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CLUB-FOOT

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ORTHOPEDIC SURGERY



CLINICAL LECTURES
ON
ORTHOPÆDIC SURGERY,

DELIVERED AT THE PHILADELPHIA HOSPITAL,

BY

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ORTHOPÆDIC SURGERY IN THE UNIVERSITY
OF PENNSYLVANIA, ETC.

Nos. I, II.

THE ETIOLOGY, MORBID ANATOMY, VARIETIES AND TREATMENT OF
CLUB-FOOT.

(Reprinted from the Medical News, March 13th and 20th, 1886.)



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THE ETIOLOGY, MORBID ANATOMY, VARIETIES,
AND
TREATMENT OF CLUB-FOOT.

LECTURE I.

GENTLEMEN: Every observant person, whether within or without the profession of medicine, must be impressed with the prevalence of various deformities in individuals of the human family, and their very existence must cause him to reflect upon the nature of their being, their chronic and progressive character, and the apparent difficulty of arresting them. Much of this has been due to lack of knowledge of the mechanical factors which enter into their etiology, and the very general neglect the subject of malformations has received, from an educational standpoint, in our medical schools. Though twenty-five years have elapsed since the establishment of orthopædic surgery as a legitimate special branch of surgical art, its science and practice, noticeably in this city, are permitted to occupy a very subordinate position, and its principles practically are untaught. In this clinic, which will initiate the course of lectures upon orthopædic surgery in the Philadelphia Hospital, which it will be my privilege to deliver before you this Spring, no better subject could be chosen than one descriptive of *club-foot*, a condition which you will frequently meet in practice, and of which many examples may be constantly observed in the nervous, obstetrical and surgical wards of this hospital.

We may define club-foot, or talipes, which latter designation was first employed, about thirty years ago, by William J. Little, of London, as a deformity of the foot, caused by paralysis, permanent spasm, or structural shortening of the

muscles, contractions of fasciæ or ligaments, and resulting in an alteration of the normal relations of the tibio-astragaloid articulation, or between the bones of the tarsus proper. Under the generic term club-foot, or talipes, we include all deformities of the foot which occur on an antero-posterior or transverse plane, and which are characterized by flexion, extension, inversion or eversion.

To obtain a clear conception of the deformities under consideration, it is best to divide the foot into an anterior and a posterior portion, the former, the "*pes*," or foot proper, and the latter, the "*talus*," or ankle. These portions articulate at Chopart's joint, which is formed by the astragalus and os calcis behind, and the scaphoid and cuboid in front. For purposes of clinical study, club-foot is most conveniently separated into two classes, composed of the simple and the compound forms. Of the former there are four varieties, two between the tibia and foot, namely, *equinus*, in which the heel is raised, the foot being held in the extended position, the patient walking upon the ball of the foot; and *calcaneus*, its opposite, in which the patient walks upon the heel, the foot being drawn into the position of flexion. There are also two lateral deformities: *varus*, in which the internal border of the foot is elevated, the sole directed inward, and the anterior portion of the foot adducted; and *valgus*, its opposite, in which the outer side of the foot is raised, and the sole everted. Any combination of these simple varieties will present compound forms, such as *talipes equino-varus*, *equino-valgus*, *calcaneo-valgus*, etc.; some authors have added others: for instance, *talipes cavus*, in which the arch of the foot is increased, and *talipes planus*, or spurious valgus, in which the foot is flattened, the arch resting upon the ground. Recently, Shaffer, of New York, under the title *non-deforming club-foot*, has described a class of cases in which there is little or no deformity, but which are very important on account of the inconvenience they occasion the sufferer, and the results to which they give rise, coupled with the liability of being over-

looked, unless care be taken in the examination of the patient.

The varieties of club-foot may be classified as follows:—

TABLE NO. I.

Varieties	Simple,	Antero-posterior	{ Equinus. Calcaneus.
		Lateral	{ Varus. Valgus.
	Compound, . .	Equino-	{ Varus. Valgus.
		Calcaneo-	{ Varus. Valgus.
	Other forms, .	{ Cavus. Planus. Non-deforming.	

As previously mentioned, these simple forms, or their combinations, constitute the deformities which you will meet with, and a knowledge of their relative frequency is of interest and importance. Much difficulty is experienced in the investigation of this subject, owing to the difference in nomenclature employed by various authors, similar conditions being spoken of under different names. Duval has recorded 1000 cases, of which 574 were congenital; 364 of these were in males, and 210 in females. His statistics as to relative frequency are valuable, and are as follows:—

TABLE NO. II.

	CASES.	BOYS.	GIRLS.
Equinus and equino-varus,	417	215	202
Varus,	532	302	230
Valgus,	22	14	8
Calcaneus,	9	6	3
Extreme calcaneus,	20	13	7
Totals,	1000	550	450

I have compiled the following statistics, shown in Table No. III, from the records of the New York Orthopædic Hospital, and the Orthopædic Dispensary of the University of Pennsylvania:—

TABLE NO. III.

	CONGENITAL.	ACQUIRED.
Equinus,	5	87
Calcaneus,	3	31
Varus,	73	66
Valgus,	29	236
Equino-varus,	95	68
Equino-valgus,	3	9
Calcaneo-varus,	0	2
Calcaneo-valgus,	5	34
Totals,	213	533

Lannelongue has collected the statistics of the Maternity Hospital (Paris), covering a period of ten years, from 1858 to 1867, inclusive. In 15,229 births, 8 children were born with club-foot, a proportion of about 1 case in 1963 births.

The condition may be present as a congenital or an acquired deformity, and the relative frequency of the two forms may be seen by reference to Table No. III, from the cases treated in the New York Orthopædic Hospital, and the Orthopædic Dispensary of the University of Pennsylvania, in which are recorded 746 cases, of which 213 were congenital, and 533 acquired. Tamplin's deductions, shown in Table No. IV, covering 764 cases of congenital talipes, show the relative frequency to be as follows:—

TABLE NO. IV.

CONGENITAL.		
Talipes varus,	688	cases.
“ valgus,	42	“
“ calcaneus,	19	“
“ varus of one foot and valgus of the other,	15	“
Total,	764	“
ACQUIRED.		
Talipes equinus,	401	“
“ valgus,	181	“
“ equino-varus,	162	“
“ calc. and calc.-valgus,	110	“
“ equino-valgus,	80	“
“ varus,	60	“
“ varus of one foot and valgus of the other,	5	“
Total,	999	“

Adams states the proportion between the congenital and acquired forms to be as 2:3, and the tables already referred to show the large preponderance of cases in which the deformity has been acquired. Giving due weight to the statistics which have been alluded to, we may conclude that club-foot occurs more frequently in males than in females; that cases in which inversion and adduction of the foot, either accompanied or not by elevation of the heel, or the varus types, are oftener met with, and that the right foot is more frequently deformed than the left, but that many more cases of double club-foot occur than of single; and that the primitive forms, pure equinus, calcaneus, varus or valgus, are rare.

