can be exerted unless the knee is held straight. Pressure points in a correcting splint must be over the outer side of the upper thigh and lower leg, preferably over the trochanter, and above or below the ankle, and over the inner side of the knee. The Thomas knock-knee splint is the most satisfactory one for

the purpose (Fig. 166). This consists of a single outer bar reaching from the trochanter to below the heel, the last two inches of which are round and bent at a right angle, to be inserted into a hole in the heel of the shoe or into a tube, as in the caliper splint. The splint carries a half band below the groin and above the ankle, connected behind the leg by a rigid bar; this bar is usually about half the length of the outer bar. A wide leather pad is riveted to the posterior bar, and comes around the inside of the knee and across the front, to be fastened by three webbing straps, which pass around the outer bar and double back to buckle to the pad. A bandage may be used instead of this thin pad. There is a small steel plate and a good pad over the trochanter, and in order to keep them in place and control the rotation of the leg at the hip, it has been found advisable to attach a pelvic half band to the upper end of the bar; this adds greatly to the efficiency of the splint. This pelvic band, like all movable pelvic bands, should rest at the level of the anterior superior spines of the ilium, and should carry a plate two inches long fixed to the band, and pivoted to the end of the side bar over the trochanter. When two splints are worn the two half bands are separated by several inches in front and behind, which are closed by a strap and buckle. The adjustment of these straps controls rotation. Children generally accustom themselves to the stiffness of the braces and walk very well; they may be removed at night, in mild cases. In out-knee, and the forms of bow-legs that involve the knee or thigh, stiff splints, with outer and inner bars and a foot piece to go inside the shoe, may be used in young children. The

splint reaches nearly to the groin on the inner side, and nearly to the top of the trochanter on the outer, and is provided with a long leather lacing attached to the inner bar, and reaching from above the ankle nearly to the top; it is laced inside the outer bar, and draws the knee toward the inner bar. The points of pressure are the inner side of the thigh below the groin, the inner side of the heel and leg, and the outer side of the knee and contiguous parts. For bow-legs below the knee *Knight's bow-leg splint* has proven itself useful in suitable cases (Fig. 176). This consists of a two-bar ankle splint, with a free joint at the ankle, whose inner bar is prolonged upward one and a half inches, and carries a small pad plate and a pad, bearing on the internal condyle; a leather lacing is attached to the inner bar; the foot part is worn inside a laced shoe. The points of pressure are the inner side of the internal condyle, the inner side of the heel, and the outer side of the leg. This is not a knee splint, but is mentioned here in connection with the out-knee splint for convenience.

Knee Splints with Joint Motion or Adjustment.—A knee splint on the plan of the two-bar supporting splint with foot piece, already described, may be made with a lap joint at the knee on both sides. If the joint is to have free motion, this should, nevertheless, always be stopped when the two bars are in line by the conformation of the joint or by a special stop or flange, to prevent strain on the posterior ligament of the knee and hyperextension (Fig. 231). It is often well to rivet a disc to the inner side of the outer bar, having the joint pivot as a center. If this disc is riveted to the

upper bar, and also to the lower, the joint will be fixed; but if a row of screw holes be made in the disc the angle may be changed by changing the screw from one hole to another.

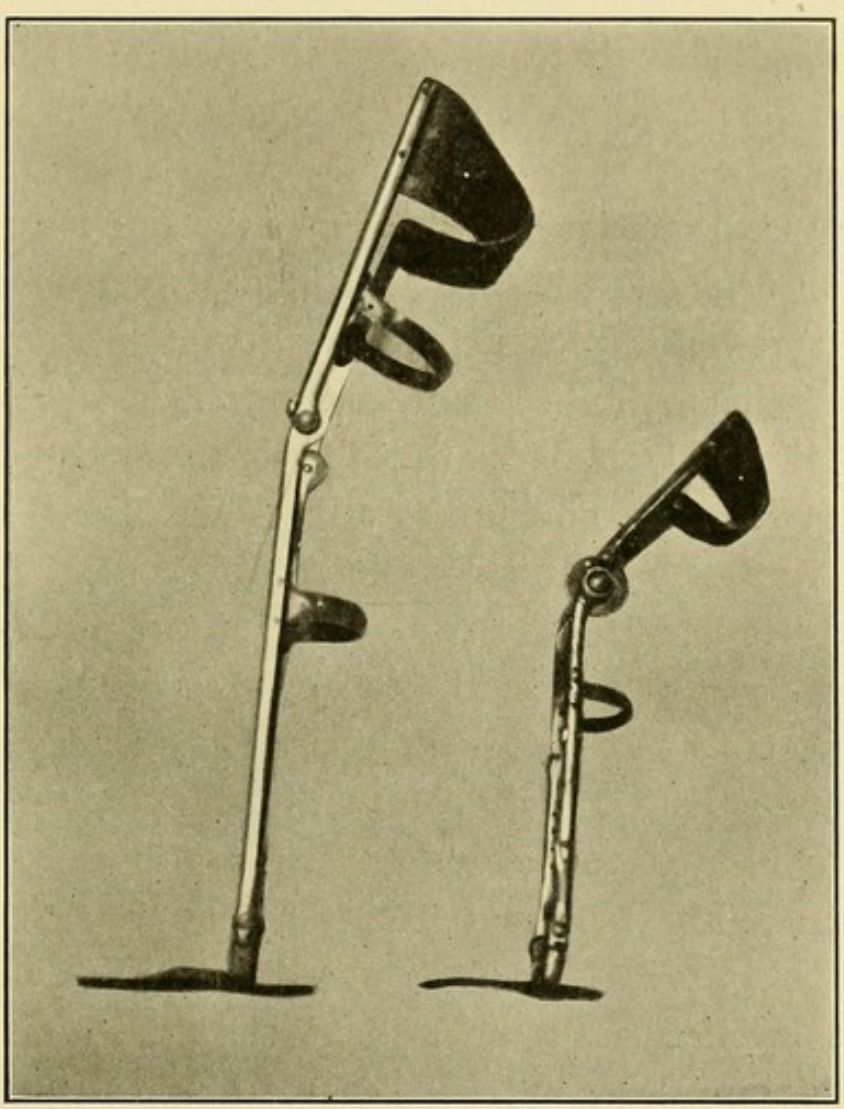


Fig. 231.—Jointed Knee Splint with Stop to Prevent Hyperextension. The splint at the right has a disc for controlling motion.

Motion may be limited by placing stops on the disc, and this motion may be shifted to any point by shifting the disc at the upper bar. A snap joint may be used as already described (Fig. 225), to give a stiff joint when standing, and allow the knee to bend when the patient is

seated. A one-bar knee brace with a long outer bar may be used, to which a short inner bar, with curved plate above the knee, is joined by two curved cross bars in front of the thigh, above the knee and below the groin. This makes a very elegant and efficient brace, but is expensive and difficult to make. The joint and outer bar must, of course, be made much stronger than in the one-bar apparatus.

In all leg braces it is well to make the side bars either above or below the knee, or both, of two overlapping pieces, screwed together to allow for adjustment and growth. Knee splints are sometimes made with a slip-joint at the ankle, in order that the shoe may be removed at night without removing the splint (Fig. 224, G).

Fixation Hip Splints.—The most practical fixation hip splint is undoubtedly the long plaster-of-Paris spica, reaching from the toes to the nipples; the posture of choice should be given to the hip, usually extension and slight abduction, and if, before the plaster is set, the knee is slightly flexed, it will add greatly to the patient's comfort. While foot and knee plasters are easily applied, the hip spica requires some little skill. The spica may be applied with the patient suspended from the head, but is usually put on with the patient recumbent. In this case the patient should be supported on a hip and shoulder rest. A tomato can padded with cotton makes a serviceable hip rest in an emergency, while the back and shoulders may be supported on a low box or one or two folded pillows. An adjustable hip and shoulder rest is in use at the Hospital for the Ruptured and Crippled, as shown in the cut (Fig. 232), and Gallie has devised a

suit case rest on the same principle (Fig. 233), with the additional advantage that the case contains the hip rest, bandages and accessories when not in use, and is port-

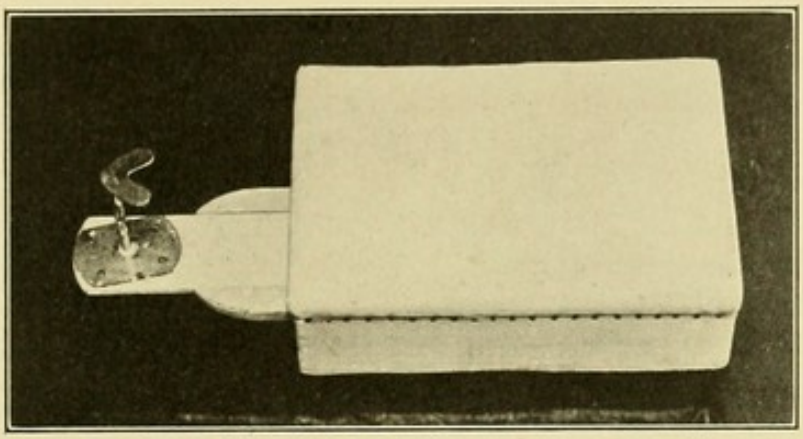


Fig. 232.—Adjustable Hip and Shoulder Rest Used at the Hospital for Ruptured and Crippled.

able. There are many other good hip rests; Schultze's (Fig. 222, C), with closing blades to facilitate removal when the spica is finished, being large and strong, is

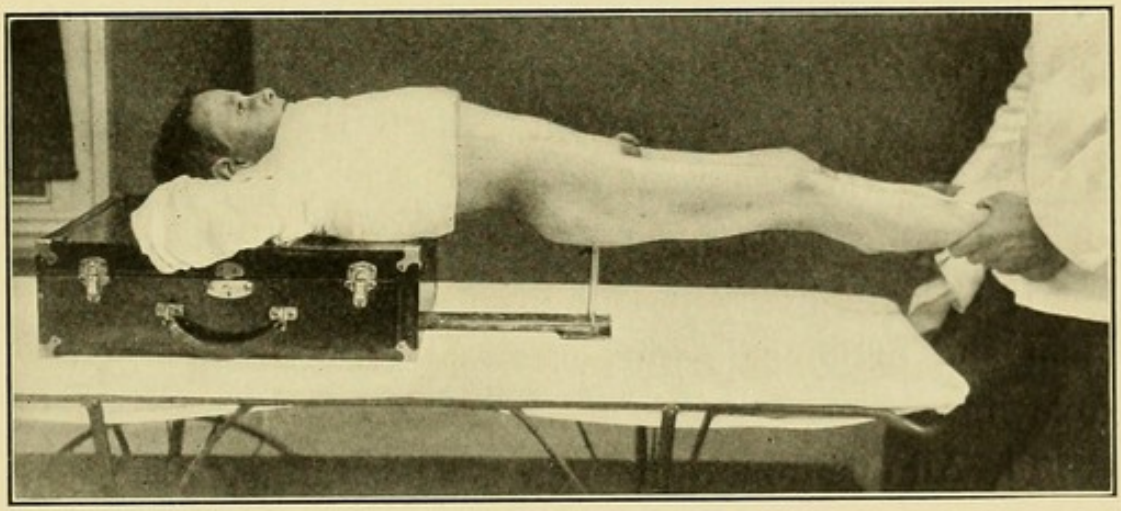


Fig. 233.—Suit Case Hip and Shoulder Rest. (Gallie.)

particularly good for adults and after operations. With all these rests, two assistants are needed to hold the legs and steady the patient, and several apparatus have been

devised to hold the leg, with or without traction in the posture of choice, in addition to supporting the pelvis

