# THE NORMAL POSITION OF THE BIG TOE.[1]

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FROM the above title it may perhaps be inferred that the big toe occupies a fixed position, but among Anatomists I need say no more in explanation than that by normal position I mean the usual lie of this digit. You are aware that this toe can be moved in a horizontal as well as in a vertical plane, that is to say, it can be abducted and adducted, as well as flexed and extended at the metatarso-phalangeal joint. But there is some doubt in the mind of the Anatomist, and especially in that of the Surgeon, as to what is the normal lie or position of this leading digit of the foot. Surgeons are told that the big toe should be straight and should lie in the direction of a line drawn from the inner side of the heel to the inner side of the joint of the big toe (Meyer, Ellis).

What grounds are there for this statement, and is it true? I venture to bring before you a series of data which you can easily verify for yourselves, and which demonstrate conclusively to my mind that this statement is contrary to fact, as the big toe is neither straight nor does it usually lie in line with the inner border of the foot.

The right and left big toes are asymmetrical and are not interchangeable with one another. The difference between the two is especially marked on examination of the phalanges, and it is not difficult to distinguish from a mixed collection of the phalanges of the big toe those which belong to the right from those which belong to the left.

The first phalanx of the big toe is asymmetrical, it being longer on its inner than on its outer border, in one specimen as much as 4 mm.; this asymmetry is well seen if the phalanx be taken and laid with its proximal end on a horizontal table, when not only the inequality in length of the two borders will

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be seen, but the inclination of the phalanx to one side becomes obvious.

The direction of this inclination may be used to determine the side to which the phalanx belongs; for if this bone be set

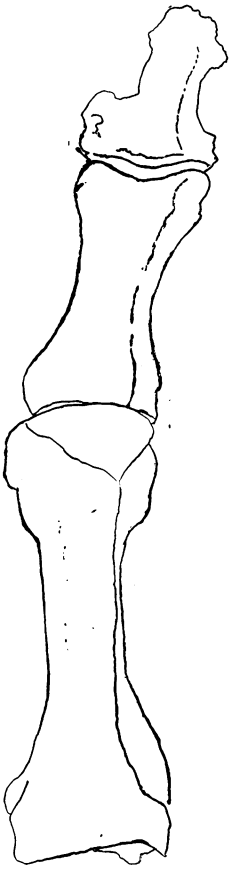

FIG. 1.—Dorsal view of phalanges of big toe and first metatarsal of right foot—(nat. size).

on its proximal end with its plantar surface forwards, it leans towards the side to which it belongs; that is to say, if the inclination be to the left, the bone belongs to the big toe of the left foot, and *vice versâ*. In consequence of the inequality in length of the two sides, the distal articular surface is on a slant from within outwards and a little backwards.

The terminal phalanx is even more asymmetrical than the first, the inner border being longer than the outer; it inclines in the same direction, but even to a greater degree. The side

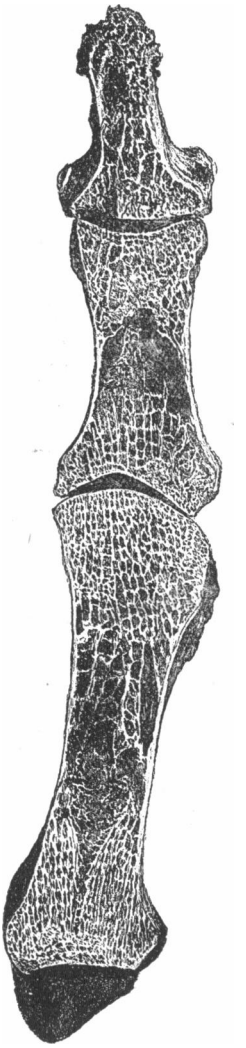

FIG. 2.—Horizontal section of phalanges of big toe and first metatarsal of left foot, showing disposition of lamellæ in each. In anterior end of the metatarsal the lamellæ run slantingly outwards, showing the direction in which first phalanx is pulled backwards upon the metatarsal.—(Nat. size.)

to which it belongs may be determined by the method above referred to in connection with the first phalanx.

