

which the jaws have been replaced by two strong pins slightly bulbous at the ends to keep the covers of rubber tubing from slipping off (Figs. 2163-2166).

The wrench is applied to the inner side of the foot and screwed down, so that it may "bite" and hold its place firmly, for if it slips it is likely to abrade or tear the skin; then with considerable force the foot is twisted outward and upward. The "keynote" of the operation is so to wrench the foot that it loses its elasticity, and shows no tendency to recoil toward deformity. The foot is then placed in the best possible position and retained there by the Thomas foot splint or by a plaster bandage. In certain instances one may complete the rectification at one operation, but this is not usually attempted, the procedure being repeated at intervals of a few days until the deformity has been over-corrected. In very resistant cases eight or ten applications of force may be necessary. When the deformity has been rectified, the foot is held in the over-corrected position for several weeks by the splint or plaster bandage.

As a walking appliance, a simple upright of iron with a calf band is applied to the inner side of the leg from a point just below the knee to the heel of the shoe, into which it is inserted, as is the Thomas knock-knee brace. By bending the upright the foot may be kept in slight valgus, and this position is still further assured by making the outer side of the sole of the shoe thicker than the inner, so that the weight falls upon the inner border of the foot.

In many instances the walking brace may be dispensed with in the after-treatment, but a light brace is usually worn to hold the foot in the corrected position during the night, until the power of the abductors and dorsal flexors has been regained. Massage and manipulation are used in the after-treatment in the manner already described.

Properly applied the treatment is satisfactory and free from danger. Sloughing of the tissues caused by the pressure of the instrument or by the plaster bandages has been reported, but such accidents have not occurred in the extensive practice of Thomas and Jones.

Correction by Means of the Osteoclast.—The late Mr. Grattan, of Cork, used the osteoclast that goes by his name to crush and to over-correct resistant club foot. The operation may include, besides the correction of deformity of the foot itself, fracture of the leg above the

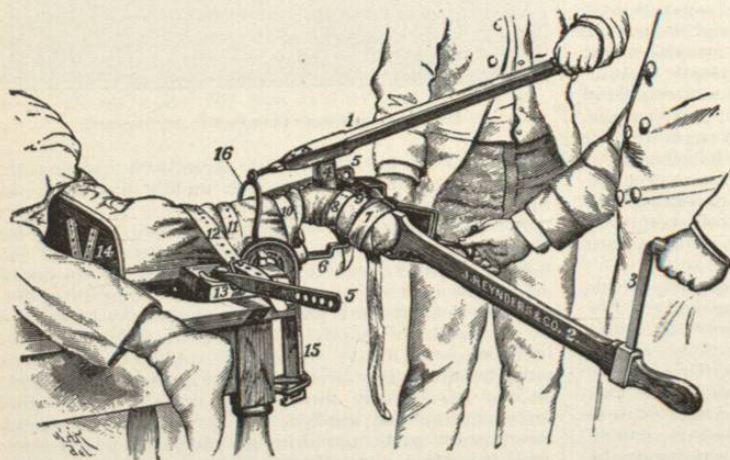


FIG. 2173.—Phelps' Machine in Use for the Correction of Club Foot in the Adult.

malleolus to turn the foot toward valgus, and a second fracture half-way up the limb, to overcome the twist of the tibia.

Other appliances constructed on somewhat similar principles may be employed. Of these the Lorenz osteoclast and the Bradford lever apparatus are the most effective.

The Open Incision Combined with Forcible Rectification of Deformity—Phelps' Operation.—When extensive division of soft parts is indicated, as in resistant cases, the open incision is to be preferred because of the opportu-

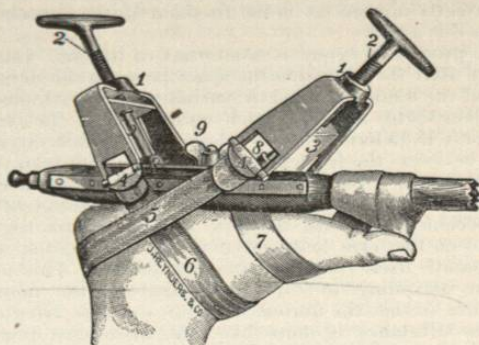


FIG. 2174.—Phelps' Machine Adjusted to the Foot.

nity thus offered for the recognition and for intelligent selection of structures that require division in the final correction of the deformity.

Phelps' operation is in all essential respects simply the division of the contracted parts through an incision on the inner border of the foot, combined with the manual or instrumental force sufficient to over-correct the deformity. It is the most conservative of the more radical procedures, and by it even the most severe type of deformity in the adult can be corrected; that is to say, the deformity may be overcome and a serviceable foot may be assured to the patient. Perfect functional cure is not possible when deformity has become habitual after many years of neglect.

The steps of the Phelps operation are as follows: After proper surgical preparation the Esmarch bandage is applied. The tendo Achillis, and usually the posterior ligament of the ankle, are divided subcutaneously, and by manual or instrumental force the equinus is corrected as far as possible. An incision is then made on the inner border of the foot, just below and in front of the internal malleolus which is

extended directly downward over the head of the astragalus to include the inner quarter of the sole. Through the incision all resistant parts are divided, according to Phelps, somewhat in the following order:

1. The tibialis posticus, and the anticus if it offers resistance.
2. The abductor pollicis.
3. The plantar fascia.
4. The flexor brevis digitorum.
5. The long flexor of the toes.
6. The deltoid ligament in all its branches.

During the successive division of the tissues repeated attempts are made to correct the foot, and only those structures are divided that present themselves as tense and resistant tissues when the foot is forcibly abducted.

In the adult type of club foot no attempt is made to recognize the different structures, but all the tissues on the inner side of the foot including blood-vessels and nerves,

the deep ligaments, and occasionally the tendon of the peroneus longus muscle, are divided. Even then it is necessary to apply considerable force to correct the deformity (Figs. 2173 and 2174). In rare instances the rectification of deformity necessitates osteotomy of the neck of the astragalus, or the removal of a cuneiform section from the os calcis. The object of the Phelps operation is, by

the use of force and by division of resistant tissues, to over-correct the deformed foot at one sitting, and as much force and as extensive division as are required should be employed by the operator.

When the foot can be held in the desired position without resistance, the wound is covered with Lister protective, the foot and leg are thickly covered with gauze and cotton, a plaster bandage is applied, and the limb is elevated. In younger subjects the patient may walk upon the corrected foot in a few days. The large gaping wound closes by granulation in from one to three months; in many instances healing is practically completed under the first dressing.

By this operation the foot, even in severe cases in adult life, may be made straight in appearance. It is evident, however, that in such cases the correction of the deformity of the bones is by no means always perfect, for the fore foot may be simply twisted outward and upward while the astragalus and os calcis may remain in an approximation to their original deformity. After thorough over-correction by the Phelps method the danger of recurrence of deformity in the adult and adolescent type of club foot is not great, and in many instances support other than that of the plaster bandage for several months after the operation may be unnecessary; but in childhood the ordinary precautions in after-treatment to prevent relapse will be necessary.

Operations on the Bones.—Osteotomy of the neck of the astragalus, as a supplementary part of the operation of forcible correction, has been mentioned. In certain instances, particularly in the adolescent or adult type of deformity, the displaced astragalus may offer such an obstacle to correction that its removal is indicated—an operation first performed by Mr. Lund of Manchester.

Astragalectomy.—The astragalus is usually removed by means of an incision passing over its most prominent part, in a direction forward and downward from the tip of the external malleolus, between the tendons of the peroneus brevis and peroneus tertius. The soft parts are drawn aside, the ankle and astragalo-scapoid joint are opened, and the attachments to the scaphoid, and, as far as possible, those at the inner and outer border, are divided. The foot is next adducted so that the head of the bone may be seized with forceps and drawn upward; the interosseous ligament and the internal lateral ligament may then be divided with curved scissors and the bone may be removed. If after removal of the astragalus the deformity cannot be corrected, the anterior part of the os calcis or the external malleolus should be removed as well. A useful movable foot may be obtained by this operation, but it by no means assures the patient from recurrence of deformity. It is rarely indicated as a primary operation. The varus should be thoroughly corrected as a preliminary procedure; then the resistance that the astragalus offers to dorsal flexion can be estimated.