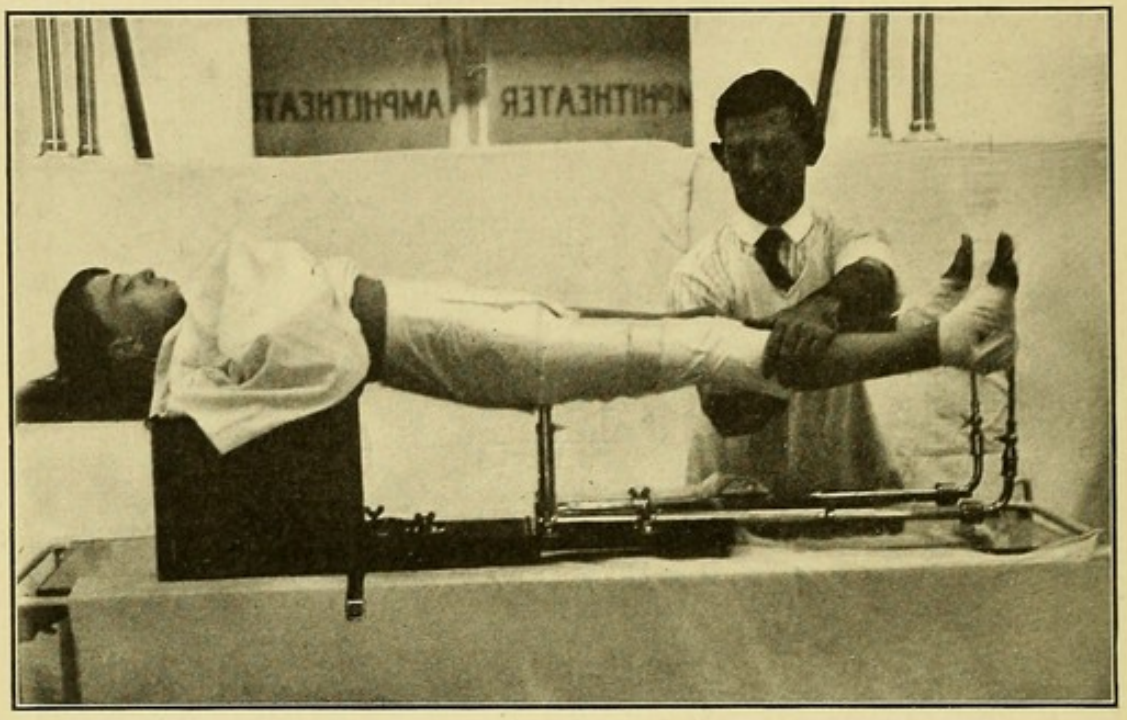


Fig. 234.—Portable Hip and Shoulder Rest and Extension Apparatus. (Sanderson.)

and shoulders. Sanderson's portable machine (Fig. 234) seems to be a very good model.

The Echols traction apparatus "was designed primarily for the treatment of fractures of the femur by means of the spica plaster-of-Paris (ambulatory) cast, but it is exceedingly useful for a variety of other surgical and orthopedic purposes, chief of which are the following:

"1. All open operations on the femur where traction and fixation of the limbs during operation is desirable, such as operations for ununited fracture, osteotomia subtrochanterica, etc.

"2. Application of a spica cast immediately following such operations; the apparatus permits the operator to

vary the adduction, abduction, flexion, etc., of the limbs without releasing the traction or disturbing the position of the patient.

"3. Breaking up old tuberculous ankylosis of the hip-joint in cases where there is lordosis with flexion and adduction.

"4. By using a suitably improvised back and shoulder support the apparatus lends itself admirably to the application of body casts for Pott's disease.

"5. From a study of the accompanying illustrations it will be seen that by inverting the apparatus the same traction may be applied to the legs without lifting the patient from the bed—a procedure which may be useful in applying a Liston splint.

"As the figures indicate, the apparatus when in use is merely laid on a table, but is not attached to it in any way—an obvious advantage in many cases.

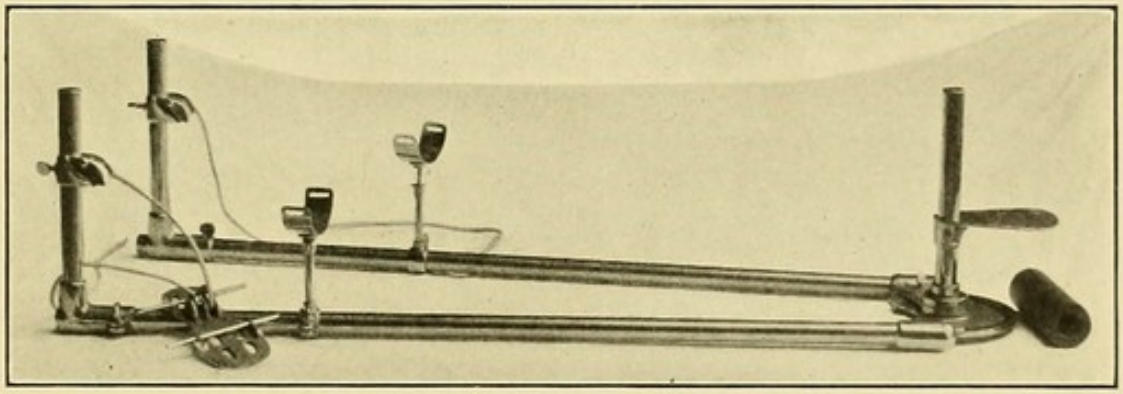


FIG. 235.—HIP REST AND TRACTION APPLIANCE. (Echols.)

"Fig. 235 shows two long horizontal leg bars, each forty-two inches in length, a vertical perineal post twelve inches in height, and two vertical foot posts of the same height—all made of drawn seamless steel tubing one and

one eighth inches in diameter, comparatively light, and practically unbreakable.

"The perineal post is supplied with a thin, strong sacral plate which is adjustable at any height. A leather-covered hollow cylinder of wood can be slipped over the perineal post to give a broader surface for pressure in cases where strong traction is wanted.

"The horizontal leg bars can be opened, compasslike, to any desired degree of abduction up to 180 degrees and securely locked in any position by means of a set-screw clamp.

"Two sliding and telescoping crutches are attached to the horizontal leg bars by means of split clamps, and are adjustable in a great variety of positions.

"A specially designed sole plate equipped with a double pulley is attached to each of the patient's feet by means of a common muslin bandage.

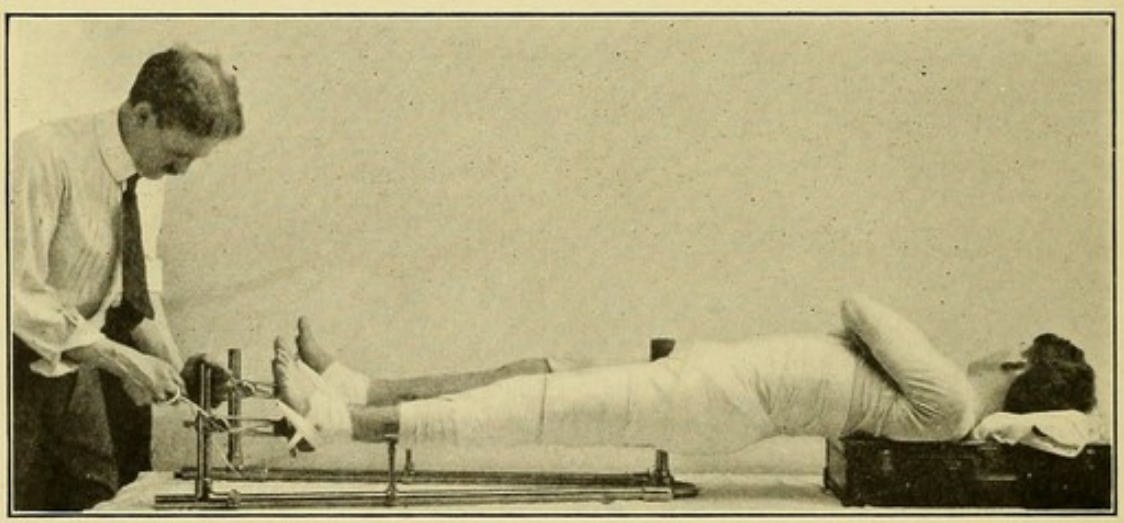


FIG. 236.—HIP REST AND TRACTION APPLIANCE IN USE. (Echols.)

"On each of the vertical foot posts is an original tackle block and clamping device, adjustable at any height. Traction is made as indicated in Fig. 236. The

pull made by the operator is multiplied by 4. For example, a pull of 100 pounds on the cord produces a traction of approximately 400 pounds on the foot. When the operator stops pulling, the automatic clamp pinches the cord firmly and prevents any release of traction.

"Hyperextension or moderate flexion of the hip-joint may be produced by (*a*) raising or lowering the sacral plate, (*b*) raising or lowering the clamping device on the vertical foot posts, and (*c*) varying the thickness of the improvised head and shoulder rest.

"The castings are all made of tough malleable iron. The entire apparatus is nickel plated. It can be quickly

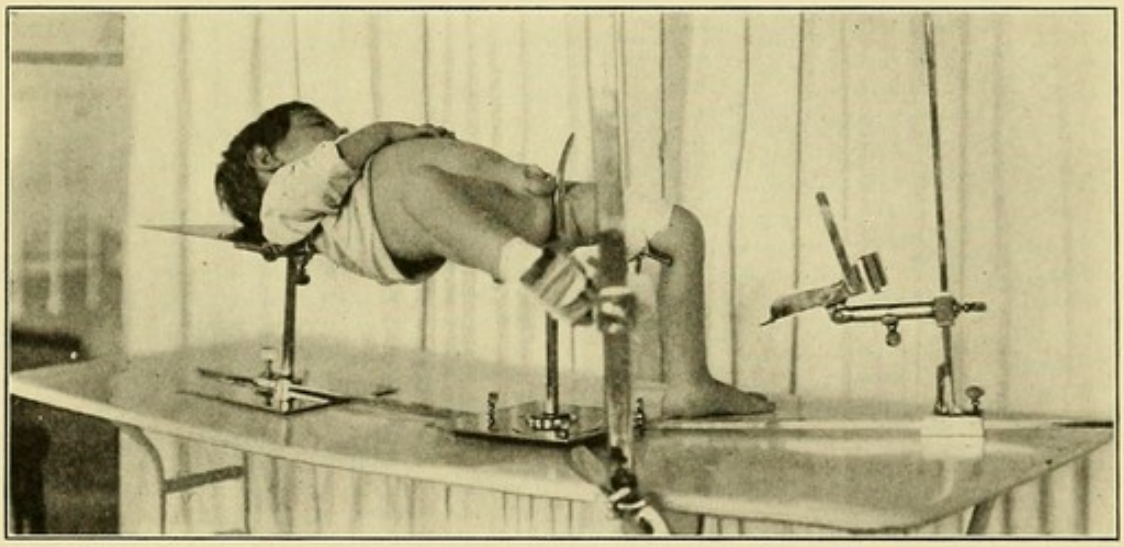


FIG. 237.—DUCROQUET'S MACHINE.

dissembled, and is carried like a shotgun in a canvas bag. It weighs about twenty-five pounds, and will tolerate a strain of at least 600 pounds traction." (Echols.)

The elaborate appliance of Ducroquet (Fig. 237) combines a hip and shoulder rest with means for controlling rotation and flexion of the legs as well as lateral motion. It is especially useful for holding the patient in the vari-

ous postures necessary after the reduction of congenital dislocation of the hip, and in overcoming thigh adduction after coxitis.

The long spica, applied during traction and well molded to the knee and limb, undoubtedly diminishes pressure on the joint during locomotion, which is nevertheless to be avoided during the acute stage. It should be strengthened in front of and behind the hip and behind the knee.