The etiology of congenital talipes is veiled in obscurity. The difficulty of studying pathological changes occurring during intrauterine life is self-evident, as the foetus cannot be subjected to any direct scientific method of investigation. Comparative physiology, embryology, and the changes and diseases which occur subsequently to birth, give us data of comparative value, but all such investigations have resulted in much speculation, many theories, and but few facts. The theory that diseases which produce the acquired forms have their prototypes during intrauterine existence has its supporters, notably Little. But microscopical research has not yet shown the existence of changes in the foetal brain and spinal cord analagous to those found in cases of the acquired paralytic forms. Voluntary muscular control is retained in congenital cases, while it is lost in the acquired varieties referred to, and the electrical reactions are markedly different; so that this theory has no foundation to rest upon, except the similarity in the appearance of the deformities.

Hereditary influence, with its transmission of peculiarities of face and form, of various tendencies, of traits of character, etc., has some weight as an etiological factor.

Another theory of causation is that of arrest of development, and although cases occur in which co-existing deformi-

ties, such as spina bifida, harelip, cleft palate, etc., are also present, the feet show no evidence of arrest of development, the only alteration being that of the direction of the planes of the feet which is characteristic of the deformity. Adams and Hüter, it is true, have described changes in the bones involved, consisting of alteration of form and relative position of articulating facets, but these changes are by no means constant, and whether they be causative or secondary to the altered relation of the bones, is a matter regarding which there is much difference of opinion. Personally, I incline to the latter view, although the theory has many eminent supporters, including A. Lücke.

The theory which has, perhaps, the greatest number of votaries, is that which ascribes to abnormal intrauterine pressure, and deficiency of amniotic fluid, the influence productive of club-foot; the foot being permanently fixed in the abnormal position during intrauterine life. Although numbering among its supporters such names as Volkmann, Kocher, Banga and Parker, I do not think the assumption tenable, for the following reasons: Were this deformity the result of pressure, it is reasonable to believe that in many cases deformity of other members would co-exist, having been exposed to the same pressure-influence; such, however, is not the case, combinations of this kind being of rare occurrence. Again, in children who have been born with club-foot, and in which the mother had previously given birth to several healthy children, no appreciable difference in the quantity of amniotic fluid discharged during the various labors can be made out. Further, I have recently seen a case of double equino-varus in a twin, the other child showing no deformity whatever.

Dr. H. W. Berg, of New York, in a series of investigations which are commendable for their originality, ascribes congenital equino-varus to a failure of rotation during intrauterine existence. In his studies at the New York Hospital and Wood's Museum at Bellevue Hospital, he has followed the changes which occur in the position of the lower extremi-

ties at different periods of foetal life. At first, the entire leg is rotated outward, and the feet are in a position of marked varus, and, subsequently, of equino-varus. Later, rotation inward takes place, gradually diminishing the amount of varus; but even after this rotation has been completed some varus remains, and, in a very slight degree, is the normal position of the foot in the newborn. Dr. Berg found, in some instances, equinus to be present in foetuses of two, three and four months, the condition disappearing in the process of normal growth, and he reaches the conclusion, that in early foetal life equino-varus or varus is physiological, and that its disappearance is coincident, and keeps pace with the normal rotation of the limb. When, from any cause, rotation is retarded or arrested, club-foot results.

To summarize the theories to which I have alluded, and which constitute the principal ones advanced in explanation of the causes of congenital talipes, I have reduced them to the following: that which would ascribe club-foot to pathological changes occurring in the foetus, similar to post-natal diseases; that which assumes, as a cause, the action of mechanical forces upon the child in utero; then the theory of heredity, with its influences but little understood; the theory of arrest of development; and, lastly, the theory promulgated by Dr. Berg, which would make club-foot dependent upon the absence or retardation of rotation. The last mentioned possesses the merit of being demonstrable by embryological research, and in the present state of our knowledge it has, in my opinion, greater claims to recognition than those which are based upon similarity of post-natal conditions, or those which rest upon even a more fanciful basis.

Turning our attention now to the consideration of the etiology of acquired talipes, we do not find the path of investigation beset with the difficulties we met with in the study of the causation of the congenital types. We may divide the causes into six groups: 1st. Infantile spinal paralysis. 2d. Spastic contractions due to an irritative lesion of the spinal

cord. 3d. Contraction of aponeuroses. 4th. Traumatism. 5th. Rachitis. 6th. Hysteria.

By far the greater number of cases of acquired talipes are due to infantile spinal paralysis—"poliomyelitis anterior." This is essentially a disease of childhood, usually occurring at the period of dentition, its invasion being, as a rule, sudden, marked by fever, gastro-intestinal disturbance, sometimes ushered in by a convulsion, and immediately followed by muscular paralysis, more or less extensive. Recovery follows rapidly in many of the muscles affected, but is rarely, if ever, complete, a certain amount of residual paralysis remaining permanently, in one or both of the lower extremities. Atrophic changes now take place, and are characterized by wasting of the muscles of the limb, loss of electro-contractility, especially to the faradic current; later by reactions, when stimulated by galvanism, characteristic of degenerative change, and deformity, of which the most frequent is club-foot.

It has been thought that the deformity in these cases was due to the loss of equilibrium between the muscles of the limb; one set being paralyzed, their antagonists drawing the foot into the deformed position; but Hüter has shown that the weight of the limb, in the position assumed in paralysis, is the cause of contractions, and that these were due to atrophy and arrest of growth, and were not in any sense muscular. In some cases, resulting from poliomyelitis, the deformity is due entirely to the force of gravity, the foot dropping into the position of equinus, and the anterior portion being adducted by its own weight. In these cases there is little, if any, contraction, and the deformity is readily reduced by manual pressure, but, of course, returns immediately upon the removal of the hand. Volkmann, also, has directed attention to the fact that, owing to the weight of the body, the limb assumes an abnormal position, which eventually becomes permanent, being due, not to contraction, but to abnormal growth.

The "spastic paralysis" of Erb is also productive of club-foot. This condition has been called by Adams, "paralysis

with rigid muscles," and by Seguin, "tetanoid paraplegia." It is well illustrated by the case I now present.

CASE I. *Tetanoid Paraplegia, producing double Talipes Equino-varus*.—Barney, æt. six years. No record or information could be obtained regarding previous history. Having stripped him, it will be noticed that the thighs are adducted and slightly flexed upon the pelvis. The legs are held firmly at a moderate degree of flexion at the knee joint. The feet are extended and inverted in the position of pronounced equino-varus. All muscular groups of the lower limbs are in a condition of spasmodic rigidity. You will notice these contractions may be temporarily overcome by firm and continuous pressure, but immediately reappear upon the removal of the opposing force. Locomotion, with assistance, is accomplished, with difficulty, by a swinging, discordant gait, typical of the disease, the patient walking only upon the ball of the feet and toes, the weight of his body not being sufficient to overcome the contraction and bring the heels to the floor. The other symptoms characteristic of the central lesion—deficient intelligence, strabismus, exaggerated muscular reflexes, and general rigidity and spasm of the muscular system, are all present. As I propose to operate upon this patient, I will defer a further consideration of his *feet* until my next clinic. The condition appears to be due, in some instances, to retarded development in the motor tract of the brain; in others, to a lesion in the same position, followed by secondary changes in the lateral columns of the cord. The researches of Rupprecht, of Dresden, not only show that tenotomy is followed in some of these cases by improvement in the position of the feet, but that the mental state is also appreciably benefited by the operation. His article has been published in Volkmann's series of clinical lectures, and constitutes an important and valuable contribution to our knowledge of this interesting class of cases. Various spinal diseases, acute compression, syphilis, tumors, caries, etc., are frequently productive of a similar condition. Other diseases of the nervous

system should be mentioned as causes of club-foot. In rare cases, pseudo-hypertrophic muscular paralysis, and post-hemiplegic contractions produce the deformity, but neuro-mimetic conditions, which of late years have attracted much attention, are more frequently the cause of it. A careful elimination of other possible etiological factors in a given case, coupled with a proper appreciation of the general condition, will usually lead to correct conclusions in the cases of the latter kind.

