ON SOME POINTS
IN THE
SURGICAL PHYSIOLOGY OF THE FOOT

BY
T. S. ELLIS
CONSULTING SURGEON TO THE GLOUCESTER INFIRMARY

(COMMUNICATED BY MR. HOWARD MARSH)

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IT is now nearly thirty years since an accident to one of my own feet specially directed my attention to foot-physiology. A subastragaloid dislocation inwards with displacement of the middle cuneiform bone upwards and of the cuboid downwards are all evident at the present time. The permanent shortening and somewhat flattened sole is shown by impressions made with printer's ink nine years ago (Fig. 1.) How the depression of my plantar arch was ultimately raised by exercises, in application of the bow-string theory which I had conceived, has been often told;¹ first in a paper read before the local branch of the British Medical Association in 1874,² and expanded into a pamphlet in 1877, of which a copy is in the Society's library.³

¹ 'Lancet,' 1884, vol. i; 'Brit. Med. Journ.,' 1888, vol. i.

² 'The Influence of Muscular Action in the Prevention and Cure of Flat-foot.'

³ 'On the Arch of the Foot.' It is noticed in the first edition of the 'Treatise on Surgery,' by Mr. Holmes. This, so far as I can discover, is the earliest account of the treatment of flat-foot by muscular exercise.

During all these years I have never had any occasion for doubting either the soundness of that theory or its general application to the treatment of acquired flat-foot. I maintain that as the plantar arch is developed by muscular action, so it may by the same agency be restored.¹ But while I am able to produce plenty of cases where complete

FIG. 1.—Shortening of right foot, permanently flattened, by sub-astragaloid dislocation and displacement of tarsal bones. Functional recovery. Author's own case.

recovery has been due to that agency, and to it alone, I have always felt, until recently, that I could not give a satisfactory answer to such a question as this:—If it be true that action of the long flexors (and especially of the flexor longus pollicis) forms the arch, how is it that excessive action, as in the case of dancers, does not over-form it? I have felt that such explanation as I have given in 'The Human Foot'² of the *limiting* as well as *forming* influence of some muscles was not so complete as it should be. We

¹ 'Edin. Med. Journ.,' January, 1890.

² Churchill.

know that excessive formation does sometimes occur ; it is seen in the condition known as hollow or claw-foot (Fig. 2). The principal object of this paper is to demonstrate, with the help of a model, why these two features which give the alternative names are found together.

FIG. 2.—Hollow or claw foot. Characters: 1, claw-like toes; 2, prominent heads of metatarsal bones, with callosities on the sole; 3, exaggerated arch, most marked in middle line; 4, contraction of plantar fascia; 5, persistent equinus position; 6, attenuated calf. Compare Fig. 7.

Here we have, manifestly, perverted function of the toes, of the muscles acting upon them. In the most comprehensive book on anatomy that I know, and where one would most expect to find the natural action explained, I find this :—"The flexor and extensor muscles of the toes, including the lumbricales and the interossei, act like the corresponding muscles of the hand."¹ But this, while true if the toes be used as fingers, is altogether untrue and misleading if the toes be used as toes. Then the *flexors* do not flex ; they are *pressors* of the toes against the ground

¹ Quain's Anatomy, vol. ii. part 2, 1892, p. 274.

(Figs. 3, 4). So, too, the extensors do not extend ; they are *tractors* acting from the toes, as fixed points, and drawing the moveable body forwards.¹ The two sets of muscles are antagonistic in the hand ; they co-operate in the foot. The

FIG. 3.

FIG. 4.

3.—Hammer-toe position, same as that of functional activity or pressure. 4.—Flexion.

pressing-down action of the flexors is necessary to give fixed points from which the extensors can act. Nor does this express the whole truth. The flexor longus pollicis, for instance, plays many parts at the same time.

(1) It presses the great toe against the ground, and so forms a point on to which the body can be lifted.

(2) In doing this, it assists in so lifting the body. In the model (Fig. 5) it is shown as the only agent in effecting the movement to, and sustaining the tiptoe position.