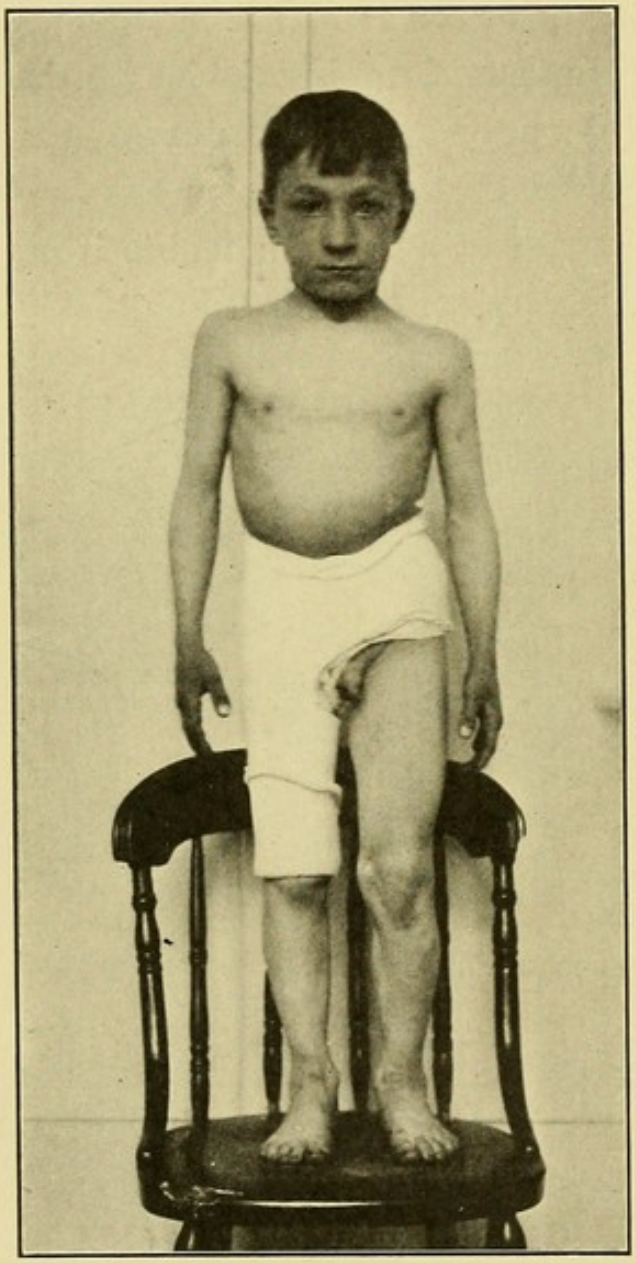


Fig. 238. — Short Plaster Spica for Fixation at the Hip; the Fixation is Better if the Spica is Prolonged Upward Nearly to the Nipples.

The long plaster spica has been abbreviated at both ends, but then gives less fixation. Calot molds it carefully to the pelvis and ends it near the waist. Others terminate it above the ankle or at the knee. Such spicas answer certain indications very well, especially those in the treatment of congenital hip luxation after replacement. They

should be thickly padded, as they are made thick about the pelvis and are subjected to a good deal of strain; they often remain three months or more without change.

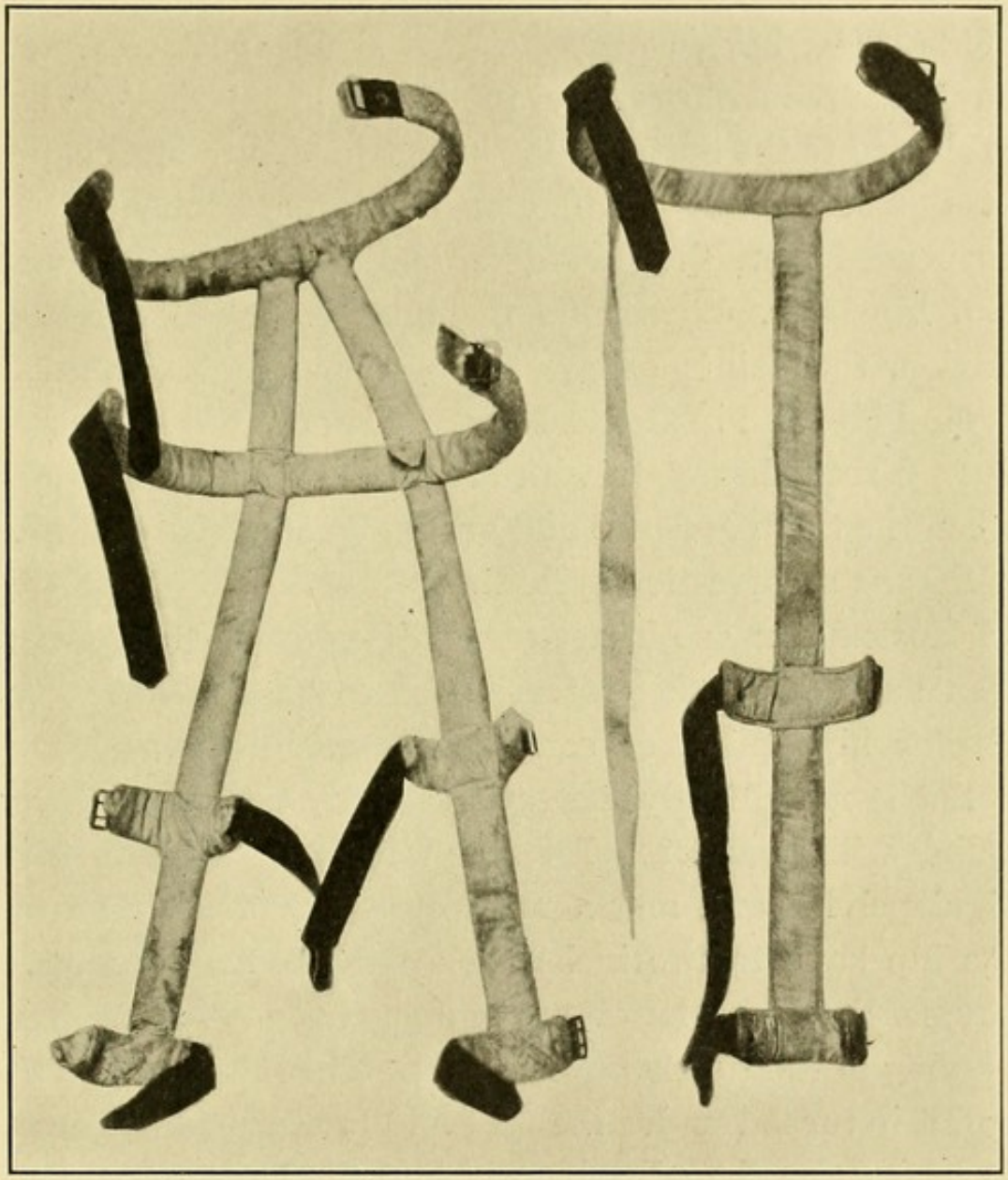


Fig. 239.—Thomas's Hip Splints, Single and Double.

The edges should be wet and rubbed after trimming, to round off the inner margins and to seal the plaster. The short spica may be covered with the surplus of the stockinette over which it is applied, or with a muslin spica

to keep it clean. The short spica from the knee to the umbilicus is much used in the convalescent stage of hip disease (Fig. 238).

Another form of fixation splint is the *Thomas hip splint* (Fig. 239), consisting of a strong posterior steel bar from the axillary level to above the ankle. This bar is shaped to the buttock, and is provided with steel bands at the bottom, top, and also below the crotch. It is suspended from the shoulders, and secured to the trunk and hip by bandages. If the thigh has a tendency to flexion, the points of pressure are in front of thorax, behind hip, and in front of leg. This splint is to be used during recumbency or with crutches; it may be applied when the thigh is flexed and gradually straightened, thus acting as a correction splint.

Suspension and Traction Hip Splints.—Most American surgeons have preferred for a traction splint the Taylor hip splint, or some of its modifications. This splint is not directly a fixation splint, but a suspension splint with traction. Its simplest form consists in a rigid pelvic band and a rigid outer bar reaching from the hip band to two inches below the foot. This outer bar consists in a lower part notched for a ratchet, and playing in the tubular upper part. The lower end of the splint is turned under the foot and is attached by straps to buckles on the adhesive plaster; the hip band carries two perineal straps; the side bar is firmly clamped or riveted to the hip band (not jointed), and has a steel band behind the knee carrying a strap. When the ratchet is screwed out by a key the splint is lengthened, and may be fixed by a stop at any point; if the adhesive and peri-

neal buckles are fastened, the leg is pulled (traction). When used as an ambulant splint, a cork sole is to be worn on the well foot.

This splint has been much misunderstood, but has rendered good service. It affords only indirect and partial fixation by the brake action of the perineal straps, and has properly been supplemented by the addition of a thoracic band joined to the pelvic band by a rigid upright bar at the side, and simplified by the elimination of the ratchet, as in the so-called Polyclinic hip splint (Fig. 153), a very simple and efficient appliance. The upright is forged from $\frac{7}{16}$ to $\frac{5}{8}$ inch steel, clamped to the band by a nut and screw with square shank. The band is made of bar steel $\frac{1}{8}$ to $\frac{3}{16}$ inch thick and 1 to $1\frac{1}{8}$ inch wide. This is a fixation and suspension splint for the hip, furnishing so much traction as may be obtained by tightening the adhesive-plaster buckles. This, however, may be done to the limit of the patient's endurance; the ratchet can do no more. The ratchet, however, is convenient for adjustment, but this can be readily obtained by making the splint of two overlapping forged bars screwed together.

Phelps has given precision to the action of the splint by dropping the perineal straps, which are difficult to keep clean, and too readily loosened, and replacing them by a wire ring borrowed from the Thomas knee splint. He thought also to add lateral traction, but this was really unnecessary, and was finally reduced to a band above the knee, whose only function is to steady the leg. The simple form of the *Phelps hip splint* (Fig. 152) without a ratchet, to be used with crutches and a high shoe

on the well side, is, perhaps, all things considered, the most satisfactory form of hip splint for ordinary use in

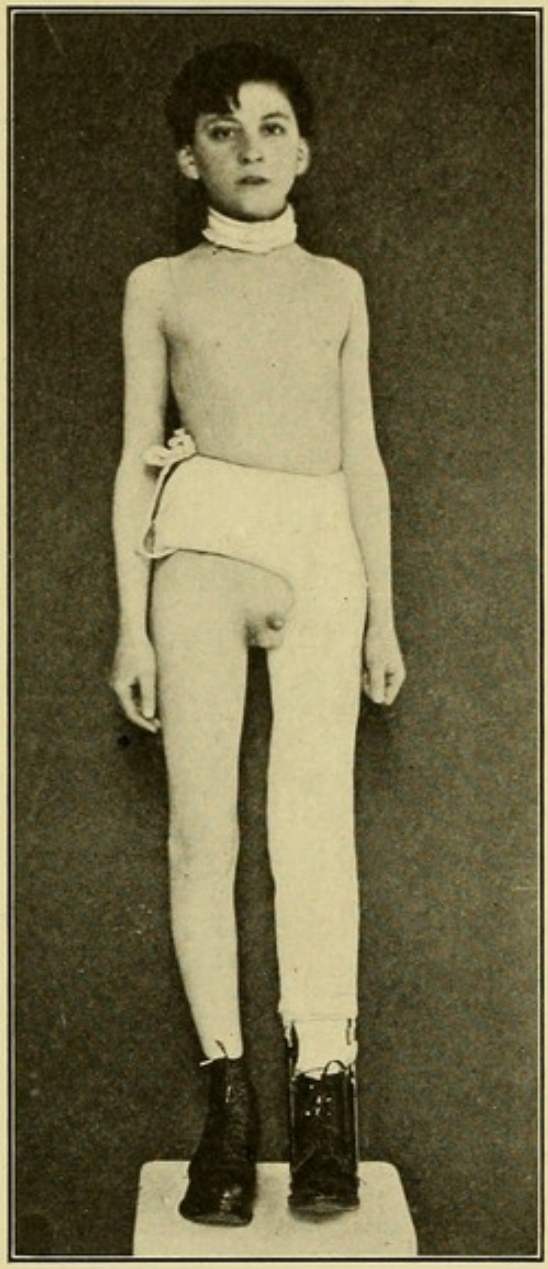


FIG. 240. — PLASTER SPICA ENDING ABOVE SHOE, PROLONGED TO FLOOR BY A RIGID U-SHAPED STEEL BAR, SUSPENDING LEG. (Lorenz.)