Cuneiform Osteotomy.—The removal of cuneiform sections of bone from the outer border of the foot is sometimes necessary, but the operation should be secondary to other methods of correction. The aim should be to lengthen contracted and shortened tissues on the inner border of the foot, to the extent required for reposition; not to remove bone to accommodate these shortened tissues. If this has been shown to be impossible by ordinary means, then removal of bone may be indicated, but this is practically never necessary in childhood or even in adolescence. If sufficient bone is removed from the adult foot to allow of perfect correction of the deformity, relapse is not usual; but in childhood, as has been stated, no operation will take the place of after-treatment.

The treatment by cuneiform osteotomy as it is ordinarily carried out is sufficiently simple. In severe cases, the astragalus is usually removed and a wedge-shaped section of bone is taken from the os calcis and the cuboid, and if necessary also from the scaphoid bone. The external malleolus may be removed if it interferes with reposition. Preliminary fasciotomies and tenotomies are usually performed, but those who favor this method of treatment rarely use force in reposition. In less ad-

vanced deformity the astragalus is not removed, but a part of its body and neck is included in the cuneiform resection. The foot is retained in proper position until the wounds are closed; then plaster bandages are employed for several months. Braces are seldom used in the after-treatment.

In certain cases of relapsed or ineffectively treated club foot, even in childhood, deformity of the os calcis either interferes with correction of the foot or favors relapse. In such instances the removal of a cuneiform section of bone from the anterior extremity, as a supplementary part of over-correction, may be of service.

Simple Mechanical Rectification of Deformity in Walking Children and in those of Older Growth.—It has been stated that simple mechanical rectification of deformity was possible even up to adolescence, but that the time required for such treatment, usually extending over several years, as a rule excluded it from consideration.

The simplest mechanical treatment is that by which the foot is slowly forced from equino-varus into equino-valgus by a brace on the lever principle, which is at first shaped to the deformity, and is then gradually straightened as the resistance diminishes. When the midpoint has been passed between varus and valgus the weight of the body aids in the correction of the remaining varus and equinus. The modification of the Taylor brace used by Judson, an advocate of pure mechanics in the treatment of club foot, will serve to illustrate the type of apparatus which, with slight change, may be employed to correct or to support the weakened or deformed foot.

The brace consists of an upright, a flat tapering bar of mild steel, a foot-plate of steel from 18 to 16 gauge, and a strong calf-band. The shape of the brace, the method of its attachment to the legs by straps of webbing, and its effect in gradually changing the attitude of the foot from varus to valgus are shown in the accompanying figures (Figs. 2174-2181).

The upright is firmly riveted to the foot plate in the angle of deformity, so that the patient walks upon his toes; as the equinus is decreased by the influence of the weight of the body, this angle is lessened.

The important points are, that the brace should be strong enough to hold its place under the strain of use, and that the foot shall be firmly secured to it, whether one or many straps of webbing are required, as may be seen in the figures. The use of massage and manipulation is of course combined with the mechanical treatment.

By persistent attention to the details of treatment satisfactory results can be obtained by this method in the less resistant cases, even in adolescence.

Recapitulation of the Principles of Treatment of Congenital Talipes Equino-Varus.—The object of treatment is to overcome and to over-correct the deformity at as early a period of life as is possible, and as quickly as possible. The object of over-correction is to overcome all the resistance of the tissues that may even in the slightest degree limit the normal range of motion in any direction. The foot must be supported in the over-corrected position until the recoil of the tissues toward deformity is no longer present.

It must be supported in the proper relation to the leg, and at a right angle with it, until the muscular balance has been re-established by stimulation of the weaker, and by limitation of the activity of the stronger, muscles, and until transformation of the internal structure has been completed.

If efficient mechanical treatment is applied at the proper time, that is to say, in earliest infancy, no operation, other than division of the tendo Achillis, will be required.

If the deformity is not corrected or is but partially corrected, when the child has begun to walk, some form of operation is as a rule indicated; but division of the resistant tissues must always be combined with the employment of sufficient force to accomplish the desired result, viz., over-correction of the deformity. Manual correction, applied in the manner described, is the most

efficient means of attaining this object. No instrument can equal the hand, and the force that can be applied by the hand is sufficient in all the ordinary cases in early

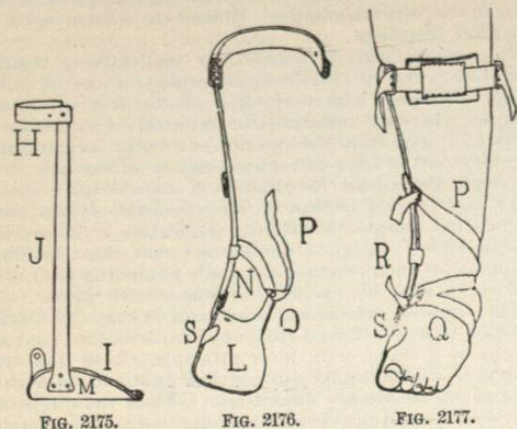


FIG. 2175.

FIG. 2176.

FIG. 2177.

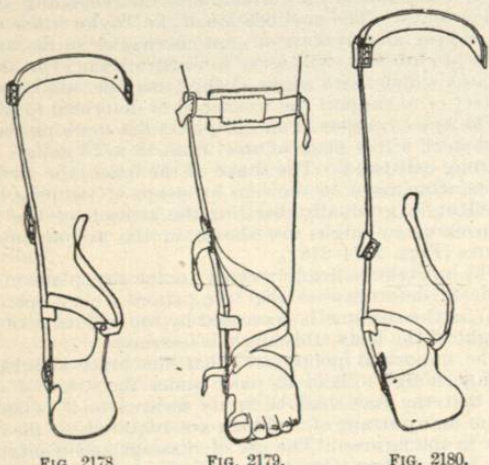


FIG. 2178.

FIG. 2179.

FIG. 2180.

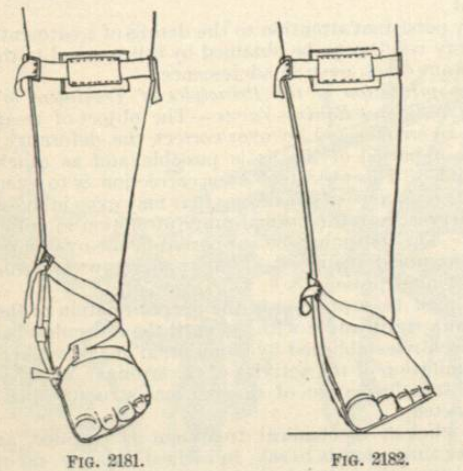


FIG. 2181.

FIG. 2182.

childhood, and in combination with subcutaneous division of the more resistant tendons and ligaments, even in later childhood and adolescence.

Forceful correction by the Thomas wrench under the same conditions is an efficient treatment, but there is a manifest disadvantage in submitting a patient to a succession of operations, even of so slight a character, if immediate over-correction can be attained by other means.

The Phelps' operation, which combines thorough division of the resistant parts with the application of proper force to over-correct the foot, is the operation of selection for the more resistant cases in adolescence, in adult life, and in extremely resistant cases in childhood.

Astragalectomy and cuneiform resection are never indicated as primary operations, but one or the other may be necessary in the rectification of the deformity when other means have failed.

Complete cure of deformity, even in the later years of childhood, is possible by means of braces alone, but such treatment is very tedious. It requires not only the continuous supervision of the skilled surgeon, but the intelligent and persistent co-operation of the parents. The results are in no way superior to those attained by more rapid methods, while the disadvantages of long-continued use of braces are sufficiently obvious. To the popular



FIG. 2183.—Congenital Talipes Varus.

faith in braces as a cure-all of deformity, and to the unintelligent use of braces, may be ascribed, now as in former times, the failure of treatment of this eminently curable deformity. This statement seems justified, even when balanced by the equally fallacious belief, so prevalent among physicians, that an operation, if not synonymous with cure, is, at least, the essential part of the treatment.

Rectification of deformity, by whatever means, simply completes the first stage of treatment. Perfect cure can be assured only by attention to the small details of after-treatment, by checking the slightest impulse toward deformity, and by guiding the unbalanced foot toward perfect functional use.

OTHER VARIETIES OF CONGENITAL TALIPES.—Forms of congenital distortion of the foot other than equino-varus are not uncommon, but as a rule these deformities are so slight, and, as compared to equino-varus, so easily remedied that they are relatively of little importance (Fig. 2183). This distinction does not apply, however, to acquired talipes, of which the various forms will be considered in other sections.

