The SIGNIFICANCE *of the* SCAPHOID TUBERCLE *of the* FOOT *as a* BONY LANDMARK

By HENRY O. FEISS, M. D.
CLEVELAND, OHIO

1909

The Significance of The Scaphoid Tubercle of the Foot As a Bony Landmark

—BY—
HENRY O. FEISS, M. D.
CLEVELAND
OHIO

PRINTED PRIVATELY

1909

TO EDWARD HICKLING BRADFORD, in kind remembrance of early encouragement and pleasant associations, this pamphlet is inscribed.

PART I.

The Normal Foot with Reference to Its Bony Landmarks

Present Methods of Studying the Foot

There is no part of the human body so subject to deformities as the foot, yet there is no part of the body in which the estimation of its deformities is so inaccurate and vague. The most common deformity that we see is flat foot, yet the diagnosis of flat foot so far as its physical signs go, rests on the most ambiguous basis, and in attempting to teach students what we mean by flat foot we are seldom able to give them a convincing and definite picture. The only method which pretends to any accuracy at all is that of taking a print or an impression of the bottom of the foot. The deductions made from the print of the foot are dependent on the extent with which the sole of the foot touches the underlying surface. The rule is that the greater the excavation of the arch of the foot, the more perfect (?) the print will be. Personally, I see little value in that method. In the first place, the print of the foot only represents the imprint of the skin of the sole. If a foot happens to be fleshy or swollen it would naturally make a greater impression and thus seem to connote a lower arch than when a foot is thin and not swollen. Again, a foot which may be very flat may make an almost perfect print if its arch has not lowered itself quite enough to be properly represented in the print. Yet even if it is allowed that this method aids us in diagnosis in extreme types it adds nothing in estimating the amount of lowering of the arch in those types which are intermediate. Therefore in the last few years I have been especially attracted to the study of the foot, seeking for a basis for comprehending certain deviations with special reference to the estimation of the height of the arch, and the aim of this report is to suggest and elaborate such a method.

The Estimation of Deformity in General

In estimating deformities of the body there is no process more valuable than that of studying the relationship of bony landmarks to each other. In fractures of the wrist and of the ankle the relationships of the ends of the long bones are of extreme importance. A splendid example of valuable relationships is Nelaton's Line. No study of the deformity of the hip is ever complete unless an estimation is made of the relationship of the trochanter to this famous line. Finally, I may call attention to such other important methods as Bryant's Triangle and Meyer's Line. These simple geometric methods can hardly be omitted for a clear and proper elucidation of deformity. To be sure, the Roentgen picture is the final test in many cases and hence may seem to detract from the significance of these geometric methods. However, such a seeming inference is not justifiable. The Roentgen picture cannot diminish the value of these methods. In the first place a great many cases come to our notice where the symptoms or signs are slight so that one hesitates before putting the patient to the trouble and expense of having a Roentgen picture. In such cases the knowledge of the relationships of bony landmarks is of great value in telling us which cases are apparently serious and which are not. In the second place, it is not always convenient or possible to get a Roentgen picture. In the third place, for purposes such as treatment, it is absolutely essential to have a distinct knowledge of how the bones feel to the touch. No Roentgen picture can give us this information. Finally, the Roentgen picture is difficult of interpretation, for the image transcribed is always a distorted image. The rays from the anode of the tube forming a cone of light, scatter the shadows on the plate in such a manner that the distortion, even if comprehensible, is in many cases very confusing. Even if we have an accurate knowledge of the physical nature of the image, the superimposition of the various planes of shadows connotes an extremely complicated idea. For all these reasons and perhaps others, it may be stated that the value of the Roentgen picture, great as it is, must only be regarded in relation to our older knowledge. It cannot displace that older knowledge, it can simply add to it.

The Selection of Bony Landmarks of the Foot

In the case of the foot we must seek for a clear and definite method of determining its variations and malformations as based on an actual knowledge of the skeleton. The foot, however, differs greatly within normal limits, even as other parts of the body, such as the skull, the chest, the hand, etc., and one difficulty at the start is that it is not a simple matter to state exactly just which feet are normal, which are varieties of normal and which are deformities—but this is an additional argument for the necessity for selecting proper bony landmarks on which to base an estimation. Even if we do not succeed in establishing a new method of diagnosis, we may at least be able to furnish an anatomical starting point on which the definition of normal may in part be based.

It has been intimated that the chief indication is to study the relationship between certain bones in order that we may observe the changes of such relationship as they take place as a result of deforma-

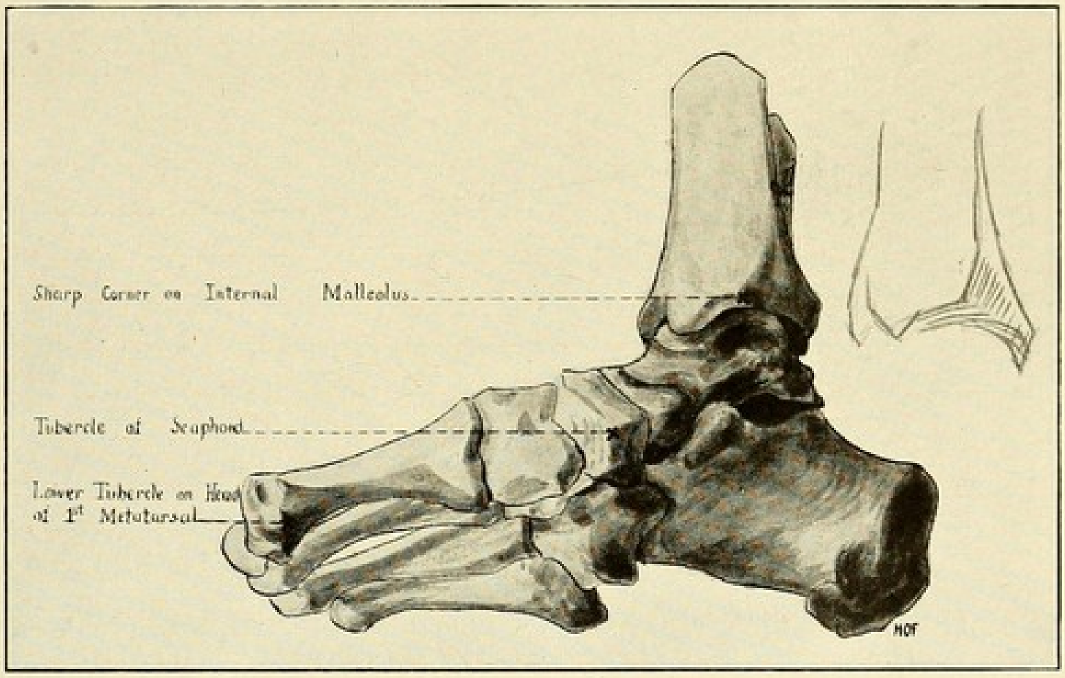

Fig. 1. Sketch showing the position of the bony landmarks under consideration.

tion. The first task then is to select proper bony landmarks and such a task becomes quite simple after its original conception.

In the selection of bony landmarks of the foot we naturally turn to its inner aspect because it is on this side that the changes in the arch are most apparent. Starting in front the only landmark representing the anterior part of the arch is the lower tubercle on the inner side of the head of the first metatarsal bone. This tubercle can always be felt. Posteriorly, the best landmark is the internal malleolus. This, to be sure, is not a part of the foot itself but its relationship to the foot is easily comprehended. It is also true that this relationship is not a fixed one because it travels backwards when weight is borne on account of the rotation of the tibia (it also travels slightly downward and inward), but as this movement may be clearly analyzed it need not confuse our estimation. With regard to the arch itself, the clearest and most logical landmark which presents itself is the tubercle of the scaphoid bone.* This tubercle is almost always pronounced and after practicing palpation on a few dozen cases it can usually be distinguished by its peculiar shape and position from such lesser tubercles as that on the internal cuneiform bone, on the head of the astragulus and the sustentaculum tali. I admit that in certain deformities which are marked the head of the astragulus and the sustentaculum tali are liable to delude us, but if we recognize this liability and keep it in mind then in the ordinary type there will be little danger of being led astray.

A Closer Scrutiny of the Selected Landmarks

Before advancing let us briefly examine more closely the landmarks that have been selected, as it is absolutely essential that the observer knows definitely just what part of the skeleton his finger touches in his examination. The figure (Fig. 1) appended is a wash drawing of a disarticulated skeleton which brings into exaggerated relief the landmarks in question.

The Lower Tubercle of the Head of the First Metatarsal Bone

In examining the head of the first metatarsal bone in the disarticulated skeleton we find on its inner aspect two ridges separated by a groove. Each of these ridges ends posteriorly in a prominent tubercle. The upper tubercle does not concern us, the lower one is sharp and is the one which applies to the present series of observations.

*The only author that I know of who calls attention to the relationship of the scaphoid tubercle as a bony landmark is Deaver in his Surg. Anat., Pg. 548, Vol. III, who refers to it as being placed 1 inch in front and a little below the inner malleolus. Other anatomists simply mention it as a bony landmark in connection with other landmarks of the foot.