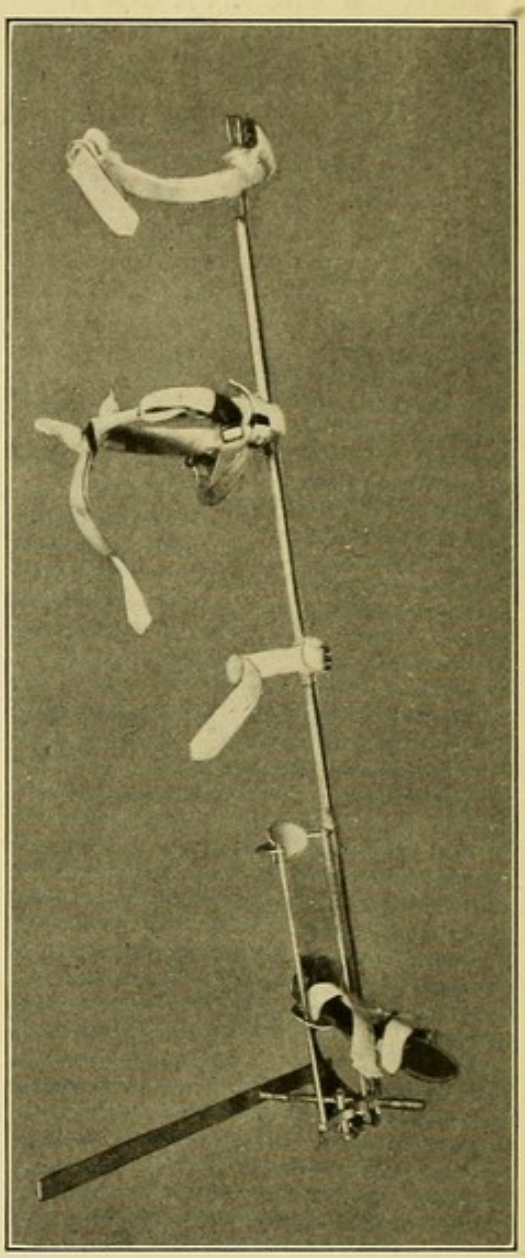


FIG. 241. — GALLIE'S HIP SPLINT FOR TRACTION IN BED. (Starr and Gallie.)

hip tuberculosis. If a plaster spica, reaching to below the calf, is carefully molded to the pelvis and perineum, and prolonged under the foot by a bent steel bar, as is

done in Vienna, a similar effect is produced (Fig. 240). No splint is capable of filling the indications in all cases or in all stages; the stage of acute symptoms is best treated by recumbency with traction in bed (Figs. 151 and 241), and the stage of convalescence by splints which permit partial use of the limb.

Pelvic Splints.—The pelvis serves as a base for spinal splints, and transmits the body weight to suspension splints. It also serves by fixing the position of a pelvic band to control the direction of the foot (hip rotation).

The splinting which the pelvis itself requires is mainly that of circular support by a snug enveloping band, adjusted above the trochanters to relieve the sacro-iliac joints of strain. This may be done by a circular bandage with short double spica, by strapping with four strips of two-inch zinc-oxid plaster, pulled tight, and interrupted for a few inches in front (Fig. 128); by a three-inch surcingle and buckle, which may be attached to the lower end of a long corset; by a wide plaster-of-Paris belt, secured by perineal straps (Fig. 242). When it is necessary to control the tilt of the sacrum, or to support the spine in addition to the circular compression, a plaster-of-Paris corset or jacket should be applied, which must come well down over the hips and be snugly adjusted to the pelvis. A long woman's corset, strengthened with side and back steels and provided with surcingle and buckles below, answers admirably in some cases.

Arm Splints.—As the arm is naturally pendant and does not bear weight, the appliances for controlling it are much simpler than those for the leg.

The fingers may be fixed by binding with adhesive plaster, stiffened with small splints of wood or whalebone, or by small aluminium splints with or

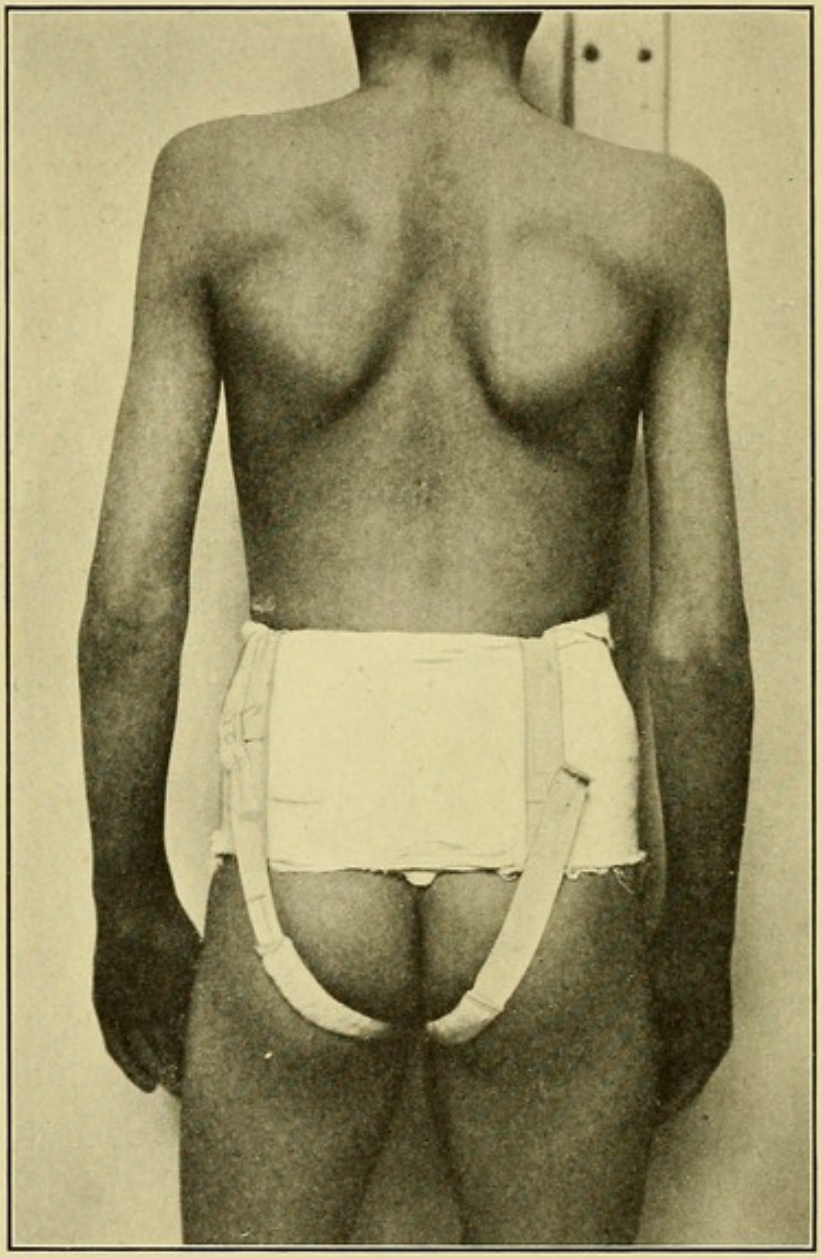


FIG. 242.—PLASTER-OF-PARIS BAND WITH PERINEAL STRAPS FOR PELVIC SUPPORT. The patient is recovering from tuberculosis of the pelvis.

without flanges. If the metacarpo-phalangeal joint is to be controlled the splint must include the palm (metacarpus). If the fingers are to be flexed they

may be bandaged over a roll of bandage or a ball of yarn.

The wrist, forearm, elbow, and upper arm are pretty readily fixed in the posture of choice by plaster-of-Paris splints of either the tubular or gutter type.

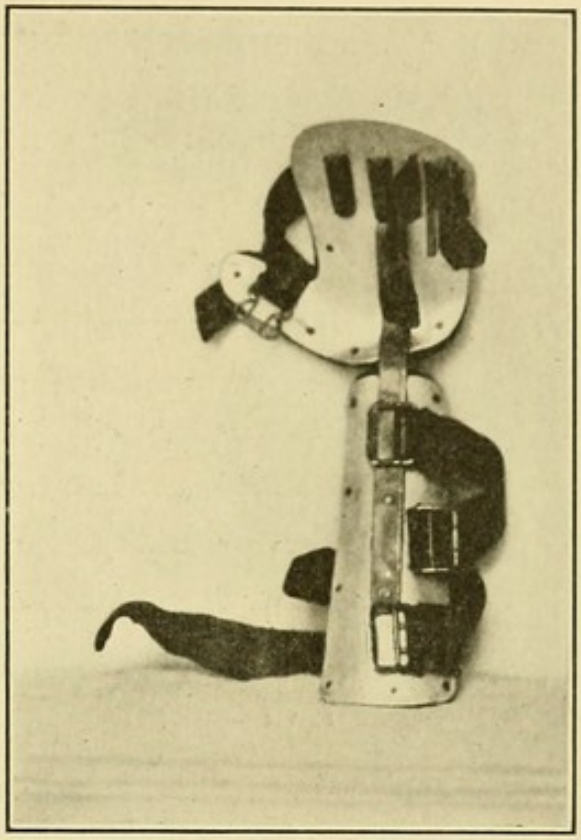


Fig. 243.—Splint for Wrist and Hand.

Padded wire splints, and bar and band splints, may be used for the elbow, as at the knee. A wrist splint should include the hand, and often the fingers, and may consist of aluminium or other thin metal applied to the palmar surface, and bent up at the wrist. It may be bandaged in place, or secured by straps below the elbow, over the wrist and metacarpus (Figs. 122 and 243).

The shoulder and elbow may also be relatively immobilized by the neck halter, a simple and ingenious device of Thomas, by carrying the arm in a sling or by pinning the sleeve to the top of the jacket by a safety pin (Fig. 111). If it is desired to immobilize the shoulder with the arm abducted, a shoulder cap or spica of plaster encircling the upper thorax may be used (Fig. 117).

The elbow may be kept in acute flexion by strap-

ping the forearm against the upper arm with adhesive plaster.

Spinal Splints, Frames, Jackets, Corsets, and Braces.—Efficient spinal appliances give lateral as well as anterior and posterior support. They are practically all fixation splints, no matter what their construction, as will appear after a complete study of their mechanical effect. The only real spinal traction is by head suspension, which cannot be long maintained, or by weight and pulley or frame traction in recumbency.

The different so-called suspension and traction appliances are merely different ways of applying leverage to the spine, and they are efficient in proportion as they do actually fulfill the conditions of an effective lever. It has been thought by some that recumbency alone would relieve the sore or weakened spine of superincumbent weight, and thus furnish relief. This method has been extensively tried with poor results, and it is easy to see that an ordinary bed could hardly furnish the necessary conditions for efficient fixation, even if the patient could lie without moving, which is impossible. While periods of recumbency are indispensable in the acute stage of spinal disease, they must be supplemented by definite mechanical support to the spine.

Antero-posterior Spinal Splints. — The *Whitman frame* is the simplest and most practical of all the gutters, cuirasses, plaster-of-Paris beds, and similar appliances to enforce recumbency and at the same time give definite spinal support. It is the appliance of choice in the early stages, and may be used for a year or more in children under three, and even for older children,

suffering from both hip and spinal disease, bilateral hip disease, or multiple joint involvement. A wire frame was used by Bradford many years ago, but has been so radically modified by Whitman as to require a different name. The Whitman frame is an elongated quadrilat-