Congenital Talipes Varus.—This deformity often appears to be an incomplete form of equino-varus, but in some instances there is simply a slight inward twist of



FIG. 2184.—Congenital Talipes Calcaneus.

the foot without supination; in fact, the fore foot seems to be drawn inward by the active movement of the great toe, which in such cases seems almost prehensile (see Pigeon Toe). In the more marked form the foot is adducted and supinated, and the tissues are very resistant.

The slight grades of deformity may be treated by simple manipulation, and if deformity remains after the first year, the shoe will, as a rule, correct it. The more marked varieties must be treated like the varus deformity of club foot, until the varus has been transformed into valgus. The after-treatment is the same as that for ordinary club foot.

Congenital Talipes Equinus.—This is a rare congenital deformity, about half as common, according to the statistics, as varus (40 cases in 1,660). The term equinus implies that dorsiflexion is limited, but that the foot is not deviated to one or the other side (toward valgus or varus). In congenital equinus the deformity is as a rule slight, and it may be overcome usually by simple manual force applied frequently. In the more resistant type, mechanical correction, or tenotomy, followed by over-correction and support, may be necessary.

Congenital Talipes Calcaneus.—Congenital calcaneus is comparatively rare (28 cases in 1,660). As a rule the heel is prominent, the foot is habitually dorsiflexed, and the dorsum can be brought into contact easily with the crest of the tibia (Fig. 2184). The exaggerated cavus that is usually present in acquired calcaneus is absent. Occasionally the deformity is accompanied by hyperextension of the knee, and if, as in many instances, there is a history of breech presentation, it may be inferred that the attitude before birth was one of extreme flexion of the thighs upon the abdomen, while the anterior surfaces of the extended legs were pressed closely to the ventral surface of the body, the feet being fixed in an attitude of dorsiflexion. As a rule the deformity is slight, and the resistance of the tissues on the anterior aspect of the leg can be overcome easily by massage and manipulation. The foot should be gently forced toward plantar flexion several times in the day, and the weak muscles of the calf should be stimulated by massage.

Cure may be hastened by the use of some simple form of retention splint to hold the foot in plantar flexion until the posterior group of muscles has recovered its power.

Tenotomy or other operative treatment is not often necessary. In rare instances, the tibia may be bent slightly backward, thus increasing the deformity. In such cases the distortion of the bone may be overcome by manipulation and by apparatus.

Congenital Talipes Valgus.—Congenital valgus is somewhat more common than the preceding varieties (123 in 1,660). Not infrequently it is combined with a slight degree of calcaneus or equinus. The resistance of the contracted tissues is not great and the deformity may be overcome, in most cases, by persistent manipulation. If the muscular power is sufficiently unbalanced to warrant it, the foot should be held in the over-corrected position (varus) for some time.

Congenital valgus is one form of what is known as weak ankle, and it frequently passes unnoticed until the child begins to walk. If at that time, in spite of massage, the muscles appear weak or the foot inclines outward when weight is borne, it is well to make the sole of the shoe wedge-shaped, the thicker part (one-quarter of an inch) on the inner side. In more persistent cases, a brace may be necessary, as described in the treatment of the acquired variety (see the Weak Foot).

Talipes equino-valgus is less common. This must be treated as the other varieties by complete over-correction of deformity, manual or otherwise, by massage, and subsequently by support if necessary.

Calcaneo-valgus, calcaneo-varus, equino-cavus, valgo-cavus, valgo-cavus and cavus are extremely rare. If treated early by persistent forcible massage, these, as well as nearly all slighter grades of congenital deformity, may be corrected or cured even, before the child begins to walk.

CONGENITAL DEFORMITIES OF THE FOOT ASSOCIATED WITH DEFECTIVE DEVELOPMENT.—**Talipes Equino-Valgus Associated with Congenital Absence of Fibula.**—This is a rare deformity, but the most common of this class. The foot at birth is usually in an attitude of well-marked and resistant equino-valgus. The leg is somewhat shorter than its fellow, and the tibia is often bent sharply forward, sometimes to an acute angle, at a point somewhat below the centre, as if it had been broken in utero. At the most prominent point the skin may be adherent or it may present a dimpled appearance. In some instances the formation of the foot is perfect, but more often one or more of the outer toes, with the corresponding metatarsal bones, are absent.

The cause of deformity associated with absence of bone must be either an original defect in the germ or it



FIG. 2185.—Congenital Talipes Valgus—"Flat Foot."

may be due to interference with its development. In some instances amniotic adhesions may be one of the predisposing causes; the sharp bend in the tibia, so often present, may be due to lessened resistance of the defective part.

Treatment.—The indications for treatment are to cor-

rect the deformity of the foot in the usual manner. The bend in the tibia may be straightened by manipulation and splinting, or by osteotomy if necessary. When the patient begins to walk the foot must be supported. A light steel upright on the outer side of the leg, provided with a T strap to hold the ankle against it, may be used to supply the place of the missing fibula. The growth of the tibia is retarded, and a final shortening of three or more inches may be expected, but with care a useful limb may be assured.

Talipes Varus or Equino-Varus Associated with Congenital Absence of the Tibia.—Defective formation of the tibia is much less common than that of the fibula. In most cases the femur is somewhat shortened and its lower extremity is imperfectly developed. The foot is practically always in an attitude of varus. The toes may be normal, but in a number of instances one is found to be lacking.

The prognosis, as regards a useful limb, is extremely bad. The growth of both the thigh and the lower leg is much retarded, and it is almost impossible to balance the foot upon the fibula by any form of brace.

The ordinary treatment, after the correction of the deformity of the foot, has been to resect the extremities of the femur and the fibula to produce ankylosis between the bones. No final results have been reported. A full account of the reported cases may be found in an article by Launois and Kuss, *Revue d'Orthopédie*, September, 1901.

Deformity of the Foot Associated with Absence of Bones.—The leg bones may be perfectly formed, but one or more bones of the foot itself may be absent. In these cases, after the reduction of the deformity, a support to hold the defective foot in its proper relation to the leg must be used.

The foot may be divided into two parts so that it resembles a lobster claw. Supernumerary toes, or deficiency of toes, or hypertrophy of one or more of the toes, with or without corresponding overgrowth of the foot or leg, are not extremely uncommon. These deformities must be treated on ordinary surgical principles.

Constricting Bands.—Tightly constricting bands of scar-like tissue, which cause deep indentations in the flesh of the foot or leg, are sometimes seen. These are supposed to be caused by amniotic adhesions. "Spontaneous amputations" of toes, or of the foot itself, are due to the same cause.

In ordinary cases the bands require no treatment, but they interfere with the nutrition of the foot. They may be removed.

Congenital Edema of the Feet.—In rare instances, sometimes in combination with deformity, the tissues of the feet appear to be edematous, although the circulation seems to be perfect. The condition is apparently due to obstruction of the lymphatic circulation. It should be treated by massage and compression.

Spina Bifida and Talipes.—Talipes coexisting with spina bifida should be treated as are other forms of club foot. If paralysis of the lower extremities be present, as is often the case, the corrected feet must be supported as in the ordinary forms of paralytic deformity.

ACQUIRED TALIPES.

It has been stated that equino-varus is by far the most common of the congenital deformities of the foot and that as compared with it the other forms of talipes are of slight importance.

In the acquired varieties of talipes, equino-varus is much less common (32.5 per cent. of the total number as contrasted with 77 per cent. of the congenital deformities). Acquired equinus comes next in frequency (26 per cent. as compared with 2.4 per cent. of the congenital deformities), and every variety and combination of distortion finds its representative in acquired talipes as may be seen in the table of statistics.

ETIOLOGY.—The cause of acquired talipes is almost always paralysis. In the table of statistics it may be

noted that in 82.8 per cent. the paralysis was of spinal origin (anterior poliomyelitis); in 11.3 per cent. the lesion was of the brain, the talipes being a part of the deformity of hemiplegia or paraplegia. A few cases were caused by local disease of the nerves, and the remainder, 5.4 per cent., were of traumatic origin.

The distinction between congenital and acquired talipes is well marked. In the congenital form the disability is due simply to local deformity, and when this has been overcome a perfect cure may be expected. In paralytic talipes the rectification of deformity is but a part of the treatment, and perfect cure is impossible except in that small proportion of cases in which the spinal cord has sustained no permanent injury, or in which the deformity was the result of some slight or passing disability or disease.

Congenital deformity cannot be anticipated or prevented; acquired deformity is an evidence that protective treatment has been neglected. It is a result, therefore, that may be foreseen and prevented.