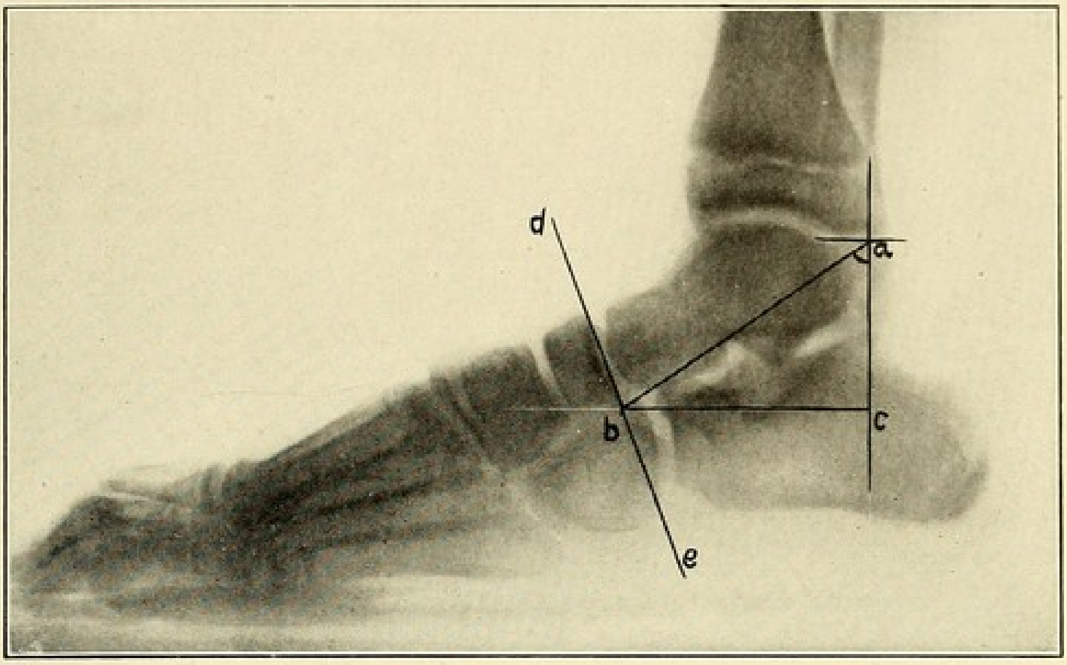

Fig. 2. Roentgen picture of a foot of a young individual without weight-bearing, *a*, marks the posterior inferior corner of the tibia. *b*, the posterior inferior corner of the scaphoid, *a-c*, vertical line dropped from *a*. *d-e* passes through the upper and lower posterior corners of the scaphoid.

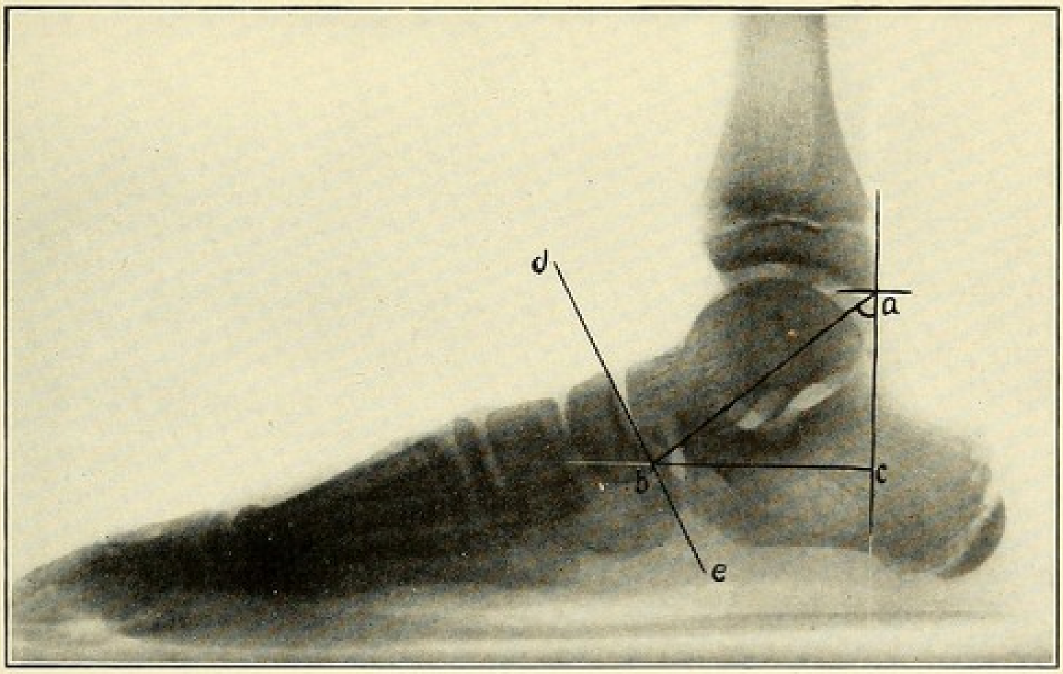

Fig. 3. Roentgen picture of same foot with weight-bearing. Same points marked. *b-c* here is less than in previous picture. Angle *b-a-c* also less, *d-e* inclines more.

The Tubercle of the Scaphoid Bone

The tubercle of the scaphoid bone is best seen by looking at the scaphoid bone from above. It will then be apparent that the whole external surface of this bone forms a ridge. The apex of this ridge is the so-called tubercle, being in fact the most prominent bone as palpable to touch. The tendon of the tibialis posticus ends close to this tubercle.

The Posterior Inferior Corner of the Internal Malleolus

As seen in the sketch and as will be apparent on the examination of the skeleton the internal surface of the tibia is bounded at its lower end (internal malleolus) by three edges, an anterior edge, an inferior edge and a posterior edge. Where the posterior edge strikes the inferior edge a sharp corner can always be felt. So, if we run our finger over the part in question we simply determine the most inferior posterior corner in the internal malleolus as thus evidenced.

To summarize then, the three landmarks which concern us are the lower tubercle on the head of the first metatarsal bone, the most prominent point on the tubercle of the scaphoid and finally the posterior inferior corner of the internal malleolus. If the reader take the trouble to examine these points on the skeleton and feel them carefully he will in the ordinary foot seldom be confused in determining where they occur under the skin.

Changes in the Skeleton of the Foot, With and Without Weight-Bearing

The investigation of the foot differs from that of other parts of the body in one respect—namely, that the relationship of the bones becomes altered with weight-bearing. Therefore, this alteration is necessarily the first study which must concern us. As similar studies have been made by a great many other observers and the results are pretty well established, we will only confine ourselves to the change in the relationship of the landmarks in question.

The Excursion of the Scaphoid Bone in Weight-Bearing

General Views Based on the Literature*

With reference to the scaphoid, the view seems pretty well established that when weight is borne it travels downward and inward,

---

*G. H. V. Meyer.......Statik und Mechanik des menschlichen Fusses, 1886.
G. H. V. Meyer........Statik und Mechanik des menschlichen. Knockengerustes, 1873.
John Dane ....Transactions Am. Orth. Assoc., 1897.
Golobiewski ....Zeitsch. f. Orth. Chir., 1894.
Lovett & Cotton........Transactions Am. Orth. Assoc., Vol. XI.
Bradford & Lovett......Textbook of Orth. Surg., 2d and 3d Edition.
Whitman ....Orth. Surg.
Quain's Anatomy.

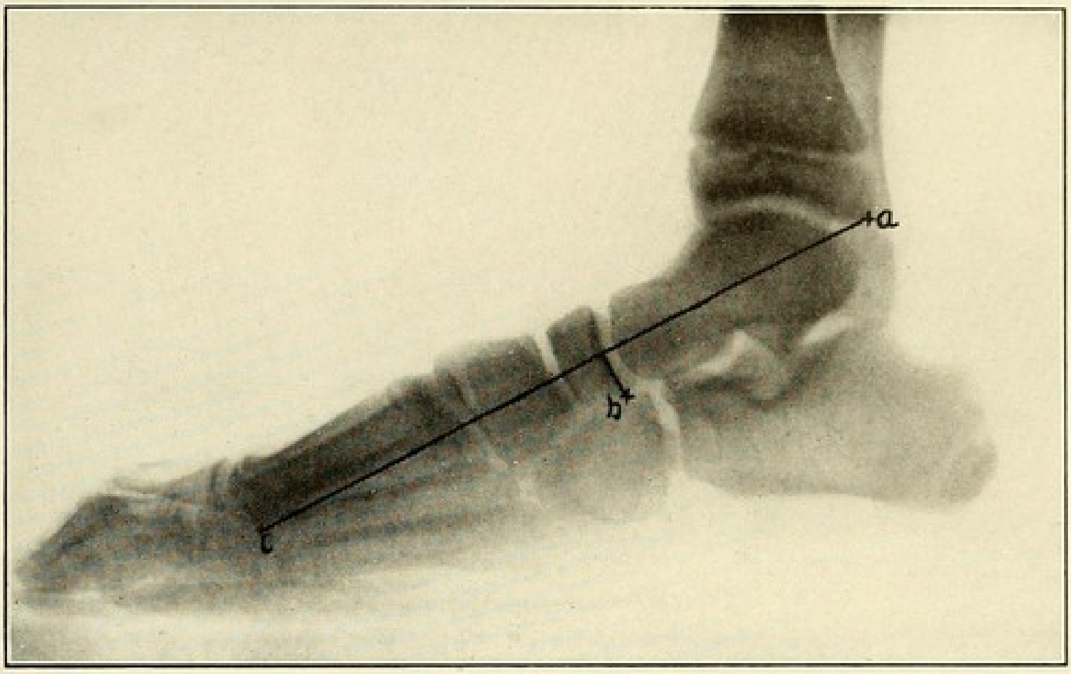

Fig. 4. Roentgen picture of same foot without weight-bearing. *c* marks posterior inferior corner of the head of the first metatarsal. Vertical line erected from *b* to *a-c*.

