

function is necessary for any length of time, as in the chronic cases, it is well to apply a leg brace to the shoe with a joint at the ankle so arranged as to prevent dorsal flexion beyond a right angle. As patients are usually sensitive to direct jar, a rubber heel should be employed, and an increased height of the heel sufficient to throw the weight forward upon the front of the foot usually lessens the discomfort.

As has been stated, in the chronic cases there is usually an accompanying weakness of the longitudinal arch. This may require the application of a support and further treatment as described in the section on the weak foot.

Operative Treatment.—In persistent cases, particularly those in which the bursa is palpable and in which the adjoining tissues of the os calcis are infiltrated, the removal of the bursa is indicated. This is accomplished by an incision beside the insertion of the tendon where the bursa is most prominent. Irregularities of the underlying bone should be removed at the same time. The wound is then closed and a plaster bandage is applied. This should be worn until the patient can walk without discomfort. Support may or may not be required in the after-treatment. Operative intervention is of course indicated when suppuration of the sac is present or when it is the seat of primary or secondary tuberculous disease. As has been stated, the local disability may be induced or prolonged by systemic disease. In such instances appropriate remedies should be employed.

XII. ACHILLO-BURSITIS POSTERIOR.—A small sensitive bursa over the insertion of the tendon, between it and the skin, sometimes causes symptoms resembling those of the preceding affection. This bursa is usually caused by the pressure of the shoe, and it may be relieved by removing the exciting cause and by strapping with adhesive plaster.

Bursæ or sensitive points elsewhere on the heel are to be treated in a similar manner. Irregular projections on the bone may require removal.

XIII. STRAIN OF THE TENDO ACHILLIS.—Pain on use of the foot referred to the tendo Achillis may follow strain or overuse, the symptoms may resemble those of Achillo-bursitis, but the sensitive point is often localized at the middle of the tendon or at the junction with the muscular substance. Apparently there is, in these cases, an irritation within the fibrous sheath of the tendon or injury to the muscular fibres.

The treatment is functional rest. As a rule the application of the adhesive-plaster strapping, as described in the treatment of Achillo-bursitis, is effective.

XIV. PAINFUL HEEL—CALCANEAL-BURSITIS.—Pain and sensitiveness to pressure referred to the bottom of the heel are common symptoms of the contracted or hollow foot, in which there is abnormal pressure on the anterior and posterior pillars of the arch. It may be in normal feet a symptom of overuse, as when the tissues beneath the heel become sensitive after long standing or walking, and it is a common symptom of the weak foot of which the so-called heel walk is characteristic.

In rare instances the point of tenderness is distinctly localized and is due to a small inflamed bursa lying over the periosteum of the inner tuberosity of the os calcis.

Treatment.—This must be directed to the condition of which the pain is a symptom. The treatment of the weak foot and of the contracted foot is described elsewhere. If the sensitiveness is due to overuse or to abnormal pressure, the use of a rubber heel combined with frequent change from the passive attitude, in which the weight is supported entirely on the sensitive part, may relieve the symptoms. In many instances the use of an arched foot plate, to distribute the pressure along the entire sole, is of service.

Painful bursæ may be protected from direct pressure or removed if necessary. *Royal Whitman.*

FOOT, DISTORTIONS OF.—TALIPES.—In the preceding article, the disabilities of the foot of which the discomfort is of greater importance than the deformity

have been described. One may now consider those of congenital and acquired origin of which deformity is the most noticeable feature. A distortion of the foot of this class is simply an abnormal retention of a normal attitude, or what is an exaggeration of a normal attitude. In other words the centres of motion, at which the foot is deformed, are the centres of normal motion and the different distortions may be simulated by a normal subject. If the foot has been fixed in the abnormal attitude during foetal life, or if it has been used for any length of time in the abnormal position, the deformity becomes exaggerated beyond the possibility of imitation, and secondary variations in its shape, size, and nutrition follow.

The deformities of the foot are grouped under the generic name talipes, derived from talus (ankle) and pes (foot), signifying therefore a form of deformity in which the patient walks upon his ankles. Talipes was therefore originally synonymous with the popular term club foot, but at the present time it is used preferably as a prefix to the descriptive titles of the different distortions, while club foot is usually applied only to the most common of the deformities, equino-varus, in which the distorted foot is club-like in form.

VARIETIES.—There are four simple varieties of the distorted foot or talipes:

1. *Talipes Equinus*, the extended or plantar-flexed foot. In well-marked cases the patient walks upon the heads of the metatarsal bone, an attitude that suggested the name equinus (horse-like).

2. *Talipes Calcaneus*, the dorsi-flexed foot in which the heel is prominent, and which alone bears the weight in walking; hence, calcaneus from calcaneum, the heel bone.

In these forms the centre of motion is at the ankle joint. Under the terms equinus and calcaneus are included not only the cases of marked deformity, but also those in which the range of dorsal or plantar flexion is sufficiently limited to cause a change in the contour of the foot.

3. *Talipes Varus*, the inverted foot. In this deformity the foot is turned in or adducted, and combined with the inward twist, which exaggerates the normal curve of the inner border, there is always a certain amount of supination, or inversion; that is, the inner border of the sole is elevated and the outer border is depressed, so that the weight falls to the outer side of the centre of the foot.

4. *Talipes Valgus*, the everted foot. This deformity is the reverse of varus. The foot is abducted, that is, the foot is twisted outward at the centre and pronated, so that in use the weight falls on the inner border.

In these forms of lateral deformity the centres of motion are at the mediotarsal and subastragaloid joints.

These simple deformities in which the foot is persistently extended or flexed, or twisted in or out, are comparatively uncommon.

Compound Deformities.—As a rule, the deformities are combined in varying degree; thus, the over-extended or the over-flexed foot is usually twisted inward or outward, making four varieties of compound deformity. 1. *Talipes equino-varus*—downward and inward. 2. *Talipes equino-valgus*—downward and outward. 3. *Talipes calcaneo-varus*—upward and inward. 4. *Talipes calcaneo-valgus*—upward and outward.

In the simple and compound varieties of talipes the arch of the foot may be increased or diminished in depth. It is, for example, usually increased in calcaneus and equinus, and it is usually diminished in valgus; but this secondary or subordinate deformity is not recognized in the ordinary classification. If the arch of the foot is exaggerated, the condition is sometimes called *talipes cavus*; if it is lessened or lost, *talipes planus*. These slight degrees of distortion, in which the functional disability is far more important than the deformity, are rarely classed as forms of talipes. Simple cavus, the hollow or contracted foot; and planus, one of the forms of the common weak or flat foot, have been described already.

ETIOLOGY.—From the remedial standpoint, the cause

of the deformity is of far greater importance than its form. Thus the distortions of the foot fall primarily into two groups: 1. *The congenital form*, in which the foot has become deformed in process of formation. 2. *The acquired form*, in which the foot, perfect at birth, has at a later time become distorted.

Congenital Talipes is simply a twisted foot, of which the component parts, although malformed to a greater or less degree, are capable of regaining perfect form and function. This is practically true of the great majority of cases, although there are exceptional instances in which congenital deformity is complicated by defective formation of the foot or leg, or in which the deformity is caused by, or at least accompanied by, paralysis, as, for example, in certain forms of spina bifida or other congenital defect or disease of the nervous apparatus.

Acquired Talipes is almost always a consequence of paralysis of spinal origin (anterior poliomyelitis) in early childhood. Certain muscles or groups of muscles being paralyzed, the muscular force is unbalanced and the foot is drawn into a distorted position by the action of the unopposed muscles, and by the influence of gravity. This distortion is confirmed and increased by the accommodative changes that accompany functional use and growth in the abnormal attitude.

Far less often acquired talipes may be the result of paralysis of cerebral origin, of other forms of spinal disease, of local paralysis following neuritis or injury to a nerve trunk. It may be caused by scar contraction, as after a severe burn, or by direct injury to the bone, or by disease that may interfere with subsequent growth. Such are, however, extremely uncommon causes, and the statement holds good that congenital talipes is a simple distortion capable of perfect cure, while the acquired talipes is a deformity and disability usually secondary to disease of the spinal cord. It is therefore capable only of rectification, not of perfect cure unless recovery from the original disease, of which it is a result, has taken place.

CONGENITAL TALIPES.

ETIOLOGY.—The etiology of congenital talipes as of other congenital deformities is somewhat conjectural. In some instances the influence of inheritance is apparent, and again two or more children with club foot may be born of the same mother, but, as a rule, there is nothing in the family or personal history that can in any manner explain the deformity. The most reasonable explanation applied to the majority of cases is that the foot has from some cause remained for a longer or shorter time in a constrained or fixed position, and has thus grown into deformity.