The phalanges, when viewed from above, are not in line with one another, nor is the first a direct continuation of the inner metatarsal bone. It will be remembered that in the metatarso-phalangeal joint of the big toe there is lateral as well as antero-posterior movement, so the position of the first phalanx is necessarily not fixed. The lateral range of movement of the big toe is limited to about twenty degrees, that is, between the one extreme and the other. In spite of this degree of lateral mobility, it is generally easy to observe that the first phalanx

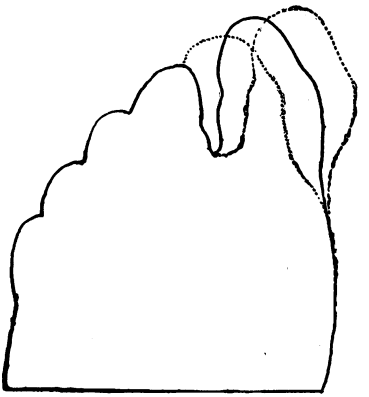

FIG. 3.—Outline of anterior part of foot and toes, showing the range of movement in a horizontal plane of the big toe—(half nat. size).

does usually deviate outwards from the line of the inner margin of the foot to which the inner metatarsal bone is set at an angle. In some examples this deviation is so small as to be difficult of determination, whereas in others it may be as great as twenty degrees, the average being about ten. Between the two phalanges the joint surfaces are shaped in such a way as to prevent any movement except that in an antero-posterior plane, lateral motion being absent. The terminal phalanx invariably deviates outwards, and its axis may diverge as much as twenty degrees from that of the first phalanx.

We find, then, that in a normal big toe the first phalanx deviates outwards from the inner line of the foot, and even more from the axial line of its corresponding metatarsal bone, and

that the terminal also turns outwards from the central line of the first phalanx. These three bones, which lie end to end, are indeed set in a gentle curve with its convexity inwards towards the middle line of the body. The above characteristics in the form and outline of the phalanges and the position they occupy

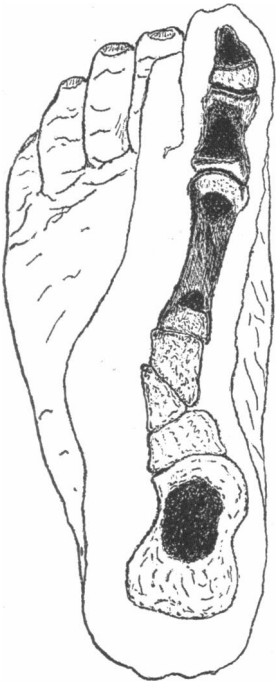

FIG. 4.—A horizontal section of left foot of fœtus born at full term, showing that the proximal phalanx of the big toe is deviated 4° in an outward direction from he long axis of its corresponding metatarsal, and that the terminal turns 12° outwards from the axis of the proximal phalanx—(nat. size).

in respect to one another in the adult are present in the fœtus at and even before birth, that is, prior to a time when any external influence whatsoever can be brought to bear on deforming this digit. For in a child born at full term the asymmetry of the phalanges is unmistakable; the deviation in the axis of the first phalanx from that of the innermost metatarsal is often small, but the central line of the terminal turns well outwards from that of the first phalanx.

Accordingly we find in the first pedal digit of the newly-born precisely the same characteristics as those observed in the big toe of the adult, there being perhaps a little less deviation from one another in the central lines of the several bones in the child than in the grown-up, which resolves itself to a difference in degree and not in kind.

It may be of interest to give here some measurements of the degree of deviation of the first segment of the big toe from the inner line of the foot as determined by me in a few specimens of casts of ancient Greek sculpture which I had access to in the Archæological Museum of the University.

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|---|---|---|---|
| (117) | 1. Athlete pouring oil into his hand, . . | right foot | 10° |
| (271) | 2. Wounded Amazon. Pheidias, . . . | left ,, | 16° |
| (280) | 3. Athlete carrying spear. Doryphoros, . | right ,, | 8° |
| (291) | 4. Young athlete. Idolino, . . . . | left ,, | 20° |
| (384) | 5. . . . . | right ,, | 0° |
| (112) | 6. Olympia marble girl starting in a foot race, | left ,, | 10° |
| (118) | 7. Diskobolus, . . . . . | right ,, | 12° |
| (110B) | 8. Charioteer of Delphi, . . . . | left ,, | 8° |

Average 10·5°.