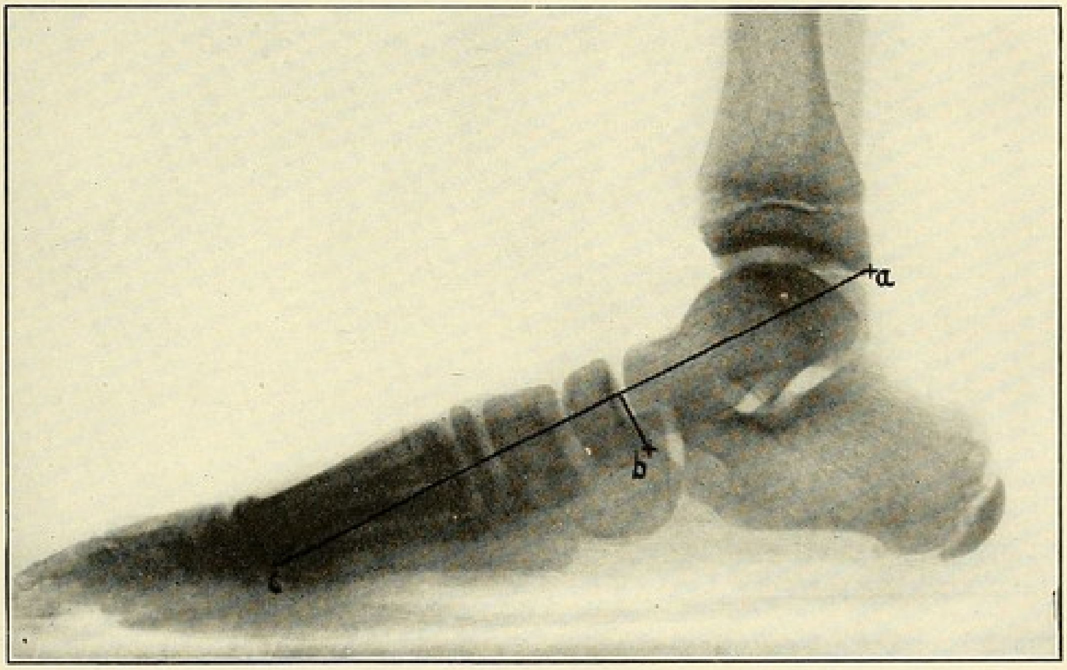

Fig. 5. Roentgen picture of same foot with weight-bearing. Same points marked. Note increased distance of *b* from connecting line.

although as regards its immediate relation to the head of the astragulus it seems to move outward. According to Bradford and Lovett, a separation takes place at the astragulo-scaphoid joint owing to the fact that the front of the foot travels outward, "so that the head of the astragulus, rotating inward, is in part exposed." "The head of the astragulus, which is roughly spherical, moves in a ball-and-socket joint formed by the sustentaculum tali, the calcaneo-scaphoid ligament, and the scaphoid. This allows of free movement, but the relations of surface are such that an inward rotation of the head of the astragulus (when the foot is under weight) determines an outward movement of the scaphoid swinging on the calcaneo-scaphoid ligament." This agrees with Meyer and is no doubt true. Nevertheless, if we compare the position of the scaphoid during weight-bearing with its original position the general change is in an inward direction and this is shown in the very figures which Bradford and Lovett use in their textbook (Figs. 575, 576, 577 in the Edition of 1899). The opinion expressed by Whitman seems to bear this out. He says, in slightly different language, that the scaphoid becomes depressed with the astragulus although to a less degree and with it the entire border of the inner foot is depressed also. Thus depression of the arch is always accompanied by a bulging inward of the inner side of the foot. Moreover, in the 1905 edition of Bradford and Lovett the following statement appears, "The astragulus rotates inward, the scaphoid, the cuneiform and the proximal head of the first metatarsal move downward and inward." In short, therefore, even if the scaphoid apparently makes an outward movement with respect to the astragulus, its general motion is downward and inward.

Meyer further states that the scaphoid bone moves forward with weight-bearing. This is also true. The bone does actually travel forward on account of the forward thrust conveyed by the astragulus. However, we have just shown that the bone travels inward, although less so than the astragulus. This latter motion is on a fairly horizontal arc. Consequently, a view of the foot from the inner side during weight-bearing carries with it an apparent backward displacement of the scaphoid with reference to its original position on account of the foreshortening of the arc seen from that point of view. On the other hand, however, the actual distance between the internal malleolus and the tubercle of the scaphoid increases in weight-bearing on account of the fact that the internal malleolus rotates backward; then the spreading of the two points might suggest a forward traveling of the scaphoid tubercle. But as may readily be understood, such a forward excursion is for the most part only an apparent one, because it is chiefly the internal malleolus that is moving. However, leaving out of consideration

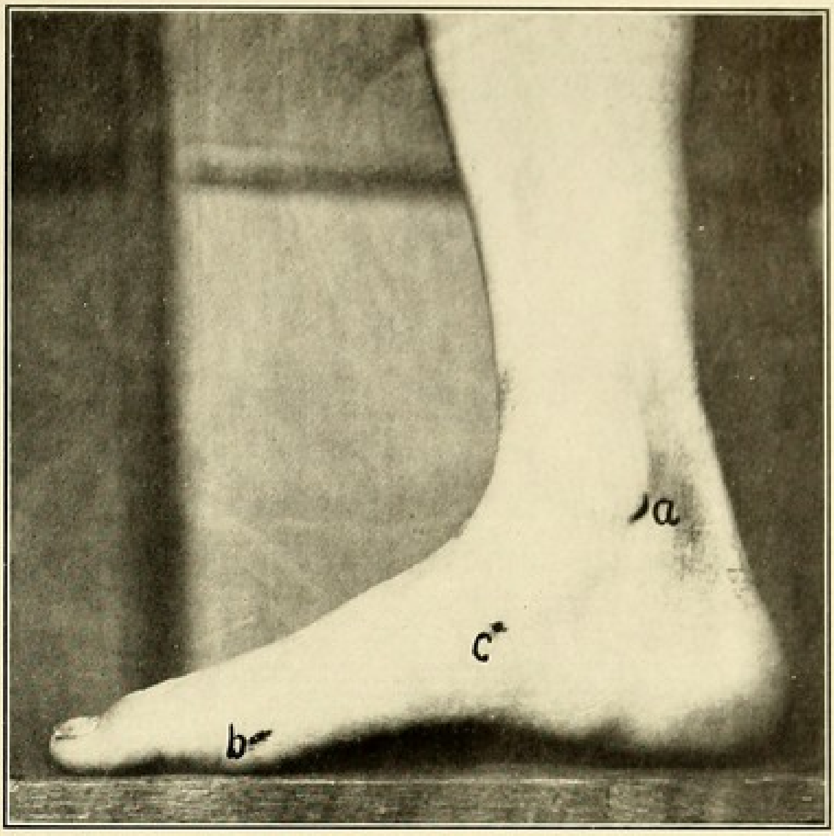

Fig. 6. Photograph of well developed foot without weight-bearing in which are marked the posterior inferior corner of the internal malleolus *a*, the lower tubercle of the head of the first metatarsal *b*, and the tubercle of the scaphoid *c*.

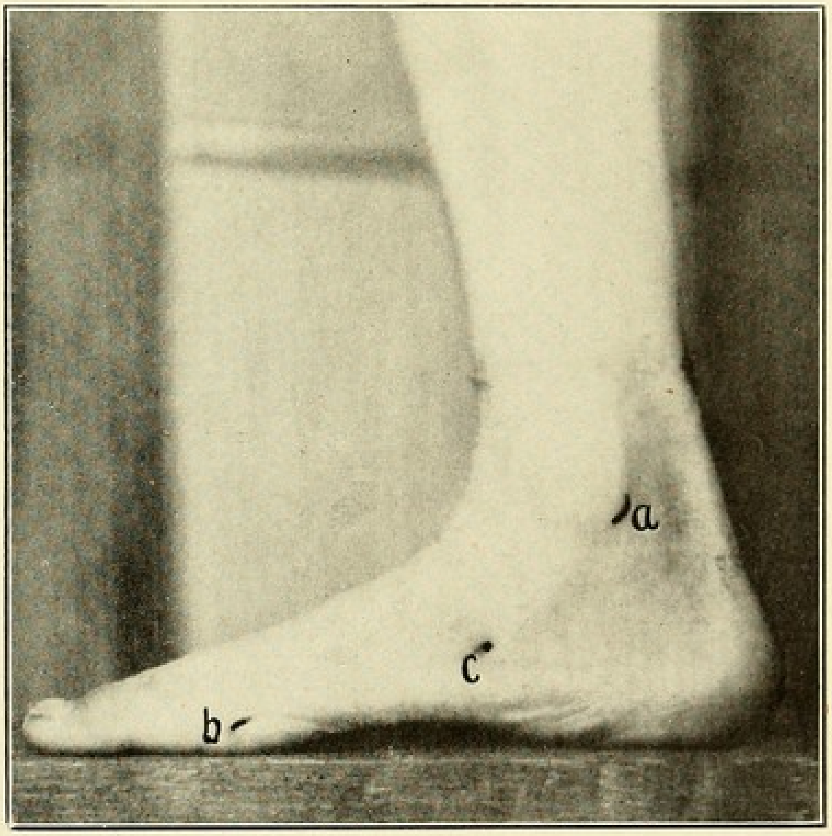

Fig. 7. Photograph of same foot with weight-bearing. Same points marked.

for the present, the apparent increase of distance from the internal malleolus to the scaphoid and only considering the scaphoid's movements from its original position we have both a forward and a backward movement, the latter occurring later on the arc of motion and often being sufficient to cancel the former, at least as viewed from the inner side of the foot.