Sayre has advocated the view that paralysis due to reflex irritation is, in many instances, productive of talipes, and has reported cases in which he claims that functional disturbance of the nervous system can cause spasm of muscles, which, if sufficiently prolonged, while healthy growth continues in their antagonists, becomes the cause of a permanent deformity. Much discussion has taken place concerning this condition as a cause of club-foot, but I do not consider Dr. Sayre's theory as in any way tenable.

Talipes equinus sometimes occurs as a concomitant of the paraplegia of Pott's disease of the spine, but disappears upon recovery from the paralysis; joint diseases of the lower extremity are also potent factors in the production of club-foot. In ankle-joint disease the deformity may follow osteitis of the articulation, and remain as a permanent condition, due to ankylosis of the joint in the position of extension. In hip-joint disease, it would be due to prolonged malposition during the period of growth. I have lately seen a case of this disease in which the limb upon the affected side was shortened but one inch, and in which there was a marked equinus accompanied by contraction of the plantar fascia. Occupations requiring long-continued standing in one position can be also considered causative agents; printers, bakers, blacksmiths, and those engaged in kindred trades may be mentioned as the principal sufferers. The enforced position and the weight of the body are the factors in the production of this variety of the deformity, which is most commonly a valgus. The same

remarks will apply to the valgus of adolescence, due probably to rapid growth, and increased weight of the body, without, however, a corresponding development of the muscles, aponeurosis, and ligaments of the feet. The influence of long-continued decubitus is further shown by the case reported by Volkmann, in which an equinus was found, after prolonged typhoid fever, so resistant that it required a year's treatment to restore the feet to their normal position. As to traumatism, it will be only necessary to allude to the possibility of wounds, burns, rupture of tendons, etc. The former may result in the production of deep cicatrices, which, by their contraction, tend to draw the foot into a deformed position. Spurious valgus, or splay-foot, is frequently the result of rachitis, although, as before mentioned, occupation is often an important factor in its causation. All these forms may be simulated by hysteria, and this class of cases frequently taxes the knowledge and ingenuity of the surgeon; their recognition lies in a thorough understanding of general morbid conditions and a careful diagnosis by exclusion.

Before closing, I desire to call your attention to the morbid anatomy of club-foot. I shall, however, touch upon it only sufficiently to give you an idea of the muscles involved in the production of the various deformities, and will illustrate my remarks by reference to the following classification.

TABLE NO. V.

Extension (equinus)	{	Gastrocnemius. Soleus. Plantaris. Peroneus longus.
Flexion (calcaneus)	{	Tibialis anticus. Peroneus tertius. Extensor longus digitorum.
Adduction (varus)	{	Tibialis anticus. Tibialis posticus. Flexor longus digitorum.
Abduction (valgus)	{	Peroneus longus. Peroneus brevis. Peroneus tertius.

Dividing the muscles into three groups, which move the foot in four directions, as shown in Table No. V, we have a posterior group, the calf muscles, the gastrocnemius, and the soleus, and two anterior groups, the tibial and the peroneal. In the normal condition, an equilibrium is maintained between these muscles, and the correct anatomical relation of the parts is preserved; but should spasmodic contraction or paralysis of one or more of these groups occur, the balance is destroyed, and deformity takes place. As has been remarked, the purely primitive forms of club-foot are extremely rare, and this statement will apply to these deformities, whether they be congenital or acquired. A brief consideration of them, however, is necessary in order that a clear understanding of the compound forms which are encountered most frequently in practice may be obtained. They are *equinus*, *calcaneus*, *varus*, and *valgus*; the two former being antero-posterior deformities; the two latter occurring upon a transverse plane.

In *talipes equinus* the heel is raised, the patient walking upon the ball of the foot. Here we find the posterior group of muscles, consisting of the gastrocnemius and soleus contracted and shortened, the tendo-Achillis being felt as a tense band. In the opposite condition, *talipes calcaneus*, the anterior groups of muscles, tibialis, anticus, posticus, and peronei, are at fault, and being shortened, maintain the foot in the position of flexion, the patient walking upon the heel. *Talipes varus* manifests itself by inversion and adduction of the foot, the deformity taking place anterior to Chopart's joint; in it, the sole is turned inward and raised, and the anterior portion of the foot adducted, the tibialis anticus and posticus and flexor longus digitorum being contracted. In *valgus*, on the contrary, the sole is turned outward, and its outer border raised, the peronei being the muscles at fault. In this deformity, however, the plantar fascia is involved, the arch of the foot being diminished by its relaxation.

In all these varieties, changes occur, not only in the muscles,

but also in the ligaments, fasciæ, and in the bones themselves, whether as causes or effects; but we shall defer the study of them until our next meeting, my object in briefly mentioning the primitive deformities now, being merely to impress upon you the character of the changed relation of the parts from an anatomical rather than a pathological standpoint, which latter condition can be best considered when we come to speak of the most frequent of all the forms of club-foot, namely, *talipes equino-varus*.

LECTURE II.

GENTLEMEN: Our last meeting closed with a brief description of the primitive forms of club-foot. We now pass to the consideration of the treatment of *talipes* in general, such modifications as may be necessary to correct the deformity in any special case which may come before us being deferred until we discuss the compound forms. Properly to cope with these conditions, it is essential that you should thoroughly comprehend the factors, pathological and mechanical, which produce them. Because of the lack of exact knowledge upon the subject by the profession, many cases of deformity remain uncured, and scores of children who could otherwise be relieved are left to the care of inconsiderate instrument makers. It is only by the intelligent application of measures fitted exactly to the case that success can be achieved; and the knowledge requisite to do this is not possessed by the mechanician in any greater degree, than is the knowledge necessary properly to care for a medical case a part of the education of the apothecary. Nor has the training of the general practitioner been such as to make him an adept in this branch of surgery, and when it is considered how few are his opportunities of seeing many such cases, it is not strange that extreme deformities are frequent, and that their existence and progression should be an opprobrium. It is only by the dissemination of knowledge by clinical teaching, and the

establishment of institutions dedicated to the care of these special cases, that a better state of things may be hoped for, and the importance of such measures cannot be over-estimated.

The object of treatment in club-foot is not only to remove the existing deformity, but to restore to the foot its functions; and to do this many procedures have been resorted to, which have been in turn discarded. We may consider the methods now in use as *mechanical* and *operative*. First among the former is manipulation, applied so as to stretch the contracted tissues, passive motion, massage, shampooing, and electricity being used the while, to aid in the restoration of function. The hand, if pressure and traction to the contracted tissues could be continuously applied by it, would, no doubt, constitute the best instrument for the relief of club-foot; the apparatus which is best adapted to take its place is that which should be relied upon in the mechanical treatment of the deformity.

Massage and electricity serve, in paralytic cases, to restore, as far as possible, the functional activity of the paretic muscles, and should always be employed as adjuvants in such cases.

