

On hallux flexus, claw toe, and pes cavus / by N. Davies-Colley.

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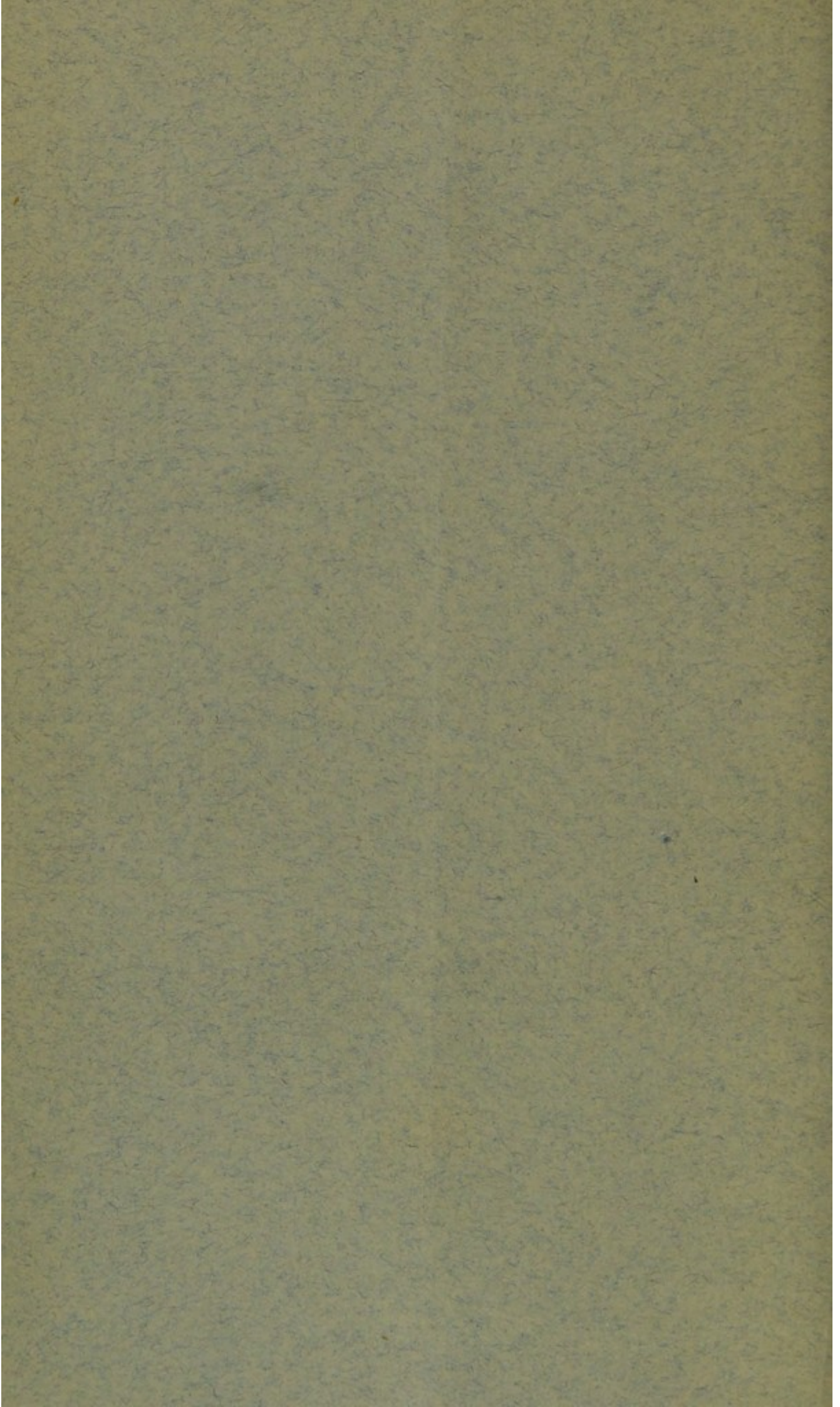
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Waller Jones to
James Colley

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ON HALLUX FLEXUS, CLAW TOE, AND PES CAVUS.

By N. DAVIES-COLLEY.

I PROPOSE in this paper to call attention to some of the deformities of the toes, the causes by which they are produced, and the best way in which they may be treated. Considering the pain and disablement to which these deformities give rise, it is strange that they have not obtained more attention from the writers upon orthopædic surgery. In the lectures, however, which were given by Mr. Anderson before the Royal College of Surgeons in 1891,¹ and in the more recent work of Mr. Walsham on Deformities of the Foot, some interesting information will be found upon this subject.

In the Clinical Society's 'Transactions' (vol. xx, p. 165) I wrote a short account of one of the deformities of the great toe, to which I gave the name hallux flexus. Soon after the reading of this paper many articles and letters appeared upon the subject of this and the allied deformity to which Mr. Cotterill has given the name hallux rigidus. I have but little to add to my original account of the deformity, but a more extended observation of the various affections to which the metatarso-phalangeal joint of the great toe is liable, has suggested to me a clearer explanation of the ætiology of hallux flexus and rigidus.

These two affections are closely allied. The stiff great

¹ 'Lancet,' 1891, ii, p. 214.

toe to which the term "rigidus" has been applied is a condition in which the first phalanx of the toe, while capable of complete flexion, cannot be extended beyond the straight line with the first metatarsal bone. In the deformity called hallux flexus the first phalanx is flexed, and is often capable of still further flexion, but it cannot be extended even as far as the straight line with the first metatarsal bone. Both hallux flexus and hallux rigidus are alike in the fact that the first phalanx cannot be extended with anything like the normal range of movement; they differ only in the precise point at which the movement of extension is arrested. Hallux flexus may therefore be considered to be a more extreme form of hallux rigidus.

Various reasons have been given since the reading of my paper on March 25th, 1887, for the occurrence of hallux flexus and hallux rigidus.

Mr. Anderson ('Lancet,' 1891, vol. ii, p. 280) ascribes it to "an irregularity in the nutrition by which the ligamentous fibres" (*i. e.* of the lateral ligaments) "undergo imperfect longitudinal development, and consequently induce premature arrest of the movement of extension." But as far as I can gather from his remarks upon the subject, he does not give any reason why the development of the plantar part of the lateral ligaments of the metatarso-phalangeal joint should be arrested.