These motions of the scaphoid during weight-bearing are of considerable interest and might arouse further discussion, but I believe all the authorities agree on the main principles, although they use somewhat different ways of description. One thing that they certainly agree on is the downward displacement, and this for our purpose is the important thing as will be shown.

Original Roentgen Studies*

I have made studies on six different individuals with and without weight-bearing and the findings have been fairly uniform. It is therefore only necessary to use the illustrations from one case, Figs. 2, 3, 4 and 5. In taking these pictures the patient was first placed in a sitting position, the knee being held relatively firm by means of a wooden frame for the purpose. The negative was placed on the inner side of the foot in a particular position. The exposure was then made. The plate having been removed the patient was allowed to rise with his knee held in position and told to allow his weight to come on his foot. The Roentgen tube was not altered. A new plate was then placed in exactly the same position as the other and another exposure was made. Finally, the plates were developed and ready for study.

In studying these plates it becomes evident that the landmarks as externally apparent are not to be identified in the Roentgen pictures except in the vaguest way. This is due to the fact that the density of the bone is not sufficient at those particular points to cause sharply distinctive shadows on the plate. I had, therefore, to choose fixed points on the negatives which could be identified in all of them and which seemed to correspond fairly well to the chosen landmarks. I selected the posterior inferior corners of the three bones of our investigation—namely, of the head of the first metatarsal, the scaphoid and the tibia. These points can be identified in every plate and it is safe to assume that the points chosen on the scaphoid and metatarsal act

*In these studies I have in mind the argument earlier presented against the use of Roentgen pictures for the estimation of skeletal changes. But here comparison is being made of pairs of images where all antecedent conditions remain the same except weight-bearing. Hence the error of distortion, great as it is, is the same for each of the pair, and may therefore be eliminated. Consequently, if one image of the pair shows certain characteristics in weight-bearing which are different from those on the other image taken without weight-bearing, we have a right to regard these differences as the effects of the one variable antecedent—weight-bearing.

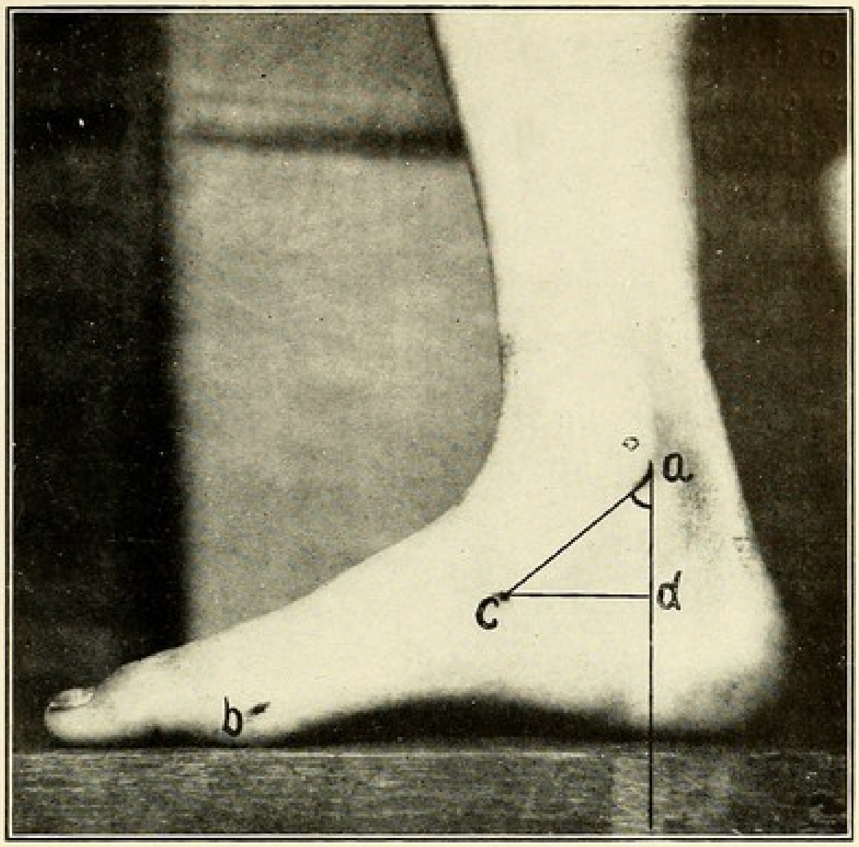

Fig. 8. Photograph of same foot without weight-bearing. Same points marked. *a-d* dropped from *a*, perpendicular to upper edge of under lying block. *c-d* drawn perpendicular to *a-d*.

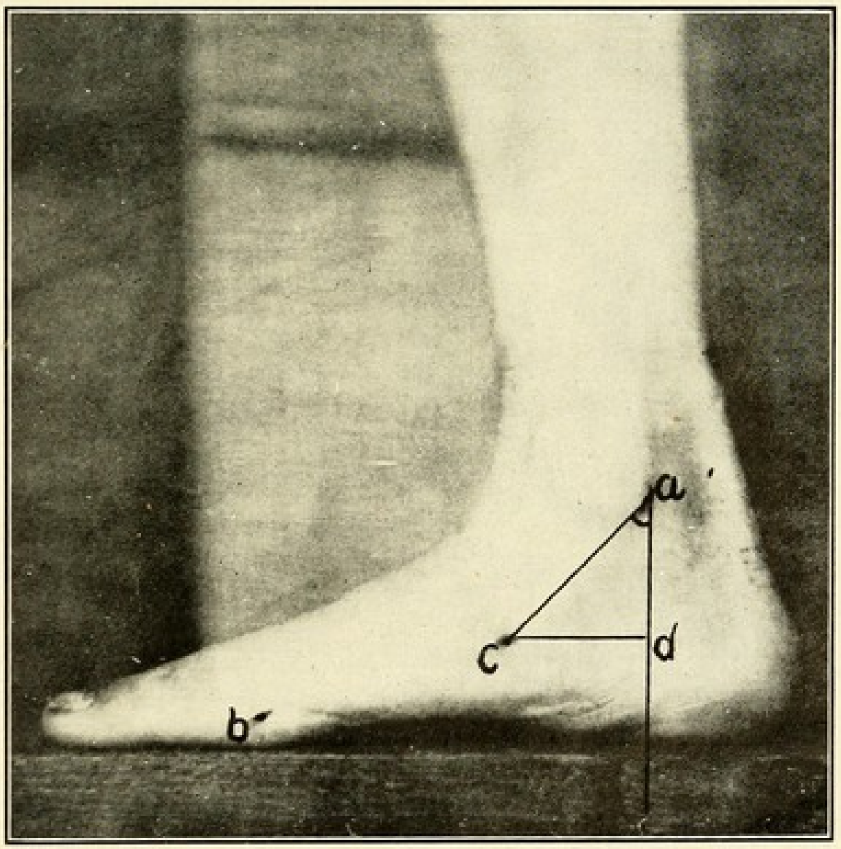

Fig. 9. Photograph of same foot with weight-bearing. Note *c-d* and angle *c-a-d* both less than in previous Fig.

pretty much as the external landmarks. With regard to the tibia, the movement of the posterior inferior corner of the internal malleolus, as seen on the negative, does not exactly correspond to the movement of the corner of the internal malleolus as externally palpable. The latter is bound to travel more because it is located further away from the center of motion on which tibial rotation takes place. Noting this error, however, and because of the fact that the fixed point chosen on the plate is traveling less than the externally palpable landmark we may proceed with our investigation because the error is on the safe side. In Fig. 2 (not weight-bearing), I have marked the posterior inferior corner of the tibia by (*a*) and the posterior inferior of the scaphoid by (*b*). The line *a-c* is drawn on the negative with a T square, perpendicular to the lower edge of the plate and is therefore vertical, because the lower edge of the negative was placed horizontal when the exposure was made; *b-c* is drawn perpendicular to *a-c*. Comparing *b-c* in Fig. 2 with *b-c* in Fig. 3 (weight-bearing) where the same points are marked, it is apparent that the latter is smaller than the former, indicating that the scaphoid traveled backward and to a considerable degree, because the rotation in the tibia has taken place. If this rotation had not taken place the difference in the two measurements would be still greater.

The line *d-e* is drawn through the upper and lower posterior corners of the scaphoid in both plates. As indicated in the weight-bearing negative the scaphoid has tilted, taking its motion from the astragulus. This is interesting, showing one of the reasons for the backward excursion of the lower corner of the scaphoid.

A more important observation is the difference in the angle *b-a-c*, in the two plates, that in the non-weight-bearing image (Fig. 2) being greater than in the weight-bearing image (Fig. 3). This must indicate an actual descent of the scaphoid bone with respect to the corner on the tibia. For no matter how this point has moved by itself, the fact that the line *a-b* in the latter plate subtends a lesser angle with the vertical *a-c* must mean that point (*b*) must be traveling downward with respect to the corner (*a*) of the tibia.

A simpler way of determining the downward movement is by connecting the posterior inferior corner of the tibia with the lower corner of the head of the first metatarsal by a line *a-c* (Figs. 4 and 5 which are prints from same negatives as Figs. 2 and 3). If a perpendicular is drawn from the posterior inferior corner of the scaphoid (*b*) to that connecting line, it is evident that in weight-bearing (Fig. 5) point (*b*) has descended with respect to that line. Therefore, it is shown that the lower inferior corner of the scaphoid travels downward both as measured by the angle subtended with the vertical as well as by its actual distance traveled from an established base line.