The characteristics of anterior poliomyelitis are described elsewhere. In its effect upon the foot the usual sequence is somewhat as follows: Immediately after its onset the paralysis is usually widespread, affecting the entire limb, for example. Then follows a period of partial recovery, after which the amount of damage that the spinal cord has sustained may be estimated. It is during the period of partial recovery, the six months or more following the attack, that contractions which lead to deformity occur. If, for example, the anterior group of leg muscles is paralyzed, the foot habitually hangs downward, a position due to the force of gravity and to the contraction of the unaffected posterior group. If this attitude is allowed to persist, the tissues accommodate themselves to the new position; the muscles that are never extended to their normal limit become structurally shortened, while the paralyzed group becomes correspondingly longer. Even within a few weeks after the onset of the paralysis the evidences of advancing deformity appear. The contracted tissues resist passive motion in the direction opposed to the habitual attitude, and the child shows evidence of pain if force is used to increase the limited range of motion. As has already been stated, paralytic talipes is an unnecessary deformity. It may be prevented by supporting the paralyzed part in a right-angled relation to the limb, and by systematic passive exercise throughout the entire range of normal motion.

Anterior poliomyelitis is most common during and after the second year of life or when the child has already begun to walk. When the first and more general effect of the disease has passed away, the child again uses the disabled limb as best it may; thus the distortion of the foot is increased and confirmed by the weight of the body and by functional use in the abnormal attitude.

The final deformity in a particular case may be predicted from the knowledge of the function of the muscle or muscles which has been lost. For example, paralysis of the tibialis anticus, the most powerful dorsiflexor and adductor of the anterior group, must result in equino-valgus; paralysis of the tibialis posticus induces valgus. If the peroneus brevis and tertius are affected varus will follow. Paralysis of the calf muscle will cause calcaneus. Paresis or paralysis of the entire anterior group will cause equinus. If all the muscles are paralyzed, what is called a "dangle foot" is the result. The cold atrophied member dangles from the attenuated leg with but little tendency to deformity unless the limb is used, when it is usually forced into an attitude of equino-varus or valgus.

A slight degree of paralysis may cause so little disability that it may be entirely overlooked, and its later effect in causing disability or deformity may not attract attention for many years. This fact has been mentioned in the etiology of the contracted foot.

DIFFERENTIAL DIAGNOSIS BETWEEN CONGENITAL AND ACQUIRED DEFORMITY.—The history itself is usually sufficient, for deformity of the foot at birth is never overlooked by the mother. Acquired talipes is practically always preceded by a history of disease, or weakness,

or injury which was soon followed by slight and afterward by increasing and confirmed deformity.

In paralytic talipes (anterior poliomyelitis), there is evidence of paralysis in loss of function of certain muscles, as shown by electrical stimulation or by pricking the foot with a pin; later, in the atrophy of the muscles, and the evident change in the nutrition and diminished growth of the limb.

Only in extreme and untreated cases of congenital deformity of long standing could there be difficulty in distinguishing between the acquired and the congenital deformity. In rare instances, it is true, paralysis may be present at birth, due to intra-uterine disease or to defect in the nervous apparatus. In such cases the cause of the paralysis is usually apparent (spina bifida, or spastic paralysis associated with defective cerebral development), and the treatment does not differ from that of the acquired form.

ACQUIRED TALIPES EQUINUS.

In well-marked cases, the foot is plantar-flexed to its full limit, and it is held in this attitude by the shortened structures on the posterior aspect of the leg. The patient walks upon the heads of the metatarsal bones, the toes being dorsiflexed to accommodate the attitude. The arch of the foot is increased and the tissues of the sole, particularly the plantar fascia, are contracted. The entire foot is broadened and shortened, the breadth being especially increased across the metatarsal region. On the dorsal surface the cuneiform bones are prominent, and the head and body of the projecting astragalus may be felt beneath the skin. Occasionally, in cases of ex-



FIG. 2186.—Acquired Talipes Equinus.

treme deformity, in which all the anterior muscles are paralyzed, the toes may be plantar-flexed so that the patient walks upon their dorsal surface.

The cavus or exaggerated arch is due primarily to the plantar flexion of the fore foot at the medio-tarsal joint, and in many instances this dropping of the fore foot is largely responsible for the equinus, for the os calcis is rarely plantar-flexed to the degree commonly found in the ordinary congenital equinus.

In the slighter degrees of the deformity the toes are usually dorsiflexed, an attitude due apparently to the over-action of the extensor longus digitorum and proprius pollicis, an aid in dorsiflexion.

ETIOLOGY.—Equinus in the slighter degrees is perhaps the most common of the forms of acquired talipes, and it is not at all infrequent as a result of other affections than anterior poliomyelitis, although this is by far the most important cause. The nerve supply of the anterior muscles of the foot seems especially susceptible, and toe-



FIG. 2187.—Slight Equinus Caused by Paralysis of the Tibialis Anticus Muscle. The distortion of the toe due to the over-use of the extensor proprius pollicis is characteristic.

drop from neuritis of various types is not at all uncommon. As a sequel of infectious diseases it has been mentioned as an explanation of the slight forms of equinus first noticed after recovery from such affections.

Equinus may be a result of cerebral disease, or even, in rare instances, of pseudo-hypertrophic muscular paralysis or of locomotor ataxia. It is sometimes induced by habitual posture, as after long confinement to the bed for the treatment of fracture, or during the treatment of hip disease by apparatus. The contraction may be an effect also of voluntary posture as when the patient habitually walks upon the toes because of a short leg. It is a very common result of neglected disease at the ankle joint, and it may be due to direct injury; but as of paralysis, so of these less frequent causes it may be said that equinus need never follow, if the foot is protected.

The changes in the internal structure of the foot are secondary to the deformity and are more marked in the cases of long standing originating in early life than in those that follow other forms of deformity; the tissues on the long side are lengthened and attenuated while those on the short side become contracted. The bones themselves are but little changed in gross appearance, but the articulating surfaces are in different relation to one another; for example, only the posterior aspect of the astragalus is in relation to the tibia, while only the lower part of its anterior surface articulates with the scaphoid bone.

In all cases of equinus there is a strong tendency toward lateral deviation to varus or valgus, particularly in cases of paralytic origin.

Symptoms.—If the limb is actually shorter than its fellow, and if the foot is firmly fixed in the deformed posi-

tion, surprisingly little discomfort or disability may be experienced other than from corns or calluses beneath the metatarsal bones. If the limb is not shorter, the additional length caused by the equinus must be compensated by an upward tilting of the pelvis, which may induce symptoms of discomfort in the lumbar region. The gait is always awkward, giving the impression as of stepping over an obstacle. If the foot is not fixed but simply hangs downward when it is lifted, the gait is very awkward because of the insecurity and because of the exaggerated flexion of the knee at each step, necessary in order that the pendent foot may not drag upon the ground.

If the equinus is extreme, the limb is usually flexed at the knee when in use; if the equinus is slight, the strain resulting from the limitation of dorsal flexion is felt at the knee, and in childhood at least there is often a well-marked tendency to over-extension, or recurvation, caused by the effort to place the sole flat on the ground.

In the slight forms of equinus, discomfort about the calf is experienced; the limitation of dorsal flexion causes a rather shortened stride and awkward gait, while an unguarded step that throws a sudden strain upon the rigid heel cord is felt as a shock and strain through the leg and body. Very often the patient complains of pain about the metatarsal bones (anterior metatarsalgia), and if the equinus is accompanied by a slight degree of valgus, symptoms of the weak foot may be present.

The prognosis depends of course upon the cause of the deformity. If it is simply the result of posture, or if it is secondary to neuritis, permanent cure may be expected. In many cases caused by anterior poliomyelitis recovery of function, complete or partial, has taken place; yet although voluntary control of the muscles has been regained it cannot be exercised because the foot is held in the distorted position by the contracted tissues.

In such instances practical cure may be predicted if, after the over-correction of deformity, sufficient time is allowed for the lengthened and atrophied muscles to regain their proper length and volume.

Treatment.—In the somewhat uncommon cases of fixed equinus combined with a short leg and not attended by discomfort, no treatment is required other than a shoe so built that the heel may support a part of the weight. In the more extreme cases in which the leg is short and the foot is atrophied, an extension foot attached after the manner of an artificial leg may be worn with comfort and with but little evidence of deformity.