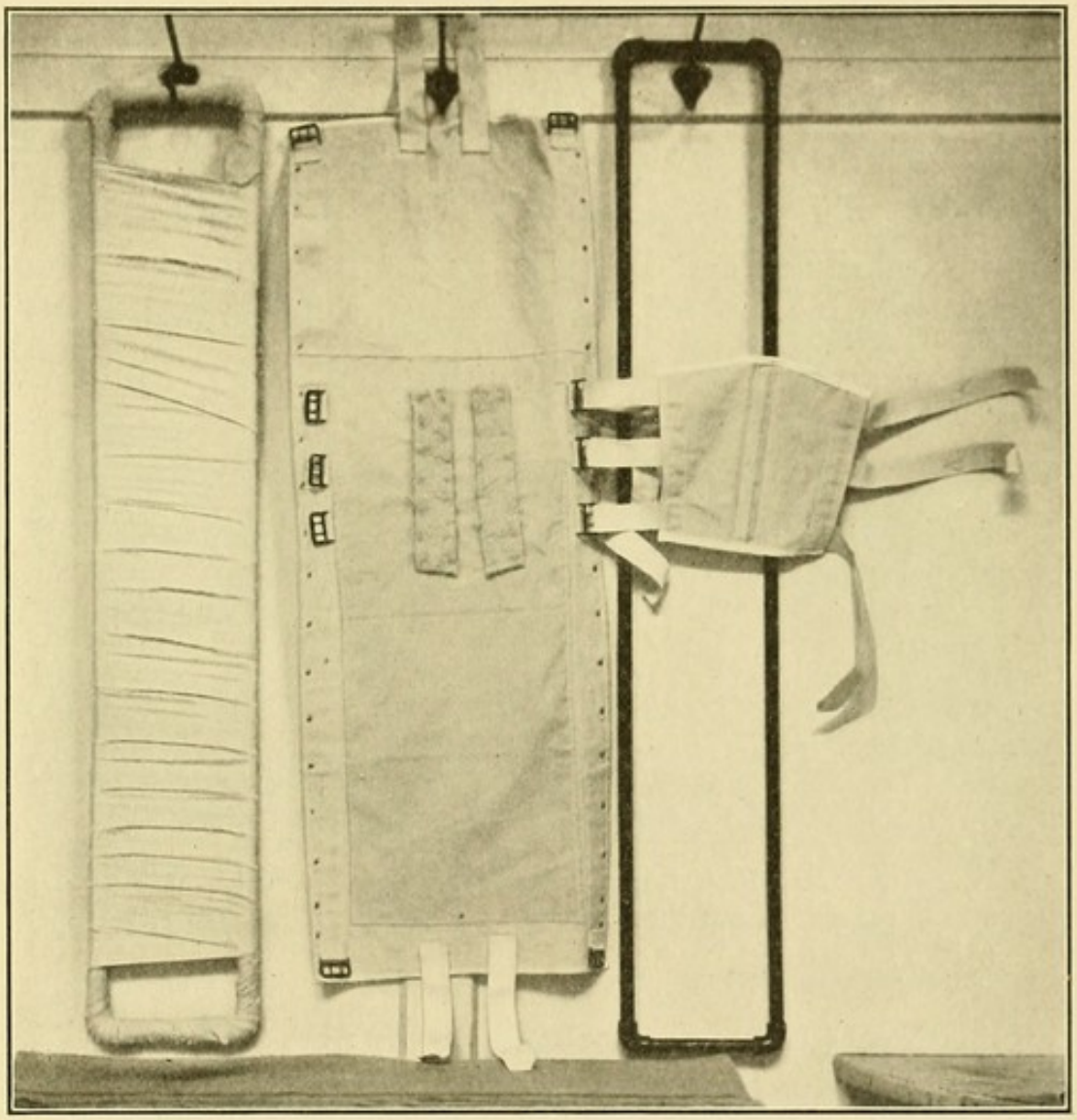


Fig. 244.—Whitman Frame Uncovered at Right, Bandaged at Left; Canvas Cover Showing Pads and Apron in Middle.

eral of quarter-inch (caliber) gas pipe, made a foot longer than the recumbent patient, and as wide as the distance between the outer sides of the anterior superior

iliac spines. A child a year old takes a frame five inches wide. The frame is covered with black enamel, to prevent rusting, and a canvas cover is made for it, which wraps around it and is laced up tight behind. The frame should be bandaged before the canvas is applied. The part of the canvas under the child's buttocks and thighs is covered with rubber cloth. The position of the kyphos is marked on the canvas, and two thick felt pads six or eight inches long are sewed to the canvas near together opposite this point, to give definite pressure over the laminæ of the affected region, as do the pads of a spinal splint (Fig. 244). The upper part of the frame is then bent back, over the edge of the table, at the point of the

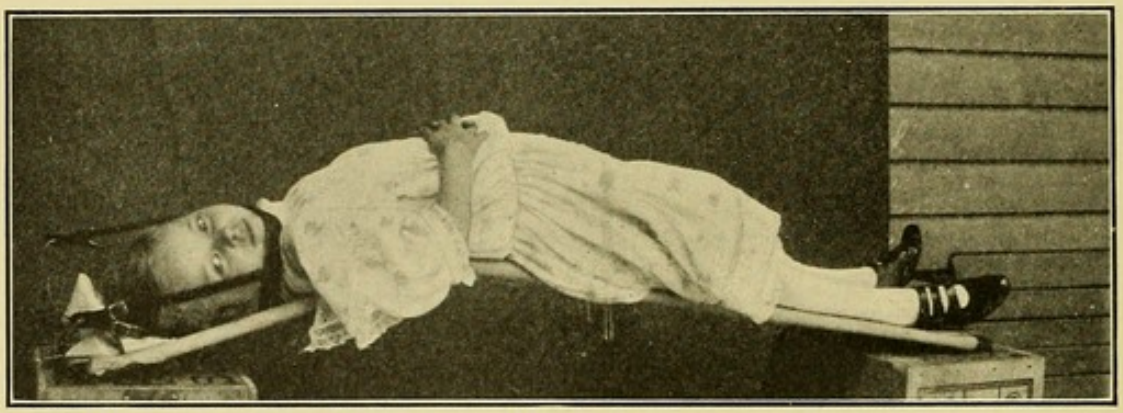


FIG. 245.—WHITMAN FRAME WITH HEAD TRACTION. This patient is making a good recovery from tuberculosis of the spine, hip, and wrist tendons. (Albee.)

projection, to allow the head to drop back and to increase the leverage. If the disease is high up, a T is added at the upper end, to which a head halter is attached (Figs. 95 and 245); traction may be increased by adding T pieces at the foot of the frame and attaching their straps to adhesive plasters on the leg; this is especially indicated in the hip cases. The child is fastened

to the frame by a canvas apron strapped to buckles at the back of the frame, where they cannot be reached by the child. The child may be carefully rolled off the frame once a day and the back rubbed with alcohol and powdered; it should never sit up. The clothes may be put on the child fastening behind, and including the frame, and the child may be carried about on the frame, which may also be placed on a long perambulator. Children may be kept a year or longer on such a frame with marked benefit, if properly cared for. The ribs and tissues flatten out behind after long confinement on a frame, giving the back a flat appearance.

The *plaster-of-Paris jacket*, properly applied, is an invaluable splint, especially in hospital and dispensary practice; it needs to be supplemented with recumbency in the acute stages of the disease. The term "jacket" is used here to indicate a fixed splint, the word "corset" being reserved for removable splints of whatever material. A fixed jacket is always worn until the patient is convalescent—a matter of years.

The problem of splinting the spine is a difficult one; jackets should be long, strong, and snug, and applied in proper posture. Jackets as usually applied by the inexpert are inefficient; they make the back sore or get soft, or the patient slowly doubles up inside of them. The plaster jacket may be applied either in the vertical or horizontal posture. The vertical posture is the one in common use, and on the whole gives the best results. The jacket is applied with the body wholly or partly suspended from the head by a head halter and traction pulleys. The compound pulleys may be attached to a

hook screwed over a doorway or into an overhead beam. The conventional tripod has always seemed to the writer an extremely clumsy and superfluous contrivance. All that is needed is a strong screw hook, compound pulleys and cord, a cross-piece of wood, and a bandage. For office or hospital use, where no beam is at hand, a projecting bracket is far better than a tripod, and for a portable appliance Wilson's adjustable bracket, which separates into three small pieces, is more convenient, as it is light and can be carried in a suit case, and can be adjusted to the top of a door without screws. A stick of wood with screw rings in the middle and at each end, and a bandage take the place of the cross-piece and head sling (Fig. 246). The patient is covered with a thin, sleeveless undershirt, or stockinette tubing twice as long as the jacket; this is tied together with a bit of bandage over the shoulders. It is well to hang strips of silent cloth four or five inches wide down the front, back, and sides, to prevent chafing; they may be suspended by folding the ends under the upper edge of the stockinette. It is also important to apply thick felt pads six or eight inches along either side of the kyphos. If a dinner pad is desired, a towel folded zigzag may be placed over the epigastrium, with an end projecting below, for removal. The dinner pad is not much used at the Hospital for the Ruptured and Crippled. In women the breasts should be protected by a compress of cotton. The patient stretches the arms up and grasps the cross-piece or bandage, and is carefully drawn up by the pulley cord until only the toes rest on the ground; the cord is fastened so that it can be quickly released, or given to an assistant

to hold. The operator, seated behind the patient, draws the patient's legs slightly back and steadies them between his knees. An assistant, seated in front, is desirable but not essential. Plaster bandages five inches wide

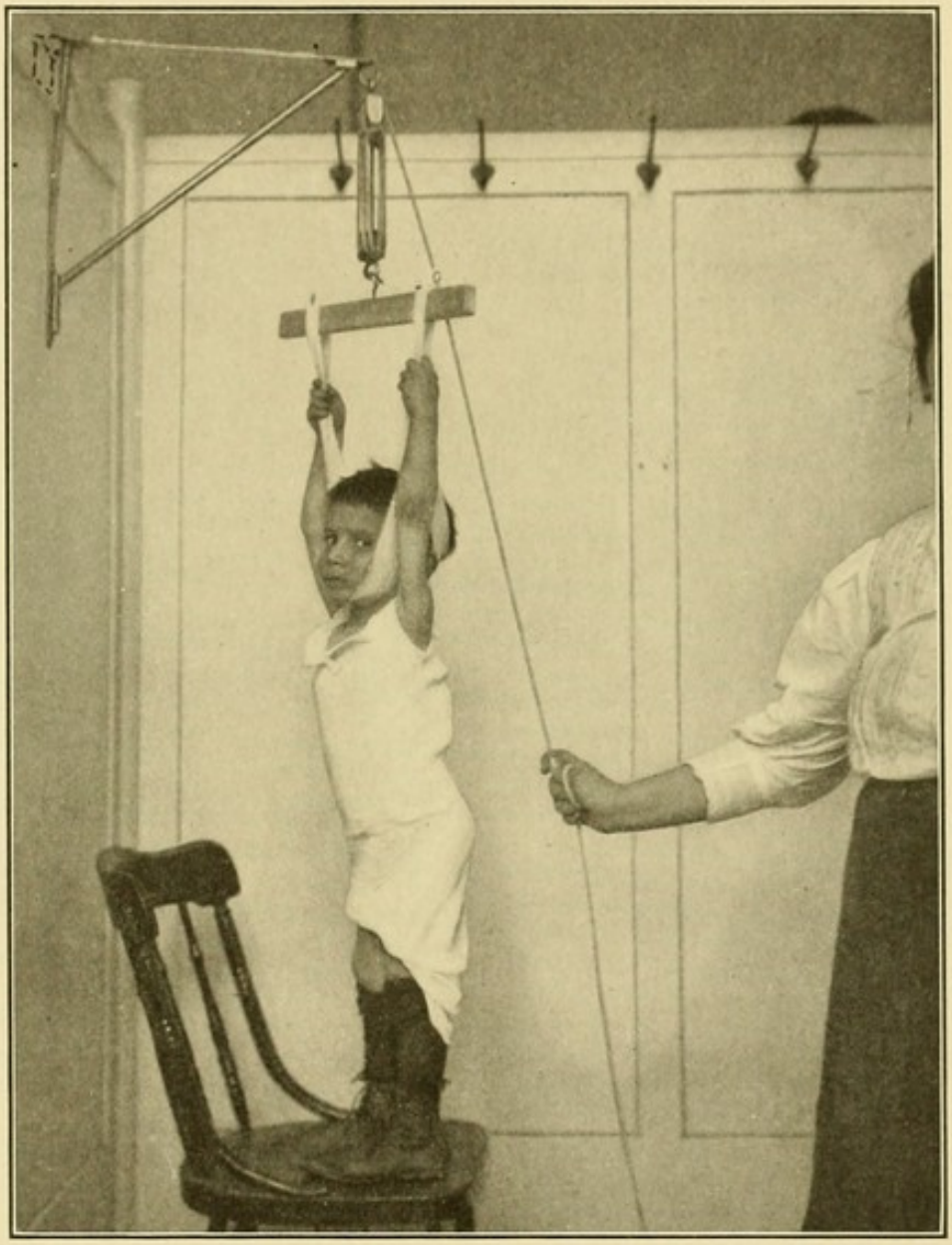


Fig. 246.—Suspension from Wilson's Adjustable Bracket, by Wooden Cross-Piece and Bandage.

and six yards long are thoroughly soaked in a pail of tepid water, and applied pretty wet. The operator may begin below and include the pelvis, first bringing the

plaster as low as the pubes in front and to the commissure of the nates behind. By spiral and crisscross turns the jacket is applied to the torso, turning in darts where there is superfluous bandage, and rubbing the turns as they are applied. The jacket is gradually prolonged upward, bringing it up to the episternal notch in front and to the base of the neck behind. Barnett, at the Hospital for the Ruptured and Crippled, prefers to apply the bandages from the top downward, and gets excellent results. The jacket must be made thick at the upper and lower edges. Before it is set it is well molded over the trochanters and iliac crests, as it is essential that the jacket have a firm grip on the pelvis to furnish a stable base. After it is finished and well rubbed down it is trimmed above and below, and well hollowed below the axillæ, and over the groins to permit sitting. The stockinette, which has been left long, is then drawn up and stitched to its upper border to make a covering for the jacket. In ten minutes the jacket is sufficiently dry to hold its shape when the patient is let down; it will not be thoroughly dry until the next day. A jacket for a small child takes four bandages of the size mentioned, and weighs a pound and a half. For an adult seven or eight bandages are needed. The jacket may also be applied with the patient lying face down on a sling or hammock, made of muslin. A strip of muslin two and a half yards long is split into five tails at each end, and the two outer tails at each corner tied to the two chairs placed back to back two yards apart. The chairs must be secured to a plank passed over the rounds, or an adult may sit on each chair. The patient is pre-

pared in the usual way, and is placed face down on the sling, the hands stretched upward and grasping the edge of the hammock. The plaster is then applied in the usual way, and the muslin may be cut off and drawn out, when the jacket is finished.