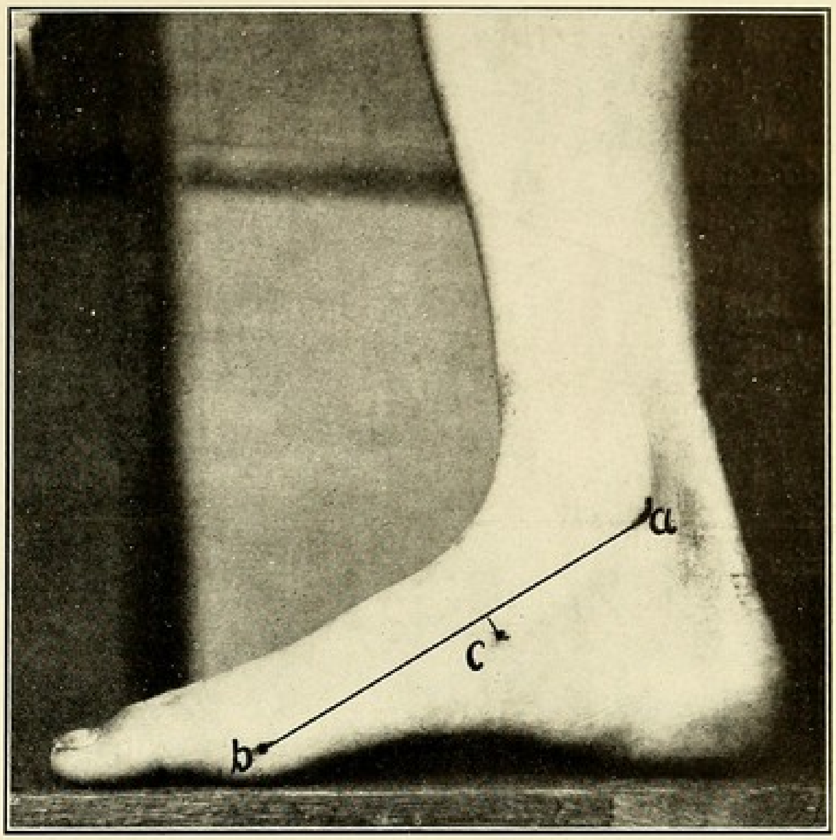

Fig. 10. Photograph of same foot without weight-bearing. Here the posterior inferior corner of the internal malleolus is connected with the lower tubercle on the head of the first metatarsal by a line.

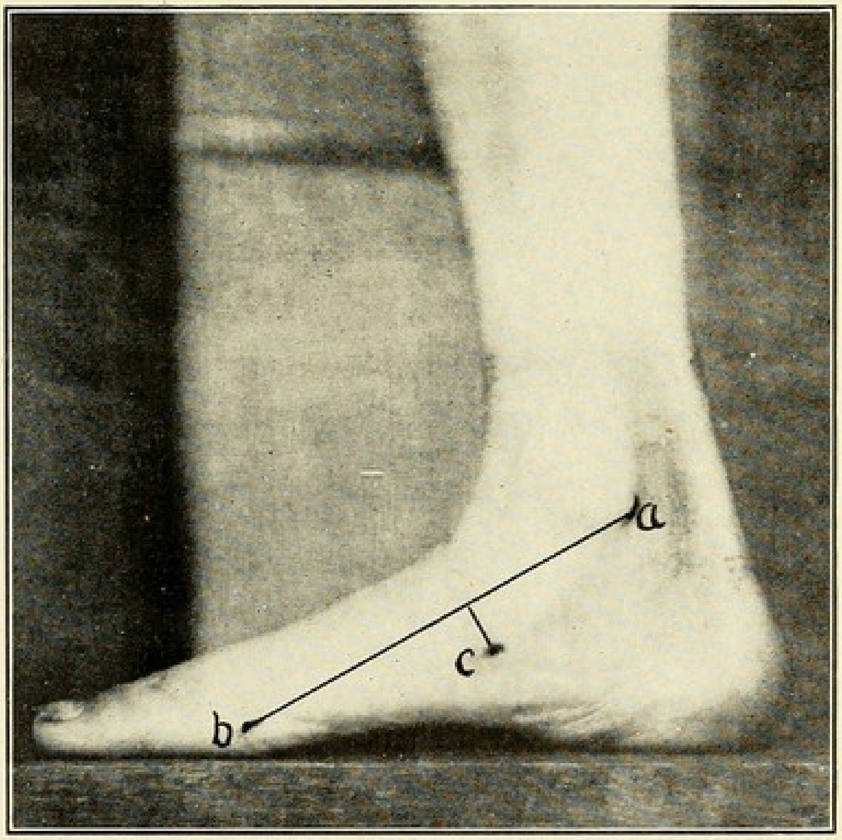

Fig. 11. Photograph of same foot with weight-bearing. Note increased distance of the tubercle of the scaphoid from the connecting line.

It will be argued that such observations, although accurate and truthful, do not apply to the external landmarks themselves because we can not be absolutely sure that they travel the same. Observations, however, on the same feet which were radiographed showed that the landmarks do act practically the same. Further than that, observations which I have made on the foot of a cadaver and on my own foot seem to bear out the conclusions which are to be drawn from the points selected in the Roentgen pictures. The following photographs will make this clear.

Studies of Photographs

Figure 6 is a picture of a well-developed foot in which the selected landmarks are indicated with small dots *a, b, c,* (*a*) being on the posterior inferior corner of the internal malleolus, (*b*) on the lower tubercle on the head of the first metatarsal and (*c*) on the tubercle of the scaphoid. The dots were then erased and the patient was allowed to bear weight on the foot, all other things being equal, including the position of the camera and the position of the foot. Then the landmarks were again marked on the foot and another photograph was taken (Fig. 7). In Fig. 8 (from same print as Fig. 6), I have erected a vertical a-d upon the print from the edge of the underlying block in the picture, then I drew *c-d* perpendicular to that line. This was repeated in Fig. 9 (weight-bearing), which is from the same print as Fig. 7. It then becomes apparent that *c-d* (Fig. 8) becomes less in weight-bearing (Fig. 9) indicating as suggested in the Roentgen picture an apparent backward excursion of the tubercle of the scaphoid with respect to the vertical *a-d*. Moreover, the angle *c-a-d* subtended at (*a*) also becomes strikingly diminished in weight-bearing (Fig. 9), thus clearly showing the descent of the scaphoid tubercle. (Of course the internal malleolus (*a*) also moves downward and inward as well as backward but this does not alter the observation that the angle *c-a-d* becomes lessened in weight-bearing.)

The method of observation which I lay stress on is that in Figs. 10 and 11 (prints from same negatives as above). In these prints I connected the lower corner of the internal malleolus (*a*) with the lower tubercle of the first metatarsal (*b*) by a line *a-b* and it becomes distinctly evident that (*c*) marking the tubercle of the scaphoid makes a marked descent from that line with weight-bearing (Fig. 11). This manner of measuring being the important one, a method will be later suggested and elaborated by which it may be made practical.

Finally, a composite photograph was made of the same foot with and without weight-bearing (Fig. 12). Here the landmarks were marked, but not remarked for the second exposure. It will seem that the scaphoid tubercle apparently travels forward, but this is doubtful

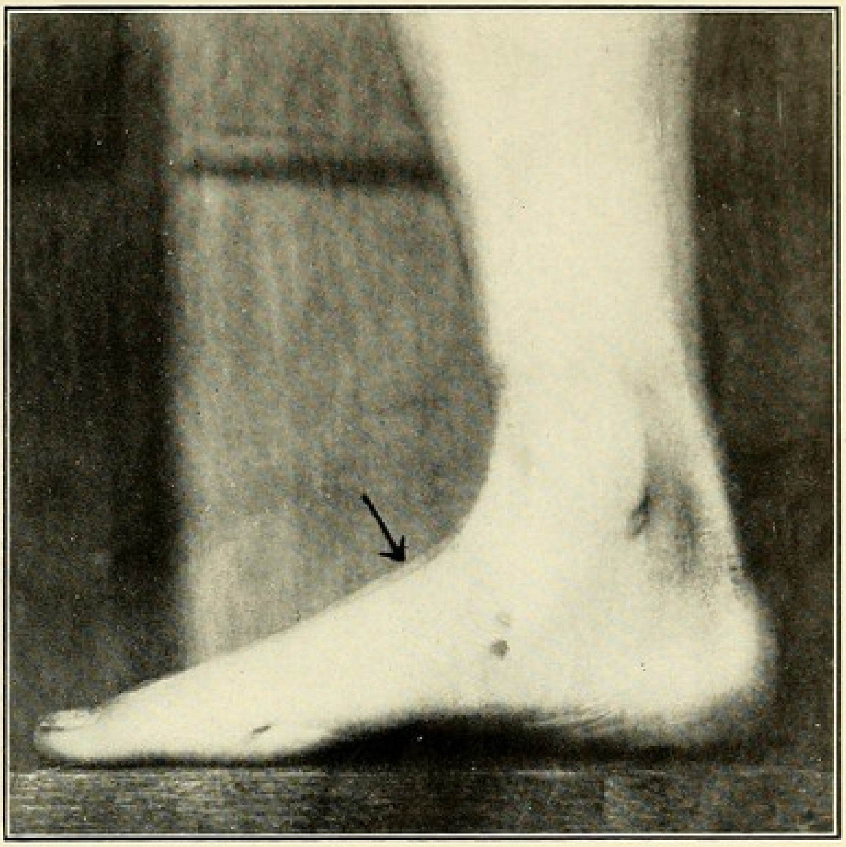

Fig. 12. Composite picture of same foot with and without weight-bearing. Points on skin not remarked for second photograph. Arrow indicates change in contour of dorsum.

because the mark only represents the position of a portion of the skin and not the bones. Be this as it may, the important thing is the change of contour on the dorsum as indicated by the arrow implying distinctly the alteration of shape of this part of the skeleton, thus explaining the descent of the scaphoid.