Tenotomy for the division of contracted tendons, called aponeurotomy when performed upon fasciæ and aponeuroses, was resorted to first by Delpech, of Montpellier, France. It was not, however, generally employed, until Stromeyer, of Hanover, rendered it popular. Little introduced the operation into England, and Dickson, of South Carolina, first performed it in America. To Deltmold, of New York, and Mütter, of this city, however, is due much of the credit of making the operation popular in this country. Opinions differ as to the indications for tenotomy and the proper time for its performance; whether, for instance, in cases of congenital talipes, it should be done prior to the time at which the child is able to walk, or subsequently. No difference of opinion can exist as to the advisability of early operation in cases in which the nature or extent of the deformity renders correction by mechanical means alone impossible; but as experience

is the only guide to discrimination, mechanical appliances should always be granted a fair trial before resorting to operation. Rigidity, or the reflex spasm caused by point pressure mentioned by Sayre, is not in itself a safe criterion, nor does excessive deformity, taken alone, furnish a reliable indication.

Retentive dressings, such as splints of silicate of soda or plaster-of-Paris, are used, either alone or after tenotomy, serving to retain the foot in the position acquired after manipulation or operation. The rubber muscle advocated by Richard Barwell, of London, and extensively used by Sayre, may be employed to take the place of paralyzed muscles; or Scarpa's shoe, as variously modified, may be applied to fix the foot and exert traction.

As I mentioned to you at our last meeting, the type of club-foot with which you will most frequently meet is talipes equino-varus. The principles of treatment appropriate to the mechanical conditions present can be applied to any of the other forms. This deformity is well illustrated by the case I now show you.

CASE II. *Congenital double Talipes Equino-varus: Mechanical extension; Recovery.*—Richard C., æt. four months, referred to my care from the Obstetrical Department of this Hospital. The deformity, which in this case affects both feet, takes place upon an antero-posterior and a transverse plane, combining elevation of the heel, *equinus*, and inversion of the foot, with elevation of the internal border of the sole, *varus*. The os calcis is drawn upward by the contraction of the gastrocnemius and soleus, and rotated in such a manner that its posterior border is turned outward and its anterior border inward. The bones of the tarsus, following the direction of the os calcis, are inverted, and the inner sole raised by the action of the tibialis anticus. The altered relation of the bones of the tarsus leads to change in form, especially of the articular facets; and some have considered these alterations as causative. This is by far the most frequent of the

congenital forms of club-foot, and it has been argued that arrest of development in bones and muscles is the principal etiological factor. As the various theories on the subject were discussed in our former clinic, they need not detain us here.

The lateral deflection of the anterior portion of the foot, as compared to that of the normal imprint, is well shown in the following cuts. The outline tracings are from impressions of the feet of patients suffering from various deformities, obtained after the method advocated by Rohmer (*Les Variations de Forme Normales et Pathologiques de la Plante*

FIG. 1.

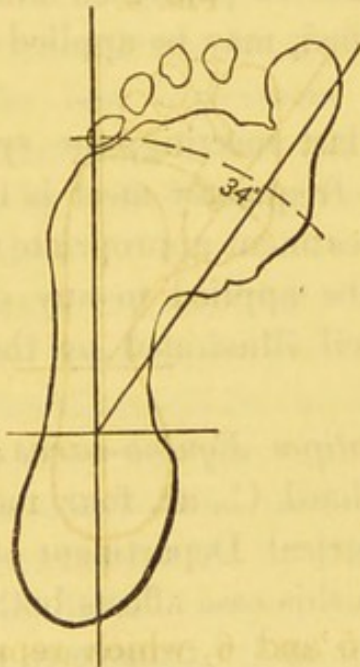
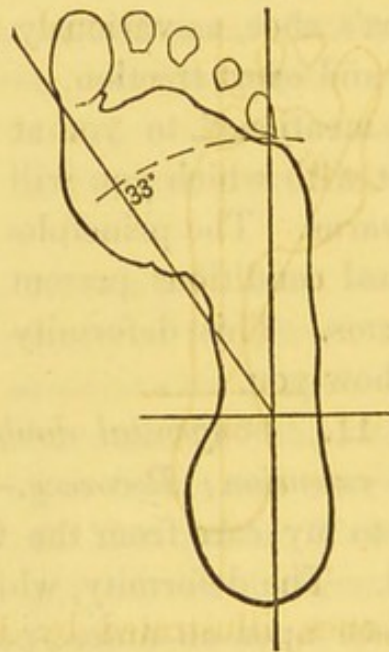


FIG. 2.



du Pied, Thèse, Nancy, 1879) consisting of first covering the plantar surface of the foot with lampblack, which leaves a correct impression of the sole upon white paper, on which the patients are then requested to walk. To obtain a correct basis of measurement, and still further to carry out Rohmer's researches as a guide to treatment, I selected the medio-tarsal joint as a base line of measurement; erecting upon it a perpendicular corresponding to the long axis of the os calcis. As they are comparatively stable structures in all deflections from the normal condition of the foot, the *position* and character

of deformity could be readily determined by a comparison of the degrees of variation.

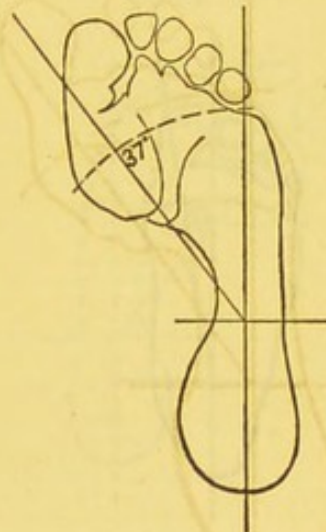
In the thirty-two normal feet measured, I have found the angle of deflection, which is represented by an imaginary line passing through the head of the metatarsal bone of the great toe, to range between 26 and 37 degrees (*average*, 20 males, 34.8 degrees; 12 females, 31.5 degrees); typical examples may be seen in Figs. 1 and 2, *males*, and Figs. 3 and 4, *females*.

In valgus, on the contrary, the angle of internal deflection is reduced to from 12 degrees in moderate cases, to 5 degrees in

FIG. 3.



FIG. 4.



extreme ones, illustrated by Figs. 5 and 6, which represent the imprint of patient's feet suffering from acquired "flat-foot" of rachitic origin. From an examination of seven cases, I have ascertained the average deviation from the perpendicular to be about 8.2 degrees.

The adduction of varus has in two instances reached an internal rotation of 63 degrees. I consider all feet that have an internal deviation in excess of 40 degrees as abnormal. An examination of fourteen cases of varus yields an average of 51 degrees.

This method of measurement I believe to be of importance, as furnishing us with an excellent and accurate guide to the

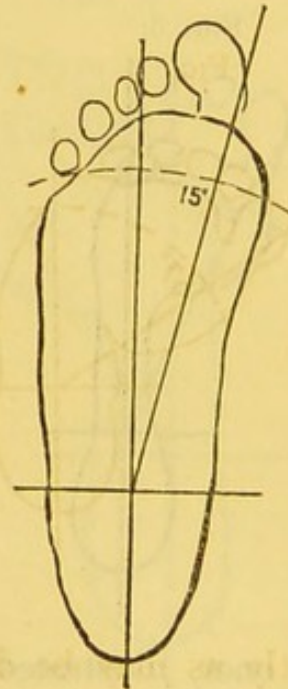
amount of deformity, as well as affording an opportunity of determining the improvement that may follow any plan of treatment instituted.