If the usual cross-piece carrying the head halter is fastened to a hook three feet from the floor, and the patient's feet are grasped by an assistant, holding the child in the horizontal posture, the effect is the same. There is a large number of frames, rests, and other devices for supporting the patient in the prone or supine posture, but they are not essential.

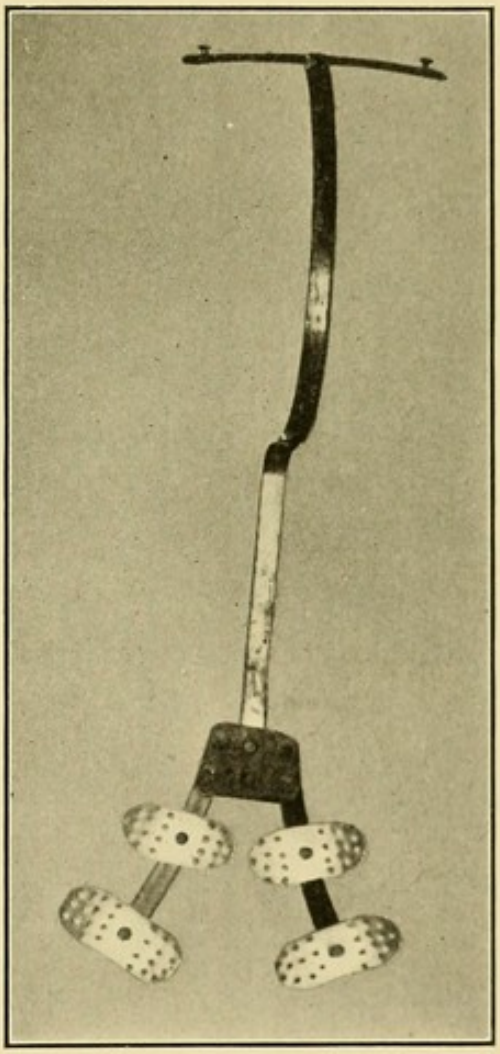


Fig. 247.—Jury Mast.

The conventional jacket, as described, does not give efficient support above the ninth dorsal vertebra, and when the disease is above this point the leverage must be prolonged upward. This is usually done by adding a jury mast and sling for head support, and to pull the head backward (Figs. 96 and 247). The lower end of the jury mast is incorporated in the plaster when the jacket is applied. Calot,

for the same purpose, prolongs the jacket upward, bringing the plaster in front of and over the shoulders, or includes the neck, chin, and occiput, or even the whole head (Figs. 97, 98, 99, and 248). He also cuts a large window in front, since this is not needed for a counter pressure, and a narrow one behind, over the kyphos, through which cotton is packed to make firmer pressure in order to reduce the deformity; the window is then replaced and bandaged down with a few turns of plaster bandage. The plaster head support is mechanically better than the Sayre jury mast, but is untidy and none too comfortable. When there is psoas contraction a short spica may be combined with the jacket, and if the disease is at the lumbo-sacral junction, a double spica reaching to the axillæ should be applied, or the child placed upon a frame.

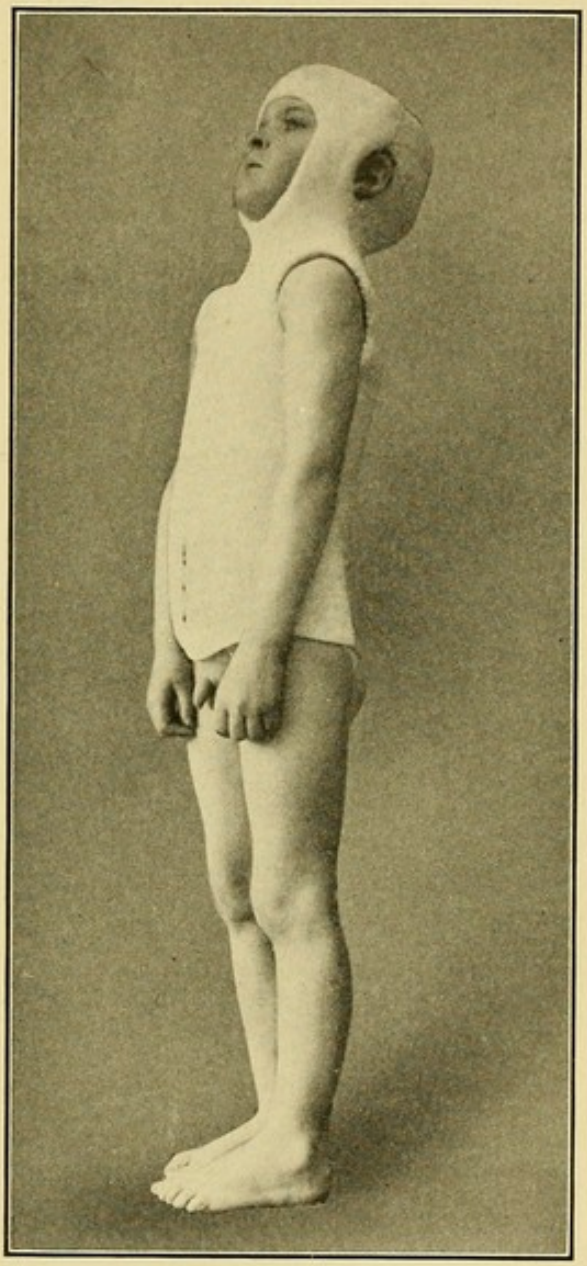


Fig. 248.—Plaster Jacket Including Head and Neck. (Starr and Gallie.)

When the jacket is applied for scoliosis the leverage

is usually from the side or diagonally. It should be applied in suspension or on a corrective frame, and it is well to pad out the hollow side with a cotton pad, which is to be removed. If the shoulders and neck are included the leverage will be increased.

Removable jackets are called *corsets*. Corsets should be used for cases of Pott's disease only after pathological convalescence; in other words, when the patient is practically well and needs only moderate support. The plaster is applied to the patient as for a plaster jacket; when the plaster has set it is cut down in front and sprung off. It is then dried at 300° for a day; the edges are trimmed, bound with buckskin or rubber adhesive, and a row of hooks for lacing is sewed on either side of the cut (Fig. 76). The corset should be laced when the patient is lying on the back, as it can be laced tighter in this posture. Corsets for scoliosis should be made over a cotton pad on the flattened side, which is removed when the corset is finished, and the leverage may be increased by adding layers of felt inside the corset over the prominence. Jackets and corsets, if made over a cast of the torso, may be made of paper, felt, celluloid, and leather (see p. 419). The complicated scoliosis splints of the shops, some of which purport to reduce torsion, are usually valueless. It seems practically impossible to grasp the pelvis firmly enough, nor will the patient bear sufficient continuous pressure to produce detorsion; in any event, the spinal column can be only indirectly attacked.

The *Van Winkle corset brace* is a spinal splint in the form of a woman's corset; it has given great satisfaction in light and medium cases of scoliosis and round-back

(Fig. 73). A long, straight corset of strong coutil is first made to measure; it is important to cut the material square with the fabric to avoid stretching, not bias as is usually done in corset making. At the first fitting strong steels are shaped to the sides of the back, but are made the same, thus exerting pressure on the prominent side and protecting the hollow side. A pair of thinner steels is fitted either side of the lacing, and another between the first two. At the second fitting the steels are incorporated in the corset, and broad shoulder straps are fitted which start at buttons under the arms, pass up in front of and over the shoulders, cross behind the scapulæ, where they are sewed, and attached to buckles in front of the iliac spine. These straps pull the shoulders backward and press the posterior borders of the scapulæ forward. To the front of the corset are attached strong stocking supporters, which, when tightened, incline the trunk slightly forward.

Steel Spinal Splints.—The simplest and most directly acting spinal splint is probably C. F. Taylor's, which has been much modified in various hands, but scarcely improved (Figs. 100 and 249). This apparatus is a spinal lever, consisting of two uprights, one and a quarter inches apart, riveted to a pelvic band of 17-gauge steel reinforced by a shorter band inside. The lower edge of the pelvic band just clears the trochanters and ends at a point just above their middle. The uprights, made of mild steel $\frac{9}{16}$ inch wide and 8 to 10 gauge, are shaped to a lead tracing of the back taken over the laminæ, not over the spinous processes; these carry steel pad plates three quarters to

seven eighths inch wide and six or eight inches long either side of the kyphos. Steel hooks curving over the shoulders near the neck are attached to the top of the back bars. The back bars are united by a cross bar at the axillary level, and a second cross bar two inches lower. The pad plates carry thick pads of felt or ground

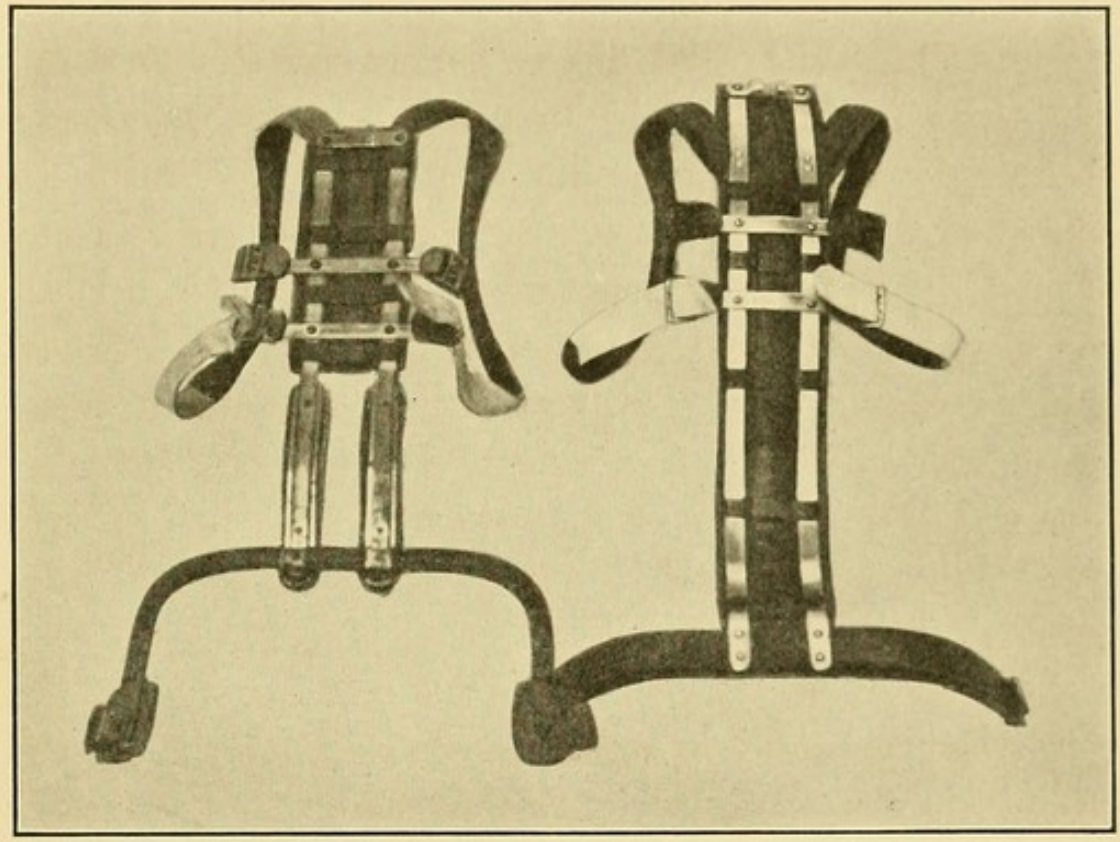


Fig. 249.—C. F. Taylor Spinal Splints; the One at the Left has the Vertical U Hip-Band; the One at the Right the Horizontal Hip-Band, which is Easier to Fit.

cork, the shoulder hooks carry padded webbing straps, and the cross pieces and pelvic band buckles at the ends. The bars and pelvic band are lined with leather, and the splint is completed by an apron of strong drilling, extending from the top of the sternum to the pubes in front, and is provided with webbing straps above and below, and two or three pairs in between. The padded

straps of the shoulder hooks buckle to the second cross bar, the upper straps of the apron buckling to the first. The leverage is exerted by the pull on the upper and lower apron straps and the shoulder straps. A chest piece similar to the front part of the clavicle splint (Figs. 109 and 110) may be used to increase the leverage in front. If the disease, however, is above the tenth dorsal, it is necessary to add a circular chin piece, occipital piece with forehead strap, or other device, to increase the leverage (Fig. 250). The splint should be worn day and night, and the child should never sit up when being bathed. The leverage and pressure may be modified as the case progresses by bending the back bars.