It has been claimed by Eschricht, and by Berg (Berg, *Archives of Medicine*, New York, December 1st, 1882) that at about the third month of intra-uterine life the thighs of the embryo are abducted, flexed, and rotated outward, the legs are crossed, and the feet are plantar-flexed and adducted so that the inner surfaces of the thighs, the tibial borders of the legs, and the plantar surfaces of the feet are held in close apposition to the abdomen and to the pelvis of the fœtus. Later there is an inward rotation of the legs so that the feet are turned gradually outward until the soles are brought into contact with the uterine wall, the feet then being in the attitude of abduction and dorsal flexion. According to this theory there is a regular succession of attitudes during intra-uterine life. If the inward rotation of the lower extremity is prevented, or if it is incomplete, the foot remaining in the original position becomes deformed. Thus, equino-varus being the normal attitude of the early and middle period of intra-uterine life, is the most common and the most intractable of the congenital deformities. If the constraint or pressure is not exerted until a later period, after rotation has taken place, when the foot has attained or nearly attained its normal size and shape, it will then induce the less common and comparatively slight grades of deformity such as calcaneus or valgus.

This theory which seems interesting and reasonable,

appears to rest on an insecure basis. Bessel Hagen states that in embryos of 30 mm. in length, the foot is in extreme plantar flexion; in those of 90 to 100 mm., the foot is at a right angle to the leg; and from this size to that at full term, the foot may be found in any position, abducted, adducted, or dorsiflexed. He states also that supination is not the usual attitude at an early period, but is more common near the termination of intra-uterine life, and that when it is present it is more often combined with dorsiflexion. In other words, there is no time when the foot regularly and normally assumes the attitude of club foot, from which it is changed by the rotation of the legs. Scudder (*Boston Medical and Surgical Journal*, October 27th, 1887), after similar investigations, arrived at

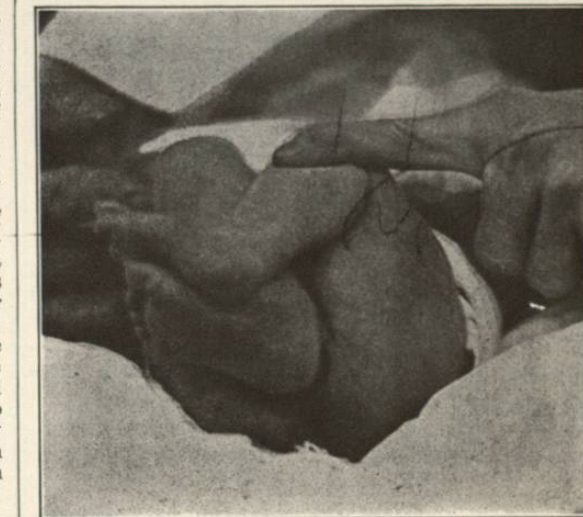


FIG. 2147.—Congenital Talipes Illustrating the Attitude of the Limbs at Birth.

practically the same conclusions. He states that there is no necessary relation between the age, the rotation of the legs, and the position of the feet.

It would appear, however, that there is during the process of development a normal alternation of attitudes and postures. If the feet for any reason are fixed in one position during this period of rapid growth, distortion must follow; if the constraint is slight, and if its influence is exerted at a late period, the deformity will be slight; if it occurs at an early period, the deformity will be more resistant.

One of the causes of constraint, and thus of ultimate deformity, appears to be the interlocking of the feet. Many museum specimens show this, and in some of the cases of talipes seen during the first weeks of life, the feet may be replaced in the attitude in which they had been fixed before birth. Intra-uterine pressure, although not necessarily direct pressure, undoubtedly has an influence in aggravating the deformity. The effect of pressure is not infrequently shown in atrophic areas of skin, and bursæ even are sometimes found over prominent bones. Entanglement in the umbilical cord, the direct pressure of extra- or intra-uterine tumors, and the like, may be mentioned also as possible causes of restraint or fixation of the foot that induces deformity. Further evidence of restraint of normal movements and of abnormal attitudes of the limbs is seen not infrequently in connection with club foot. For example, there may be hyperextension or fixed flexion of the knees, and in cases of extreme deformity the foot is often smaller than normal or otherwise asymmetrical. In certain instances the distorted foot may be imperfect in structure; toes may be absent ("spontaneous amputation"), or constricting bands about the leg or foot may be present. Such ab-

normalities are usually ascribed to amniotic adhesions. Talipes may be combined with evidences of impaired or arrested development, with harelip, exstrophy of the bladder, spina bifida, absence of patella, or with other deformities, such as club hand and wry neck. Or there may be evidence of intra-uterine disease, as shown by ankylosis of joints or by so-called foetal rickets. Finally, deformities of the foot may be complicated by absence of bones of the foot or of the leg, indicating original defects in the germ itself. This latter group, which includes the complications of club foot and imperfection of structure, is comparatively small. As has been stated, congenital club foot, in the great majority of cases, is a simple deformity capable of perfect cure.

The relative frequency of the congenital and acquired forms of talipes has given rise to much discussion in the past, and statistics on this point are at considerable variance with one another. This may be explained by the fact that acquired paralytic talipes is, as a rule, a preventable deformity. At the present time the extreme degrees of acquired talipes are comparatively infrequent and the deformity is usually of a much slighter grade than the corresponding form of congenital distortion.

SEX OF CONGENITAL TALIPES.*			SEX OF ACQUIRED TALIPES.		
Males.	Females.	Total.	Males.	Females.	Total.
1,066	585	1,651	975	828	1,794
64.5%	35.5%		54%	46%	

Congenital talipes is much more common among males than among females. All the statistics are in accord upon this point. Acquired talipes is more equally divided between the sexes.

FOOT AFFECTED IN CONGENITAL TALIPES.				FOOT AFFECTED IN ACQUIRED TALIPES.			
Right.	Left.	Both.	Total.	Right.	Left.	Both.	Total.
510	440	710	1,660	781	768	254	1,803
31.1%	26.8%	42.7%		43.3%	42.6%	14.1%	
Unilateral... 950		57.2%		Unilateral... 1,549		85.9%	
Bilateral... 710		42.7%		Bilateral... 254		14.1%	

In congenital talipes the deformity is far more often bilateral than in the acquired form. In each variety the right foot appears to be more often affected than the left.

THE RELATIVE FREQUENCY OF THE DIFFERENT FORMS OF CONGENITAL TALIPES.

	Cases.	Per cent.
Equino-varus.....	1,272	77.0
Valgus.....	123	7.4
Varus.....	85	5.1
Calcaneo-valgus.....	62	3.1
Equinus.....	40	2.4
Calcaneus.....	28	1.7
Equino-valgus.....	28	1.7
Calcaneo-varus.....	7	.4
Cavus.....	5	.3
Valgo-cavus.....	1	.0
Equino-cavus.....	1	.0
Different deformity in each foot.....	18	1.1
Total.....	1,660	

RELATIVE FREQUENCY OF THE DIFFERENT FORMS OF ACQUIRED TALIPES TOGETHER WITH THE ETIOLOGY.

	Anterior Poliomyelitis.	Cerebral Hemiplegia.	Cerebral Paraplegia.	Other Forms of Paralysis.	Traumatic.	Total.	Per cent.
Equino-varus.....	479	28	35	4	29	575	32.5
Equinus.....	321	66	46	3	29	465	26.1
Calcaneus.....	219	3	1	0	1	224	12.9
Valgus.....	134	4	7	1	27	173	9.5
Equino-valgus.....	114	6	5	0	3	128	6.9
Calcaneo-valgus.....	76	0	0	0	0	76	4.4
Varus.....	41	2	1	0	5	49	2.7
Calcaneo-cavus.....	12	0	0	0	0	12	.7
Equino-cavus.....	12	0	0	0	2	14	.8

* Statistics from Whitman's "Orthopaedic Surgery."

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upward, the plantar surface is abnormally concave and looks backward, inward, and downward. In many cases the equinus element of the deformity, masked by the extreme inversion of the foot, does not appear until



FIG. 2149.—Resistant Club Foot Showing the Secondary Knock Knees.

this has been corrected in part. The foot often seems somewhat smaller than normal, and the heel appears to be ill formed. Upon the outer dorsal surface the prominence of the astragalus and os calcis may be felt beneath the skin, the external malleolus is prominent, while the internal malleolus lies deep beneath the redundant tissue of the internal aspect of the foot.

The internal structure of the foot corresponds to the external contour; thus the relation of the bones to one another, and the shape of the individual bones even, are more or less altered as the deformity is more or less of an exaggeration of the attitudes that the normal foot is capable of assuming. These changes are most marked in the astragalus and os calcis. The astragalus is somewhat wedge-shaped from without inward; it is plantar-flexed so that a large part of its body protrudes from between the malleoli. Its neck is often somewhat longer than normal, and it is, as a rule, depressed and deflected inward. The os calcis is also in an attitude of plantar flexion; the external tuberosity is drawn upward to the vicinity of the external malleolus, its anterior extremity looks downward and inward, and it is often twisted inward on its long axis corresponding to the deformity of the neck of the astragalus. Its external surface looks downward and forward, and it lies directly beneath the astragalus, instead of to its outer side as in the normal relation.