It is now evident that on selecting the scaphoid bone, we have taken a part of the arch very susceptible of change in weight-bearing because it not only deviates in a horizontal plane in connection with the rotation of the astragulus and tibia, but what is more important, it also lowers pretty much as the arch lowers because it is practically the keystone of the arch. From the above observations these facts become so evident that they require no further proof. Therefore, as the excursion of the scaphoid tubercle can be easily measured, it may be regarded as an index for estimating the height of the arch.

Conclusions

With respect to the scaphoid tubercle the weight-bearing foot differs from the non-weight-bearing foot according to a definite rule. This rule is that in weight-bearing the tubercle descends, both as measured from the line connecting the internal malleolus with the head of the first metatarsal and by the angle subtended with the vertical line dropped from the internal malleolus. (The horizontal excursion of the scaphoid bone also takes place according to rule, but as this part of the rule is complicated, it is of slight practical value.) This excursion of the scaphoid being a direct consequent of the so-called lowering of the arch, its selection as an index of this lowering seems justifiable.

PART II.

The Study of the Position of the Scaphoid Tubercle in One Hundred Young Male Adults

After having examined the anatomical data above described, it seemed wise to study a number of apparently healthy individuals with reference to these points.

The Individuals Chosen

The individuals chosen for the observation were young male adults from the evening gymnastic class of the Cleveland Y. M. C. A.* The men were taken as they came along and no questions were asked. It may be assumed that such a gymnasium would furnish a representative group of healthy young men who conduct the ordinary affairs of life.

The Method of Observing These One Hundred Cases

In order to make proper observations a standard method of estimation had to be applied. A wooden box was constructed, consisting of three sides—a base, a posterior side and a lateral side. Its dimensions were 12x12x5 (outside measurements). The box was placed on the seat of an ordinary chair (about 17 inches from the floor). The right foot was used. The subject stood on the floor with the left leg straight and the right knee bent (Fig. 13). Then the right foot was placed in the box, the calf just touching the upper edge of the box and the heel resting in the corner (Fig. 14). The weight of the body was therefore chiefly transmitted through the left leg. In this way the foot could be examined in a definite and uniform position without weight-bearing. The points marked were those landmarks earlier discussed—namely, the posterior inferior corner of the internal malleolus, the tubercle of the scaphoid and the lower tubercle on the head of the first metatarsal. These points were marked with very fine dots (finer than the dots in the cut). The following observations were made as to be noted in Fig. 15, which is an outline diagram of Fig. 14.

The distance of the posterior wall of the box to the internal malleolus .... *A-E*

---

*For the privilege of examining these cases, I am indebted to the kindness of Dr. Roberts, Physical Director of the gymnasium, and his assistant, Mr. Clulee.

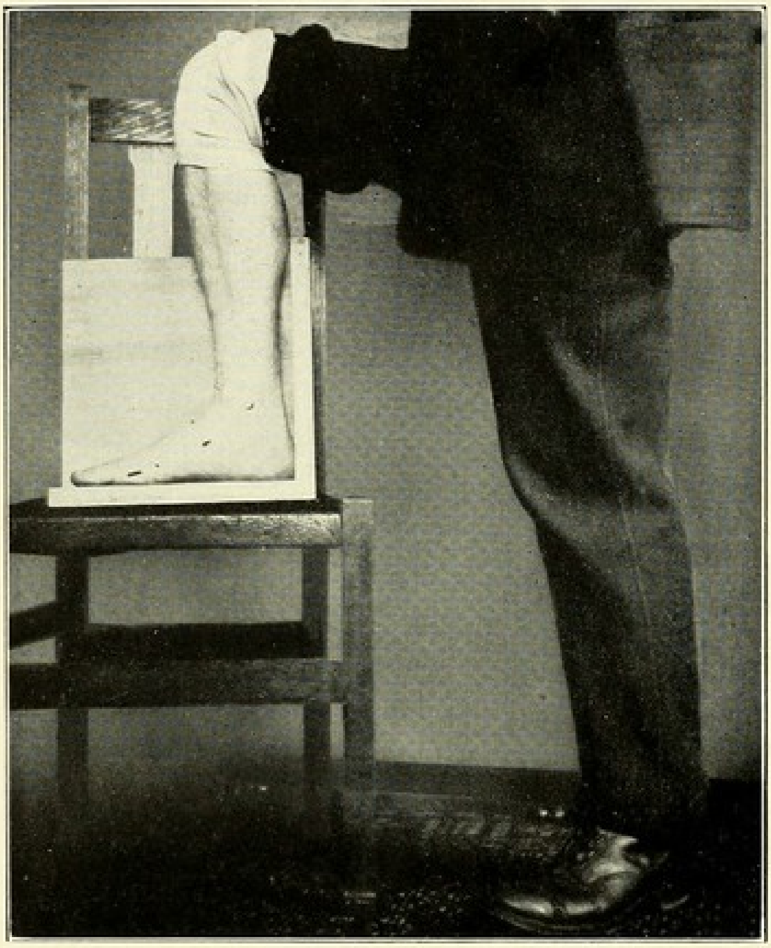

Fig. 13. Photograph of position in which the one hundred healthy individuals were measured.

The distance from the posterior wall of the box to the tubercle of the scaphoid .... *C-F*

The distance from the tubercle of scaphoid to the internal malleolus .... *A-C*

Referring to Fig. 15, let us construct a triangle by dropping a vertical *A-D* from the internal malleolus, *A*. Let us connect this vertical with the tubercle of the scaphoid *C*, by a horizontal line *C-D*. We have then constructed a right angle triangle of which we know the hypotenuse *A-C*. Now, knowing the dimensions *C-F* and *A-E*, then *C-D* can be obtained by simple subtraction, because *A-E* equals *D-F*. We now have two known sides of the triangle, the hypotenuse and one leg, *b* and *a*. The ratio of these two sides *b/a* equals sin. *A*. Knowing the sine of the angle the angle can be obtained.

(Instead of estimating the angle in every case I added up the dimensions of the sides of the triangle in the one hundred cases and estimated the average sine of the angle, then the angle itself was read from a table of natural values.)

Finally, the actual distance of the scaphoid tubercle from the line connecting the internal malleolus with the lower tubercle of the head of the first metatarsal was measured as follows: A thin transparent celluloid rule, provided with a scale (Fig. 16), was applied to the foot so that its upper edge coincided with the dots on the head of the first metatarsal and on the internal malleolus. Then the distance of the tubercle of the scaphoid from that edge could be read through the transparent rule by means of the scale (the corners of this rule were cut off so that they would not interfere with the sides of the box). This method of measuring the distance of the scaphoid tubercle is applicable to clinical work.

Summary of Results

The average age of the one hundred young men was found to be 21.6, the youngest being 17 and the oldest 34.

The average distance from the tubercle of the scaphoid to the internal malleolus (*A-C*) was 2.15.

The average horizontal distance of the tubercle of the scaphoid from the vertical line dropped from the internal malleolus (*C-D*) was 1.59.

Therefore the average sine of A was found to be .7390, which is the natural value of 47 degrees and 40 minutes.

In other words, the average angle subtended at the internal malleolus by the line connecting it with the tubercle of the scaphoid on the one hand and the vertical dropped from the internal malleolus on the other was found to be 47 degrees and 40 minutes.

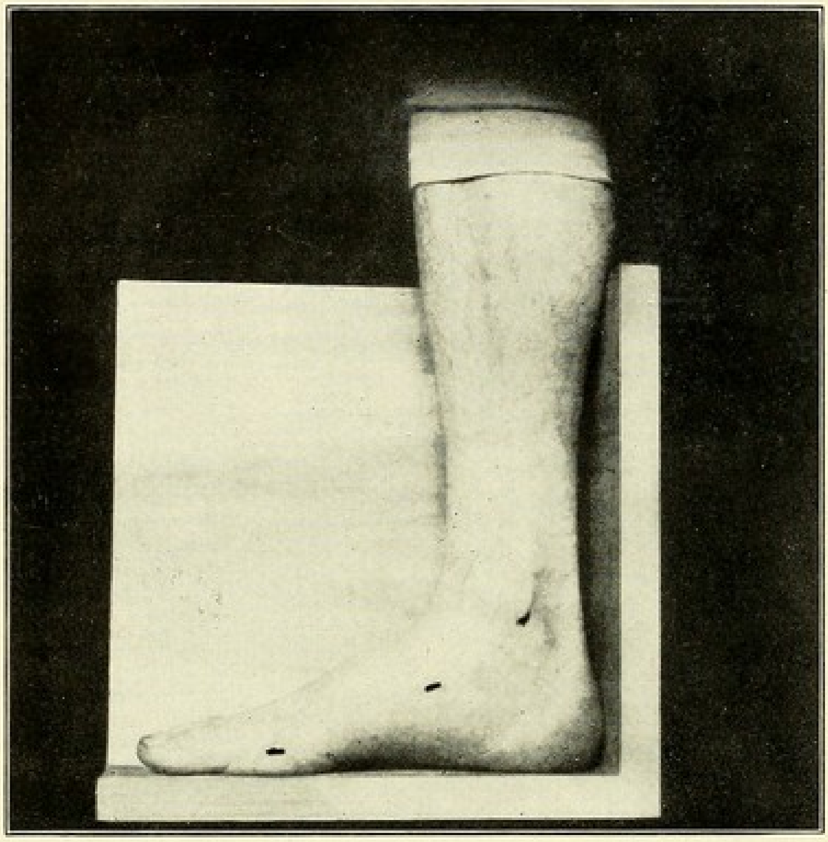

Fig. 14. Same showing especially the position of foot in the box.