(3) It also draws the two extremities of the plantar arch towards each other, so relieving the strain upon the ligaments on the under side of the tarsus.

(4) By tending to include in the plantar arch everything between the final phalanx of the great toe in front, and the ankle behind, it lifts up the head of the metatarsal bone, which, as seen in the model, does not touch the ground line. Thus injurious pressure on that part is prevented ;

¹ This *tractor* influence, although disputed, admits of demonstration. Stand on one foot, the other uplifted and extended backwards as far as possible ; then spring forwards without lifting the heel from the ground. The movement is effected by the *tibialis anticus*, *peroneus tertius*, and the extensors acting, as can be seen, together.

the head of the bone is let down gently when the weight of the body overpowers the uplifting influence.

(5) Being attached to the inner side of the foot and to

FIG. 5.—Model representing a foot, the bones united by hinges and balanced on the two phalanges of the great toe only, with the leg A (supporting the weight of the body, W) free to move between two parallel boards B. The great toe is kept straight and the curve of the plantar arch maintained by cords representing muscles in action. 1, 1, 1, 1 (elastic above), flexor longus pollicis; 2, divisions of tibialis posticus; 3, 3, flexor brevis and adductor pollicis, with a moveable bolt, 4, to set them free; 5, extensor.

the outer side of the leg, its action, by drawing towards a straight line between the two points of attachment, throws the ankle outwards. This serves a double purpose; more

room is given for the opposite foot to pass by, and the weight of the body is thrown on to the outer side of the foot and off the inner side, where the weight falls when the sole is flat on the ground.

(6) It resists the tendency of the extensor pollicis to lift up the great toe as the latter muscle draws the body forwards.

(7) When the leg has been drawn forwards the distance between the two attachments of the flexor longus pollicis is increased; this muscle (already contracted) is then enabled, by a following-on or continued action, to propel the body onwards.

Sir James Paget, from whom it was my privilege to receive my first lessons in physiology, used to insist on the frequent duality of function. Here we have seven separate results from the action of one muscle.

But in order to have a straight toe as a fixed point from which this powerful muscle can efficiently act, it is necessary to have the co-operation of the flexor brevis pollicis, which holds down the first phalanx. The influence of the long flexor, acting alone, is seen by drawing on that muscle in an amputated foot; it flexes the inter-phalangeal joint, however firmly the foot be pressed downwards.

It is in this position that the great toe is represented in two striking pieces of sculpture to be seen side by side in the South Kensington Museum, the "Athlete strangling a Python" of the late Lord Leighton, and the "Teucer" of Mr. Thornycroft. It is also seen in the classic "Discobolus of Myron." But, *pace* the accomplished Professor of Anatomy at the Royal Academy, I say that it is not really artistic, because it is neither true to nature nor is it expressive of the highest ideal of the human foot, that of a pressing and not of a grasping organ.

Here I would say that the terms *origin* and *insertion* as applied to muscles are so misleading that I have often wished them to be abandoned. They suggest that muscles always act *from* their fleshy *origins* as fixed points, *on* their tendinous *insertions* as moveable ones. In the foot es-

pecially it is not so; either end may be the fixed point. I always try to speak of *attachments* only.

Now if the phalangeal attachment of the short flexor become a fixed point, it is clear that continued action of this muscle must *tend* to draw down the tarsal attachment at the other end. For reasons to be given, I hold that it does so act and effectively so.