The scaphoid bone is drawn inward and upward, and articulates with the inner part of the deflected head of the astragalus, lying in close proximity to, and often articulating with, the internal malleolus. The cuboid is displaced upward and inward and lies to the inner side

of the anterior extremity of the os calcis. The remaining bones are changed in position, but not materially in shape. In many instances the tibia is rotated inward upon the femur at the knee joint, and combined with this inward rotation there may be an inward twist of the tibia on its long axis.

The ligaments are altered to correspond to the changed relations of the bones. Those on the short side are more or less resistant according to the duration of the deformity. The muscles are normal as to their structure and their origin and insertion, but the direction of the tendons as they pass across the foot is changed. Those attached to the inverted side, the extensor and adductor group, are shortened and are relatively stronger than those on the outer side, which are lengthened and atrophied from disuse.

To sum up: all the component parts of the foot participate in the deformity. The most noticeable changes in the bones are in their position and relation to one another, but the astragalus, os calcis, and scaphoid bones are usually somewhat distorted.

The most resistant structures in the deformed foot are the plantar fascia and the ligaments that bind the scaphoid, the os calcis, and the internal malleolus to one another. The muscles that are most active in retaining and increasing the deformity are the tibialis anticus, the tibialis posticus, and the combined gastrocnemius and soleus.

The changes that have been outlined, which are comparatively slight and which may be easily rectified soon after birth, become more marked as the part develops. And when the child begins to walk, the weight of the body, combined with growth and functional use in the abnormal position, increases and fixes the deformity.

In the adolescent or adult type of club foot the deformity may be so extreme that the patient actually appears to walk on the outside of his ankles, as the term talipes implies. The feet turn directly inward, or even inward, upward, and backward, and the peculiar walk, by which interference of inverted feet is prevented, has given another name (reel foot) to the deformity.

Genu valgum is usually present in such cases. This deformity may be congenital, but it is oftener a secondary or accommodative distortion. The legs are shrunken from disuse. The foot itself is atrophied, and is much smaller than the normal. The changes in the bones are much more marked; only a small part of the articulating surface of the astragalus lies between the malleoli, and this posterior extremity is flattened out to the shape of a wedge. There is consequently an apparent backward displacement of the fibula.

All the bones of the foot are more or less atrophied, and the normal area of cartilage has, to a great extent, disappeared from the proper articular surfaces. In this advanced stage the foot serves practically as a simple rigid support.

In these extreme cases cure, in the sense of perfect functional recovery, is of course out of the question; but relief of the deformity, that is, replacement of the foot in the axis of the leg at a right angle to it and in the plantigrade attitude, is nearly always possible.

SYMPTOMS.—The symptoms of congenital club foot are practically included in the description of the deformity. The functional disability is of course considerable, although some patients are surprisingly active and are able to walk long distances. Discomfort from club foot is due almost entirely to the corns or inflamed burse over the bony prominences, and its degree depends of course upon the use to which the foot is subjected.

TREATMENT.—Although congenital club foot is an eminently curable deformity, yet perfect and permanent cure often requires minute attention to details during the active stage of treatment, supplemented by long-continued and careful supervision after the cure is supposed to be complete. No other deformity presents such a record of failures and incomplete cures; of relapses after apparent cure; of tedious and ineffective treatment by braces, often for many years, and of unnecessary and

BIBLIOTECA
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mutating operations. Some of the failures may be explained by the neglect of the parents and by want of opportunity. A few are due to the unusual obstacles in the deformity itself, but by far the greater number must be accounted for by failure of the physician to apprehend the true nature of the deformity, or by his inexperience in the practical details of treatment.

Proper treatment implies suitable opportunity. Under such conditions the treatment of congenital club foot would be included in the first of the following sections:

The infantile club foot is, as has been stated, simply a twisted foot. It is true that there are slight changes in the bones, but the bones of an infant's foot are represented by yielding cartilage which will rapidly reform under changed conditions. The shortening of the muscles and ligaments may be overcome, and when the relation of the bones to one another is set right, the joints will become normal. The treatment of a club foot may then be divided into three stages:

1. The rectification of the external deformity.
2. The support of the foot in proper position during the process of transformation of its internal structure, and until the normal muscular power, unbalanced by the deformity, has been regained.

3. The period of supervision. This would include the treatment of possible complicating deformities of the knee, the laxity of ligaments, and the like, as well as the oversight of the functional use of the foot and the leg during the early years of life.

The First Stage of Treatment: Rectification of Deformity.—It should be stated at once that "rectification of deformity" does not mean apparent symmetry, a misapprehension to which the majority of failures in treatment may be ascribed. It means that when deformity is really rectified all contracted and resistant parts must have been so elongated that every passive motion and attitude possible for the normal foot is equally possible and as easily attained in that which was deformed. This is actual functional rectification, as contrasted with the simple straightening of deformity.

The most important part of the club-foot deformity is varus. The foot that is rolled over and twisted inward to the attitude of extreme adduction, must be untwisted and forced into the attitude of extreme abduction or valgus, the so-called over-correction. Until this is accomplished no attention whatever need be paid to the residual equinus. There are two reasons for dividing the procedure into two parts: first, in order that the attention of the surgeon may be concentrated on one and the most important part of the deformity; second, because by this preliminary untwisting the os calcis is brought into the upright position, into its proper relation to the astragalus, to the bones of the leg and to the tendo Achillis, so that the true degree of equinus may be appreciated.

Preliminary Manipulation. For obvious reasons, the second or third week of life is as early as mechanical treatment can be undertaken. Until then, preliminary manipulation by the nurse, more particularly manual rectification of the deformity by gently drawing the foot toward abduction and retaining it in the improved position for a few minutes, as often as is possible, may be of service in overcoming its resistance. As a treatment by itself, however, simple manual rectification is tedious and ineffective, although partial cures have been attained by perseverance with this means alone.

Mechanical rectification is the treatment of choice and routine in infantile club foot. In this treatment two methods may be described: (1) by the plaster bandage; (2) by some form of simple splint.

The principle of the two is essentially the same. The foot is drawn toward an improved position and retained there by the plaster bandage, or it may be fixed to some form of metal splint or brace whose shape is gradually changed from week to week, as the resistance lessens.

Gradual Rectification of Deformity by Means of the Plaster Bandage.—In this treatment care should be taken to avoid undue pressure, irritation of the skin, or insecurity of the bandage. Shreds of cotton should be placed be-

tween the toes, and the outer aspect of the ankle, where the skin is thrown into folds when the foot is straightened, should be smeared with vaseline. A narrow strip of adhesive plaster long enough to reach from the knee to a point an inch or more below the heel is applied to the outer side of the leg. A thin layer of cotton is wound about the leg, just below the knee, in order to protect the skin from the hard margin of the plaster bandage, and a similar strip is carried about the toes. The foot is then drawn gently toward the abducted position, often as far as the axis of the leg at the first dressing, without causing discomfort. While it is held in this position a narrow flannel bandage is smoothly applied to the leg and foot, the band of adhesive plaster being drawn out between the folds about the ankle. A very light plaster bandage is then applied from the knee to the extremities of the toes, and into this bandage the projecting strip of adhesive plaster is incorporated, so that no displacement of the dressing is possible. The turns of both the plaster and the flannel bandage are made from within, downward, and outward, in order that the tension may aid in retaining the foot. When the plaster bandage, which during the hardening process has been constantly rubbed and manipulated so that it may fit the part perfectly, has become firm, a long stocking is drawn over it and is attached to the body clothing. At the end of a week the bandage is removed. The leg and foot are gently bathed with alcohol, thoroughly dried, powdered, and protected as before, and the bandage is again applied. At this second dressing the irritated adductor muscles, after the interval of complete rest, will be much less active and the contracted tissues will be less resistant, so that the foot may be easily turned somewhat outward, or beyond the line of the leg.