Mr. Cotterill, on the other hand, assigns the rigidity to two concurrent factors:—(1) *flat foot*, which allows the sinking of the proximal end of the first metatarsal bone, and (2) a short boot, which prevents the consequent gliding forwards of the tip of the great toe, causes an elevation of the head of the metatarsal bone, and a flexion of the joint between this bone and the first phalanx. I cannot accept this ingenious explanation, as the large majority of my cases have not had flat foot, and I find also that of the cases which have been seen by Mr. Anderson and other surgeons only a small proportion have been associated with flat foot. Theoretically also I consider that the explanation is not likely to be the right one, for it is obvious that a flat foot can vary very little in length when subject to the pressure of the weight of the body; so that if the boot is long

enough in the condition of rest, the tip of the toe is not likely to be forced backwards during the tread.

Mr. Howard Marsh, in the 'British Medical Journal' of May 28th, 1887, suggests that the stiffness of the great toe-joint in male adolescents is in some way connected with the development of puberty, and refers to some observations of Dr. Ord, who has "recorded instances in which female patients have, with each menstrual period, suffered attacks of osteo-arthritis, which have subsided when menstruation ceased." Whatever association there may be between the disease of the genital organs and the joints, it seems to me very unlikely that a natural physiological development should be the cause of pathological change in so remote a part of the body.

My own explanation of hallux flexus and hallux rigidus is as follows:—Those who wear boots are exposed to two disadvantages which affect especially the first metatarso-phalangeal joint. These are, firstly, that as the back part of the sole is raised by the thickened heel of the boot, the foot is on an inclined plane, and the great toe, which either alone, or in conjunction with the second toe, forms the front part of the foot, is by this cause made to press unduly upon the "toe" of the boot, and so to transmit a pressure along its phalanges to its metatarsal bone and the chain of bones behind it; secondly, boots are constantly worn which, as regards length, fit the foot during the position of rest, but cramp it during the tread. For as soon as the weight of the body is placed upon the well-formed foot, the arch should sink, and the antero-posterior measurement increase from a quarter to half an inch. From these two causes, namely, elevation of the heel and shortness of the boot, the chain of bones which forms the inner part of the skeleton of the foot, viz. the two phalanges and metatarsal bone of the great toe, the internal cuneiform bone, scaphoid, and astragalus, are subject to abnormal pressure in those who walk about in boots. But granting this to be the case, it may be asked why the metatarso-phalangeal joint should be the one to suffer especially; why should not the phalangeal joint or one of the tarsal joints become inflamed from an influence which would appear to be equally exerted upon them all?

To this I would reply that the pressure is not equally exerted upon each of these joints; that in all the joints but one there is no movement or only a slight gliding during the alteration of the shape of the foot occasioned by the pressure of the tread; but that in one, viz. the metatarso-phalangeal joint, the movement is considerable, for as the heel is elevated in walking, the first phalanges are hyper-extended upon their metatarsal bones, while the straightened toes support the weight of the body until the foot leaves the ground for another step. I would submit that it is this movement of the metatarso-phalangeal joint which makes it especially obnoxious to the effects of the pressure which, as I have endeavoured to show, is continually acting along the inner side of the foot in those who wear boots with heels, and especially when those boots are not sufficiently long.

The existence of this abnormal pressure may be inferred from many pathological conditions observed in the foot. One of these is the frequency with which a chronic form of onychia is seen in the great toe, producing a roughness and enormous thickening of the toe-nail. This is due, as I believe, to the pressure with which the front part of the great toe is jammed into the end of the boot. Another example which indicates that the metatarso-phalangeal joint is especially affected by this pressure is the fact that gout, in its search for a weak point in the system, usually begins by attacking this joint. Again, in osteo-arthritic patients it is common to find this articulation enormously enlarged by osteophytes thrown out from the head of the first metatarsal bone. Sometimes, without any other evidence of osteo-arthritis, the head of this bone becomes so surrounded by osteophytic growths as to cause a serious interference with locomotion.¹

¹ In January, 1894, I had to operate on this bone on both sides in a man aged twenty-six. The metatarso-phalangeal joint was enlarged and somewhat stiff, and he suffered greatly from tender corns, which had formed about the head of the first metatarsal bone on each side. I cut down upon the joint under aseptic precautions, and found that the cartilage at the upper margin of the articular surface had thickened and ossified so as to form a mushroom-shaped projection, which overhung the shaft of the metatarsal bone. I chipped away all the osteophytes with a chisel, and on the right side removed the corn and a bursa which lay beneath it. The parts healed by primary union, and a month after the patient was walking about quite free from pain.

From these considerations, and from the examples which I have given, I infer that the first metatarso-phalangeal joint is especially exposed to abnormal pressure. If it should be injured by a blow or crush, the slight inflammation consequent upon the lesion is aggravated by this pressure. In other cases the inflammation is set up by the pressure alone. As in other joints, the effect of inflammation is for the bones which form the joint to assume a particular position about halfway between the limits of extreme extension and extreme flexion. I would therefore compare the deformity of hallux flexus to the bending of the knee and hip in diseases of those joints, and I would suggest that the inability to extend the first phalanx, which is the common characteristic of hallux flexus and hallux rigidus, is similar to the condition observed in the knee and in the hip. In these joints I may also observe that we frequently find, as in the great toe, that inability to extend is associated with a fair amount of movement in the direction of flexion.

I would explain the greater frequency of this affection in the male sex by the fact that men walk about more and that they wear stiffer boots than women. That it should occur in adolescents more often than adults is due, I believe, to the greater sensitiveness to pressure in the structures of the joint before the epiphysial cartilages have ossified.

With regard to treatment, I have little to add to what I stated in my paper in the Clinical Society's 'Transactions.'

In the earlier stages, when pain is first felt, I should take great care to avoid undue pressure upon the joint, by seeing that the patient wears laced boots with low heels, and with soles at least half an inch longer than the foot. When the case has gone so far that the great toe cannot be extended beyond the straight line with the metatarsal bone, I advise the forcible hyper-extension of the first phalanx with or without the aid of an anæsthetic, and follow up this treatment by the regular employment of passive movements.

In the more severe cases of hallux flexus it may be necessary to divide subcutaneously the lateral ligaments before this hyper-extension can be satisfactorily carried out, and in the worst cases of all an excision of the base of the first phalanx will remove the deformity without seriously

interfering with the shape of the ball of the great toe, which forms so important a part of the tread of the foot.

CLAW TOES.