Fig. 6 represents a scheme of the plantar arch which may be regarded as a construction of moveable pieces of bone held in position not only by ligaments, serving as braces, but also by muscles and tendons, serving as bow-strings or tie-rods. These are represented in the figure as cords. It is clear that if only one were present, as in the ordinary bow, and that one drawn too tightly, it must tend to over-form the arch. If, too, it remain firm, a weight placed over any point of the arch, as at W, sufficient to weigh it down at that point, must cause a corresponding

FIG. 6.—Scheme of plantar arch with muscles and tendons serving as tie-rods. *a b, j*, abductor pollicis and flexor brevis digitorum. *a, g*, peroneus longus. *c, h*, long flexors. *c, e f*, tibialis posticus. *f g, i*, flexor brevis and adductor pollicis. *h, j*, interossei.

elevation elsewhere. Here we have, however, other cords extending from one extremity, or a point beyond it, to the other extremity, or to intermediate points in the arch; while some go from one intermediate point to another. It is, I think, also clear that all these, if properly arranged and sufficiently strong, will combine to hold the arch in position and prevent either sinking or undue uprising.

A cord reaching from one extremity to the other could only be, in relation to the arch, a supporter or *formator*;

but most of the cords shown, while *formators* of that portion of the arch which they subtend, are controllers or, as I call them, *limitors* of the particular points in the arch to which they are attached, or beyond which they pass; they tend to *limit* any projection outwards at those points which might be caused by action of the *formators*. Now, of the muscles of and acting upon the foot, the tibialis posticus at the one end, and the flexor brevis with the adductor pollicis at the other, fulfil these conditions within that part of the arch which is most yielding, and of which the flexor longus pollicis forms the tie-rod or bow-string. In the model (Fig. 5) this is shown. It is true that the flexor brevis and adductor pollicis are not attached (as represented by the corresponding cords) to the base of the first metatarsal and cuneiform bones, but they are attached to parts of the tarsus opposite to those points.¹ I have, too, purposely omitted anything to represent the peroneus longus. The interossei are disregarded. I want to show that the muscles which I have represented in front (flexor brevis and adductor pollicis) are so placed that they would, if strong enough, be of themselves sufficient to hold down the arch and prevent undue formation. I do this because I allege that failure of these combined muscles to hold down the first phalanx is the cause of the claw-like toes seen in Fig. 2, and failure of them to hold down and limit the formation of the arch is the cause of the hollow foot which accompanies that condition. Moreover, failure to hold down the first phalanx leaves that bone free to rise, and so form an angle projecting downwards at the head of the metatarsal bone. Pressure at this point leads to callosities, another attendant condition, as seen in the photograph (Fig. 2). In health this is prevented by that which I have given as the fourth effect in action of the flexor longus pollicis.

¹ Objection is made that these muscles are not fairly represented by the cords, because of their extensive attachments to bone. But this, necessary in the foot, in order that the bones may preserve their shape, is not necessary in the wooden model where, as I contend, the essential conditions are fulfilled.

In the model it will be seen that the head of the metatarsal bone (Fig. 5) does not really rest on the ground line; the whole structure is balanced on the inter-phalangeal joint. It will be seen, too, that the great toe is straight, and the plantar arch moderately developed, clefts remaining open between the cuneiform and the bone on either side of it.

Now if I remove the bolt at 4 which retains the cords representing the flexor brevis and adductor pollicis, we find that, immediately, the head of the metatarsal bone goes down plump on the ground line; the great toe becomes flexed, and only wants the influence of the *extensor* to draw it backwards and give the complete claw-like character seen in Fig. 2; while at the same time the arch becomes much more pronounced, the clefts just mentioned disappearing (Fig. 7). Thus not only are the features which

FIG. 7.—Showing effect on the great toe, on the head of the metatarsal bones, and on the plantar arch, caused by removal of the bolt, 4, in Fig. 5. Compare also Fig. 2.