After four or five applications of the bandage at weekly intervals the foot, in ordinary cases, can be held without resistance in the attitude of extreme equino-valgus. The sole, which at first looked backward, inward, and upward, is now turned in the opposite direction, forward, outward, and downward, and the inner border of the foot, which was concave, is now convex. When the varus has been completely overcome, treatment is directed to the equinus. At this stage it is sometimes of advantage to cover the bottom of the foot with a plate of thin wood (splint wood or cigar-box cover) to give the plaster bandage more solidity to aid in flattening the

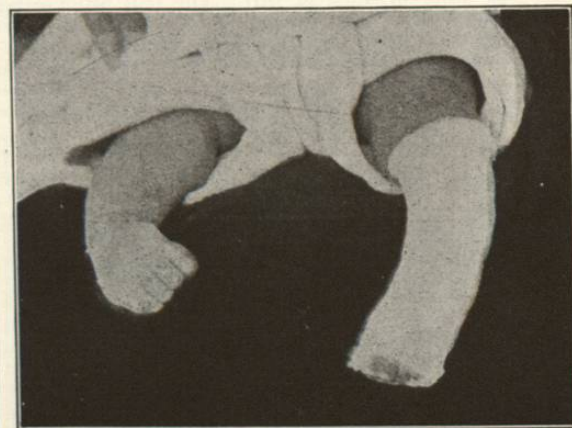


FIG. 2150.—The First Application of the Plaster Bandage, Showing the Improved Position.

rounded sole. At the first application of the dressing one carries the foot upward (toward dorsal flexion), while it is still retained in the abducted position; but when the right-angled position has been attained, it is brought nearer to the axis of the leg. The pronation or eversion of the sole is retained, however, until correction is completed. In correcting the equinus, a certain amount of

force is required, sufficient to cause some discomfort during the application of the plaster, but not sufficient to cause suffering afterward. The force is applied by means of the sole plate to the entire foot so that the posterior extremity of the os calcis may be drawn downward by actual lengthening of the tendo Achillis, and not, as is often the case, by an over-correction of the forefoot, while the heel remains in its original position of plantar flexion. By the proper application of force the equinus is gradually overcome; the sharp indentation or fold at the insertion of the tendo Achillis is lessened, and the heel becomes more prominent.

The reduction of the equinus may be somewhat more difficult than that of the varus, but it should be entirely corrected in three or four months from the time of beginning the treatment.

As has been stated, correction of the deformity implies over correction; and it is well when this has been attained to hold the foot for several weeks, by means of the plaster bandage, in an attitude of extreme pronation and dorsal flexion (calcaneo-valgus) in order to impress, as it were, the new position upon its structure.

This concludes the first stage of the treatment, the simple rectification of deformity.

Correction by the plaster bandage has the great advantage of placing the treatment entirely under the command of the surgeon. When properly applied, the support fits perfectly and holds the foot in the desired attitude without undue pressure.

The disadvantages of the treatment are almost entirely due to its improper application. For instance, the bandage may be too heavy, or the padding may be so thick that it does not retain its position. Excoriations are usually due to carelessness in the application of the bandage or they result from a failure to remove it in proper season. The fear of compression, of atrophy of muscles, of stunting the growth of the limb, is groundless. At the end of the retention treatment the corrected foot is, as a rule, larger than one that has remained untreated. The stunted foot is the result of non-treatment, or of ineffective treatment by braces or otherwise; not of the enforced rest necessitated by the methodical reduction of deformity.

It may be noted in this connection that the normal infant moves the foot in various directions in a more or less regular alternation of postures, while in club foot motion is in one direction only, that toward which the foot is turned. The muscles on the back and inner side of the leg, which are alone active, become relatively irritable and hypertrophied as compared with those on the front and outer side that are disused. Thus, muscular activity of the deformed foot is in reality harmful, because it increases deformity and still further disturbs the muscular balance. For this reason the temporary restraint of motion, necessary during the rectification of the deformity, may be considered rather of advantage than otherwise. When movement is again allowed and encouraged, it must be in the directions opposed to the attitudes of deformity, with the aim of so strengthening the weakened group of muscles at the expense of the stronger, that the balance of muscular power may be re-established.

Correction of deformity may be accomplished by holding the foot in an improved position by strips of adhesive plaster, or by the elastic traction of rubber bands attached to the leg and foot. As compared with the ease, rapidity, and certainty of correction by the plaster bandage, such methods are uncertain and ineffective and they will not therefore be described in detail.

The Rectification of Deformity by Splints and Braces: Of mechanical supports there are many varieties. Complicated appliances should be avoided because they are unnecessary, and because they serve to distract attention from the prime object of treatment, the rapid and systematic correction of deformity.

Of the simpler braces, that used by Judson of New York is one of the best and will serve as a type to illustrate this form of treatment. The method of application may be described in Judson's own words:

"The apparatus which I have conveniently used to effect this reduction before the child learns to stand is a simple retentive brace which acts as a lever making pressure on the outer side of the foot and ankle, at A, in

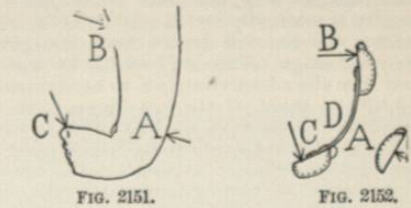


FIG. 2151.

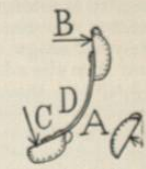


FIG. 2152.

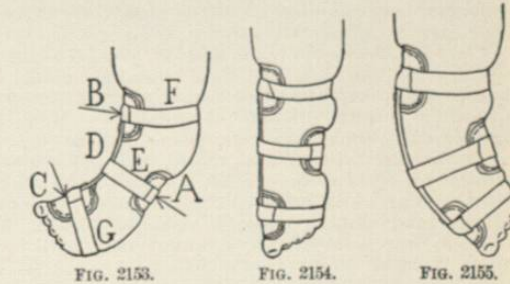


FIG. 2153.



FIG. 2154.



FIG. 2155.

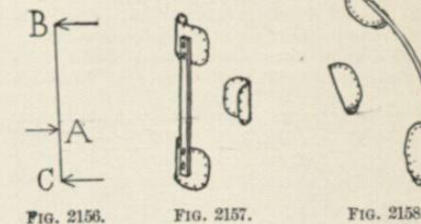


FIG. 2156.

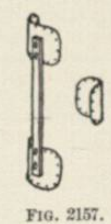


FIG. 2157.



FIG. 2158.

Figs. 2151 to 2153, inclusive, and counter-pressure at two points, one on the inner side of the leg, at B, and the other at the inner border of the foot, at C. It is advisable to keep in mind that this simple instrument is a lever, because, if we know that we are using a lever with its three well-defined points of pressure, we can make the apparatus more efficient than if we view it, in a more general way, as an apparatus for giving a better shape to the foot.

"I use a little brace made of sheet brass, doing the work with a few simple tools. An advantage of doing the work one's self is that there is no room for doubt as to where the blame lies if the apparatus does not work well. Two curved discs, B and C, Figs. 2152 and 2153, are riveted to a shank, D, and thus is formed that part of the brace which applies the two points of counter-pressure, while, on the other hand, the point of pressure is brought into action by a third disc, or shield, A, which is drawn tightly against the outer side of the foot and ankle, and held in place by a strip of adhesive plaster E, which includes the limb and the piece which connects the two discs, B and C. The discs are lined with two or three thicknesses of blanket, easily renewed, when necessary, with a needle and thread. These braces are so cheap and easily knocked together that it is nothing to apply new and larger ones, using heavier material for the shank as the child grows. In general, three sizes will be enough, the shanks being 12 gauge, $\frac{3}{8}$ in. wide; 14 gauge, $\frac{1}{2}$ in. wide; and 16 gauge, $\frac{3}{4}$ in. wide. The discs are conveniently made from 22 gauge, $1\frac{1}{2}$ in. wide. The rivets are copper belt-rivets, No. 13. A lip turned on the edge of the discs, with the flat pliers, gives stiffness to the thin brass, and protects the skin from the rough edge. If more easily obtained, tin discs, light bars of iron or steel, and ordinary iron rivets, would doubtless answer. (See Figs. 2152, 2157, and 2158.)

"The brace is applied with three strips of adhesive plaster. The upper and lower pieces, *F* and *G*, Fig. 2153, are simply to keep the apparatus in place, which they do effectively if ordinary gum plaster is used, while, by drawing the middle strip, *E*, tightly over the shield, and straightening the brace from time to time, the deformity is gradually and gently reduced. At each re-application the brace is made a little straighter than the foot at that stage. This may readily be done by the hands, and then the adhesive strip is to be tightened over the shield till the shape of the foot agrees with that of the brace. After a few days, the brace is to be made still straighter and again re-applied, and made tight till another point of improvement is gained. The brace is applied very crooked at the beginning of treatment, as in Figs. 2152 and 2153, and is straightened from time to time, and a longer brace applied as the deformity is reduced and the patient grows. It should be removed every week, or two weeks, and an interval of a few days allowed for freedom from the brace, when the mother is advised to manipulate the foot constantly, using as much force as she will in the direction of symmetry. Manipulating the foot during these intervals is of great importance, as cases have occurred in which varus and equinus have been entirely overcome by the mother's hand alone.