A common deformity of the toes is a hyper-extension of the first phalanx with extreme flexion of the second phalanx. In the case of the four outer toes this may or may not be accompanied by flexion of the last phalanx. When all the toes are thus deformed, Duchenne speaks of the foot generally as "*griffe pied*," from the likeness which the toes present to the curve of a lion's or eagle's claws, the toe of the beast or bird corresponding in this comparison to the rest of the human foot. As it is convenient to be able to designate this condition, however produced, by some short term, I would suggest that "*claw*" toe or "*claw*" finger should be the English, and "*digitus uncus*" the Latin name. For the word *uncus* in this sense I have the authority of Virgil, who speaks of the Harpies with "*uncis pedibus*," and of Columella, who applies the term to the fingers.

The deformity of *Digitum unci*, or claw toes, when all the toes are alike affected, is usually associated with the condition called *pes cavus*. In some cases the deformity is secondary to the *pes cavus*. In other cases I believe with Duchenne¹ that the deformity of *pes cavus* is due to the clawed condition of the toes, which has been set up by a paralysis of the *interossei* muscles of the feet. I notice that Dr. Parkin ('*Med.-Chir. Trans.*,' vol. lxxiv, p. 485), in treating of the causes of *pes cavus*, dismisses this statement of Duchenne's as altogether improbable. He thinks that it is unlikely that so small a group of muscles as the *interossei* of the feet should be specially singled out by infantile paralysis. For my part I can see no reason why this group should not be singled out as much as any other group or even single muscle. Certainly I have seen several cases in which the *tibialis anticus* appears to have been the only muscle paralysed, while all the other muscles, though weakened, have retained a certain amount of power. It does not, therefore, seem to me at all improbable that the *interossei* and the short

¹ '*Physiologie des mouvements*,' p. 528.

muscles of the sole, which act upon the great toe in association with the action of the interossei upon the other toes, should be attacked. It is easy to understand that a paralysis of the interossei will prevent them exercising their proper function of flexing the first phalanges of the toes and extending the last two phalanges. The action, therefore, of the extensor longus digitorum upon the first phalanges, and of the flexor brevis and flexor longus digitorum upon the second and third phalanges respectively, will give rise to a hyper-extension of the first phalanges and flexion of the last two—in short, to the deformity of the toes under discussion. I do not, however, agree with the explanation which Duchenne gives of the way in which claw toes produce pes cavus. He attributes the pes cavus to the downward pressure of the base of the dislocated first phalanges upon the heads of the metatarsal bones. It seems to me that the toes being so much smaller and more movable than the metatarsal bones would act very feebly in this manner.

I would rather explain the pes cavus thus :

The forces which tend to flatten the arch of the foot are : (1) the weight of the body during walking and standing ; (2) the contraction of the tibialis anticus and peroneus tertius, which pull upon the bases of the first and fifth metatarsal bones ; and (3) the long extensors of the hallux and four outer toes, which act most directly, as Duchenne and others have shown, upon the bases of the first phalanges of the toes. The action of the tibialis anticus and peroneus tertius is somewhat feeble in flattening the arch of the foot, as they are attached to the bases of the metatarsal bones. That of the extensor proprius hallucis and the extensor longus digitorum is, on the other hand, more considerable, as they act upon the anterior abutment of the arch, being in their insertion very close to the *heads* of the metatarsal bones. But that these muscles shall act effectually it is necessary for the first phalanx of each toe to be held firmly down so as to be nearly in a line with its corresponding metatarsal bone. This is done in the four outer toes by the interossei, and in the case of the great toe by its abductor, flexor brevis, and adductor. When the interossei and the short muscles of the great toe are paralysed, the

first phalanx of each toe yields readily to the pull of its long extensor, and the influence of the extensor proprius hallucis and extensor longus digitorum upon the flattening of the arch of the foot is thus reduced to a minimum. The various muscles, therefore, which tend to maintain the arch of the foot, viz. the tibialis posticus, the peroneus longus, and the flexors of the toes, being feebly resisted by the tibialis anticus and peroneus tertius, draw backwards the anterior abutment of the arch of the foot. Hence ensues the pes cavus which is consecutive to paralysis of the interossei and the associated muscles.

In the cases, on the other hand, in which pes cavus occurs before the clawing of the toes, viz. when it is produced by talipes equinus or in one form of talipes calcaneus, *vide* Fig. 1, page 20, I presume that the hyper-extension of the first phalanges is the consequence of the highly arched instep putting upon the stretch the tendons of the extensor longus hallucis and extensor longus digitorum. These in their turn make tense the tendons of the flexors of the toes, and so the other phalanges are drawn down.

Another form of claw toe especially affects the great toe, and may be called hallux uncus. In this form the first phalanx is extended, the second bent, and the tendon of the extensor proprius hallucis starts up and forms a prominent web, which occupies the angle between the dorsum of the hyper-extended first phalanx and the first metatarsal bone. This deformity, *vide* Fig. 2, page 23, is associated with a certain amount of talipes equinus and a tendency to talipes valgus. It is due to infantile paralysis of the tibialis anticus, and is produced in the following manner.¹ The patient having lost the strong assistance of the tibialis anticus in flexion of the ankle-joint, has to rely upon the other three flexors, viz. the extensor proprius hallucis, the extensor longus digitorum, and the peroneus tertius. As the two last of these muscles are abductors and everters, as well as flexors of the foot, any effort to flex the ankle is accompanied by abduction and eversion; hence the valgus. An especial strain is thrown upon the extensor proprius

¹ A full account of this condition is given by Duchenne, 'Physiologie Pathologique,' p. 479.

hallucis, as it is the only muscle which, in the absence of the tibialis anticus, can flex and at the same time adduct. The short fleshy muscles upon the inner side of the sole yield to the severity of the strain. Hence the hyper-extension of the first phalanx, which puts the flexus longus hallucis tendon on the stretch, and thus brings about the flexion of the last phalanx. Another result of the weakened flexion is that the calf muscles, being feebly opposed, raise the heel and produce talipes equinus. It will therefore nearly always be found that when a patient has marked clawing of the great toe and but little of the others, together with some degree of talipes equinus and, when he is told to flex the foot, talipes valgus also, there is paralysis of the tibialis anticus. This inference may readily be verified by examining the front of the leg, in which there will be a hollow corresponding to the normal position of the tibialis anticus, and also by feeling for the tendon of that muscle just below the ankle, when the effort of the patient to flex his ankle is being resisted by the hand of the surgeon. Electrical tests will also confirm the diagnosis.