These few measurements suffice to show that the position of the big toe in the feet of the ancient Greeks, as represented by the best sculptors the world has ever seen, is similar to that occupied by the toe in the foot of the modern Britisher, that is to say, it lies more or less midway between the extremes in its lateral range of movement.

In the Museum of Anatomy in the University there are skeletons of the ancient British, of Negroes, of Australian Bushmen and others, one and all of which show, and without any doubt, the distinctive features of the big toe which have been pointed out above.

Owing to the kindness of Professor Macalister I am able to show you that these characteristics of the big toe are well exemplified in the feet of ancient Egyptians, for in them also the phalanges are asymmetrical, and they deviate in the same direction, namely, outwards from the first metatarsal bone and from one another, just as they do in us who live at the present time.

Accordingly, in reviewing our data we may say that in the newly-born child, in the adult, in the savage as well as in civilised man known to us the big toe presents the same characteristics. It is asymmetrical, it is gently curved in its long axis with the convexity inwards towards the opposite foot, and it is directed outwards more or less from the inner line of the foot as well as from the line of the innermost metatarsal bone.

From the above it is clear the big toe does not possess a straight axis in any position; for even if the first phalanx be in a line with that of its metatarsal, the terminal phalanx deviates outwards, even it may be to as much as 20°.

FIG. 5.—View from above of anterior portion of left foot of an ancient Egyptian, showing the inclination outwards of the big toe—(half nat. size).

The results of the above observations are opposed to the views of Professor Meyer, from whose pamphlet the following quotation is taken.

"The great toe plays by far the most important part in walking; because when the foot is raised from the ground with the intention of throwing it forwards, we first raise the heel, then rest for a second on the great toe, and in lifting this from the ground the point of it receives a pressure which impels the body forwards. Thus, in raising the foot, the whole of the sole is gradually as it were 'unrolled' up to the point of the great

toe, which again receives an impetus by contact with the ground. The great toe ought therefore to have such a position as will admit of its being unrolled in the manner described; that is to say, it must so lie that the line of its axis, when carried backwards, will emerge at the centre of the heel; and this is its position in the healthy foot."[1]

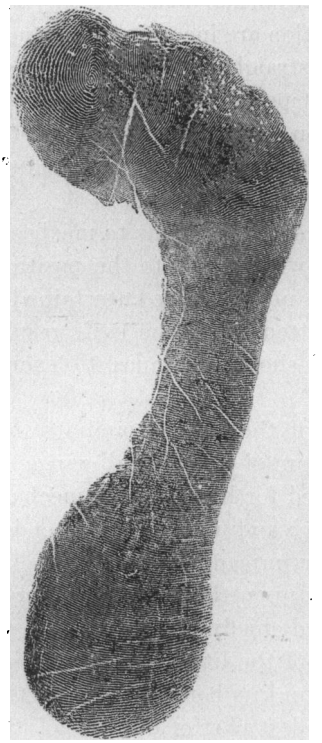

FIG. 6.—Reduced half imprint of right foot, taken when standing erect upon both feet.

It has already been shown that the axis of the big toe is not such as to admit of its prolongation backwards in a straight line to emerge at the middle of the heel, for it forms a curved line in the normal first digit, also that this digit usually lies in a position practically midway between that of extreme abduction and full adduction. The axis of the first phalanx would, as a

[1] *How the Shoe Pinches.*—(Trans. by Craig, p. 20.)

rule, if continued backwards, leave the foot just behind the metatarso-phalangeal joint, and if projected backwards, would pass clear, and well to the inner side of the heel. Thus, even the line of the first phalanx does not follow the inner border of the foot. Professor Meyer, from a study of how we walk, conceived that the big toe ought to lie in a definite line in what he regarded as the ideal normal foot, but the data upon which he built up this conception are incorrect, inasmuch as the big toe has a curved and not a straight axis, and that the central line of the first phalanx, except perhaps when the big toe is in a position of extreme abduction from the middle line of the foot, would if projected backwards emerge well to the inner side of, rather than through the centre of the heel.

Sufficient evidence has, it seems to me, been produced to show that Meyer's views with regard to the position of the big toe in the healthy foot can no longer be entertained, but the good work he did in drawing attention to the evils resulting from ill constructed boots and shoes continues to exercise its beneficent influence.