"By this simple and prosy treatment, carried out systematically and without haste, or violence, or pain, the foot, unless it is a frightful exception, may with certainty be changed from varus to valgus. At the same time the tendo Achillis is lengthened till the position of the foot is near the normal, or at right angles with the leg, as the result of manipulation and giving the brace from time to time a partly antero-posterior action. Figs. 2152 and 2153 show approximately the shape of the brace at the beginning of treatment, Fig. 2154 when the varus

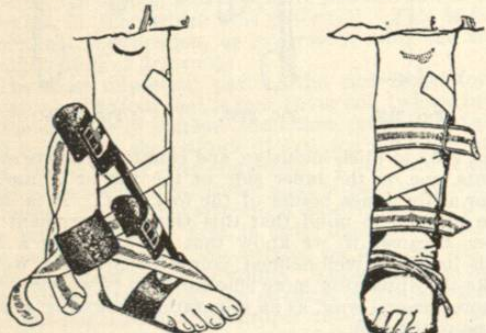


FIG. 2159.

FIG. 2160.

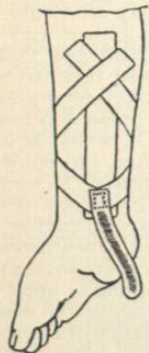


FIG. 2161.

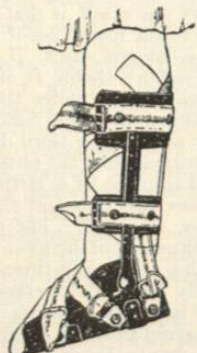


FIG. 2162.

FIGS. 2159 TO 2162.—The Taylor Club-foot Brace.

is reduced, and Fig. 2155 when valgus has taken the place of varus. The foot, in this latter stage, may not hold itself valgus, when left to itself, but with almost no force and with one finger it may be pushed into valgus."

When the varus deformity is reduced, the equinus is gradually corrected by carrying the splint behind the internal malleolus, and finally, if necessary, direct upward pressure may be obtained by lengthening the brace and applying it to the posterior aspect of the foot and leg.

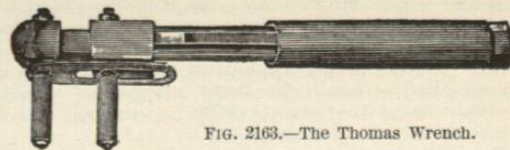


FIG. 2163.—The Thomas Wrench.

It may be noted that manipulation and stretching of the contracted parts when the brace is removed, is of much importance in the correction of deformity by this or other means. Splints of wood, tin, felt, and the like may be employed, but they present no particular advantage over that which has been described.

Tenotomy: The equinus has been spoken of as the secondary deformity, but its complete correction is sometimes more difficult than that of varus. The mechanical stretching of the contracted parts by means of the plaster-of-Paris bandage, or the brace, is often accomplished with ease, but in more resistant cases time will be gained after the foot has been forced into the position of equinovarus, by the division of the tendo Achillis, which is the most resistant of the shortened tissues. After division of the tendon it may be necessary to use considerable force to stretch the other contracted parts, and to force the foot up to the limit of normal dorsal flexion, which is the object of the operation. Occasionally the obstacle seems to be in the posterior ligament of the ankle, and it is sometimes of service to re-insert the knife and to divide this structure, in part at least, so that it will give way under manipulation. When the foot has been forced into the position of over-correction, it is fixed in a plaster bandage which is allowed to remain for several weeks, until the interval between the separated ends of the tendon is filled in with the new tissue.

In many instances the leg is rotated inward upon the thigh, an attitude that is accompanied by accommodative changes in the ligaments of the knee joint. During the rectification of the club foot, this secondary distortion may be corrected, in part at least, by forcible manual rotation of the leg outward on the thigh, several times daily.

The management of the first stage of the treatment of infantile club foot is then—manipulation by the nurse or parents from birth until systematic rectification can be begun,—mechanical correction, first of the varus and then of the equinus deformity, terminating with a period of retention in the over-corrected position (calcaneo-valgus). Division of tendons, other than the tendo Achillis, is not often necessary. The time required for the first stage of treatment, or over-correction of deformity, should not under favorable conditions exceed three months.

The rapid and complete correction of deformity in the manner described, begun as early as possible and accomplished as quickly as possible, cannot be too strongly urged. In the first months of life the tissues are not resistant, the bones are in large part cartilaginous, and when the foot in its external appearance is rectified, the rapid growth in the first months of life will change the internal structure to conform to the normal conditions. The fear of atrophy, compression, or other harm from the temporary fixation necessary during rectification is groundless, and in fact exercise, so-called, except in the direction opposed to deformity is harmful rather than beneficial.

The Second Stage of Treatment: Support and Restoration of Function.—When the deformed foot has been corrected, in the sense that all normal motions are unhampered, the first and most difficult part of the treatment will have been completed, and in some instances a practical cure is assured. Such a result is unusual, however, for although the foot may be normal in appearance, its muscular balance has not been restored. This is

shown by the fact that there is little power in the dorsal flexors and abductors to draw the foot upward and outward. For this reason, the foot must be supported in proper position until the slack of the lengthened tissues has been taken up by development in the normal attitude, otherwise the deformity must recur. Practically, support is always necessary until the child has begun to walk.

The Retention Brace: The form of retention brace will vary some-

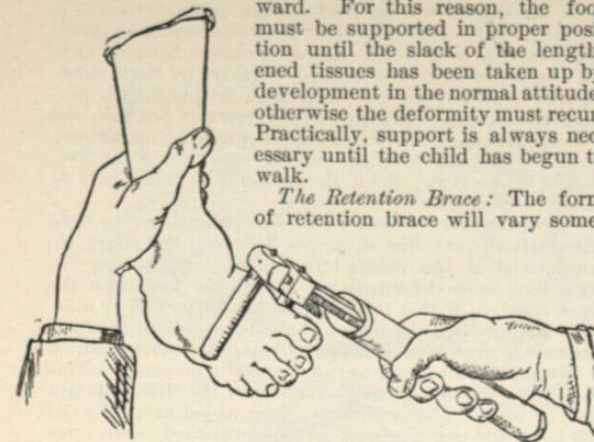


FIG. 2164.—The Thomas Wrench Applied to a Case of Talipes Equinovarus.

what according to the indications of the individual case, the one essential being that the foot shall be supported in normal position, or better, in an attitude of slight dorsal flexion and abduction.

One of the best supports is the Taylor brace, the invention of Dr. C. F. Taylor of New York. This consists essentially of a light upright that extends along the inner side of the leg to the knee, and a thin steel foot plate of the exact size of the sole, with an upright flange on the inner side rising to a point just above the dorsal surface of the foot, against which the foot is closely pressed so that recur-

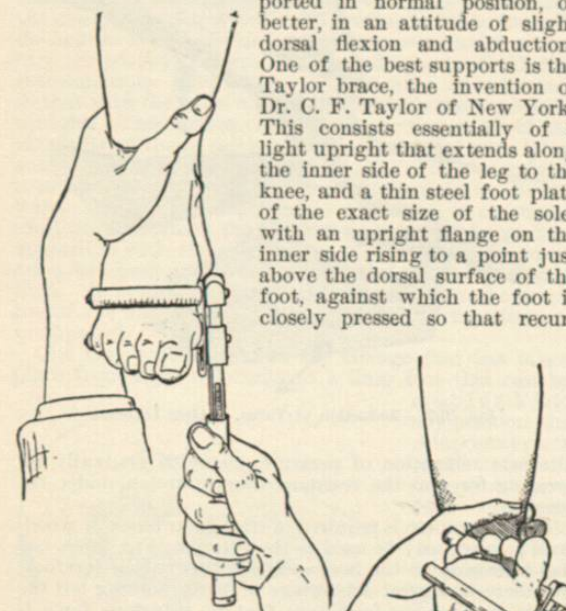


FIG. 2165.—The Deformity Partially Corrected by the Wrench.

rence of the varus deformity is prevented. The joint at the ankle is provided with a catch that prevents plantar flexion, but allows dorsal flexion (Figs. 2159, 2160, 2161, and 2162). By bending the upright and the sole plate the foot may be held in slight abduction. The apparatus is applied with straps as illustrated, and if necessary its position is further fixed by a band of adhesive plaster applied on the inner side of the leg to hold the heel firmly against the foot plate. The foot is thus held constantly

FIG. 2166.—The Deformity Fully Corrected by the Wrench.

at a right angle to the leg, or better, in the early stage of treatment, in an attitude of dorsal flexion and valgus. Occasionally, after complete rectification of the deformity, the foot still turns in. In most instances this is due to an inward rotation of the tibia on the femur at the knee joint, but in some cases it is caused by a spiral twist of the tibia itself. In order to correct this secondary deformity the upright of the brace is carried beneath the leg, provided with a joint at the knee, and is