Occasionally we find a general "clawing" of the toes without either pes cavus or any paralysis of muscles to account for the deformity. I have suspected that the cramping of the toes in short boots during early life may have been the cause in these cases, but it is difficult to produce any convincing proof of the correctness of this suspicion.

Lastly, the condition called "hammer-toe" may fairly be classed as a form of "digitus uncus." As far as I have had experience, it is always found in the second toe, and frequently in both feet of the same individual. Its characteristic features are the hyper-extension of the first and flexion of the second phalanx. The third phalanx is somewhat variable in its position. In many cases it is hyper-extended upon the second phalanx, so that the pulp rests upon the ground. I believe that the cause of this deformity is the lateral pressure exerted upon the toes during walking by boots which are too narrow in front. There would appear to be some anatomical peculiarity in the second toe which causes it to "fall out of the rank," so to speak, when

such pressure is experienced. Perhaps this may be its greater projection forwards and the fact that it is more hemmed in on both sides than the other toes. The third and fourth toes, on account of the sloping outline of the front of the foot, are much freer to move outward than the second, and the other two toes being on the borders of the foot cannot be squeezed out in the same way by their neighbours. Moreover, some people are much more liable than others to the occurrence of this deformity, and it is not rare to see in young children a tendency of the second toe to become slightly bent and to project above the level of the other toes, which if especial care is not taken to allow of the proper lateral expansion of the tread during walking, will soon lead to the development of this deformity. When hammer-toe has once been established, certain inflammatory changes are set up in the first phalangeal joint, and the contraction of the lateral ligament takes place which some look upon as the cause, but which I prefer to regard as the result, of the deformity.

Whatever be the cause of claw toes, the results are very similar. They give rise to two sets of prominences upon the foot, the first beneath the heads of the metatarsal bones—the “balls of the toes,” as they are called; the second upon the dorsal aspect of the first phalangeal joints. Corns form over these prominences, and the pain to which they or the small bursæ which are developed beneath them give rise, is often so great as to make walking most difficult.

It is in this way also that, as far as my experience goes, the pes cavus usually causes trouble. The muscles of the leg in this condition are often well developed, and the feet are perfectly efficient for progression; but the lines of corns along the ball of the foot and over the claw toes become so exquisitely tender that the patient can only hobble about with great pain and difficulty.

Treatment.—In all cases of claw toe, except hammer toe, as soon as corns form and interfere with the patient's power of walking, I believe that the best treatment is to bring down the first phalanges from their hyper-extended position, and to straighten out the first phalangeal joint. By these means the two prominences above mentioned are removed,

and the corns soon disappear. A simple way of securing this end is to divide the extensor tendons upon the back of the instep, and then to bind the toes down upon a foot-piece in such a way as to remove the flexion of the phalangeal joints and the hyper-extension of the metatarso-phalangeal joints. There is, however, some fear that after the repair of the tendons the deformity may return. For some time past, therefore, in all cases in which the deformity has been severe, I have removed a piece of the extensor proprius hallucis tendon, and have implanted the proximal end upon the base of the first metatarsal bone in the following manner. The patient being under an anæsthetic, and the parts having been rendered aseptic, I make an incision about two inches long upon the tendon of the extensor proprius hallucis with the middle point a little in front of the tarso-metatarsal joint. I then cut away about an inch of the tendon, leaving the proximal end of the tendon just long enough to reach easily to a point half an inch in front of the joint between the internal cuneiform and the first metatarsal bone, when the sole is at a right angle with the leg. Having dissected down to the periosteum of the metatarsal bone, I make a T-shaped incision upon the bone, with the transverse limb, which should be about half an inch long, crossing the base of the metatarsal bone a quarter of an inch in front of the tarso-metatarsal joint, and the vertical limb, which should be also half an inch long, running forwards upon the middle line of the shaft. I then, with a dissector, strip the periosteum from the bone on either side of the vertical limb, so as to raise two small triangular flaps. To these flaps I attach the proximal end of the extensor proprius hallucis tendon with chromicised catgut sutures in such a way as to place the end of the tendon in close contact with the bare bone. I usually, through the same incision, divide the innermost tendon of the extensor brevis digitorum. If the smaller toes are clawed, I make another incision, through which I seize the tendons of the extensor longus digitorum which go to each of the toes, and snip away a piece of each tendon. Latterly I have not attempted to stitch down the proximal end of these tendons, because the oblique fleshy bellies and tendons of the extensor brevis

digitorum are in the way. The incisions are then stitched up and an antiseptic dressing applied, and in most of my cases primary union has followed. The extensor tendons should now act directly upon the front part of the instep, and the tendency to the incurvation of the toes should be much diminished.

At first, however, it is well to bind down the sole and the toes upon the flat foot-piece of a ordinary back splint, which should reach up to the top of the calf. In about a fortnight the dressings and splint may be removed, and some simple apparatus worn upon the toes which will keep them in position, but at the same time allow the patient to walk about with his boots on. The plan I usually find efficacious in the carrying out of this object is to have a piece of sole leather cut to the shape of the under surface of the five toes, and to make four cuts in it corresponding to the spaces between the toes. The piece of leather is then placed beneath the plantar aspect of the toes, and held in its place by tapes which pass through the slits and bind down separately each of the toes. The operation I have described not only fulfils the purpose of removing the flexed condition of the toes and the painful corns which the condition produces, but also it strengthens the foot by furnishing a much more firm insertion to the extensors of the toes. I hope also, though I have not yet been able to demonstrate, that the action of the extensors of the toes upon the metatarsal bone may, if the operation be performed in children, tend to diminish the height of the instep in the numerous cases in which pes cavus is associated with claw toes.

In the case of hammer toe, which may be described as *digitus uncus* affecting the second toe, a different treatment is required. If the case is so far advanced that the first phalanx cannot be depressed and the second phalanx extended so as to bring the toe into parallelism with the other toes, it may be possible by a subcutaneous division of the lateral ligaments of the first phalangeal joint to straighten the toe. But in most cases I have found it necessary to resect the head of the first phalanx. This is readily done through a longitudinal incision over the back of the first phalangeal joint, and as soon as the incision has healed,

which is usually in a few days, some simple appliance can be used to keep the toe straight. That which I have found most efficacious is the strip of sole leather described on page 12. Amputation of the toe, which was formerly customary, and which is still resorted to by some surgeons, seems to me an objectionable procedure, as it is so likely to be followed by hallux valgus and a bunion.