In the ordinary cases, whether permanent cure is expected or not, the rule holds good that the heel should bear the weight of the body and that the range of dorsal flexion should not be limited when the calf muscle retains its power. If the nervous apparatus has received permanent injury, the foot must be supported after the deformity has been rectified; but even in this class the gait may be improved and the discomfort relieved by removing the restrictions to normal motion. The slightest degrees of equinus, such as those that are seen soon after the onset of anterior poliomyelitis, may be rectified by simple manipulation and retention in a splint or in plaster of Paris.

The Shaffer extension shoe is also a useful appliance, and is especially so in that it may be employed to reduce the accompanying cavus at the same time.

The weight of the body may be utilized as a means of overcoming slight equinus, when the foot is held in its proper relation to the leg by a brace which extends above the knee; but this tedious method has but little to recommend it in ordinary cases. The elastic tension of straps and bands attached to a brace or to the foot itself by means of adhesive plaster is of some service in slight cases, but by far the most effective method is the immediate reduction of the deformity by a simple forcible manipulation under anesthesia, or by tenotomy combined with forcible manipulation, or by wrenching.

Immediate Correction of Deformity.—Attention has been called to the cavus as an accompaniment of confirmed equinus, and whenever one attempts to correct the deformity by force, the exaggerated arch should be reduced

to its normal depth, otherwise the foot will appear stunted and deformed.

One of the most effective procedures for overcoming the cavus is the use of the Thomas wrench. The contracted bands of the plantar fascia are first divided subcutaneously, the wrench is then fixed to the foot, and, with sudden force exerted against the resistant tendo Achillis, the foot may be straightened, the deep ligaments being ruptured or stretched to the proper degree. The tendo Achillis is then divided, and the foot having been dorsiflexed is fixed by a plaster-of-Paris bandage. As the patient is encouraged to walk upon the foot as soon as possible, the weight of the body forcing the relaxed tissues against the unyielding sole, completes the flattening of the arch. In many of these cases the knee has been over-extended by use in the deformed attitude, so that the habitual flexion necessary to bring the dorsiflexed foot upon the ground during the two months allowed for the complete union of the divided tendon is of benefit as it serves to correct this secondary weakness and deformity.

The importance of the immediate relief of the strain of the deformed position upon the weak anterior group of muscles, together with the complete relaxation of the over-stretched tissues which allows the "slack to be taken in" during the long rest in the over-corrected position, is not generally appreciated. Whenever the weakened muscles after paralysis show by tests, electrical or otherwise, that they have recovered their power in part, this treatment should be that of selection. The application of electricity or other form of stimulation to muscles that are unable to exercise their function because of contraction of opposing tissues is useless. Nor is any form of artificial stimulation equal to that of the functional use, which is made possible by the removal of the deformity and by the employment of proper support.

In many instances after the equinus, which more often than any other deformity is the result of slight or temporary disability of the anterior group of muscles, has been corrected in the manner described perfect cure seems to have been attained when the plaster bandage is finally removed. But even in such cases the application of a simple support to hold the foot at a right angle with the leg for several months is an advantage. The after-treatment by massage, muscle-beating, electricity, and the like, combined with methodical passive movements to the limit of dorsal flexion to guard against recontraction of the calf muscle, should be continued for a long time, or until the muscular balance has been regained.

The same form of support is necessary in cases of hopeless paralysis, to hold the foot at a right angle with the leg. The common form is a simple steel sole plate of sufficient size to support the foot and the toes, if their muscles are paralyzed, attached to a light upright provided with a calf band. The upright is usually applied on the inner side of the leg where it is least noticeable. At the ankle there is a "stop joint," which allows dorsiflexion but prevents the toe-drop. This, when properly fitted, can be placed inside the ordinary shoe, as the paralyzed foot is usually somewhat smaller than its fellow. If the toes do not need support, the upright can be attached to the outside of the shoe and the foot plate may be dispensed with; or the upright may be concealed by introducing it inside the shoe to a joint sunk in the heel; the toe-drop being prevented by straps passing from the front of the upper leather of the shoe to the calf band.

Equinus due to posture or disease may be cured by simple correction of the deformity. That due to fracture, when the deformity is caused by displacement of the bones, may be treated by direct operation or by the removal of a cuneiform section from the anterior surface of the tibia above the ankle.

ACQUIRED TALIPES CALCANEUS.

Acquired talipes calcaneus is much less frequent than equinus and it is almost always of paralytic origin (anterior poliomyelitis).

There are several varieties or grades of the deformity. In the early stage, and especially if all the muscles of the posterior group have been paralyzed, the foot assumes an attitude of slight dorsiflexion and the range of plantar flexion is gradually lessened by secondary contractions.



FIG. 2188.—Acquired Talipes Calcaneus.

This variety resembles closely the congenital form. In the ordinary and typical form of calcaneus, when fully developed the patient walks, as the name implies, on an elongated heel. The arch of the foot is much increased in depth, and the fore foot is atrophied and useless.

The development of the deformity is somewhat as follows: The support of the calf muscle being removed, the os calcis, in the foot that is used, gradually assumes an attitude of dorsiflexion. It stands on end so that its posterior surface becomes inferior. The posterior projection of the heel is lost and it lies in the plane of the atrophied calf. The change in the position of the os calcis increases the distance from the malleoli to the ground; thus calcaneus, though in less degree than equinus, makes the leg longer. The turning of the os calcis on end shortens the foot and increases the arch; thus cavus in more marked degree than with equinus accompanies calcaneus. The cavus is a later complication of nearly all cases of paralytic calcaneus. In many instances there is no permanent dorsiflexion or elevation of the forefoot, although in all the range of plantar flexion is limited. In this class the power in the remaining muscles of the posterior group is probably sufficient to counteract the contraction of the dorsiflexors. Cavus is thus a direct effect of the displacement of the os calcis. If the entire posterior group of muscles is paralyzed, while the anterior muscles are unaffected, the foot will be somewhat dorsiflexed and the cavus will be less marked. If the calf muscle only (gastrocnemius and soleus) is paralyzed, the remaining muscles of the posterior group will counterbalance the dorsiflexors and at the same time increase the cavus. In some instances the calf muscle is alone affected, in others one or more of the anterior muscles may be paralyzed also, in which case the foot is usually turned toward varus or valgus. The changes primarily caused by the paralysis and by unopposed muscular action become fixed by habitual use and by secondary adaptation of the tissues. The heel only is used in walking, and the area of callus which marks the weight-bearing surface becomes much enlarged, while the fore foot and toes, which have but little functional use, become atrophied, a mere appendage to the enlarged heel.

Symptoms.—The gait is awkward and inelastic; the patient, who is, as it were, "ham-strung," stamps along upon the insecure support of the heel in a manner which is easily recognizable by one familiar with the disability. The changes in the internal structure of the foot, the inevitable adaptations to the deformity, do not call for especial description; the disused bones atrophy together with the other tissues and new articulating surfaces form to accommodate the necessities of functional use.

Treatment.—When the diagnosis of paralysis of the calf muscle is made one may predict, unless recovery takes place, a deformity such as has been described. This deformity may be prevented by proper support, by massage, and by methodical stretching of the tissues that have a tendency to contract. The form of brace used for walking and for support should be provided with a sole plate, upright, and calf band, as already described in the treatment of paralytic equinus. If motion is allowed at the ankle it should be in plantar flexion only, the stop being the reverse of that used in equinus, or as this form of check entails much strain upon the brace, the joint may be omitted as in that form used by Judson. Thus the strain removed from the weakened tissues is borne by the anterior surface of the leg. Other forms of braces provided with elastic bands to supply the place of the calf muscle are sometimes used, but as a rule the improvement, in gait hardly compensates for the trouble in adjustment or the conspicuousness of the appliance.

The most important part of the actual deformity of calcaneus is the cavus due to the changed position of the os calcis; and in confirmed cases it is practically impossible to reduce this completely because the absence of the tendo Achillis takes away the point of resistance that makes the corrective force efficient. If the deformity is not marked operative treatment is not required. The foot may be drawn as far as possible toward equinus and fixed in a plaster bandage. Upon this the patient may walk, the heel being built up with cork wedges to make the sole level. When the contraction of the anterior tissues has been overcome, the brace is applied and the usual treatment of manipulation and massage is continued.

The method of prolonged fixation in the attitude of equinus by means of the plaster bandage is often very efficacious in childhood and cures of apparently hopeless cases by this means have been reported.