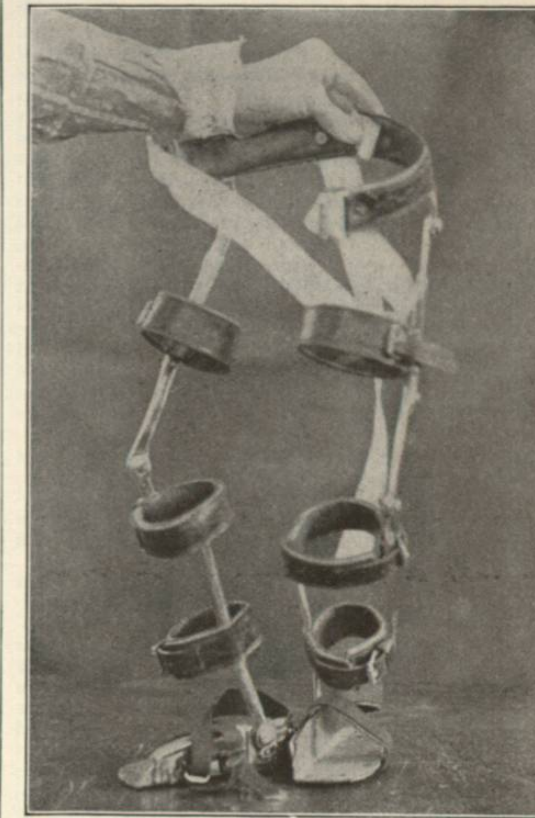


FIG. 2167.—Club-Foot Braces, to Correct Inward Rotation.

extended up the outer side of the thigh. At the hip it is attached by a free joint to a padded pelvic band of light steel. The band holds the upright in the proper relation to the thigh; thus, by twisting the part below the knee the foot can be rotated outward to the desired degree. In less marked cases, the retention bands used for pigeon toe may be employed. (See Pigeon Toe.)

Methodical Manual Correction: Several times during the day the brace should be removed in order that the foot may be thoroughly massaged and forcibly abducted, that is, twisted outward at the medio-tarsal joint so that the inner border is made convex, and then to the extreme limit of dorsal flexion and abduction. If the leg is rotated inward, it is forcibly turned outward on the femur. Even if the tibia is actually twisted on its long axis, the influence of the brace and forcible manipulation will usually correct the deformity. If not, an osteotomy of the tibia may be required at a later period; this, however, is not often necessary. Active contraction of the weak muscles may be induced by tickling the sole of the foot or by the use of electricity; and finally, the entire limb should be thoroughly massaged before the brace is re-applied.

When the ability to dorsiflex and abduct the foot has been regained, the brace may be removed for a part of the day; later it is used only at night, and finally it may

be discarded if the child walks normally. But it is best to continue the daily manipulation, more particularly the systematic stretching or over-correction of the foot, for a long time. Thus one may check the tendency toward deformity of which the first sign is always a slight limitation of the range of dorsal flexion and abduction.

In many instances the deformity may have been so thoroughly over-corrected by the plaster-of-Paris bandage or by the brace, and the after-treatment of massage and stretching may have been so efficiently applied by the nurse or parent that no support is required after the child begins to walk. On the other hand, the inclination toward deformity may be so marked that it may be necessary to hold the foot in slight abduction and valgus for a year or longer.

In other cases, the use of a light brace to hold the foot in the over-corrected position during the night is alone required. These are points to be decided by the circumstances of each case. The period of observation and supervision is included in the final stage of the treatment.

Third Stage of Treatment: Supervision.—During this period the attitudes of the limb and foot of the child in walking must be carefully watched and one should observe the signs of wear on the sole of the shoe. If it shows greater wear on the outer side than is usual, it is an indication that the weight does not fall on the centre of the foot and that there is therefore a tendency toward deformity. This must be counteracted by making the sole thicker on the outer border, or somewhat wedge-shaped, so that the weight may be deflected toward the inner side.

This third period of treatment, or rather of oversight of the functional use of the foot, must be continued indefinitely. In fact, it is the quality of this final supervision that decides in most instances whether the ultimate outcome is to be what is called a satisfactory result, or a perfect cure.

The Treatment of Neglected Club Foot.—The treatment of club foot, under what may be called the proper conditions, as outlined in the preceding pages, applies practically to all cases before the completion of the first year of life, and mechanical rectification may be successfully employed in cases far beyond this limit of age. As a rule, however, when the patient has walked for any length of time, the resistance of the tissues has increased to such an extent that more rapid and effective treatment is indicated. The investigations of Wolff have shown that the internal structure of the bones corresponds to their external contour, and that the structure and contour are adaptations to functional use. This internal structure is not, however, permanent, but is readily transformed to conform to changes in form or function. If then the external contour of the club foot were suddenly reversed, and if use of the foot were permitted in this new attitude, a transformation of the internal structure of the bones and at the same time of their shape would begin at once. This would continue until both structure and shape had become adapted to habitual function. It is upon this natural power of transformation that one depends for the final and complete change of the distorted bones to the normal; and what is true of a resistant structure like bone is equally true of the other constituents of the deformed foot.

Age as Influencing Treatment.—There is then this very essential difference between the indications for treatment in infancy and in childhood. In the first instance the foot has no essential function. In the walking child, however, the weight of the body and habitual use tend to confirm and to increase the deformity. As a general principle of treatment, therefore, walking should not be permitted until the weight of the body may aid rather than retard the correction of deformity. This is another point in favor of rapid, as opposed to gradual, correction of deformity.

The Rapid Correction of Deformity.—The principles on which operative treatment is conducted are the same as those which govern mechanical treatment. Thus the deformed foot must be over-corrected, and it must be held

in the over-corrected position, until the immediate tendency toward deformity has been overcome. It must then be supported until the foot has become adapted to its new position and until the balance of muscular power has been regained. No surgical operation, however radical, can be, in childhood at least, curative by itself alone. Operative procedures are undertaken simply for the purpose of making the primary over-correction possible, and that operation by which this object can be accomplished, with the least interference with the structure of the foot, should be selected. Such an operation is what may be called forcible manual correction.

Forcible Manual Correction.*—The patient having been anesthetized, one first attempts to correct the sharp inward twist at the medio-tarsal joint. Supposing the right foot to be deformed, one grasps the heel with the right hand, in such a manner that the projection or muscular part of the palm lies on the outer aspect of the foot, against the most prominent part of its outer border, which is at the junction of the os calcis and cuboid bones. This hand serves as a fulcrum, over which the inverted foot may be bent. The forefoot is then grasped firmly by the left hand and one begins a series of outward twists over the fulcrum of the opposing palm, gently at first with

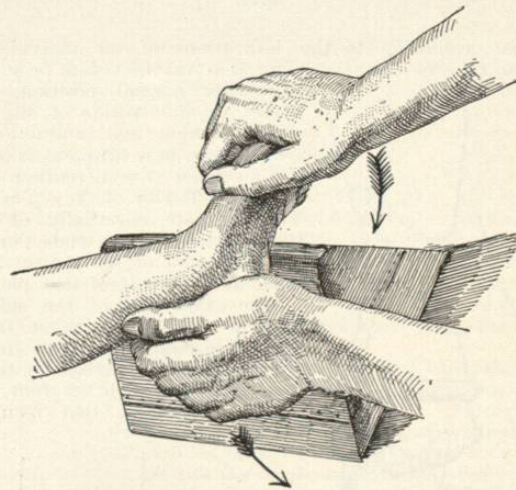


FIG. 2168.—Reduction of Varus. (After Lorenz.)

alternate relaxation of pressure, but with gradually increasing force as the resistant tissues stretch under the tension.

If greater force is required, a triangular block of wood, well padded, may be used as the fulcrum (Fig. 2168), one hand pressing on the heel and the other on the forefoot; but there is a great advantage in using nothing but the hands, because one feels sure that no injurious force is likely to be exerted. Under this steady manipulation, the foot soon loses its rigidity and its elastic recoil toward deformity; it becomes so limp that with two fingers one can not only hold the sole straight, but can push it or bend it outward. Thus the first stage of the methodical correction has been accomplished.

One then turns his attention to the supination which makes the outer border of the foot lower than the inner border. The leg is grasped firmly near the ankle with the left hand, and with the right the foot is forcibly twisted in a direction downward, outward, and upward, over and over again, with steadily increasing force as the tissues slowly yield, until it may be forced into a position of extreme abduction, so that the sole may be made to look outward and downward—the reverse of the former attitude.