The following cases of claw toe with pes cavus, and with paralysis of the tibialis anticus, I have operated on by various methods, at first on somewhat different lines from the operation which I have described in this paper. I think that all have been improved by the operation, but in some cases the tendon of the extensor proprius hallucis has been restored so completely that it has regained its old insertion, notwithstanding that I had attached the proximal end to the first metatarsal bone. It appears to be of much importance to remove a large piece of the tendon.

CASE 1. *Hallux uncus* from paralysis of *tibialis anticus*; fixation and subsequent division of tendon of *extensor proprius hallucis*; improvement.—Ellen B—, æt. 7, was admitted to Guy's Hospital under my care January 23rd, 1887, having been sent to me by Mr. B. Scott, of Bournemouth. She was a fair delicate-looking child, somewhat pale and ill-nourished. She was suffering from lameness and deformities of both legs. Five years ago, from what was supposed to be a chill, paralysis of several muscles in the lower extremities had come on somewhat suddenly. The right foot was in the position of talipes equinus, and this deformity, which was the chief one of which she complained, was treated in the ordinary way by division of the tendo Achillis, followed by the application of a plaster-of-Paris bandage. The interesting point, however, in the case was a peculiar deformity of the left foot. The first phalanx of the great toe was hyper-extended, and the second phalanx much flexed. I could not feel the tendon of the tibialis anticus anywhere, nor could I see any projection of this tendon when she attempted to flex her foot. On the other hand, the tendon of the extensor proprius hallucis was very strong and prominent, and the hyper-extension of the first phalanx was much

increased by this movement. Usually the front part of the foot hung down, and large corns had formed underneath the ball of the great toe. I decided to attach the tendon of the extensor proprius hallucis to the bony structures on the front of the inner side of the instep. On the 7th February she was placed under the influence of ether, and I cut down, with antiseptic precautions, upon the tendon at the point where it passes over the base of the first metatarsal bone. I divided the periosteum down to the bone and stitched the inner side of the tendon by four fine silk sutures to the periosteum on the inner side of the incision as well as to the adjacent connective tissue. I also inserted two similar sutures into the outer side of the tendon and the outer edge of the periosteal incision. After the application of the ordinary antiseptic dressings, a short straight splint was applied to the sole of the foot and a plaster-of-Paris bandage over all. The wound healed by primary union.

On the 22nd of March I found that when she attempted to flex her foot, which remained somewhat pointed, there was still a little extension of the first phalanx of the great toe. I therefore, under ether, divided the tendon of the extensor proprius hallucis subcutaneously opposite to the metatarso-phalangeal joint.

April 18th.—My report states that the left great toe is now quite straight, and the extensor proprius hallucis can be felt acting.

August 16th.—When I saw her last she was able to walk well without the support of the sticks which she had previously used. When she flexed her foot there was still a slight extension of the first phalanx of the great toe by the action of the extensor proprius hallucis, which I could distinctly feel; but the second phalanx was very little flexed, and the greater part of the peculiar incurvation of the great toe which had arrested my attention upon her admission had disappeared.

CASE 2. *Pes cavus with claw toes and some talipes varus; division and fixation of tendons of extensor longus digitorum, and subcutaneous division of tibialis anticus, extensor proprius*

hallucis, and *plantar fascia*; marked improvement twenty months later.—George K—, æt. 20, sailor, admitted under my care into Guy's Hospital on June 13th, 1889, with talipes cavus of both feet, but especially of the right one. He says that his feet have been deformed all his life, but that the right foot has been much worse since a slip three years ago. He looks very healthy, but his right instep is much arched, all the toes are clawed, and the front half of the foot is adducted. The *tibialis anticus* acts well. The circumference of the right calf is five eighths of an inch less than that of the left. He can separate his toes much better in the left than the right foot. Electrical examination gives somewhat uncertain evidence. There is very little movement of the *interossei* muscles upon faradisation, but the same was noticed on the less affected side. The *tibialis anticus*, *peronei*, and the other muscles of the foot react well. He was almost unable to walk on account of the pain caused him by corns on the balls of the toes and on the dorsal aspect of the phalangeal joints.

On June 21st I operated upon his foot under ether. Having first divided the inner band of the *plantar fascia* and the *extensor proprius hallucis* tendon subcutaneously, I exposed the tendons of the long extensors of the toes by a longitudinal incision three and a half inches long from just in front of the ankle-joint nearly to the root of the toes, joined upon the outer side near its posterior extremity by a short transverse incision. After dividing all the tendons of the long extensor about an inch behind the web of the toes, I sewed the proximal end of each tendon to the fibrous tissues covering the posterior part of the fourth *interosseous* space. I then divided the tendon of the *tibialis anticus* subcutaneously, and brought the edges of the skin incision together with sutures. Some suppuration followed upon the dorsum of the foot, and the wound was not completely healed till November. He could flex the ankle well at that time without the toes showing any tendency towards hyper-extension. There was also less of the varus deformity when he walked.

In February, 1891, I saw him, twenty months after the operation. He said he could walk about quite comfortably.

The great toe was still clawed, but the others were natural. I could feel the extensor longus digitorum tendons quite tight as he flexed his ankle, so that they appeared to work well with their new insertion. The talipes cavus was about the same, and there was still some talipes varus, but there were now no corns under the balls of the toes.

I wrote again to ask the present condition of the patient, and was sorry to hear from his sister that he had been lost in the barque "Port Yarrock" in January, 1895. She adds that he certainly walked much better after my operation, complaining only after excessive walking or standing.

CASE 3. *Double pes cavus with claw-toes and corns; division and attachment to the metatarsal bones of the tendons of the extensor proprius hallucis and extensor longus digitorum.*—James E—, æt. 10, was admitted under my care into Guy's Hospital on March 21st, 1891, with painful corns from pes cavus of each side.

The high arches of the feet were first noticed when he was fifteen months old. In addition to the pes cavus, all the toes were clawed, and he had painful corns. On carefully examining the feet by the faradic and continuous currents I could find no action of the interossei.

On April 3rd, 1891, I cut down, under ether, upon the long extensor tendons of the great and the other toes of each foot, and removed a quarter to half an inch of each tendon. I then cut down upon the metatarsal bones and attached the proximal end of each tendon to the edge of the divided periosteum. In the case of the great toe I applied two stitches for this purpose.

On the 20th I note that the wounds are quite healed, and that when he flexes the ankle the toes do not become clawed. On the other hand, I add that the tendons seem to be still attached to the toes, so that I fear lest the deformity may return. On the 23rd I note that he walks well, with the toes down on the ground.