In the correction of equino-varus, as in that of the other compound forms, it is best to divide the process of rectification into two stages, the object being to overcome one of the factors of the deformity before attacking the other. The reason for this will be sufficiently obvious, when it is considered that the altered relations of the tissues of the foot take place upon

FIG. 5.



FIG. 6.



two planes at right angles to each other. Our endeavor, then, should be directed first to the lateral or varus element of the deformity. Manipulation should be systematically used, and while sufficient in very mild cases, is of great service as an adjuvant in severe ones. It should be applied several times daily, and in the following manner: The heel is firmly grasped by one hand, while with the other the anterior portion of the foot is gradually and steadily brought into a position of valgus, and held there for a few moments, then allowed to return to its abnormal position. After the manipulation has

been repeated several times at short intervals, the foot may be placed in any light dressing. This splint will retain the foot in its corrected position, and may be modified from time to time to suit the lessened amount of varus. It may consist of material suited to the case. In the milder degrees of the deformity, adhesive plaster wound around the foot and attached to the fibular aspect of the leg answers the purpose, but when greater strength is required splints made of leather, gutta serena, or hatters' felt may be moulded to the parts, and secured by a roller bandage. These have the advantage over fixed dressings of plaster-of-Paris in allowing inspection as

FIG. 7.

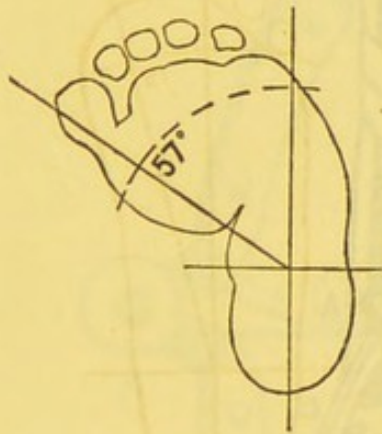
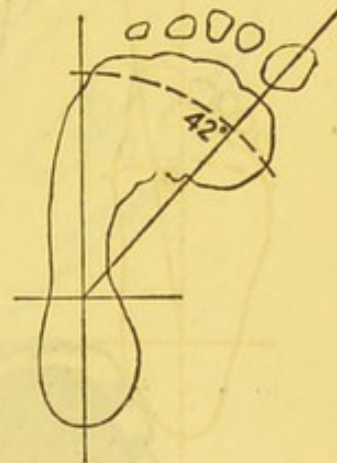


FIG. 8.

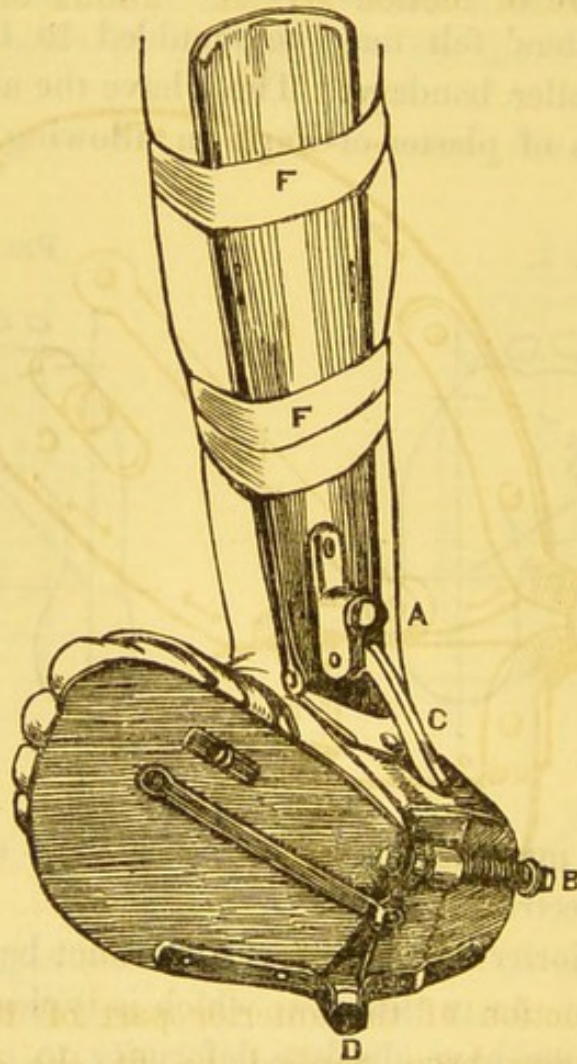


frequently as may be desired, together with the application of massage, electricity, etc.

But the majority of cases of varus cannot be cured by such simple means. As in this case, which is typical of congenital equino-varus, we have absolute deformity to overcome; tendons and muscles are shortened, and the tissues structurally altered. The so-called "mild measures" will not avail, and time occupied in the trial is wasted. Nothing will be of benefit except the application of instruments, which by their accuracy of construction and power will appropriately stretch the tissues involved, or, after a fair trial of these, operations which will divide the resisting structures.

In such cases the shoe which I now show you (Fig. 9) is of the greatest service. It is a modification of Taylor's ankle support, and in its original form was devised by Shaffer, of New York. To this brace I have given more power by substituting in the sole plate, for his extension bar a triple thread screw worked by a key at "B," and by throwing the

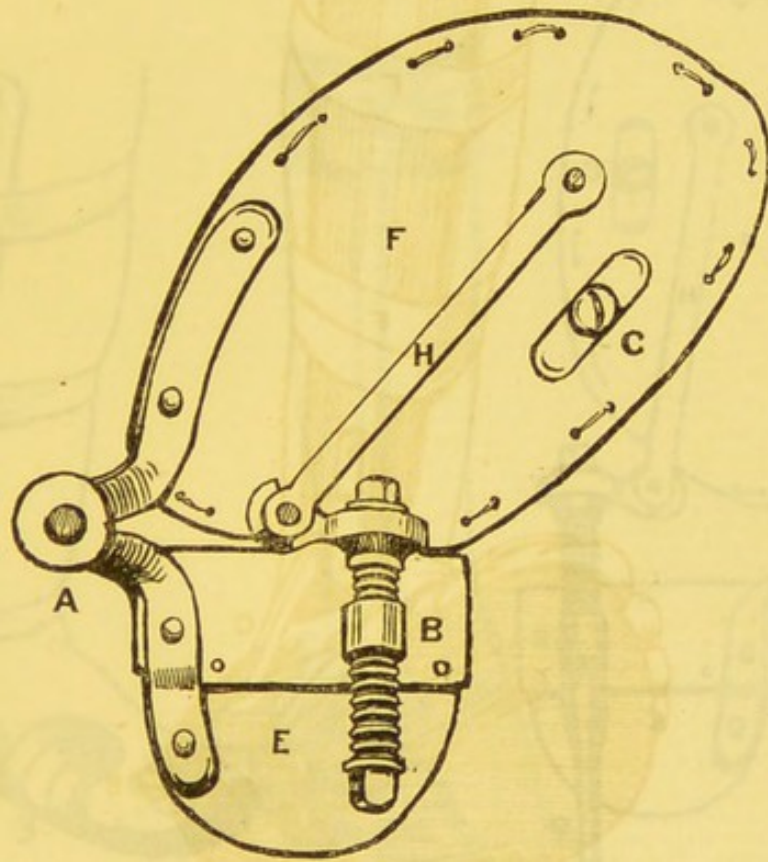
FIG. 9.