One next stretches the contracted plantar fascia and reduces the cavus, which is usually present, by forcing

* First described by Delore, of Lyons.

the forefoot toward dorsiflexion, against the resistance of the contracted tendo Achillis, until the sole is made perfectly flat (Fig. 2169). Finally, the fourth, and often the most difficult part of the rectification, that of forcing

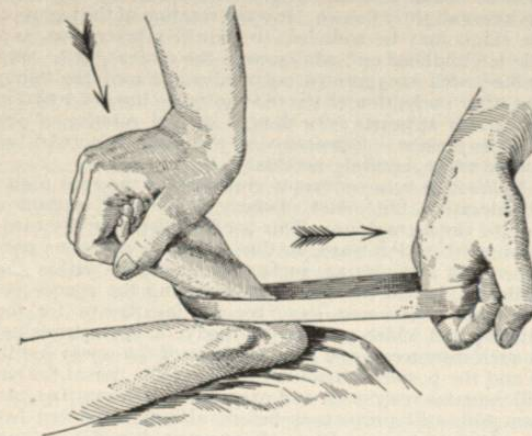


FIG. 2169.—Reduction of Cavus. (After Lorenz.)

the displaced astragalus into its proper position between the malleoli, is attempted. To accomplish this, the tendo Achillis is first divided subcutaneously, and if necessary the posterior ligament of the ankle is also divided at the same time. The patient is then turned upon his face so that with the knee resting on the table the leg is held upright. This allows one to hook the fingers about the extremity of the os calcis while the hand and arm, lying along the sole of the foot, may be used as a lever to force it toward dorsal flexion as the os calcis is drawn downward. In this manner forcible stretching is continued until the dorsum of the foot can be brought almost into apposition with the crest of the tibia. When the operation has been completed, the foot should be perfectly limp. It is usually somewhat congested from the pressure of the fingers, but it is warm and the circulation is unimpaired.

One may assume that in the change that has taken place from rigid deformity to a limp foot that can be

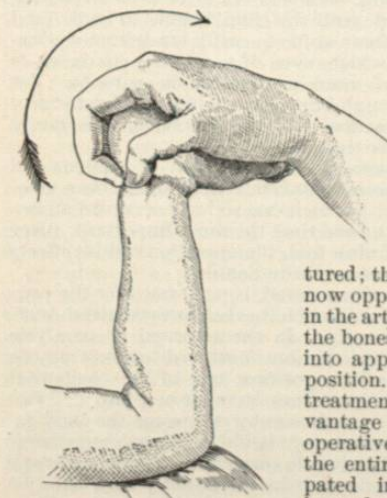


FIG. 2170.—Reduction of Equinus. (After Lorenz.)

moulded into any position, the component parts of the deformed foot must have been subjected to considerable violence; that ligaments and muscles must have been stretched and, it may be, ruptured; that new surfaces are now opposed to one another in the articulations, and that the bones have been forced into approximately normal position. This method of treatment has a great advantage over the ordinary operative treatment, in that the entire foot has participated in the correction, instead of a limited portion, as when, for example, bone is removed by cuneiform osteotomy; and it has a second and almost equally important advantage, in that the immediate use of the corrected and yielding foot is possible in the place of the necessary rest that must follow cutting operations.

For these reasons forcible massage should be the operation of choice, and preliminary, at least, to more severe procedures in the treatment of resistant club foot in childhood. The only disadvantage of the operation is the actual labor which it necessitates on the part of the surgeon, usually twenty minutes or more of rather exhausting work.

The foot must now be fixed by a plaster bandage in an over-corrected position. It is first evenly covered with a layer of cotton and a bandage of canton flannel, and while it is held by the assistant, the plaster bandages are applied from the tips of the toes to the upper part of the thigh. It is important that the toes should not project beyond the bandage, because of the swelling that sometimes follows. It is important, also, that the foot should be held in the proper position while the bandage is hardening, and that it should not be manipulated to any extent after the bandage is applied, in order that no rigid wrinkle may press against the skin. The bandage is applied to the thigh in most instances in order that the tibia may be rotated outward to its normal position and



FIG. 2171.—The Feet Fixed in an Attitude of Over-Correction.

held there, and because more effective fixation may be assured and greater pressure exerted on the foot in walking. To utilize this pressure to better advantage the bandage is made very thick beneath the sole, and a thin foot plate of wood should be incorporated in the plaster. When the bandage is applied the position of the foot should be that of over-correction of deformity, flexed beyond the right angle, twisted far outward, and the outer border should be elevated considerably beyond the level of the inner border (Fig. 2171).

One would suppose, after using the force that has been necessarily applied, that much pain and swelling would follow. This is, however, not the case. Often, on the following day, the patients are able to stand upon the foot, and always within the first week if the bandage has been properly applied. The pain following this operation is far more often caused by pressure of an ill-fitting bandage than by the violence that has been used. Thus one should be careful to remove sections of the bandage if it appears to cause undue discomfort. These points are usually the front of the ankle, the back of the heel, and the inner border of the great toe.

The immediate use of the foot is encouraged, and al-

though only the heel and inner border bear weight directly, yet the pressure of the foot plate on the parts that do not come in contact with the floor is usually sufficient to mould the foot into its proper shape. If greater pressure is thought necessary, wedges of wood or cork may be attached to the sole of the plaster bandage so that all parts may bear weight equally. The bandage is covered by a stocking, a slipper may be worn indoors, and an ordinary overshoe for street wear.

The first bandage should be removed at the end of about three weeks, as by that time it will have become loose. The foot will then be found to be extremely flexible, and by an enthusiast it might be considered cured. But knowledge of its previous condition should make it evident that a much longer time is necessary to allow for its consolidation in the new position. At this time almost no evidence of the operation remains, except, it may be, slight discoloration of the skin. The foot is again held as far as possible in the over-corrected position and another plaster bandage is applied, usually as far as the knee only. This should remain for eight weeks, or longer if it is still unbroken. The patient uses the foot constantly, and is drilled in the proper method of walking, so that the muscles of the leg may become accustomed to the new and normal attitudes.

At the end of another month or more, the plaster is replaced by a brace to be worn inside the shoe, usually of the simplest description, consisting of an upright bar with a calf-band, attached to a steel sole plate by a joint that will allow dorsal flexion but checks extension at a right angle. This is applied because the dorsal flexors, after years of disuse, only slowly recover sufficient power to resist the action of the opposing group and the force of gravity.

The second stage of the treatment is now begun. This may be divided into a period of active treatment and one of supervision. The first, or treatment stage, consists in massage of the entire leg and of the foot to stimulate the growth of the atrophied muscles, and methodical manipulation of the foot several times a day by pushing it with the hand to the extreme of the range of motions possible immediately after the operation, viz., eversion, abduction, and dorsal flexion, in the same order as at the time of operation. At the same time the patient attempts voluntarily to carry out these motions by his own muscles, the power being supplied by the hand of the masseur. Slowly the muscles gain in strength and ability and when normal muscular power and balance have been regained the patient is practically cured; but for long afterward supervision is kept up of the patient's attitude, of the manner of using the foot, of the wear of the sole of the shoe, and the like, and by constant drilling and stimulation the attempt is made to restore the normal appearance and function.

One cannot exaggerate the importance of this after-treatment, and of supervision at least on the part of the surgeon. The active treatment may often be left to the parents. But constant supervision is necessary to keep this after-treatment, which seems so commonplace and simple, up to the proper pitch; and to assure one's self that the range of motion regained by the operation does not gradually become more and more restricted, even though the contour of the foot appears to be normal.

Forcible manual correction may be employed with advantage from the second to the tenth year, although the limits may be extended in either direction in special cases. In this operation, as described, the tendo Achillis is the only structure divided. There is no particular objection to subcutaneous division of other tendons or ligaments in connection with forcible manual correction; but in such prolonged manipulation it is much better if the skin, which itself must be stretched, is unbroken and dry, rather than moist from the bleeding from punctured wounds. For this reason it is well to correct the deformity without extensive tenotomy if possible.

Treatment of Secondary Deformities.—In cases such as have been described a certain amount of secondary deformity of the leg is often present. Knock-knee rarely

requires other treatment than daily manual correction in connection with the massage of the foot and leg.

Hyperextension at the knee will correct itself during the treatment of the foot, which, being fixed in an attitude of dorsal flexion, obliges the patient to walk with the knees slightly flexed. Inward rotation of the leg upon the thigh may be sufficient to require a brace, but, as a rule in childhood and adolescence, the patient has so long walked with exaggerated outward rotation of the femur that after correction of the deformity no inward rotation of the foot appears, even though inward rotation of the tibia be present. Osteotomy of the tibia, to correct the inward twist, is rarely necessary.