The asymmetry of the big toe and its inclination outwards in the mean position of its lateral range of movement may perhaps be accounted for by a simple mechanical theory which has occurred to me, and which I will endeavour to explain. When we stand, the imprint of the foot shows that the weight of the body is borne upon the heel, outer border of the foot, and anterior part, formed chiefly by the ball of the big toe on the inner side and that of the little and 4th toe on the outer. Thus the weight of the trunk is borne behind on the narrow heel and in front on the broadest part of the sole of the foot, constituted by the anterior end of the metatarsal bones. While in this attitude the toes do not come in contact with the ground. When, however, we stand on one foot, we rest upon the toes as well as upon the sole in order to increase our steadiness, and when we take a step forward we come to rest upon the anterior ends of the metatarsal bones, the whole length of the big toe and the tips of all the smaller toes (see fig. 8). The weight of the trunk in this phase of the act of walking is borne upon a small triangular area, which is formed behind by the anterior portion of the sole, on the inner side by the big toe, and

on the outer by the tips of the other toes. From the imprint (see fig. 8) it is obvious that, leaving out the part borne by the sole, the big toe bears the greatest proportion of the weight of the body, but the other toes take their share, which is

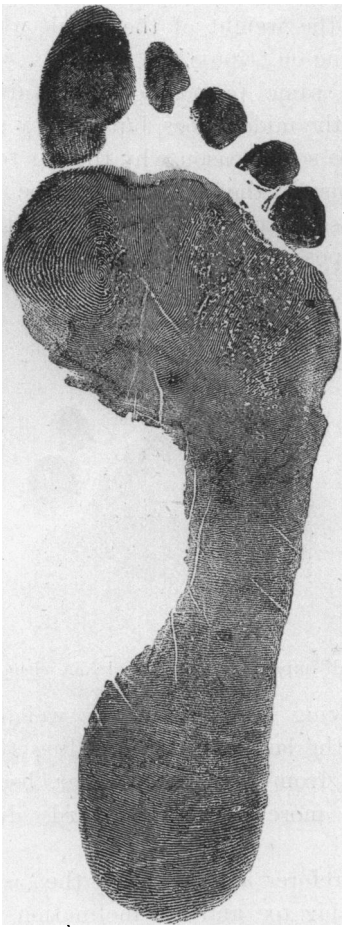

FIG. 7.—Plantar impression of right foot of an adult, showing the inclination outwards of the big toe. The foot was placed fully on the ground and stood on—(half nat. size).

but a small proportion of the whole. The big toe being much larger than any of the others and therefore more capable of bearing weight, is placed in an advantageous position to

receive and to bear the weight of the trunk in the last phase of the act of stepping off, and the nearer it approaches the middle line of the foot the better it can accomplish this work. Accordingly, it would appear that the big toe inclines outwards so as to be in the position, or as near as possible to it, where it can best receive and bear the weight of the trunk while the person is walking or standing on 'tiptoe.'

Doubtless, the same purpose could be attained by greater growth in one of the middle toes, but as they are diminutive in size, there must be some reason why the big toe has usurped in such a large measure the function of the others. Without entering into a discussion upon this subject, it might suffice for our present purpose to point out that the big toe serves, in

FIG. 8.—Reduced half imprint of right foot, taken when standing on 'tiptoe.'

addition to receiving and bearing the weight of the body in walking, to give the last push in impelling the body forwards, and it does this from its inner border, because the foot in adults is turned more or less outwards during the act of walking.

It would therefore appear that the asymmetry of the segments of the big toe and its inclination outwards clearly serve two purposes, namely, (1) to receive and to bear the weight of the body in walking, and (2) to give the last push forwards. The special construction it possesses can, it seems to me, be fully explained by the mechanical theory put forward above.

I am aware that both Prof. Meyer and Mr T. Ellis consider that

the man who walks as he should turns his foot inwards, but this is certainly not the way in which he does walk; and were he to walk thus, he would at once lose that firm and stable carriage he now possesses. The infant tends to walk with its foot turned inwards so long as it is necessary for it to spread out its lower limbs to gain stability, but as the limbs are adducted to their natural and upright state the turned-in foot gains the position (turned outwards) it occupies in the adult.