give to this deformity the alternative names of hollow or claw-foot produced at once, but with them a third becomes manifest: the head of the metatarsal bone projects downwards, exactly as seen in the deformity (Fig. 2), causing the painful callosities on the sole associated with it. But why, in this deformity, is the exaggerated arch most marked in the middle line? Because it is in the middle line of the foot that the flexor brevis and adductor pollicis are attached, and these are the muscles to whose failure to control the arch the exaggeration is due; the peroneus longus which controls the inner margin does not fail. Other

features are also found—a persistent equinus position and an attenuated calf. Now if we suppose a growing boy to have boots too short for him, he finds that by walking on tiptoe he is more comfortable; he acquires the habit of relaxing his sole muscles, which, ceasing to act on the toes, allow the toes to contract, just as we find they do in an amputated foot when the long flexors are pulled. This contraction shortens the toes. The foot is also shortened by the bow-string or tie-rod action of the long flexor, third in the list I have given of the effects ensuing. Now although it is true that when the foot is frequently raised to the tiptoe position the calf muscles are developed, yet when the foot is persistently *held* in that position the calf muscles come to serve more and more as ligaments, less capable of relaxation at will. Then the muscles waste from want of *action* as muscles; hence the attenuated calf. The contracted plantar fascia is merely adaptive shortening.

In the latest edition of ‘Erichsen’s Surgery’ (1895) it is said of this deformity that “the mode of production is very doubtful—the treatment is not satisfactory.” The indications, as I see them, are to restore by operation the form of the foot so far as possible, and especially to correct fully the equinus position, which requires a very pronounced lengthening of the tendo Achillis—to the extent, it may be, of two inches. The more this is done, the more the toes are compelled to come into line with the metatarsal bones in order to reach the ground. This done, the indication is to restore function. The best exercises are those which throw the body backwards (when standing) until it is in danger of falling; then in the effort to recover position the flexor muscles must act as *pressors*, in order that the extensors may act as *tractors*. Thus the toes are brought into the fullest functional activity, and, paradox though it seem, we have the same exercise good for hollow or claw-foot as for flat-foot. But, indeed, the object is the same in both cases, to restore the functions of the toes, and so to restore the balance of forming and

limiting agencies on the plantar arch, of *formator* and *limitor* muscles. It does not, however, follow that forces sufficient to prevent over-formation, are sufficient to correct it.

I have now to explain why, in the stage dancer, the plantar arch is rather flattened than over-formed. The sole muscles combining to act as flexors of the first phalanx are specially needed to keep the great toe in a straight line, and two of these muscles are, as I have shown, also *limitors* of the arch. The *limitors* counteract, or more than counteract, the excessive formator influence of the long flexors. Moreover, the fleshy mass of hypertrophied sole muscle fills up the hollow of the sole, and increases the appearance of flattening.

Here let me point out that the same muscles may serve in both capacities. I have demonstrated on the model that removal of the cords which imitate the flexor brevis and adductor muscles results in exaggeration of the arch. But the formator effect of an elastic cord imitating the long flexor was then in full operation. Now, having restored everything (as in Fig. 5), if I remove this latter agency the arch still stands and supports the weight as before, although not so firmly. But if now I remove the bolt at 4, just as I did on the former occasion, the arch collapses altogether, showing clearly that the cords which served as *limitors* of the arch on the first occasion were serving as *formators* or supporters on the second.

To sum up: hollow or claw-foot is due to persistent activity of the *formator* agency (long flexor) with failure of *limitor* agency (short flexor and adductor), while flat-foot is due to failure of muscular action altogether.

The many and varied and contradictory views which are still given as explaining this latter condition involve, as it seems to me, something like a scandal in a scientific profession, having regard to how common the deformity is. A recent writer says, "The muscles, tendons, ligaments, bones, fascia, and even an improper mechanical construction, have each been considered the chief factors in its

production.¹ To this list might have been added rickets (Prof. Ogston²) and "immoral practices" (Mr. Clement Lucas³). But to me equally astonishing is it to find those, who admit muscular action as an agent in supporting the plantar arch, so contradictory in their views. Here we find paralysis of a particular muscle assigned as a cause; there the division of its tendon is recommended as a remedy. Nor is the special importance of those which I regard as the chief agents anywhere recognised. I cannot recall a single writer on the subject who mentions those which I have so long regarded as bow-strings or tie-rods—the long flexors. In a very recent book on

FIG. 8.—Slight curve of the plantar arch with the sole resting on the ground.

anatomy, edited by one distinguished surgeon (Mr. Henry Morris), we are told by another (Mr. Jacobson) that the arch is maintained by (1) plantar fascia, (2 and 3) calcaneo-scaphoid and calcaneo-cuboid ligaments, (4) tibialis posticus, (5) peroneus longus, (6) tibialis anticus; there is no mention of the long flexors: while a recent French writer, who does me the honour of discussing my views, mentions the flexor longus pollicis only to say that it cannot have

¹ James K. Young, 'Orthopædic Surgery,' 1895.