Malleotomy.—In confirmed club foot of the type under consideration, the chief obstacle to perfect correction may be the astragalus. This is often displaced forward, downward, and inward, so that only the posterior portion of its articulating surface is contained within the malleoli. In the cases of long standing the spaces between the bones may have become insufficient for the anterior and wider part of the body of the astragalus. In such instances, even after division of the tendo Achillis and the posterior ligament of the ankle, dorsal flexion still remains restricted, and examination shows that the astragalus still projects as before, although the foot has been forced into a position of apparent dorsiflexion and abduction. This apparent correction is the result of over-correction at the medio-tarsal joint, of outward rotation of the tibia upon the femur, and of backward displacement of the fibula. In such cases the malleoli may be separated from one another by dividing the ligaments that hold them in apposition.

A straight incision, about two inches long, is made on the outer side of the ankle directly over the anterior aspect of the articulation, the ligaments are divided and by inserting a thin chisel the bones are pried apart, and the astragalus is replaced in the proper position. This is usually easy if the restraining tissues on the posterior part of the ankle have been divided. The wound is then closed and the foot held in the over-corrected position by a plaster bandage. Complete correction of the varus deformity should, of course, precede this operation.

It would seem on first consideration that if immediate correction of deformity could be so easily accomplished in the confirmed case, it should be employed even in infancy. There are, however, practical reasons against it; first, because the foot is so small that it cannot be easily manipulated; second, because even after it is corrected it must be supported until the child begins to walk; and third, because the foot can be so easily straightened without an operation, which, even of so slight a character, is sometimes cause of much anxiety to the parents. For these reasons, although immediate reduction of deformity is a thoroughly practical and safe operation, it is rarely advised until a later time.

Subcutaneous Tenotomy.—The division of tendons and other tissues by the subcutaneous method has been mentioned incidentally, but as it has so long occupied an important, and even at one time the most important, place in the treatment of club foot, the operation and its effects may be described somewhat in detail.

Tenotomy, as has been stated, is performed for the purpose of removing an obstacle to the correction and over-correction of deformity. In the acquired or paralytic form of club foot, one or more shortened tendons may be the chief obstacles to reposition, but in the congenital form, in which all the tissues have grown into deformity, the shortened tendons are by no means the only resistant parts, and tenotomy should be considered, therefore, merely as an incident in correction. In the ordinary treatment of infantile club foot, tenotomy may often be dispensed with, and in the great majority of cases division of the tendo Achillis is alone required.

When the tendon has been divided, the deformity is immediately over-corrected; thus the two extremities are separated to the extent necessary to allow the improved position. At the end of three weeks or more, when the first dressing is removed, the space will be filled with new

material, and in another month the splice, which will be somewhat larger and thicker than the normal, should be strong enough for use. The slight thickening at the site of the operation may be felt for a year or more, but for all intents and purposes the new and lengthened tendon is perfectly normal, as is the function of the muscle of which it is a part.

The process of repair is somewhat as follows: Immediately after the operation the space between the divided ends of the tendon is filled or partially filled with blood; then leucocytes appear, which with those in the blood clot serve as pabulum for the plasma cells which migrate from between the fasciculi of the tendon and from the tendon sheath. The fibrin and red corpuscles of the clot are absorbed, the extremities of the divided tendon soften and become fused with the new material, which begins to take on the form and consistence of true tendon, and to separate itself from the adherent sheath. This new tendon, according to Tubby, differs from the normal structure in that the fibrous fasciculi are more irregular and its substance is more like scar tissue, but practically it is perfectly normal in its appearance and function.

Since the tendon sheath serves an important purpose in repair, it should be disturbed as little as possible, and for this as well as for other obvious reasons, subcutaneous tenotomy of the tendo Achillis, which is so prominent and so distinct from other important parts, is to be preferred; but if more extensive division of other tendons is required, the open operation is often indicated.

Division of the Tendo Achillis: For this operation anesthesia is usually required, preferably by means of nitrous oxide gas, and it is hardly necessary to state that surgical cleanliness, even in so slight a procedure, is essential.

The instrument should be small and very sharp so that no force is required in the operation; the blade should be as long as the tendon is wide. The patient is turned upon the side or to the prone position, so that the foot may be held with the heel upward by the left hand. The position and size of the tendon are ascertained by careful palpation, and the knife is then inserted to its inner side, at about the level of the extremity of the internal malleolus. The flat surface of the blade is held parallel to the tendon, and it is passed beneath it until its point can be felt beneath the skin on the opposite side. The edge is then turned upward, and the tendon, being made tense, is divided by a sawing motion of the knife. When the division is complete, as indicated by the separation of the divided ends, the knife is withdrawn, and the minute opening in the skin, from which there is usually slight bleeding, is covered with a pledget of aseptic cotton. The foot is forced into dorsal flexion and is securely fixed by a plaster bandage. In applying the dressing one should take care that no pressure is brought upon the seat of operation, as this might interfere with the effusion of plastic material. As soon as the discomfort attending the operation has subsided the patient is encouraged to stand and to walk. Functional use, far from retarding repair, is, by stimulating the circulation, an important agent in assuring firm and rapid union.

Division of the *plantar fascia* is not infrequently necessary and should be performed subcutaneously. The tenotome is inserted beneath the skin at about the centre of the concavity to one or the other side of the central band of the fascia, which is divided by a sawing motion of the knife. The part is put upon the stretch, and other resisting bands to the outer and inner side are divided in the same manner; the cavus is then corrected by manual or instrumental force. The operation, like that upon the tendo Achillis, is practically free from danger.

Division of the *tibialis anticus* is not often necessary, as this tendon offers little resistance to the rectification of deformity.

The tendon of the *tibialis posticus* may be divided together with that of the *tibialis anticus* near the points of attachment. If the operation is required, it may be combined with simultaneous section of the *calcaneo-scapoid ligament*, with which are blended the anterior part of the

deltoid and fibres of the anterior ligament of the ankle.* According to Parker's directions, the foot should be strongly abducted to make the parts tense. The tenotome is entered directly in front of the anterior border of the internal malleolus, its cutting edge being turned forward between the skin and the ligament. It is then turned toward the ligament, and the tissues are divided to the bone. The blade is then made to enter the interval between the astragalus and the scaphoid, and is carried downward and forward to divide the inferior part of the ligament and at the same time the tendons of *tibialis anticus* and *posticus*.

The posterior ligament of the ankle joint may be divided or sufficiently weakened, so that it may be rup-

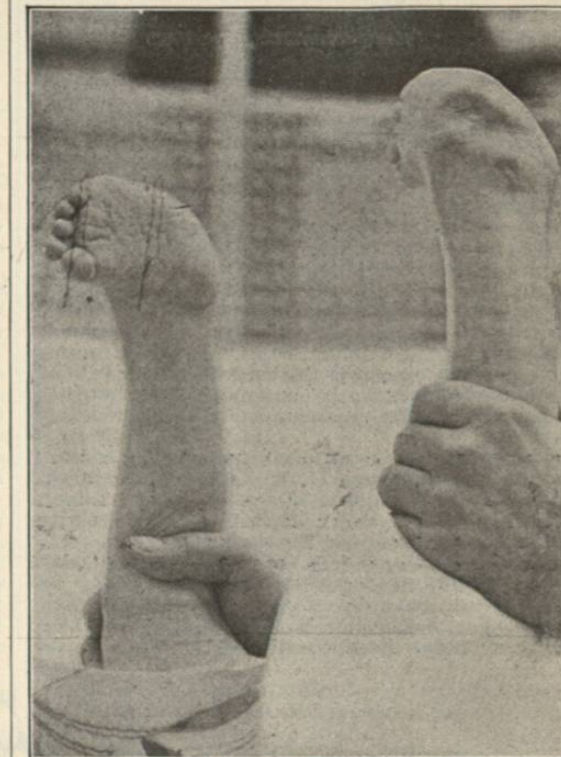


FIG. 2172.—Resistant Club-Foot in Adolescence.

tured after section of the tendo Achillis by passing the knife directly downward in the middle line upon the upper border of the astragalus.

Forcible Correction of Deformity by Means of Osteoclasts and Wrenches.—In place of manual correction of deformity greater force may be employed by means of osteoclasts or wrenches. There is this important difference between the two procedures: force may be applied by the hands for as long a time as is necessary with but little danger of injury, while force applied by a machine must be momentary because of the pressure and strain on the parts where the leverage is exerted. Manual force, continuously applied, may be supposed to stretch the resistant parts, and although much less power is exerted it is often more effective than the sudden and momentary force of the wrench or osteoclast.

Correction by means of the Thomas wrench is one of the simplest and most efficient of these procedures. The wrenching may or may not be preceded by tenotomy, a point to be decided by the resistance of the parts. As a rule division of the tendo Achillis is alone necessary. The instrument is a simple heavy monkey wrench, of

* Parker: "The Astragalo-Scaphoid Capsule."