Operative Treatment.—In more extreme cases immediate reduction of the deformity under anesthesia may be attempted. The plantar tissues, more particularly the plantar fascia, may be divided and by forcible manipulation or wrenching the foot may be somewhat lengthened and the heel pushed somewhat upward and backward, so that the foot may be fixed in a plaster bandage in slight plantar flexion. The tissues on the front of the leg that require elongation are those directly in front of the ankle. It must be borne in mind that in correcting the deformity one must not force the fore-foot downward, as this would simply increase the cavus, but whatever over-correction is gained should be by means of elevation of the os calcis and elongation of the plantar tissues.

In some instances the improved position of the os calcis may be confirmed by shortening the tendo Achillis, as first performed by Willett, of London (St. Bartholomew's Hospital Reports, vol. xvi., 1880, p. 309).

Willett's Operation for Calcaneus.—A Y-shaped incision about two inches in length is made through the tissues down to the tendon. At the lower or vertical part



FIG. 2189.—Judson's Brace Applied for Talipes Calcaneus.

of the incision, which is continued down to the tuberosity of the os calcis, the tendon is dissected free from the surrounding parts. It is then divided in an oblique direction from within outward and downward, and the heel having been pushed upward as far as possible, the divided ends are overlapped and sutured; the flap of skin is drawn downward at the same time, so that the Y incision is converted into the shape of a V. According to Mr. Willett's original directions, deep sutures are passed through the skin flaps and through the tendon on either side, so that all the tissues are united. The foot is then fixed in a plaster bandage, in the attitude of equinus, and the patient is allowed to walk about wearing a high heel to compensate for the elevation of the sole.

The operation is of especial value in those cases in which some power remains in the calf muscle, which is thus made serviceable. In cases of complete paralysis the position of the foot may be temporarily improved, but unless proper support is used afterward, the tissues will stretch under the strain of use; thus the treatment should always be supplemented by a brace of the character already described.

Astraglectomy and Backward Displacement of the Foot.—In cases of confirmed calcaneus, or calcaneus especially if combined with lateral deformity, removal of the astragalus may be indicated. This operation permits the malleoli to be brought into direct contact with the os calcis, thus improving the security of the foot.

The astragalus may be removed by a long curved external incision passing from the tendo Achillis just below the outer malleolus to the front of the joint. The peronei tendons are divided, the foot is displaced inward, and the astragalus is removed. The articulating surfaces of the leg bones and of the os calcis are denuded of cartilage; the tendo Achillis is shortened and to its insertion the peronei tendons are attached, if the muscles are active. The entire foot is then displaced backward so that the denuded malleoli overlap the anterior extremity of the os calcis. The object of this procedure is to throw the weight of the body upon the centre of the tarsus; thus the deformity is reduced and the stability of the foot is increased.

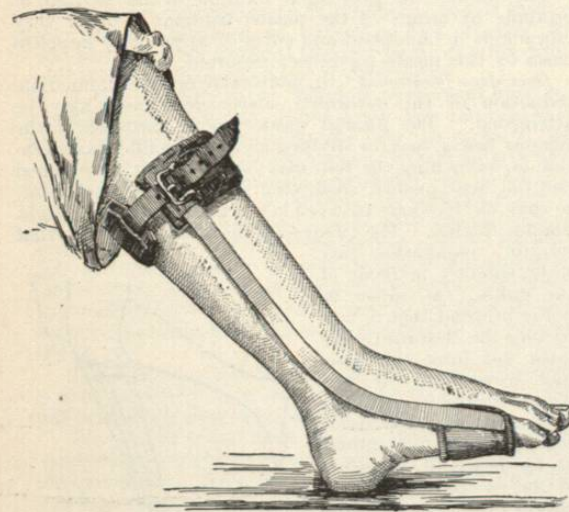


FIG. 2190.—Whitman's Brace for Talipes Calcaneus. Two lateral bars of thin steel connected by a foot plate and anterior leg band. The brace is supported by the shoe which should be elevated sufficiently at the heel to hold the foot in slight equinus.

The wound is closed and the foot is fixed in plaster of Paris. As soon as possible the patient uses the foot in standing and walking. Ultimately apparatus may be dispensed with, but a brace may be used for a time with advantage. This operation has been performed in many instances by the writer, for whom it is now the treat-

ment of choice in this type of cases. By it the usefulness of the foot is greatly increased and its appearance very much improved.

ACQUIRED CALCNEO-VALGUS AND CALCNEO-VARUS.

In many cases the foot deformed as a result of paralysis of the calf muscle is in addition turned in a lateral direction, so that the weight of the body falls to the inner or outer side of its centre.

Calcaneo-valgus, in which the foot is turned outward and upward so that the patient walks on the inner side of the heel, or even on the inner ankle, is not uncommon; the opposite deformity is far less so. **Calcaneo-valgus** is usually a result of more extensive paralysis than simple calcaneus. For example, all the muscles about the foot may be disabled except the peronei, or in cases of a milder type the tibialis anticus may be the only muscle of the front of the foot that is paralyzed.

Treatment.—When the foot inclines toward calcaneo-valgus it is difficult to hold it in proper position. The usual method is to apply the brace used for ordinary calcaneus, with the upright on the outer side of the foot; the ankle and arch are then held against it by means of the valgus strap. Another form of brace is provided with an upright on either side of the leg, the outer being slightly longer than the inner so that the sole plate is tilted inward, or as it were supinated; thus the weight is guided toward and balanced on the outer side of the foot. It must be borne in mind that other muscles of the limb are often paralyzed, so that the deformity of the foot may be but a part of more general distortion; hence the foot brace is often combined with apparatus for the support of the leg.

In these cases the deformity may be reduced and the stability of the foot may be increased by the removal of the astragalus in the manner described.

Calcaneo-varus is a much less serious affection, since the foot may be more easily supported. A brace such as is used in the treatment of ordinary varus, without motion at the ankle or provided with a reverse stop, is ordinarily employed.

ACQUIRED TALIPES EQUINO-VARUS.

Talipes equino-varus is, as in the congenital form, the most common of the paralytic deformities of the foot.

The tendency of simple equinus is usually toward varus, because in plantar flexion the foot is slightly adducted, and because the outer side of the foot is shorter than the inner side, so that in walking with the foot extended the tendency of the foot is to turn somewhat inward.

Equino-varus is usually preceded by equinus and the etiology of the one will serve for the other.

In certain cases the varus is more marked than the equinus, as, for example, when the abductors of the foot are paralyzed while the adductors retain their power; or in cases of direct injury as in fracture at the ankle; or when the growth of the tibia has been arrested as the result of injury or disease.

The appearance and effect of the deformity are sufficiently indicated in the description of the congenital form.

Treatment.—If the distortion is recent and therefore non-resistant, the treatment consists in supporting the part in proper position by a brace, of which the Taylor club-foot apparatus is the type. During the night the over-corrected attitude may be assured by a strap running from the upright to the sole plate. Massage, electrical stimulation, and the like may be applied as in the routine treatment of anterior poliomyelitis.

If the deformity is fixed it should be reduced and over-corrected by forcible manipulation under anesthesia. Division of the resistant parts is less often necessary than in the congenital form, but should be performed in suitable cases. The over-corrected position should be retained until time has been allowed for the recontraction of the

lengthened tissues, preferably for several months; such rest in the over-corrected position is by far the most effective treatment that can be applied to a weak or paralyzed part.

Astraglectomy and cuneiform osteotomy are rarely indicated, but the latter operation is sometimes of service in checking the tendency toward recurrence of deformity which is more marked after over-correction in the paralytic than in the congenital talipes.

ACQUIRED TALIPES EQUINO-VARUS.

Simple equino-valgus is usually the result of primary paralysis of the tibialis anticus, the most powerful of the dorsal flexors; thus the foot is drawn somewhat outward



FIG. 2191.—Paralytic Deformity of the Foot, of the Varus Type. The atrophy and shortening of the limb are evident.

in dorsal flexion, while the metatarsal bone of the great toe, having lost the support of the tibialis anticus muscles, falls downward and is drawn outward by the peroneus longus. In this type one's attention is often attracted by the peculiar appearance of the great toe which is deformed somewhat like a hammer toe by the over-action of the flexor longus pollicis in its attempt to take the place of the tibialis anticus. The equinus is usually slight and is secondary to the valgus. If the tibialis posticus is paralyzed in addition, the lateral displacement of the foot is more marked.

Treatment may be begun by placing the foot in a plaster bandage in an attitude of varus and allowing the patient to walk upon it until the tendency toward deformity has been overcome. A support with the catch, as for toe-drop, is applied to the shoe while the tendency toward valgus is checked by raising the inner border of the sole or by the use of a sole plate, as in the treatment of the simple weak foot.