centre of motion further to the outer side of the sole at "A" (Fig. 10). The instrument consists of a steel trough fitted to the inner side of the leg, extending from the upper part of the tibia to the internal malleolus. A hinge at "C" (Fig. 9), the direction of which is such as to allow pressure exerted upon it at right angles to operate upon the anterior or lateral deformity, connects this trough with a continuation, or foot

portion, which is joined by a plate to receive the foot by an antero-posterior joint, so that the shoe may be accurately adjusted to the "equinus" element of the deformity. The endless screw which I show you at "A" (Fig. 9) is operated by a key, and acts through this hinge upon the anterior portion of the foot. The sole is divided opposite the medio-tarsal joint, and by means of the screw "B" (Figs. 10, 11) acting upon the centre of motion at "A" allows of extreme and

FIG. 10.



powerful abduction of the anterior part of the foot. The apparatus having been applied to fit the deformity, and secured by a bandage ("F, F"), the foot is thrown into a position of valgus by means of the screw "A" (Fig. 9) acting upon the hinge "C," and this is supplemented by applying the force of the screw in the sole plate "B" (Fig. 10), which still further acts upon the anterior deformity. It is better to use the apparatus by stretching the tissues several times in succession, and after allowing them to relax, to adjust the

brace to the corrected position. Having by this method overcome the lateral deformity, as illustrated in Fig. 12, our attention must be directed to the antero-posterior or equinus element.

To correct this deformity by mechanical means, it is necessary to apply an instrument which, through the tendo-Achillis, will elongate the contracted posterior muscles of the calf. To

FIG. 11.

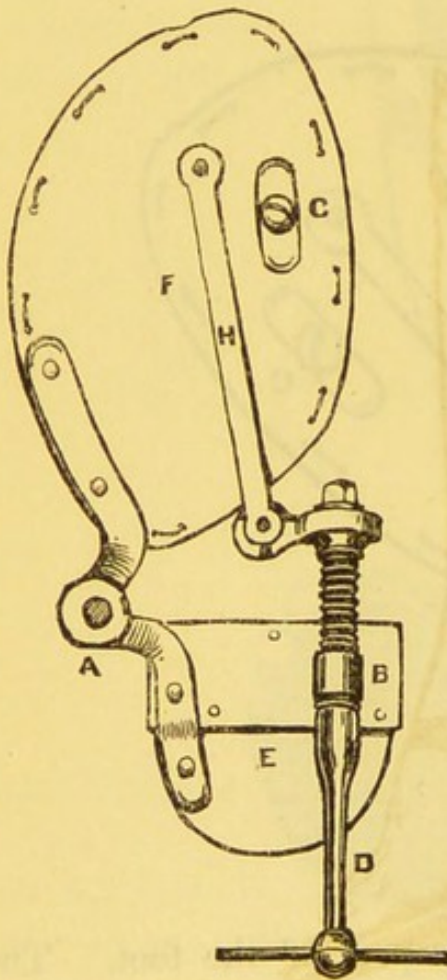
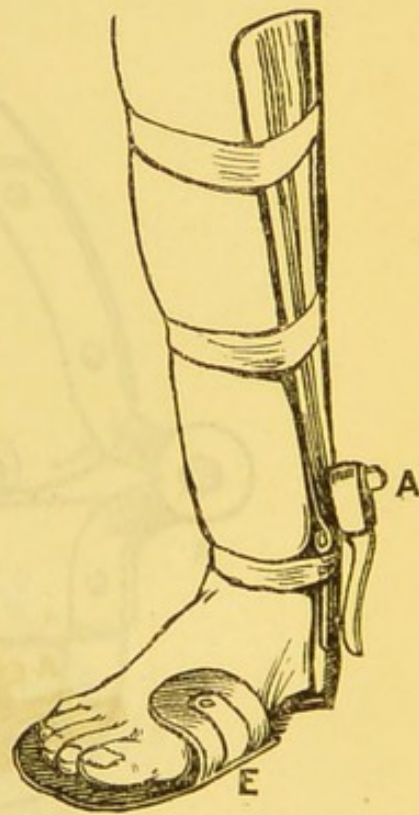


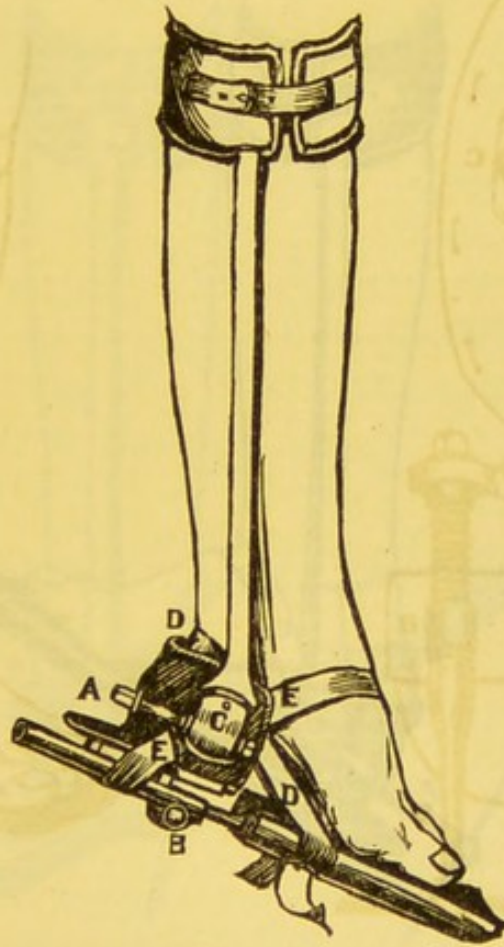
FIG. 12.



accomplish this, many modifications of Scarpa's shoe have been devised. They consist of two steel uprights extending from the upper part of the tibia to the ankle-joint, and are attached to a heel-cup and sole, to hold the foot, the heel being strapped in its place by means of a band of webbing, a bandage, or similar material passing over the instep. The sole may, or may not, be divided opposite the medio-tarsal junction. At

first sight, such an apparatus would seem to fulfill the indication of applying a force sufficient to flex the foot and stretch the tendo-Achillis, but in practice we find that as the necessary power is exerted, the centre of motion in the instrument being opposite the ankle-joint, the heel-cup slips away from the os calcis, and the posterior border of the foot is found resting upon the top of the heel-cup. To obviate this, Shaffer has in his extension shoe, which I now proceed to apply to