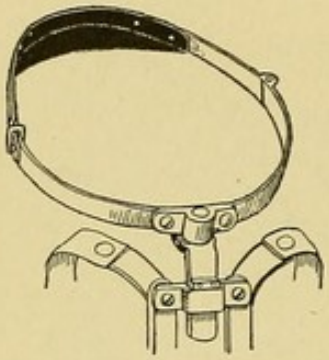


Fig. 250.—C. F. Taylor Circular Chin Support.

Neck Splints.—If spinal tuberculosis is located above the tenth dorsal vertebra, the leverage on the front of the chest is insufficient to give the proper support, and the splint should therefore be prolonged upward to grasp the head, and pull and tilt it backward. This may be done by adding neck and head parts to the jacket (Calot), by adding a steel jury mast to the jacket (Sayre), by adding a circular chin and head rest (C. F. Taylor), and by other devices.

The jury mast may be made of $\frac{9}{16}$-inch steel of 8 gauge; it curves over the top of the head to the front, where it carries a steel cross piece, with pins or hooks for attaching the head better. The jury mast should be made rigid, and is therefore not properly a head spring.

The leverage is obtained by tightening the head halter; there is little or no vertical traction in practice.

The Taylor chin rest is a rigid steel ring, cut at one side, where it may be clamped together, and jointed on

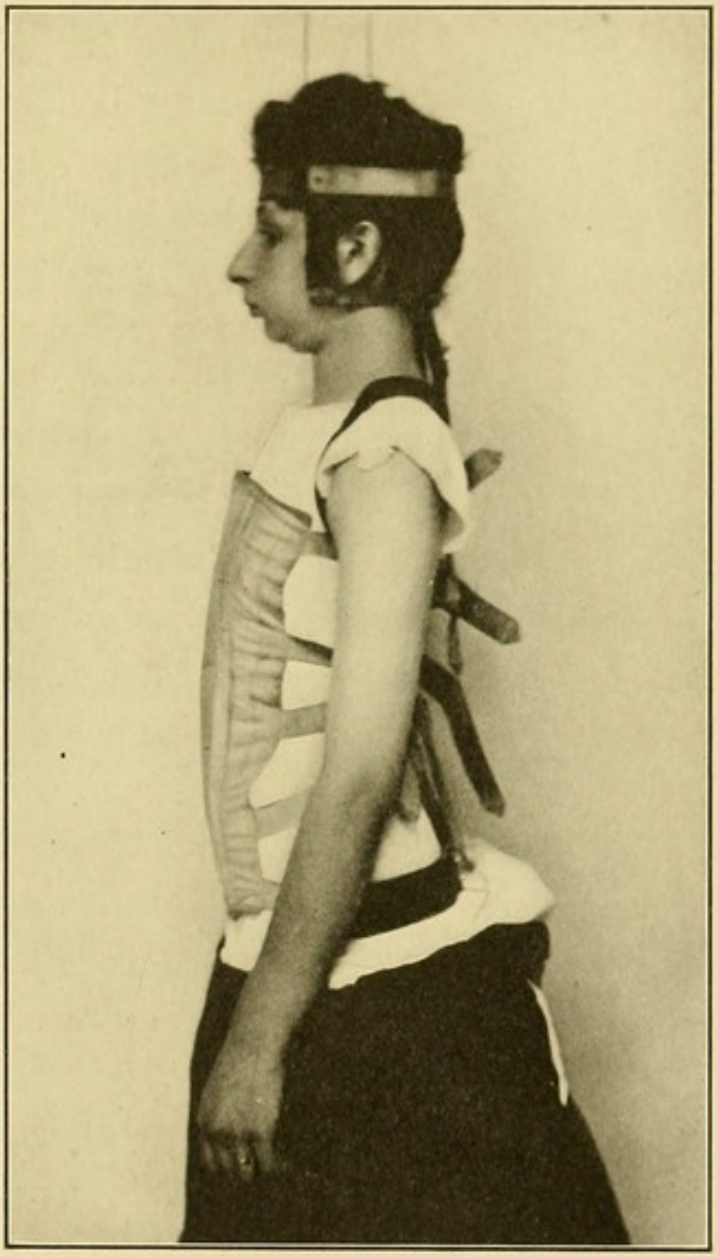


Fig. 251.—Taylor Back Splint Applied. This patient had recession of the chin, and the chin support was changed for a forehead strap.

the opposite side. It carries a hard rubber rest for the chin in front and a socket behind, which is placed over a

pivot at the top of the spinal splint. The tilt may be increased or diminished by bending the pivot bar. Liberal motion is usually allowed unless the disease is very high up, when the pivot joint may be clamped by a screw. Both the head halter and chin rest sometimes cause recession of the chin if worn for a long time. This may be obviated by omitting the chin cup in either case and using only a strap under the chin. This may be used with the head rest by cutting away the front and adding two vertical bars at the sides of the occiput, which turn forward above the ears to the sides of the forehead where the chin strap is attached, or by erecting from the half circle a bar in front of the ear as well as behind, and connecting them by a strap around the head (Fig. 251). This arrangement is somewhat less effective, but saves the chin from front pressure. Head supports

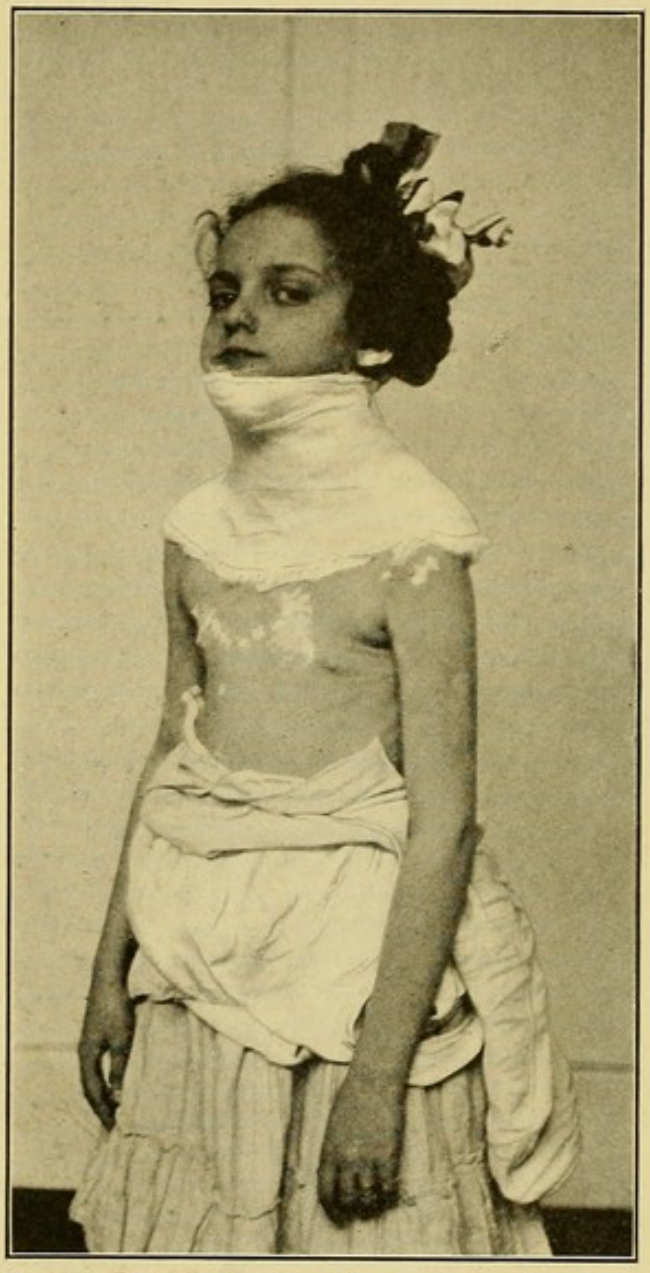


Fig. 252.—Plaster-of-Paris Neck Splint.

taking the shoulders for a base are not very efficient in active cervical tuberculosis, but are useful in some conditions where less perfect fixation is required. The Thomas collar is a leather tube much deeper in front, stuffed with hair or powdered cork. It opens behind, and fastens with a buckle. If constructed over a rigid padded frame, it keeps its shape better. A collar may be improvised by applying layers of cotton about the neck, thicker in front or on the side which needs most support, and held in place by a bandage over which adhesive plaster is wound.

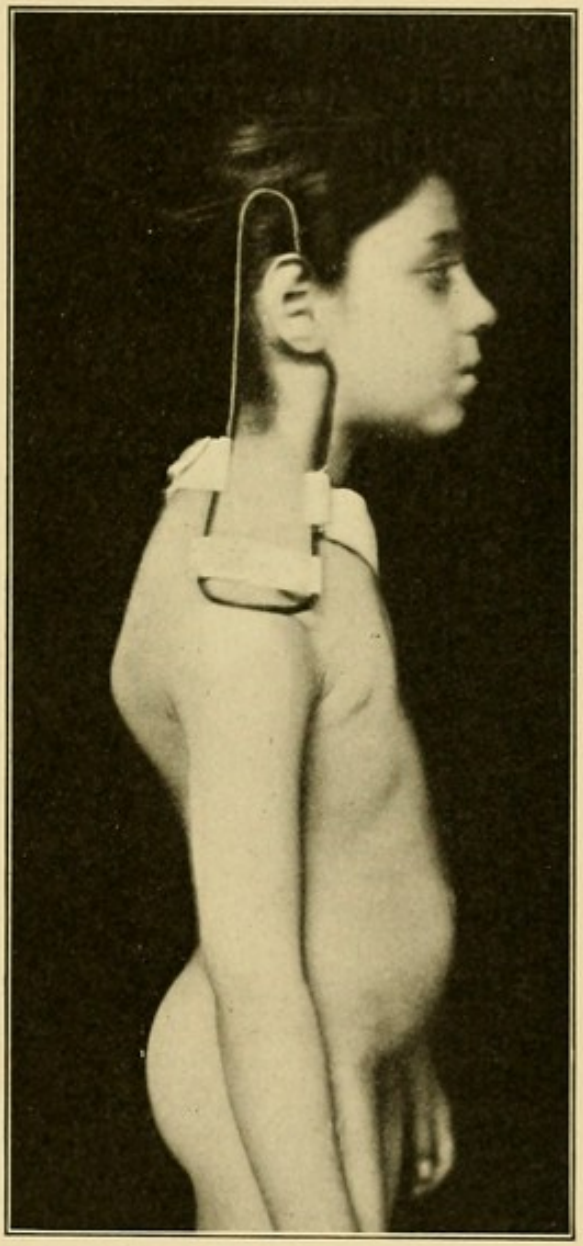


Fig. 253.—Wire Neck Splint for Lateral Support.