On the 30th May, 1895, more than four years after the operation, the mother, at my request, brought him to see me. She began by telling me that the boy was "more a cripple than he was before the operation." I was rather

pleased, therefore, to find that his toes were not clawed, and that he placed them flat on the ground as he walked. Moreover, there had been no return of the bad corns upon the ball of his toes and the back of the phalangeal joints. He does a good deal of walking about, as he earns six shillings a week by carrying parcels. The tendon of the extensor proprius hallucis on each side has become again attached to the great toe, which it can hyper-extend through more than 60° , and the only corn I notice is a small thickening of the skin over this tendon near the first metatarso-phalangeal joint of the right foot. He complains of pain in the front of his shins, and sometimes also in the insteps, but not in his toes. The mother says that she has much difficulty in procuring boots for him, as his feet are very broad in comparison with their length, and he wears out rapidly the outer part of the sole and heel on account of a tendency to talipes varus. On the whole, it seemed to me that the condition of the foot was much improved; but as I had only removed a small portion of the extensor proprius hallucis tendon, and had contented myself with a longitudinal incision of the periosteum before stitching down the tendon to it, instead of stripping the bone bare as in my subsequent cases, I am not surprised that the tendon had acquired a new attachment to the phalanges.

CASE 4. *Hallux uncus; division of long extensor tendon.*—Thomas M—, æt. 17, admitted under me in Guy's Hospital on October 27th, 1892, with bending of the phalangeal joint of right great toe. When three years old he had a fit, and was for a time unable to walk. The instep was normal and of natural height; the muscles of the foot natural. The calf was about a quarter of an inch less than that of the left side.

On the 28th ether was administered, and the tendon of the extensor proprius hallucis was subcutaneously divided.

In June, 1895, Dr. C. Gordon Roberts wrote to me that he was now working as a marine engineer. "The deformity is considerably less, although both interphalangeal and metatarso-phalangeal joints are flexed; also there is a large corn on the head of the first metatarsal bone. He suffers no

pain at all now, and often walks ten or twelve miles a day. Standing for long causes more discomfort (not amounting to pain) than walking. The foot is very irritable, and perspires very freely. He considers that the operation has benefited him a good deal."

CASE 5. *Pedes cavi, with claw toes of left foot ; operation ; little if any improvement.*—Archibald C. P—, æt. 16, was admitted under my care into Guy's Hospital, February 17th, 1894, with pedes cavi and painful corns of the left foot.

On the 23rd ether was administered, a piece three-eighths of an inch long was removed from the tendon of the extensor proprius hallucis of the left foot, and the proximal end of the tendon was stitched with catgut to the fibrous tissue and fascia over the base of the first metatarsal bone. Through another incision pieces were removed from the three inner tendons of the extensor longus digitorum. The right foot being but slightly affected was not operated on. By March 15th the wounds were healed, and the toes were in good position.

In May I note that he can walk well, with his toes flat on the ground, and that his corns are nearly gone. He has but little power of extending the first toe, but extends the others completely.

On June 13th, 1895, he came to see me at my request. I found that his toes were straight, but that otherwise his condition was little, if at all, improved. He was unable to bend his ankle to less than a right angle. When he flexed the foot the extensor proprius hallucis acted upon the great toe. His foot was slightly in the varus position, so that he wore out the outer border of the sole of his boot. He had painful corns on the balls of the great and the little toes, and over the first phalangeal joint of the fourth toe. I attribute this unsuccessful result to the small amount of the extensor proprius hallucis tendon which I removed, and to the imperfect way in which I implanted the proximal end of the tendon.

CASE 6. *Pes cavus and claw toes, secondary to slight talipes equinus ; operation ; relief.*—William J. S—, æt. 13, was admitted under my care on March 29th, 1894, with slight

talipes equinus of left side, slight pes cavus, and clawing of all the toes. He cannot flex the left foot beyond the right angle. The other foot is normal.

April 6th.—Under an anæsthetic I took away a quarter of an inch of the tendon of the extensor proprius hallucis, and stitched its proximal end to the divided periosteum of the base of the first metatarsal bone. I also snipped away pieces of the tendons of the extensor longus digitorum, but did not sew them down. The tendo Achillis was also divided subcutaneously.

The wounds healed by primary union, and on March 23rd I note that he walks without pain on the soles of his feet, with his toes in fair position.

On June 12th, 1895, his mother writes that "his foot is certainly stronger, and he runs and plays with his companions. After retiring to rest he says his foot shoots and pricks sometimes, but beyond that he makes no complaint. He walks now without limping."

CASE 7. *Paralysis of tibialis anticus; talipes equinus with pes cavus and clawed great toe; operation; improvement.*—Alice B—, æt. 13, admitted under my care into Guy's Hospital, May 2nd, 1894, with pes cavus, talipes equinus, and a clawed great toe. There was paralysis of the tibialis anticus.

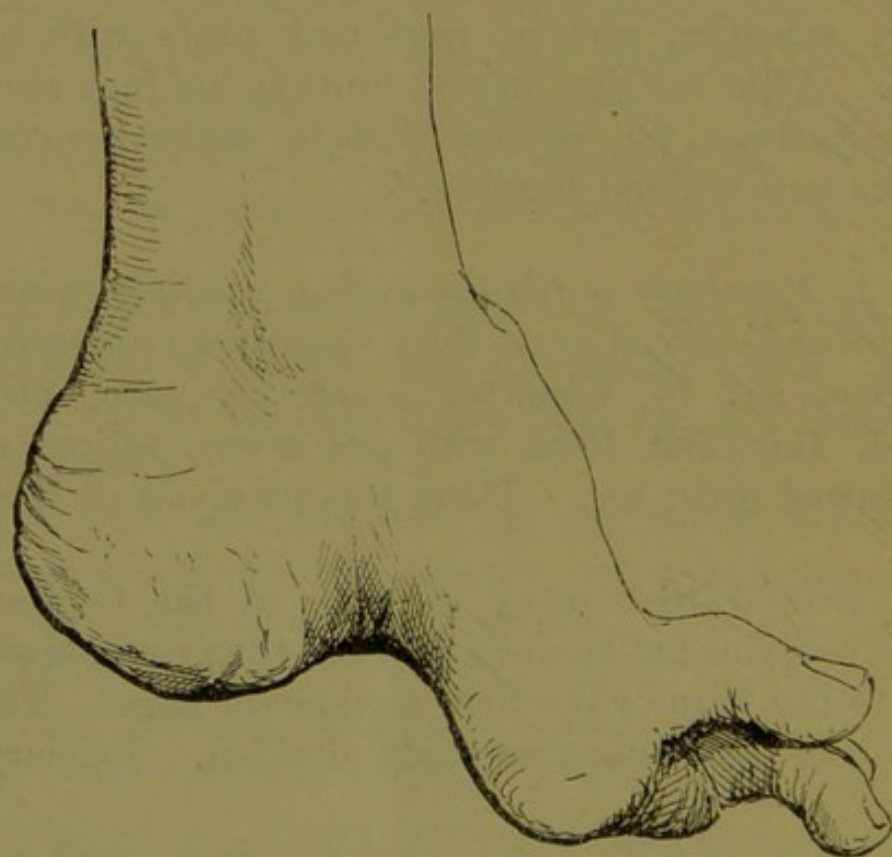
May 3rd.—I took away an inch of the tendon of the extensor proprius hallucis and stitched the proximal end of the tendon to the base of the first metatarsal bone. The tendo Achillis was also subcutaneously divided. Primary union followed.