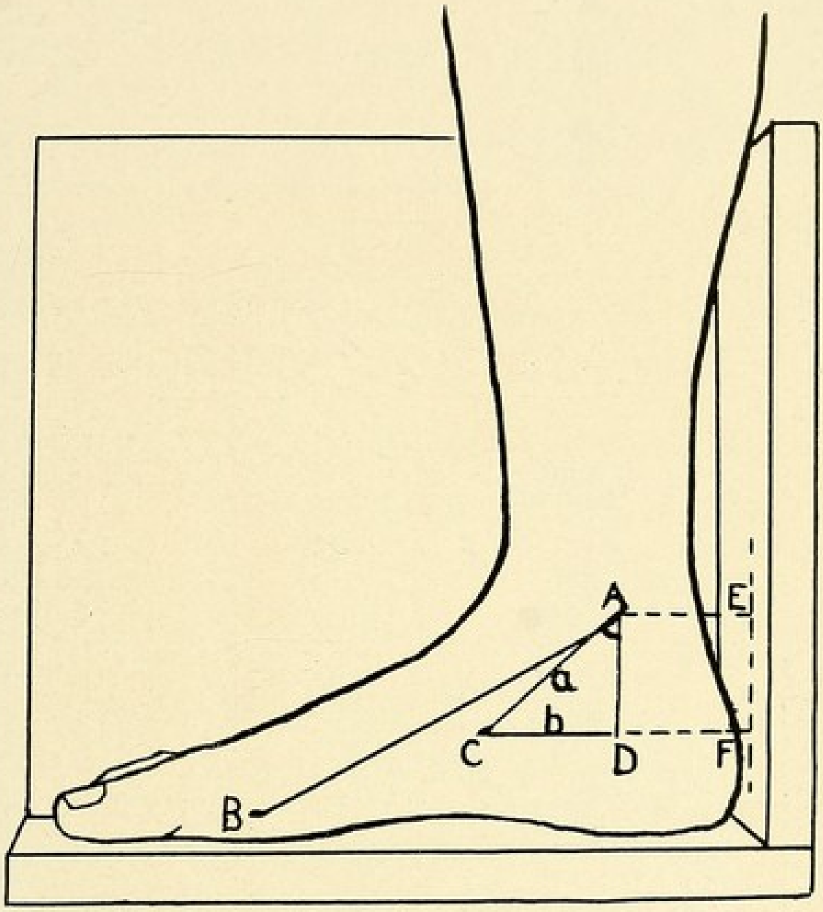

Fig. 15. Outline diagram from Fig. 14. Following measurements were made: The distance of *C* from the connecting line *A-B*; the distance *A-C*; the distances *A-E* and *C-F*; *C-F* minus *A-E* equals *C-D* because *A-E* equals *D-F*. Known sides of the triangle are therefore *A-C* and *C-D*. The ratio of these sides *b/a* equals the sine of the angle *C-A-D*.

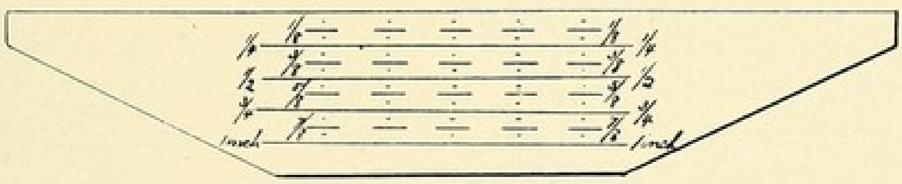

Fig. 16. Picture of transparent celluloid rule used for estimation of the scaphoid tubercle from the connecting line, reduced one-half.

The average distance of the tubercle of the scaphoid from the line connecting the internal malleolus with the lower tubercle of the head of the first metatarsal was found to be .49 inch.

These results, though interesting, are of less value than the results obtained by arranging the cases in a series graded according to the lowering of the scaphoid tubercle, and in the following table the cases were grouped in this fashion. Thus there were 2 cases in which the tubercle was not at all depressed, 2 cases where the tubercle was 1/16 inch below the line, 5 cases in which the tubercle was ⅛ inch below the line, etc.

Following is the table:

Distance of Scaphoid Tubercle from line connect. I. M. with head of 1st metatar.	No. of Cases	Distance from Scaph. Tubercle to I. M.	Horiz. distance of Tubercle from vert. line dropped from I. M.	Sine of angle formed by line connect. the Scaphoid with I. M. and the vert.	Angle	
Inch					Deg.	Min.
0	2	2.03125	1.71875	.8461	57	47
1/16	2	1.875	1.53125	.8166	54	45
⅛	5	2.0875	1.7	.8143	54	31
3/16	0					
¼	11	2.1136	1.6843	.7956	52	43
5/16	3	2.0625	1.6458	.7979	52	56
⅜	15	2.16666	1.6833	.7769	50	58
7/16	2	2.0625	1.5	.7272	46	39
½	19	2.2039	1.6052	.7283	46	45
9/16	3	2.1666	1.5625	.7212	46	9
⅝	18	2.125	1.5277	.7189	45	58
11/16	1	2.	1.4375	.7187	45	57
¾	15	2.3	1.5	.6521	40	42
13/16	0					
⅞	1	2.375	1.5	.6315	39	9
15/16	0					
1	3	2.5	1.666	.6666	41	48
Average		2.15	1.59	.7390	47	40

Glancing at this table it will be noted that there are only 9 cases where the tubercle is less than ¼ inch below the line and only 4 cases where it is more than ¾ inch below the line. Therefore, the great majority of cases show the tubercle depressed from ¼ inch to ¾ inch, which in itself is a large variation (½ inch). It is interesting to note that the angle of depression *C-A-D* varies practically as the actual distance of depression, although the estimation was based on a different set of measurements. Thus does one observation check off the other showing, as one would naturally expect (although it does not follow as a necessary consequent), that the lower the tubercle is with respect to the connecting line, the smaller the angle subtended from the vertical.

Discussion

Where there is large variation within normal limits conclusions based on only one hundred cases are of slight value, but the object of this observation was rather to determine the nature of the variation than the average extent. Attention is called to the fact that in the one hundred feet examined not all of them are necessarily well shaped, although the most of them are probably of good function. It must also be remembered that some of the feet are large and some of them are small. Other things being equal, a depression of the scaphoid would naturally be greater in a large foot than in a small one, but the limitations in the reasoning will be discussed presently, the chief points derived from the one hundred cases being the following conclusions:

There is a marked variation of the height of the arch as estimated by its index the tubercle of the scaphoid. This variation in a series of non-weight-bearing feet follows the same rule which applies to the individual foot with weight-bearing. In other words, the physiological variation (so far as the scaphoid tubercle is concerned) during weight-bearing function of the individual foot is a prototype of the anatomical variation of a group without weight-bearing.

So far, so good, but what has been gained? The conclusion just mentioned is one which has always been understood by the anatomists. It is simply a perhaps novel method of checking off the older observations; but the main question which is still open is, What is the normal foot? What kind of a foot are we to use on which we are to base the estimation of a deformity and in what should a diagnosis of a pathological foot consist? These and allied questions require careful discussion and this will be taken up separately in the next part.

PART III.

The Average Foot, the Normal Foot, the "Type" Foot and Flat Foot

The Average Foot

In the preceding part it was found that in one hundred cases, the average depression of the tubercle of the scaphoid from the connecting line was about ½ inch. As earlier stated, one hundred cases are too few on which to base a fair average. But even if thousands of cases had been used it would be fallacious to reason that all feet where the scaphoid tubercle is higher than the average are normal and all feet in which the tubercle is lower are abnormal, because the average is obtained just as much from the figures below as from the figures above. Moreover, the chief point shown in the hundred cases is that there is marked variation in the height of the scaphoid in apparently healthy feet. Consequently, as the average is based on that variation, it has no significance further than what the term indicates, representing simply an average of normal variation. Such an average can therefore not serve as a basis from which to estimate deformity.