A plaster-of-Paris splint may be applied to the neck and shoulders (Fig. 252), or a wire skeleton splint may be applied to the head and shoulder of one side for lateral action; it should be wound with a bandage and be well padded; it may pass behind the ear or both sides of it, and is kept in place by a strap from the

middle, which passes under the arm of the opposite side and buckles to the middle in front (Fig. 253; see also Fig. 38). Such retention splints are useful in some of the forms of torticollis where the deformity is not great or where the splint does not have to be worn long. Where there is structural shortening of the sterno-mastoid or other muscles a stretching or cutting operation will be required.

LITERATURE

LITERATURE

A partial list of orthopedic literature fills a large volume, and has been published by Hoffa and Blenke. The titles given here are such recent works as have been of most value in the preparation of this volume.

AMERICAN AND ENGLISH

American Journal of Orthopedic Surgery, 1903 to date.

American Orthopedic Association Transactions, 1889–1902.

Bradford and Lovett, "Orthopedic Surgery," third edition. Wood, New York, 1905.

Dwight, "Variations of the Bones of the Hands and Feet." Lippincott, Philadelphia, 1907.

Lovett, "Lateral Curvature of the Spine." Blakiston, Philadelphia, 1907.

Roth, "Treatment of Lateral Curvature of the Spine," second edition. Lewis, London, 1899.

Taylor (R. Tunstall), "The Spine," Williams and Wilkins Co., Baltimore, 1907.

Thorndike, "A Manual of Orthopedic Surgery," Blakiston, Philadelphia, 1907.

Tubby, "Deformities." Macmillan, London, 1896.

Tubby and Jones, "Modern Methods in the Surgery of Paralysis." Macmillan, London, 1903.

Whitman, "Orthopedic Surgery," third edition. Lee, Philadelphia, 1907.

Waltham and Hughes, "Deformities of the Human Foot." Wood, New York, 1895.

FRENCH

Berger et Banzet, "Chirurgie orthopédique." Steinheil, Paris, 1904.

Calot, "Luxation congénitale de le hanche." Masson, Paris, 1905.

Calot, "Tumeurs blanches." Masson, Paris, 1906.

Ducroquet, "Traité de thérapeutique orthopédique." I. Les tuberculoses osseuses. Rousset, Paris, 1907.

Kirmisson, "Traité des maladies chirurgicales d'origine congénitale." Masson, Paris, 1898.

Redard, "Traité pratique des deviations de la colonne vertebrale." Masson, Paris, 1900.

Redard, "Technique orthopédique." Rudeval, Paris, 1907.

Revue d'orthopédie, 1890 to date. Edited by Kirmisson. Masson, Paris.

GERMAN

Archiv für Orthopädie, Mechanotherapie und Unfallchirurgie. Edited by Riedinger. Bergmann, Wiesbaden, 1903 to date.

Handbuch der Orthopädischen Chirurgie. Edited by Joachimsthal. Fischer, Jena, 1904–1907.

Haudek, "Grundriss der Orthopädischen Chirurgie." Enke, Stuttgart, 1906.

Hoffa, "Orthopädische Chirurgie," fifth edition. Enke, Stuttgart, 1906.

Hoffa and Blenke, "Die Orthopädische Literatur." Enke, Stuttgart, 1905.

Klapp, "Funktionelle Behandlung der Skoliose." Fischer, Jena, 1907.

Klaussner, "Über Missbildungen." Bergmann, Wiesbaden, 1902.

König, "Tuberkulose der Menschlichen Gelenke." Hirschwald, Berlin, 1906.

Krause, "Tuberkulose der Knochen und Gelenke." *Deutsche Chirurgie,* No. 28A. Enke, Stuttgart, 1899.

Lorenz, "Heilung der Angeborenen Hüftgelenksverrenkungen." Deuticke, Leipzig, 1900.

Lüning und Schulthess, "Atlas und Grundriss der Orthopädischen Chirurgie." Lehmann, Munich, 1901.

Von Mikulicz und Tomasczewski, "Orthopädische Gymnastik." Fischer, Jena, 1902.

Schanz, "Handbuch der Orthopädischen Technik." Fischer, Jena, 1908.

Schuchardt, "Krankheiten der Knochen und Gelenke." *Deutsche Chirurgie*, Lieferung 28. Enke, Stuttgart, 1899.

Zeitschrift für Orthopädische Chirurgie. Edited by Hoffa. Enke, Stuttgart, 1892 to date.

Zentralblatt für Chirurgische und Mechanische Orthopädie. Edited by Vulpius. Karger, Berlin, 1907 to date.

Preliminary Studies by the Author

(Upon Which Parts of the Present Volume are Based)

General

"Principles and Methods of Examination in Orthopedic Practice." *Maryland Medical Journal*, July 20, 1889.

"The Orthopedic Examination of Children." *Post-Graduate*, January, 1907.

"Infantile Scorbutus." *American Medico-Surgical Bulletin*, February 1, 1894.

"Infantile Scorbutus and Its Relation to Orthopedic Practice." *Archives of Pediatrics*, September, 1894.

"Surgery of Rickets." *Journal of American Medical Association*, October 11, 1902.

"Osteitis Deformans (Paget)." *Medical Record*, January 21, 1893.

"Chronic Joint Disease in Children." *Medical News*, August 19, 1902.

"Mechanical Treatment of Non-tuberculous Joint Infections." *New York State Journal of Medicine*, April, 1907.

"The Management of Infantile Cerebral Palsies." *Medical Progress*, October, 1896.

"The Treatment of Tuberculous Joint Disease." *Post-Graduate*, October, 1907.

"The Fresh Air Treatment of Surgical Tuberculosis." *Post-Graduate*, Memorial Volume, 1908.

"Remarks on the Management of Suppuration Complicating Tuberculous Disease of the Bones and Joints." *Annals of Surgery*, April, 1893.

"Reports on Orthopedic Surgery." *New York Medical Journal*, February 25, July 8, December 30, 1893; September 15, 1894.

"The Present Status of Practical Orthopedics." *Medical News*, October 2, 1897.

"Recent Advances in Orthopedic Surgery." *Medical News*, October 10, 1903.

THORAX AND SPINE

"Imperfect Development of the Right Pectoralis Major and Right Scapula." *Pediatrics*, February 15, 1900.

"Deformities of the Chest." *Reference Handbook of the Medical Sciences*, 1901.

"Treatment of Lateral Curvature of the Spine." *New York Medical Journal*, November 15, 1890.

"Congenital Lateral Curvature of the Spine." *Pediatrics*, January 15, 1900.

"Neurotic Spine." *Pediatrics*, November 15, 1899.

"Location, Age, and Sex in Pott's Disease of the Spine." *Medical Record*, August 13, 1881.

"The Paralysis of Pott's Disease and Its Behavior Under Protective Treatment" (with R. W. Lovett). *Medical Record*, June 19, 1886.

"The Cure of Pott's Disease with Recession of the Deformity." *Medical Record*, January 8, 1887.

"A Case of Pott's Disease with Unusual Deformity. Description of Improved Spinal Apparatus." *Medical Record*, November 19, 1887.

"The Value of Mechanical Treatment in Old and Neglected Cases of Pott's Disease." *Medical News,* December 5, 1891.

"Improved Apparatus for Pott's Disease of the Spine." *Canada Medical Record,* November, 1893.

"Growth in Spondylitics." *New York Medical Journal,* October 8, 1898.

"A Bivalve Plastic Splint for Pott's Disease." *Pediatrics,* 1898.

"Final Results After the Mechanical Treatment of Pott's Disease." *Transactions American Orthopedic Association,* 1902.

"Ultimate Results of Mechanical Treatment of Pott's Disease in Dispensary Practice." *American Journal of Orthopedic Surgery,* October, 1904.

"Common Deformities of the Spine." *Post-Graduate,* July,1904.

UPPER EXTREMITY

"A New Clavicle Splint." *Pediatrics,* December 1, 1899.

"Isolated Fracture of the Greater Tuberosity of the Humerus." *Annals of Surgery,* January, 1908.

"Congenital Absence of the Radius." *Transactions American Orthopedic Association,* 1897.

LOWER EXTREMITY

"Primary Crural Asymmetry." *Medical Record,* August 13, 1881.

"Two Cases of a Peculiar Type of Primary Crural Asymmetry." *University Medical Magazine,* October, 1891.

"Affections of the Sacro-iliac Joints." *Post-Graduate,* September, 1905.

HIP

"Laxity of the Ligaments with Congenital Hip Luxation." *New England Medical Monthly,* February, 1898.

"Peripheral Palsies Following Manual Replacement of the Congenitally Dislocated Hip." *New York Medical Journal,* August 8, 1903.

"Progress in the Treatment of Congenital Hip Dislocation." *Post-Graduate,* October, 1903.

"Case of Congenital Supracotyloid Dislocation of the Hips with Cross-legged Progression." *American Medicine*, September 24, 1904.

"The Mechanical Treatment of Senile Coxitis." *New York Medical Journal*, December 15, 1888.

"A New Method for Overcoming Adduction at the Hip-joint." *New York Medical Journal*, November, 19, 1887.

"The Rational Treatment of Hip Disease." *Times and Register*, April 26, 1890.

"Adjusted Locomotion in the Recovering Stage of Hip-joint Disease." *New York Medical Journal*, July 11, 1891.

"The Prevention and Treatment of Crural Adduction." *Medical News*, March 23, 1889.

"Improved Long Traction Hip-splint, with Proper Method of Applying Adhesive Plaster." *Southern Medical Record*, November, 1893.

"Ankylosis of the Hip Joint." *Pediatrics*, August 15, 1899.

"Retardation of Growth as a Cause of Shortening After Coxitis." *Philadelphia Medical Journal*, January 26, 1901.

KNEE AND LEG

"A Ready Method for Counter-extension at the Knee." *Boston Medical and Surgical Journal*, October 16, 1890.

"The Mechanical Treatment of Osteitis of the Knee." *New York Medical Journal*, November 18, 1893.

"The Thomas Knee-splint." *Pediatrics*, March 1, 1900.

"The Effect of Osteitis of the Knee on the Growth of the Limb." *New York Medical Journal*, April 19, 1902.

"Deformity Following Excision of the Knee." *Pediatrics*, December 15, 1899.

"Enlargement of the Tibial Tubercle." *Pediatrics*, August 1, 1899.

"Affections and Injuries of the Patella." *Reference Handbook of the Medical Sciences*, 1903.

"Congenital Luxation of the Knee." *Pediatrics*, February 1, 1896.

"Specific Necrosis of the Shaft of the Tibia." *Pediatrics*, September 15, 1899.

"Absence of Fibula." *Pediatrics*, October, 1899.

FOOT

"The Treatment of Pes Equino-Varus by Continuous Leverage." *Medical Record*, March 8, 1890.

"The Treatment of Club-foot by Continuous Leverage." *New York Medical Journal*, November 19, 1892.

"Congenital Club-foot; Equino-Varus." *Pediatrics*, September 1, 1899.

"Double Paralytic Varus from Peripheral Neuritis." *Pediatrics*, January 1, 1900.

"Practical Importance of Correct Foot Postures." *American Journal of Orthopedic Surgery*, July, 1905.

"Ingrown Toe-nail Mechanically Treated." *American Medico-Surgical Bulletin*, June 20, 1896.

THERAPEUTIC EXERCISES AND PHYSICAL TRAINING

"Hygiene of Reflex Action." *Journal of Nervous and Mental Disease*, March, 1888.

"American Childhood from a Medical Standpoint." *Popular Science Monthly*, October, 1892.

"Exercise as a Remedy." *Popular Science Monthly*, March, 1896.

"Therapeutic Value of Systematic Passive Respiratory Movements." *Medical Record*, May 4, 1889.

"Physical Training in the Public Schools." *Dietetic and Hygienic Gazette*, September, 1897.

"Exercise and Vigor." *American Physical Education Review*, December, 1898.

"Exercise." *Practical Therapeutics*, 1896.

"Massage." *Practical Therapeutics*, 1896.

"Infantile Athletics." *Babyhood*, May, 1897.

"The Work of Charles Fayette Taylor, M.D., in the Field of Therapeutic Exercises." *American Physical Education Review*, September, 1899.

"The Foot in Gymnastics." *American Physical Education Review*, December, 1902.

"The Dancing Foot." *American Physical Education Review*, June, 1905.

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