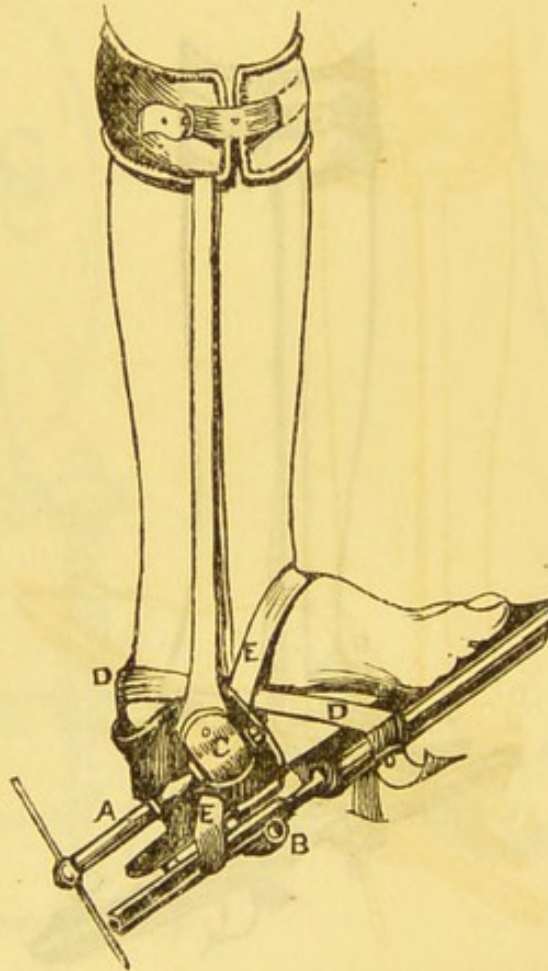
FIG. 13.



this patient (Fig. 13), divided the sole of the brace opposite Chopart's joint, and attached to the anterior portion or sole an extension bar which is worked by a key introduced beneath the heel-cup at "B." The shoe having been applied *extended to an angle corresponding to the angle of deformity*, and the heel secured in its place by a strap passing over the instep "E," the os calcis is further secured by a strap "D" passing around it posteriorly and attached to the buckles upon

either side of the anterior portion of the sole plate. When flexion is made by the key at "A," which acts upon the endless screw opposite the ankle-joint "C," the tendency of the heel, as you see in Fig. 14, is to slip away and rest upon the upper border of the heel-cup, and the degree of flexion of the foot does not correspond to that of the brace. If now, we insert the key below the heel-cup at "B," and throw the anterior portion of the sole forward, the os calcis is dragged

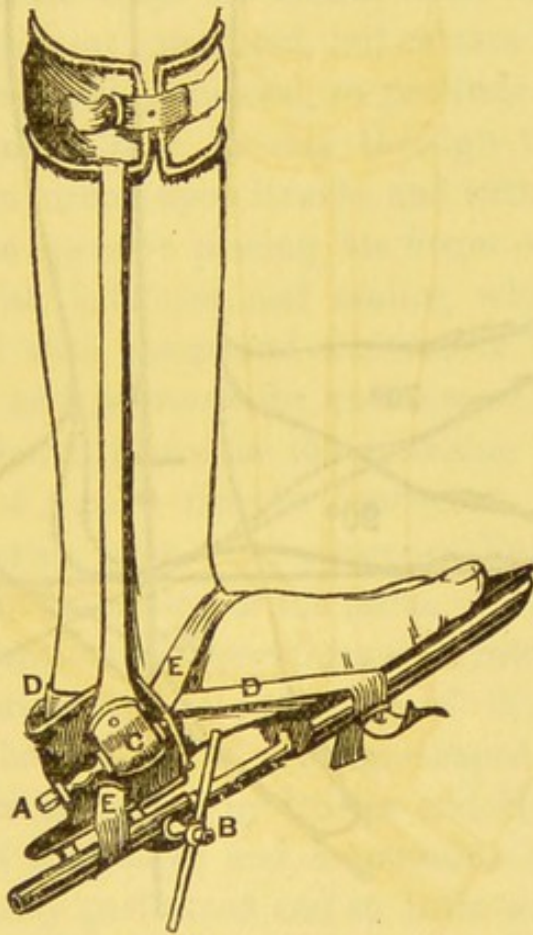
FIG. 14.



upon by the strap passing over it at "D," and the centre of motion is transferred from a point opposite the ankle-joint, to a point represented by the centre of the strap "E" which passes over the instep, and the heel descends until it rests upon the extension bar. The tendo-Achillis is thus thoroughly put upon the stretch, and may be felt as a tense band (see Fig. 15). The operation is repeated several times at each sitting, and the amount of flexion thus gained is held by readjustment of

the brace in the acquired position. No danger need be apprehended from interference with the circulation, if proper precautions be observed; the pressure is not continuous, being rather a *momentary overstretching*, followed by relaxation. The foot should be inspected daily. After the treatment has resulted in bringing the foot to a right angle with the leg, a retention-shoe with stop-joint should be worn, to keep the foot in the corrected position, and a similar apparatus must be

FIG. 15.

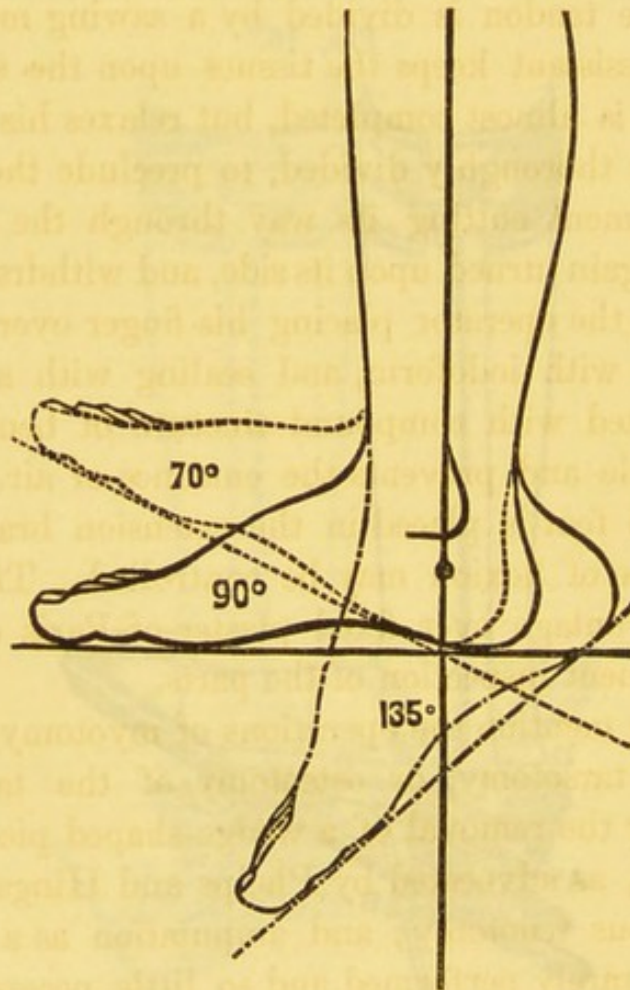


applied during the night throughout the treatment. Here let me remark that a cure is not effected when the amount of possible flexion of the foot forms a right angle with the tibia.

Referring to the diagram (Fig. 16), you will observe that the normal foot in extreme flexion forms with the leg an angle of about 70 degrees, and at the ankle joint motion is possible, in the normal condition, through an arc of which the extremes are represented by 135 degrees of extension, and 70 degrees of

flexion. Our endeavor in the treatment of talipes equinus should be to make the acquired flexion reach this amount as nearly as possible. In connection with this subject, I wish to call attention to the existence of cases of *incomplete equinus*, designated "non-deforming club-foot." In this condition flexion is impossible beyond 90 degrees, and the deformity is amenable to the treatment just described.

FIG. 16.