² 'Brit. Med. Journ.,' 1888, vol. ii.

³ Ibid., 1884, vol. i; 'Lancet,' 1892, vol. i.

any influence on the plantar arch,—“ne saurait avoir d'influence sur la voûte plantaire.”¹

Figs. 8 and 9 show the effect on the plantar arch of the tiptoe movement; they are taken from photographs. If the manifest increase in the curve be not due to the bow-string or tie-rod influence of the long flexors, acting as I have demonstrated in the model, I think that I may fairly ask to what is it due? It proves a shortening; but Camper taught that the foot, in this change of position, *lengthens* one inch. This statement, as a fact, is still made.²

FIG. 9.—Increase of curve of the plantar arch in the tiptoe position. Compare Fig. 8.

In cases of flat-foot where the deformity of the bones is such that the plantar arch cannot be replaced, the probability, or even the possibility of cure, by muscular action alone, has been questioned. My answer may be stated thus:

“A persistent effort to conceal a deformity tends to cure the deformity.” This, one of the many expressions for which I am indebted to my old teacher, Sir James Paget, is but another way of saying that the body tends to retain

¹ ‘Traité de Chirurgie,’ Duplay and Reclus; Masson, éditeur, 1892.

² Parkes’ ‘Manual of Practical Hygiene.’

the form into which it is vigorously and persistently placed, which is obviously the more effective in proportion as it is done in opposition to resistance. We know that muscles developed by use tend to remain taut and firm when not in use. We know that continuous pressure, such as a muscle in a state of tonic contraction would exercise on the surface of a joint, tends to cause wasting, and so to make the pressure even throughout the joint surfaces. The whole theory and practice of physical education, as I understand it, is based on these laws. The body is maintained in position by the exercise of its function—to move. The agency which moves, supports. The muscles which *by* their action move, *in* their action sustain, and so relieve tension of ligaments. Professor Ogston, who seeks to explain why “writers have deceived themselves regarding their cures for flat-foot,” rejects “gymnastic exercises” and other “proposed cures.”¹ But even he states that “the normal shape of the bones is admittedly produced not so much by forces within themselves as by normally acting muscles and such like agencies.” With “static deformity,” as due to want of muscular support, we are familiar. Of “labour deformity,” of the injurious influence on the form of excessive muscular action, we also something know. I ask, then, is it probable that muscles are potent to develop the form of the body, potent to maintain the form, potent also to deform, and yet impotent to re-form it? Let me point out, too, that in the treatment of flat-foot we have the advantage of ordinary exercise of the functions of the feet. Every step taken in good walking promotes the cure. The foot is put into a good position against the resistance due to the weight of the body. Surely, then, the success to which I have so often testified is not a matter for incredulity. Let me give one case. Two and a half years ago Mr. A. C. Fletcher, of Charterhouse Square, asked me to take charge of the son of a friend of his living here in Gloucester. The patient was apprentice to a yacht-builder on the coast,

¹ ‘Brit. Med. Journ.,’ 1888, vol. ii, p. 1148; 1889, vol. i, p. 293.

and was shown by Mr. Fletcher to a very old friend of mine, Mr. Howard Marsh. It was agreed that the worse of the two feet should be put up in plaster of Paris and the case sent down to be under my care. How very crippled this young man then was, these surgeons can testify. In spite of all the difficulty due to his occupation he has recovered, and long ago ceased to have any trouble with his feet, and this as a result of directed exercise, without other treatment.