Acquired simple talipes valgus, from paralysis of the tibialis anticus and posticus, is rare. Talipes valgus, as when the foot is dislocated outward, in cases of complete paralysis of all its muscles, may be regarded as a variety of dangle foot.

Talipes valgus, sometimes called spurious valgus, the simple weak or flat foot, has been described.

Traumatic valgus and equino-valgus, due to fracture at the ankle (Pott's fracture), may be treated by osteotomy of the tibia above the ankle in order that the proper relation of the leg to the foot may be restored. Equino-valgus of slight degree is not uncommon after tuberculous or rheumatic disease at the ankle or at the astragalo-

scaphoid joints. This is practically one variety of the weak foot.

TALIPES FROM OTHER CAUSES.—Talipes caused by cerebral disease or injury, whether of the paralytic or hemiplegic type, is almost always in the form of equino-varus. The hemiplegic form of talipes is usually more unyielding and rigid than the paralytic type.

The deformity must be corrected by the ordinary methods. In many instances, when the contractions are not marked, the after-treatment by a brace is not necessary.

Hysterical equino-varus or other forms of deformity are not especially uncommon. The diagnosis can be made by the other symptoms of hysteria, from the history of the onset and duration of the distortion, and from the appearance of the deformity which is evidently merely an assumed posture.

TENDON TRANSPLANTATION FOR THE RELIEF OF PARALYTIC TALIPES.—When one or more of the muscles are paralyzed the unbalanced action of those that remain tends to distort the foot. The object of tendon grafting or muscle transplantation is to utilize the power that remains by giving an active muscle a new point of attachment where it may be of service instead of an agent of deformity.

Tendon grafting is, as the name implies, the operation of attaching the tendon of a living to that of a paralyzed muscle. The first operation was performed by Nicoladoni in 1882 for the relief of paralytic calcaneus (*Archiv f. klin. Chir.*, 3, 27, S. 660, 1882). The tendons of the peroneus longus and brevis were divided behind the external malleolus, and the proximal ends united to the distal extremity of the divided tendo Achillis. The result was said to be satisfactory.

The first operation on the front of the foot was performed by Parish of New York (*New York Med. Jour.*, October 8th, 1892) for the relief of paralytic valgus, by attaching the tendon of the extensor proprius pollicis to that of the paralyzed tibialis anticus, without division of either tendon. In more recent years the field of the operation has been extended to include almost every possible combination of tendons and muscles.

Tendon grafting is most effective as a curative operation when but one muscle, for example an adductor or an abductor, is paralyzed. The most common form of this milder type is paralysis of the tibialis anticus, resulting in secondary equino-valgus. In Parish's operation the tendon of the adjoining extensor proprius pollicis was simply attached to that of the tibialis anticus, but as the extensor of the great toe is a very weak muscle, its power is hardly sufficient for the double task.

A more efficient procedure is to split the tendon of the paralyzed muscle. The outer half is then separated from its muscular attachment and the distal extremity is carried across the foot and is sutured to all the other tendons. The proprius pollicis is then attached to the inner half. In cases of longer standing and more marked deformity it is well to reduce the power of the abductors by cutting the tendon of the peroneus tertius from its insertion. This is then drawn beneath the other tendons and is attached to that of the tibialis anticus. All of the tendons may be sutured to one another, so that all may act as direct dorsal flexors.

If varus has resulted from paralysis of the peroneus tertius or brevis, or if there is weakness of the extensors of the toes, while the tendon of the tibialis anticus retains its power, it may be split, and the outer half, having been separated at the distal end, may be passed beneath the other tendons to be attached to the peroneus tertius, or a new attachment to the tissues on the outer border of the foot may be made.

Every variety of combination has been employed. The tendon of the peroneus longus has been brought across the foot and attached to the tibialis anticus for the relief of valgus, and a portion of the inner part of the tendo Achillis has been utilized for the same purpose, a procedure, however, that can hardly offer much prospect of success. Operations for the relief of calcaneus have been

practically that of Nicoladoni, the transplantation of the two peronei muscles into the tendo Achillis; or, as modified by Goldthwait, the tendon of the peroneus longus was inserted into the tendo Achillis and the brevis was transplanted into that of the flexor longus pollicis. If the tibialis posticus is paralyzed with resulting valgus, the peroneus brevis may be carried beneath the tendo Achillis and attached to its distal extremity.

The operation of tendon transplantation should not be performed until the recovery from the paralysis is considered impossible. The incision should be sufficiently long to expose the tendon and the muscular substance. The paralyzed muscle is quite different in color from the normal, being dull reddish-yellow, and the tendon is usually dull white in place of the silvery glistening color of the normal tendon. The splitting of the tendon should be begun high up, including, in some instances, muscle substance, and in joining the splices as much surface as possible of each splice should be apposed because the tendons do not readily unite. In certain instances it may be advisable to attach the transplanted tendon directly to the periosteum at the point at which its force may be exerted to best advantage. This as a routine measure is advocated by Lange (*Munch. med. Wochen.*, November 15th, 1900).

Fine silk is usually employed for suturing. The tendon sheaths are, as far as possible, closed by fine catgut and the skin incision by the same material. Before the operation is performed, all resistance to normal motion should be overcome by force, and by division of the contracted parts, if necessary. The attachment of the muscles or tendons should be made while the foot is held in proper position, and in many instances it is well to cut and overlap the paralyzed tendons to aid in retaining the foot in the improved attitude.

After the operation is completed, the foot should be fixed in a plaster bandage in the over-corrected position for several weeks or months. As a rule the foot should be supported by a brace until it is evident that the union of the parts is firm, and a good functional result is assured.

The prognosis will depend entirely upon the character of the paralysis. If the tibialis anticus is alone affected, it may be hoped that sufficient power may be borrowed from the other muscles to lift the foot at least enough to prevent awkwardness of gait, and to restrain deformity. Even more favorable is the prospect for the relief of varus caused by weakness of the abductors; but it is impossible for weak muscles like the peronei to supply the place of the great calf muscle. The power obtained from the peronei, however, which has become useless and even harmful because it draws the foot into deformity, may be sufficient to hold the heel in proper position and at least to aid the brace in retaining the foot in a normal attitude.

The relative strength of the muscles should be considered in selecting grafts, as well as in making a prognosis. According to Fick it is as follows, in kilogrameters:

BACK OF THE LEG.	
The calf muscle—gastrocnemius and soleus	8.21
Tibialis posticus	.40
Peroneus longus	.44
Flexor com. digitorum	.57
Flexor longus pollicis	.82
Total	10.24
FRONT OF THE LEG.	
Tibialis anticus	1.61
Extensor proprius pollicis	.39
Extensor longus digitorum	.72
Peroneus brevis	.31
Peroneus tertius	.20
Total	3.23

The importance of the calf muscle on the back, and of the tibialis anticus on the front of the leg, is apparent. The former is nearly four times as strong as the other muscles of the combined posterior group, the latter being nearly equal to all the others on the front of the leg.

(Rudolph Fick, "Ueber die Arbeitsleistung der auf die Fussgelenke wirkenden Muskeln," Leipsic, 1892.)

It has been claimed that the transplanted muscle may become hypertrophied sufficiently to carry out its new function, but this is somewhat doubtful. Direct transplantation of muscles on the same principle as tendon grafting has also been performed by Drobnik, Goldthwait, and others; for example, the sartorius, the gracilis, or the tensor vaginae femoris may be transplanted into the substance of the quadriceps extensor muscle. Drobnik has suggested the possibility of regenerating the paralyzed muscle by thus engrafting a portion of one that is still active, but this is, of course, a possible rather than a probable outcome.

The principle of the operation applies, of course, to other parts of the body as well, but the opportunities for its application are far less frequent than in the lower extremities.

TENDON SPLICING.—Division and overlapping of the tendons of paralyzed muscles may be employed with advantage in certain instances. For example, in complete paralysis of all the dorsal flexors of the foot, each tendon may be shortened and attached to the anterior ligament; thus the toe-drop may be remedied or reduced to such an extent that the deformity may interfere but slightly with locomotion. In most instances, however, unless support is used the shortened part will relax subsequently.

ARTHRODESIS.—Arthrodesis, for the purpose of producing ankylosis of a joint, was first performed by Albert of Vienna, in 1878. Its field is practically limited to those cases in which no muscular power remains, the so-called dangle foot. It may be of service also in cases of partial paralysis, as in equinus or calcaneus, when the patient is unable to provide himself with apparatus.