CASE III. *Acquired double Talipes Equino-varus from Tetanoid Paraplegia; Tenotomy of each tendo-Achillis.*—You will recollect the case presented at our last meeting, which comes before us now for operation. In performing tenotomy, much of its success is due to attention to detail. Two tenotomes are necessary; one sharp-pointed, with which to puncture the skin, and the other probe-pointed, which is introduced through the puncture, and beneath the tendon or fascia to be divided. The parts having been rendered aseptic by cleansing

with a solution of 1 : 2000 of bichloride of mercury, and put upon the stretch by flexing the foot, the puncture in the integument is made over the central portion of the tendon in such a manner that the incision in the skin and that of the deeper tissues shall not correspond after relaxation of the parts. Through this puncture the probe-pointed tenotome is introduced flatwise beneath the tendon, and as close to its deep surface as possible. The cutting edge being now turned toward it, the tendon is divided by a sawing motion of the knife. An assistant keeps the tissues upon the stretch until the operation is almost completed, but relaxes his hold before the tendon is thoroughly divided, to preclude the possibility of the instrument cutting its way through the skin. The tenotome is again turned upon its side, and withdrawn through the puncture, the operator placing his finger over its point of exit, dusting with iodoform, and sealing with a pledget of cotton saturated with compound tincture of benzoin, which forms a pellicle and prevents the entrance of air. After the operation, the foot is placed in the extension brace, in order that its degree of flexion may be controlled. This possesses the great advantage over fixed plaster-of-Paris dressings of allowing frequent inspection of the parts.

I shall only mention the operations of myotomy, or division of muscles; tarsotomy, or osteotomy of the tarsal bones; tarsectomy, or the removal of a wedge-shaped piece of bone; open incision, as advocated by Phelps and Hingston, instead of subcutaneous tenotomy; and amputation as a last resort. These are so rarely performed and so little necessary, that it is only essential that you should know that such procedures have been devised.

The next case I have to show you is one of acquired talipes calcaneus.

CASE IV. *Acquired single Talipes Calcaneus from Infantile Spinal Paralysis; Application of Barwell's Rubber Muscle; Improvement.*—Maggie B., æt. ten, first presented for treatment in the Orthopædic Dispensary of the University of Pennsylvania. She has kindly consented to appear before

you to-day. You will notice the characteristic deformity, the foot being flexed by the action of the anterior groups of muscles, the patient walking upon the heel. In this condition, no treatment does so well as the application of elastic force, advocated by Barwell. The rubber supplies the place of the paralyzed gastrocnemius and soleus, and should be applied as you see in this case. To the shoe are attached two uprights with an antero-posterior joint opposite the ankle. It is important that this joint should be so arranged that while it will permit flexion to any degree, it will stop extension at a right angle. The posterior rubber muscle is attached above to a band which passes around the upper part of the calf and below to the heel of the shoe. Should there be much contraction of the anterior muscles, their tendons may be divided in the manner described, before the application of the apparatus. An operation has been devised for excision of a portion of the tendo-Achillis for the radical cure of this condition, and consists in the removal of a portion of the tendon, and the stitching together of the divided ends.

The next case I have to exhibit illustrates a very important principle in treatment.

CASE V. *Acquired single Talipes Equino-varus ; Mechanical extension, Aponeurotomy ; Recovery.*—Joseph F., æt. ten years, applied to the Orthopædic Dispensary of the University Hospital for relief from a congenital talipes equino-varus with pronounced *cavus*. The case was treated by mechanical extension, as described when speaking of talipes equino-varus, and resulted in the perfect reduction of the equinus and varus. There remained, however, marked *cavus* caused by contraction of the plantar fascia. The extension-shoe was applied with the hope of relieving this condition, but without result, when aponeurotomy was resorted to. Several operations were performed, the knife being entered beneath the plantar fascia, and the resisting tissues nicked, and the extent of the division was regulated by the degree of relaxation of the plantar arch resulting from each operation. As you see, the boy has made a perfect recovery.

I wish to draw your attention especially to the inefficacy of mechanical means in cases of cavus with marked contraction of the plantar fascia, and the reason will be readily understood if we consider the structure and function of the arch of the foot. In those forms of talipes which depend upon contraction of muscles, mechanical force applied through the tendon will act upon muscular tissue and elongate it. The plantar arch, on the contrary, is constructed with the view of supporting the weight of the body, the tissues entering into its formation are of the most unyielding character, *i. e.*, plantar fascia, and no amount of mechanical power which can be safely applied will suffice in cases in which it is markedly contracted. Aponeurotomy is necessary, and performed tentatively, nicking a little, and repeated as often as necessary, yields the best results.

The last patient to which I shall call your attention to-day illustrates a condition the opposite of cavus, the essential element being relaxation of the plantar tissues.

CASE VI. *Acquired double Talipes Planus ("Flat-foot") from Rachitis; Plantar Springs; Improvement.*—John B., æt. thirteen years. This case shows the deformity in a marked degree, the plantar arch being relaxed and flattened, the internal border of the foot resting upon the ground. These cases, in which there is much pain, have received the appellation of "inflammatory valgus." Besides rachitis, the other causes of this deformity are paralysis, ankle-joint disease and rheumatism. It also occurs in growing children, and in those whose occupation necessitates long standing in one position. In mild cases, the most efficient means at our disposal for its relief are the plantar springs, which have been applied in this case, with the resulting improvement which you notice. They are made as follows:

A tempered steel spring is placed inside the shank of the shoe, moulded in such a manner as to support the relaxed tissues of the arch, and overcome the tendency of the foot to eversion. In cases of greater severity, it should be supple-

mented by an ankle support having a pad which will make pressure upon the internal malleolus.

All forms of club-foot may be simulated by the neuromimetic or hysterical conditions. In cases of this kind, the pedal deformity may be accompanied by contractions in other regions, or it may be the only symptom outside the general condition, and the dependence of the local trouble upon the neurotic state may be very difficult to discover. Here, as in neuromimetic affections in other regions, contractions and contractures may so counterfeit their organic prototypes as to render positive differentiation well nigh impossible. In making a diagnosis, the general condition and surroundings of the patient, the hereditary history, together with any fact as to previous mimicry or simulative tendency, should be carefully weighed. The local condition alone is not a reliable guide: the contractions are often as unyielding as in the real deformity; the muscles do not relax during sleep, and the condition may be very persistent. It is only by a careful consideration of each case, and a diagnosis by exclusion, that a correct opinion can be formed.

The care of this condition taxes the patience and ingenuity of the surgeon to the utmost. In few words, the treatment is that of the general neurotic state, coupled with the absolute avoidance of all local manipulations and mechanical contrivances suited to similar organic deformities, and which would here direct the attention of the patient to the affected member. Despite the most careful general treatment, the deformity may persist for months, as shown by Dr. S. Weir Mitchell,¹ of this city. In this case, hysterical single talipes equinus in a young lady of fifteen had continued for two years, notwithstanding the fact that treatment had removed all the more general symptoms of the hysterical state; and it was not until division of the tendo-Achillis, which I performed after consultation with Dr. Mitchell, that the deformity finally disappeared.

¹ Lectures on Diseases of the Nervous System, especially in Women. By S. Weir Mitchell, M.D. p. 129. Philadelphia: Lea Bros. & Co., 1885.

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