On September 24th I note that she walks well, and that the great toe is in good position.

On June 17th, 1895, she came to see me. She still has to wear an artificial muscle (Barwell's apparatus) to help in flexing the ankle. The great toe is nearly straight, and is not now so forcibly drawn up by the action of the extensor proprius hallucis. There appears, however, to be some reproduction of the insertion of the tendon upon the phalanges, although quite an inch was removed at the time of the operation. She does not suffer now from corns.

CASE 8. *Pedes cavi* with hyper-extension of metatarso-phalangeal joint of great toe on each side, and some *talipes calcaneus*; attachment of tendon of *extensor proprius hallucis*; improvement (reported by Mr. M. H. Way).—F. W. P—, æt. 16, a bootmaker's apprentice, was admitted under my care into Guy's Hospital on December 31st, 1894, with painful corns from *pedes cavi*. The patient says that he was born with a deformity of the feet, but that it has gradually increased. He has a peculiar form of *pes cavus* on each side (see Fig. 1). The instep is very high, and the back of the heel much depressed. The metatarsal bones descend with a very steep inclination to the ground, and there is some

FIG. 1.



clawing of the four outer toes. When he attempts to flex his ankle the *extensor proprius hallucis* starts into strong relief, hyper-extending the great toe, but without causing flexion of the phalangeal joint. Upon electrical examination it was found that only the *gastrocnemius* acted with faradism, but all the muscles could be made to contract with galvanism. The depression of the heel associated with the high arch and hollow sole resembled much the artificially produced deformity of a Chinese lady's foot, and I thought

that the pes cavus was probably secondary to a congenital talipes calcaneus.

As progression was very difficult on account of the pain produced by corns beneath the metatarso-phalangeal joint, I decided to operate, and on January 11th, 1895, an incision was made under an anæsthetic upon the extensor proprius hallucis of each side, three-quarters of an inch of the tendon was removed, and the proximal end stitched down to the metatarsal bone in the way I have described (page 11). The innermost tendon of the extensor brevis digitorum was also divided. Primary union followed the operation.

On March 7th he walks comfortably, and with his toes flat on the ground. He cannot hyper-extend his great toes. The extensor proprius hallucis of each side can be felt to act when he flexes the ankle.

CASE 9. *Clawed toes, with slight talipes equino-varus; operation; improvement* (reported by Mr. M. H. Way).—William C—, æt. 22, a gardener, was admitted with painful corns of the right foot, into Guy's Hospital on March 11th, 1895. He gives a history of a strain to the right foot when he was fifteen, but he considers that the painful condition of his foot began two years ago.

He has slight talipes equino-varus, so that he is unable to flex his foot to less than a right angle with the leg, and he walks upon the outer border of his sole. The arch of the foot is not abnormally high. He has much incurvation of all his toes, with painful corns upon the front of his sole and over the first phalangeal joints of the toes. No paralysis was discovered. The left foot was said in the report to be in a similar but less marked condition, and he had no painful corns. I did not notice any deformity in the left foot, which I found to be three-quarters of an inch longer than the right. The circumference of the left calf was half an inch greater than that of the right.

On March 15th ether was administered, and an incision having been made upon the extensor proprius hallucis tendon, nearly an inch of it was removed, and the proximal end was attached beneath two flaps of periosteum upon the dorsal aspect of the base of the first metatarsal bone. Pieces

were also removed from the tendons of the extensor longus digitorum, but the proximal ends of these tendons were not stitched down. The innermost tendon of the extensor brevis digitorum was also divided. Finally, the tendo Achillis was subcutaneously divided. The wounds were sewn up, but healing was somewhat retarded by a little suppuration upon the dorsum of the foot. On April 17th the patient went out. A year later he wrote:—"I walk splendid; I never knew what it was to walk with ease before."

CASE 10. *Paralysis of tibialis anticus; clawed great toe, with slight talipes equinus; operation; improvement* (reported by Mr. M. H. Way).—Charles L—, æt. 24, a grocer's assistant, sent to me by Mr. G. H. Metcalfe from Clare, Suffolk, was admitted into Guy's Hospital under my care on March 29th, 1895, suffering from painful corns, with deformity of the left foot. He says that he was quite healthy, and his legs alike until he had an attack of "brain fever" at the age of two. The left leg from that time has been weaker and smaller than the right. Of late the foot has been gradually getting worse and more tender. The limb is wasted, and the foot in the position of talipes equinus with a slight tendency to varus. The toes, and especially the great toe, are much bent at the phalangeal joints. When he attempts to flex the ankle he cannot bend it to a right angle, and the foot is placed in the position of talipes valgus. There is much hyper-extension of the great toe, with prominence of the extensor proprius hallucis tendon. The tibialis anticus tendon cannot be felt on the stretch (Fig. 2). He has painful corns beneath the metatarso-phalangeal joint and on the dorsal aspect of the phalangeal joint of the great toe. When he walks his heel does not touch the ground. There is a hollow on the outer side of the shin where the tibialis anticus muscle should be. All the muscles on the front and outer side of the leg react to faradism, except the tibialis anticus. The tibialis anticus gives a slight reaction to galvanism with A.C.C., a little greater than K.C.C.