The operation consists in opening the joint and removing the cartilage from the opposing surfaces of the bones, then sewing or nailing them to one another, or simply fixing the parts in a plaster bandage until union has taken place. If the case is one of simple calcaneus or equinus, without lateral deviation, the operation may be limited to the ankle joint, which may be opened from the back or front or side, as seems preferable. The cartilage is usually removed with a sharp spoon and at the same time relaxed tissue may be shortened after the Willett method, if the deformity be calcaneus; or the tendons on the front of the foot may be similarly shortened with the aim of lifting the toes to the proper level, if they are depressed. The operation, to be effective in cases of complete paralysis and dangle foot, must include all the larger joints of the foot. Even when ankylosis has been attained, there is a marked tendency to subsequent deformity. In cases of calcaneus, the removal of the astragalus in the manner described is the preferable operation.

Arthrodesis is also performed at the knee and at other joints for the purpose of fixing the part in a useful attitude. In certain instances the operation is indicated. It is, of course, limited to cases of hopeless paralysis and is more suitable to the older than to the younger class of patients.

The improvement in the gait obtained by the removal of deformity and fixation of the foot is often very marked, and support may often be discarded, but in early childhood, at least, cases should if possible be kept under observation in order that support may be applied if the deformity shows a tendency to recur.

Royal Whitman.

FOREARM, THE.—The forearm is that portion of the pectoral girdle or upper extremity lying between the elbow and wrist joints. Its bony framework comprises two bones, the radius and the ulna.

The skin of the forearm is soft and is usually well supplied with hairs, especially along the postero-external surface. Along the anterior surface the hairs are fewer and finer. The skin is freely movable throughout the forearm upon the deep fascial sheath. The bursa over the olecranon gives it free mobility at that point. Lying

within the layers of the superficial fascia are the superficial veins and the cutaneous nerves.

The **SUPERFICIAL VEINS** rise in two plexuses: the large *plexus of the dorsum of the hand* which is derived from the digital veins, and the smaller *plexus of the front of the wrist*, from the palm and thumb. These veins are larger than those of the deep set, have fewer valves and return most of the blood. At points of communication between these sets of veins, valves are regularly found.

The veins arising from these two plexuses are irregular in their distribution and are seldom symmetrical upon the two sides in the same body. For convenience four principal vein trunks are distinguished upon the outer, anterior and inner surfaces of the forearm: the *radial*, the *median*, the *anterior* and the *posterior ulnar* veins respectively. The *median* vein as it reaches a point opposite the insertion of the biceps receives a communication from the deep set which perforates the deep fascia. This trunk is short and is known as the *profunda*. The *median* at once divides into branches that diverge in V-form, the *median-cephalic* to the outer side and the *median-basilic* to the inner side of the biceps. The *median-cephalic* ascends to a point a little above the elbow, is joined by the *radial* vein, and this trunk, called the *cephalic*, lies in the furrow to the outer side of the biceps in the arm. The *median-cephalic* vein overlies the cutaneous branches of the musculo-cutaneous nerve as they pass the elbow. The *median-basilic* vein passes upward and inward and is usually joined at a point about in front of the internal condyle by both the *ulnar* veins. The trunk so formed is called the *basilic* and lies to the inner side of the biceps in the arm. The *median basilic* is usually larger and shorter than the *median cephalic*; the *basilic* is usually a considerably larger trunk than the *cephalic*. The *median basilic* vein overlies from without inward the bicipital fascial aponeurosis, the brachial artery, a part of the anterior division and the whole of the posterior division of the terminals of the internal cutaneous nerve.

SUPERFICIAL NERVES.—The cutaneous nerves are the musculo-cutaneous, with a few fibres from the musculo-spiral near the elbow, for supplying the outer side of the forearm, front and back; the internal cutaneous, for supplying the inner side of the forearm, front and back. Lying between the two on the back of the forearm is the distribution of the lower (larger) cutaneous branch of the

musculo-spiral. All these nerves pass the elbow. Behind, over a small area, limited to the olecranon, is the nerve of Wrisberg.

Piercing the fascia at the lower third of the forearm,

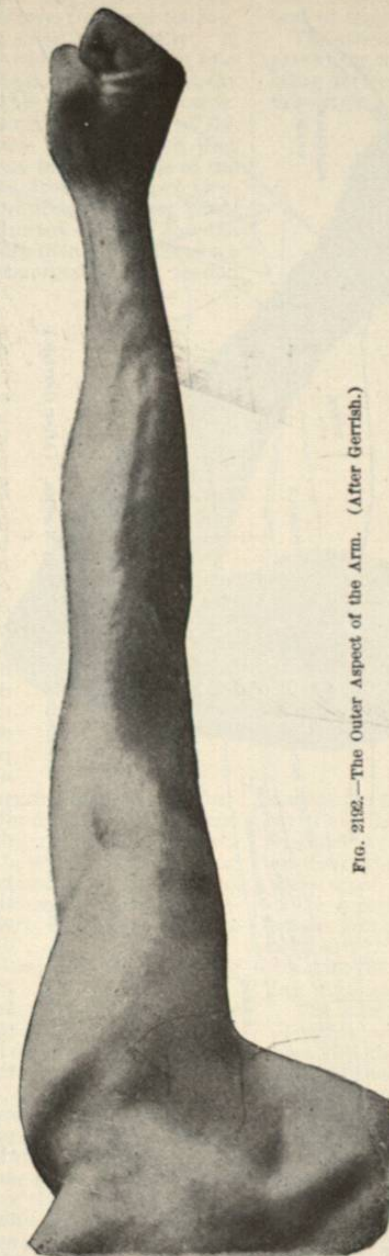


FIG. 2182.—The Outer Aspect of the Arm. (After Gerrish.)

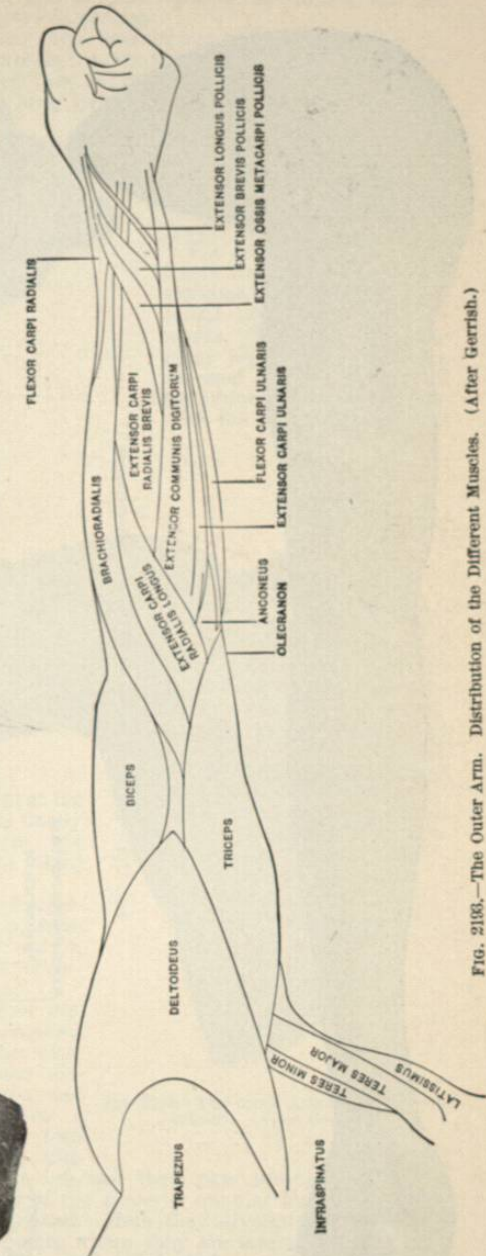


FIG. 2183.—The Outer Arm. Distribution of the Different Muscles. (After Gerrish.)

following nerves become superficial or cutaneous: the palmar branches of the ulnar median and radial nerves on the front, and the dorsal branch of the ulnar nerve and the radial nerve on the back.

The *brachial (deep) fascia* at the elbow is firmly fixed to the bony prominences, and is strengthened in front by the bicipital fascia. This slip is given off from the tendon of insertion of the biceps, which bridges over the brachial artery, and is lost over the pronator teres and its sheath at the inner side of the forearm. Some fascial fibres are also often received from the tendon of the triceps. Together in the upper third of the forearm this deep fascia