There are, however, eminent surgeons who write on flat-foot and who ignore muscular action, or want of it, as at all concerned. Sir William Stokes, for instance, does not include it in the remedies for even slight cases.¹ He gives a drawing of the bones of a flat-foot taken from "a powerfully built muscular individual," where "no evidence existed of atrophy of any muscle." How it could be possible for the bones of the foot to rest on the ground line and yet not have caused atrophy of the sole muscles; and how the long flexors could have continued to act on a foot in that condition without the sole muscles to co-operate with them, are questions which at the time of the report I raised in vain.² Flat-foot, as I insist, cannot be or, being, cannot continue with active long flexor muscles.

To promote such activity under the most favorable physiological conditions ought to be the surgeon's aim, not only in flat-foot, but also in other painful affections.

In order to understand how troubles result from defects of function, or, in other words, from wrongly directed movements, it is necessary to realise the position of rest,³ for the foot as a whole and for the toes. This, as in other parts of the body, is the same in fatigue and in pain. It is that of the least tension of ligamentous structures, least pressure on articular surfaces. The point involves ques-

¹ 'Brit. Med. Journ.,' 1894, vol. ii.

² Ibid., 1894, vol. ii.

³ "The Position of Rest in Fatigue and in Pain," 'Brit. Med. Journ.,' 1878, vol. i.

tions of so much surgical importance that I wish to call attention to the plaster cast from which the frontispiece to 'The Human Foot' is taken (Fig. 10). First, the foot is extended and inverted, just as seen in anyone suffering pain from a kick on the shin and hopping on one leg, or lying on his side in bed. The degree of extension, as I

FIG. 10.—Position of rest. Extension and inversion with great toe directed over the second.

find it, suggests the necessity for a greater angle than is usually given for fixation splints or apparatus. Mr. Arbutnot Lane regards abduction or eversion as the position of rest; but although, as he states, the feet do turn outwards when the body is laid on the back, that is

due to the weight of the thighs. Let anyone do as I did on reading Mr. Lane's article,¹—lie on his back, fasten a strong strap round the pelvis, and then stuff rolled-up bandages behind the trochanters until they are completely supported. I found then that the inner margins of the feet came into apposition throughout. As the foot hangs from the leg in the standing position it is, in relation to the leg, inverted. This, as I contend, is the position in which the footfall—it ought not to be a foot-placing—does in physiological walking come to the ground. That 824 cases of blistered feet occurred on the march to the New Forest manœuvres last year is not creditable to military hygiene.² But such things will be until the military march has been reformed.³ They need not be. To give a proper hold of the ground and so prevent friction, and at the same time to give best support to the plantar arch, and generally the best physiological conditions, the feet must not be everted.⁴

Surely it is better that the body be drawn forward *along* the line of the foot, of the muscles acting upon it, and *across* the hinges upon which the foot moves, rather than obliquely *across* the line of the foot and *along* the line of the hinges.

The position of rest for the great toe, extended and lying somewhat over the second, and its plane of movement, obliquely downwards and inwards away from the others, are points of great surgical importance; but I have not seen them noticed. If the great toe be fixed in the position shown, as it is generally fixed in the median-pointed boot, then such movement as it can make is in the natural plane, and when it is still it is really at rest. If,

¹ "Fallacy of the Vertical Foot-piece," 'Brit. Med. Journ.,' 1893, vol. ii, p. 1049.

² See Report of H.R.H. the Duke of Connaught on these manœuvres in 1895.

³ The arguments in favour of this reform, as set forth in 'The Human Foot,' are fully accepted by Mr. Walsham ('Deformities of the Foot,' 1895). The present practice is defended in Parkes' 'Hygiene.'

⁴ 'Lancet,' 1884, vol. i.

however, it happen to be packed beneath the second toe, then if it move at all it must be in a plane for which the joints are not adapted (Figs. 11, 12). Grinding of the cartilage and consequent irritation is a necessary result. Then the condition known as "hallux flexus," "hallux rigidus," or "hallux dolorosus,"¹ in varying degree of severity, is liable to follow. The toe is flexed because it is held down beneath the second; it is rigid because movement is

FIG. 11.