Measurements of legs in February, 1895 :

	Right.	Left.
Circumference of calf	13 $\frac{3}{4}$ in.	11 $\frac{1}{4}$ in.
„ „ thigh ten inches above patella	18 $\frac{1}{2}$ „	13 $\frac{1}{2}$ „
Length from anterior superior spine to internal malleolus	34 $\frac{1}{2}$ „	33 $\frac{1}{2}$ „
„ of foot	9 $\frac{5}{8}$ „	8 $\frac{3}{4}$ „

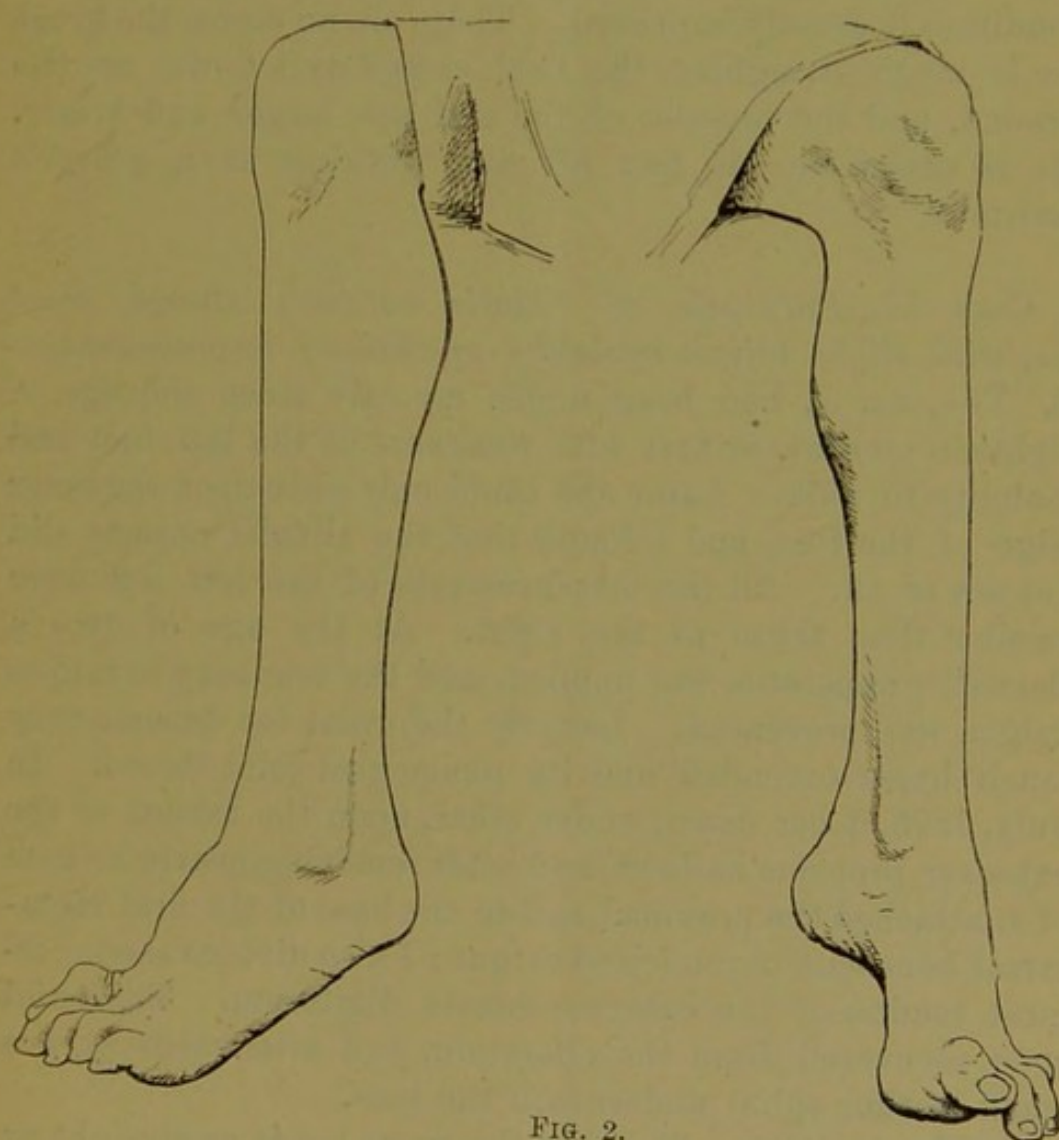


FIG. 2.

There is good patellar reflex on the right side, but none on the left.

April 2nd.—Gas and ether having been administered, an incision was made upon the tendon of the extensor proprius hallucis. One inch was removed and the proximal end attached to the base of the first metatarsal bone. The innermost tendon of the extensor brevis digitorum was also

divided through the same incision and the tendo Achillis by subcutaneous tenotomy. Primary union followed.

On April 23rd I note that the foot is in good position, that he can bend his ankle to less than a right angle, and that he uses the extensor proprius hallucis well, but without any movement of the great toe; this is still a little bent at the phalangeal joint. The corns no longer give him pain. A year later Mr. Metcalfe writes that his "general condition is greatly improved. There are no corns, the great toe is much straighter, the heel comes well down on the ground, and the muscles of the calf are larger and firmer. He is about on his feet all day, working as a grocer's assistant."

CASE 11. *Paralysis of tibialis anticus; clawed great toe, with slight talipes equinus; operation; improvement.*—

B. T—, æt. 7, had been under my care since the age of eighteen months, at first with weakness of the left foot and inability to walk. Later she could only walk upon the inner edge of the foot, and I found that the tibialis anticus did not act at all. All the measurements of the left leg were smaller than those of the right. At the age of two a Barwell's apparatus was applied, and the tendency to talipes valgus was prevented. Latterly the great toe became very much hyper-extended and its phalangeal joint flexed. In July, 1895, I cut down, under ether, upon the tendon of the extensor proprius hallucis, and after removing nearly an inch of it attached the proximal end to the base of the first metatarsal bone with chromicised catgut; I also divided the innermost tendon of the extensor brevis digitorum. The child soon recovered from the operation, and afterwards wore a small leather splint underneath the toes.

In March, 1896, I find that the great toe is as straight as on the other side. There seems to be no return of the hyper-extension and clawed condition. The extensor proprius hallucis acts well as a flexor of the ankle, but it appears to do this by virtue of its attachment to the first phalanx of the great toe. I came to the conclusion, therefore, that the connection of the tendon with the great toe had been re-established, although nearly an inch had been removed. So

far, however, the operation had been successful, as there had been no return of the clawed condition of the great toe. It was still necessary for the child to wear Barwell's apparatus on account of the tendency to keep the heel off the ground in walking.