FIG. 12.

11.—Great toe packed over the second, its position of rest, conducive to hammer-toe. Compare Fig. 3 and Fig. 10. 12.—Great toe packed under the second, conducive to hallux flexus or rigidus.

painful; it is painful more or less, even when still, because fixed in an unnatural position; it is never in a position of rest. If sufficient muscular inactivity be attained, flat-foot also ensues.² But when the great toe is fixed in the former position on the top of the final phalanx of the second toe, it lies there on a sort of bed formed by the final phalanx which in the so-called *flexion* of the toe lies flat on the ground, while there is an elevation of the joint between the first and second. The toe being held in this position by the great toe and straightening prevented, a hammer-toe results (Fig. 3). In any case, but the more important in the hallux flexus position, to set free the great

¹ "Deformities of Great Toe," 'Brit. Med. Journ.,' 1887, vol. i; Walsham and Hughes, 'Deformities of the Human Foot,' 1895.

² I can recall three instances where footprints have been given as illustrative of flat-foot where the impress of four toes only has indicated this condition: Hare, 'Lancet,' 1889, vol. ii, p. 953; Walsham, *op. cit.*, fig. 250; also figs. 239, 247, 251; Tubby, 'Deformities,' 1896, p. 465.

toe is clearly indicated. A boot with a straight inside line is obviously needed. More difficult, as I find, is it to get patients or surgeons to recognise the need of socks or stockings which have either a corresponding shape or a separate stall for the great toe: the pointed sock, tightened by friction against the side of the boot when the foot is inserted therein, effectually holds the toes in the false position.

I dissent entirely from the statements of Sir G. Humphry that "the toes are shut up in leather and not used,"¹ and that "their services can be spared without detriment to the rest of the frame."² It is not so. They are generally used, and as the smaller ones move in a vertical plane there is no reason why they should not move together, even in a tight boot. These toes are necessary if only to provide for their corresponding metatarsal bones the protection from pressure on the ground which, as I have shown in the model, is served by proper use of the great toe. To the want of this influence are due the callosities on the sole so often found. When the toes are used the skin is free from anything of the kind; the rugæ of the skin are distinctly seen in the printer's-ink impression shown in Fig. 1. To want of this influence are also due the conditions known as "Anterior metatarsalgia,"³ "Morton's toe," and the unnamed sufferings in the same region from time to time described.⁴ They are all evidences of defective function. Nor can the bow-string or tie-rod influence of the flexor longus digitorum on the plantar arch be properly exercised unless the smaller toes be efficient. Show me the condition of the toes in any foot, let me see how their functions are exercised, and I will predict the condition of the plantar arch.

Toes which overlap each other cannot take such good

¹ 'Lancet,' 1894, vol. i.

² 'Human Skeleton.'

³ 'Lancet,' 1889, vol. i, p. 437. Dr. Auguste Pollosson, of Lyons, in describing this condition, states that the pain is more likely to occur in going down than uphill. Exactly so; the toes are more used in going uphill.

⁴ Guthrie, 'Lancet,' 1892, vol. i.

bearing on which to act as they do when each presses on the ground line. When the extensors act on toes not firmly fixed by pressure downwards, they draw them upwards, with resulting friction and corns.¹ And, indeed, in almost any defective condition of the foot there is a surgical indication to correct or renew the function of the toes, to compel each of them by active use to, literally, find its level.

These are some of the grounds on which I base my plea for a better recognition of foot-physiology as a subject intensely interesting from a philosophic point of view, and as having important relations to surgical practice.

¹ All the toes, when at rest, should be straight. The semi-flexed position, sometimes described as if it were normal, is not really so.

(For report of the discussion on this paper, see 'Proceedings of the Royal Medical and Chirurgical Society,' Third Series, vol. ix, p. 85).