The Normal Foot

The problem is not what is the average, but what is the extent of variation which we have a right to expect in the normal physiological foot? In attempting to answer this question we deal with a problem in classification, the same problem which necessarily presents itself in the study of any series of graded objects. Given a series of objects animate or inanimate, which differ from each other only to a slight extent, it is impossible to state just where we should draw the line dividing one group from another. If we take one hundred shades of color, say yellow, and arrange these shades in a graded series from a light yellow to a brown, the differences between the individual shades which are placed next to each other are so slight as not to be detectable. Yet if we compare the beginning with the end of the series, the difference is very striking. The same holds good in a given structure in the human body where the individuals are arranged in a series according to the variations in that particular structure. So, if we take a hundred feet and arrange them in a series with reference to a given point, such as the height of the scaphoid tubercle and attempt to base a classification on that variation, it is impossible to state where the normal variation ends and where a deformity begins, although the two extremes of the series are strikingly different. This, then is our problem and the difficulty in dividing the series is apparent; there is no natural dividing line in this arrangement which can be used to define the limits of normality. I did, to be sure, find that the great majority varied between ¼ and ¾ of an inch, yet the variation as estimated from the angle is so gradual from the highest to the lowest figure that I can lay no great stress on those figures as really defining the limits of normality: and if a hundred cases are too few, it is evident that if more had been used the gaps in the figures would be filled up and make the estimation even more difficult. Nevertheless, as will be seen, such an arrangement in series is of considerable importance even if the dividing line between the normal and pathological does not exist, because the natural gradation by this method will help to "organize our knowledge" on the subject.*

The "Type" Foot

It has been shown that the average foot is not a fair basis from which to estimate a deformity and that it is not possible to make a sharp distinction in the series for purposes of classification. What then is a sensible method for systematizing our views? The only course which remains is to make an artificial distinction between the normal and the abnormal, but an artificial distinction which is not only practical, but which has a reasonable theoretical basis. If we glance over the table of our one hundred cases and note the two extremes of the series—namely, the one extreme in which the tubercle is not depressed at all and the other extreme in which the tubercle is depressed one inch, there can be no two opinions as to which extreme approximates more closely the physiological foot. There can be no two opinions but that the foot in which the tubercle is near the connecting line is a better foot than the foot in which the tubercle is one inch below the line. The reasons for this are two-fold.

In the first place, as has been shown in Part I., the ordinary foot without weight-bearing has its tubercle higher than the same foot with weight-bearing. Now we certainly know that the foot without weight-bearing has a greater strength and greater efficiency than the foot with weight-bearing, because the power of the former is not yet expended.

*Referring to classification Herbert Spencer (Principles of Biology, Vol. II, Chap. XI), says: "It may be employed to facilitate identification or it may be employed to organize our knowledge."

On the other hand, the foot with weight-bearing is in a static position in which part of its power is already used; consequently, a weaker foot for further purposes than the foot which has not expended its power. It would therefore seem that other things being equal, the higher the scaphoid tubercle is, the greater the efficiency of the foot. Consequently, if we see a large number of feet all under the same static conditions, that is, all without weight-bearing, and find this variation of elevation of the scaphoid tubercle it must mean that those feet in the group with the highest scaphoid (of which the prototype in the individual is the non-weight-bearing foot), must approximate the highest functional extreme.

In the second place, it is apparent from what has come before and also from a number of healthy feet in which I studied the functional power (besides those used in the present investigation) that all those feet in which the tubercle ~~is~~ was high with respect to the connecting line, presented high arches and high insteps. It is, I admit, very seldom that the tubercle falls exactly on the line but quite a few fall very close to it, either above or below. All feet which showed this property, I have found to be extremely well formed. In addition to the elevated arch and high instep the proportions were extremely attractive and corresponded to what an art critic would certainly deem a beautiful foot. Why is it that the artist considers such a foot beautiful? Simply because as part of the body, it seems well adapted to carry on its functions. From his point of view, it is a more graceful thing than when it is not so well adapted, and if the place were appropriate, and if it were necessary to emphasize this phase of the subject, we might quote freely from such critics as Winkelmann, Bell, Walker, Ruskin, Flaxman and Hogarth and such thinkers as Bishop Berkley and David Hume. They all lay stress on the important point that beauty is necessarily proportionate to fitness. It is therefore plain that the commonly acknowledged beautiful foot is not acknowledged so because some men happened by chance to call the thing beautiful, but simply because it is the natural kind of foot which seems best fitted for its purpose. In short, therefore, from the point of view of the physiologist and from the point of view of the artist the foot with the high arch expresses strength and adaptability to function. Therefore, such a foot connoting strength and suggesting beauty, coming naturally at the extreme of a carefully selected series must have some significance. Why not select this as an arbitrary type, remembering, of course, the method by which our type was chosen. If we do this and bear in mind that it is only an artificial selection we have a fair starting point on which to base our estimation of deformity. (For a picture of a fairly good typical foot see Part II, Fig. 14.) Even if it is asserted that such a method is not completely scientific, it is at least reasonable, and more reasonable than having no method at all.

The Estimation of the Deformity of the Foot

Let me therefore suggest the following rule for estimation of deformity in the foot: Other things being equal, the foot is deformed in direct ratio to the deviation of the scaphoid tubercle from the line connecting the lower tubercle on the head of the first metatarsal with the lower posterior corner of the internal malleous. Now I am careful to state, "Other things being equal," because I believe that no estimation is of the slightest value without considering these other things. In any problem of this sort we have no right to take one physical sign by itself and make our estimation on that sign alone, we must always consider that point in relation to other clinical evidence. Take flat foot for example, we may have a number of considerations before us—namely, the abduction of the foot, the pronation of the ankle, the prominence of the internal contour, etc. All these things may be correlative to the lowering of the scaphoid tubercle; if they are, we are probably dealing with a pathological foot, but if they are not, we must consider the relative value of each piece of evidence depending in each case upon the individual circumstances of that case. I believe that the lowering of the arch is an important point in considering the deformity and that the best index for estimating the lowering of the arch is the scaphoid tubercle, but that is all the further I am willing to go. A lowered arch does not necessarily mean a deformity, it simply means a variation, but a badly lowered arch means deformity and what is bad, we must determine in the individual case. (It will be shown in Part IV that a foot may be very abnormal even if the tubercle is above the connecting line. The other physical signs in such a case are more pathognomonic than the height of the tubercle.)

The Consideration of the Size of the Foot

With regard to the application of the rule to individuals of different size and age, I believe that its language is sufficiently broad to cover all ordinary cases, providing that one uses reasonably good judgment in the individual. Of course an equal lowering of the scaphoid tubercle in two feet, one large and the other small would necessarily be of greater significance in the latter. Thus a depression of the tubercle of ¾ of an inch in a six year old child is of greater consequence than an equal depression in an adult.*

The Definition of Flat Foot

It has been shown that the variation within normal limits in a group of feet is similar to the normal change in the individual foot with weight-bearing. From this it was naturally inferred that the more depressed a non-weight-bearing foot is, the less it is able to change with weight-bearing, and consequently that such a foot has lost part of its latent strength. Reasoning from this I showed that a sensible classification could be made if we regarded such a foot as typical of highest function and beauty which most closely resembled the healthy non-weight-bearing foot—namely, one where the tubercle was close to the connecting line, providing no other pathological sign coexisted. Flat foot may therefore be defined as a position of the bones, resembling that of physiological weight-bearing, which does not disappear when weight is removed, the amount of flattening being in the ratio of the lowering of the scaphoid tubercle.

From the above, it is clear that if we are to take such a foot as typical of beauty and function as has been described, then we can consider few feet well formed and that we must regard the great majority of human feet as flat. This is true, but if we regard them in this manner we must speak of the great majority as physiologically flat, or perhaps better, as anthropologically flat. They are only flat as based on the estimation from a type, the type being based on the consideration of the highest function and beauty, and consequently of relatively rare occurrence. It therefore becomes clear that if only a few feet are best adapted to carry on their function from this point of view and ~~that~~ if the great majority of feet are more or less deficient as compared with the high standard that has been set, the diagnosis of flat foot can have little practical weight unless it connotes bad function and pain. If we consider an individual case and note that it is moderately flat, it does not mean that the foot is unable to carry on its function, it simply means that it might have been better, if it were built more according to the type. If, however, there are signs

---

*The ratio of depression according to size:

If we wish to be extremely accurate in considering the size of the foot, we might use a ratio of depression of the tubercle instead of the actual distance. The ratio of depression is the fraction in which the numerator is the distance of the scaphoid tubercle from the connecting line (connecting the posterior inferior corner of the I. M. with the lower tubercle on the head of the first metatarsal) and the denominator, the length of the connecting line itself. In a certain case, for example, the distance of the tubercle from the connecting line might be ¼ inch and the length of the connecting line, 5 inches. Therefore the ratio would be .25/5.0 or .05. Such extreme accuracy is, however, unnecessary.

of disability accompanying the signs of depression of the arch such as pain and muscular spasm then our diagnosis is established. (We have a similar problem in the consideration of the physical signs of other parts of the body, for example in the consideration of hypertrophy of the heart. Hypertrophy of the heart may occur in apparently healthy individuals and may not in itself cause symptoms, but once urge that heart to carry on functions beyond the power of compensation and it loses its resistance to future dilatation much more readily than the heart which has not previously been hypertrophied.)

From what has come before, it is evident that the use of the bony landmarks of the foot as an aid to diagnosis must be made with the greatest caution. When we consider the extreme variation in the normal, when we consider the artificial manner of selecting one kind of foot as typical, we feel some hesitation as to advocating the measure as an aid to diagnosis at all. Nevertheless, if the observer is careful, he may in many cases derive some value from such a method. But if he uses it, he can never lose sight of the value of the other points in diagnosis, he simply has one more physical sign to use as evidence. If he goes further than this and bases his whole diagnosis on that one sign he is liable to fall into grave error.

PART IV.

Miscellaneous Examples Illustrating the Manner of Interpreting the Deformities of the Foot with Reference to the Considerations Earlier Set Forth and Certain Sources of Error

If one follows such a suggestion as has been made, namely, that of estimating the variation and deformity of a foot from an artificial type, it is necessary that the estimation should rest upon a standard method of examining the patient. Such a method has already been shown in Part II—namely, that of using a box of given dimensions, placing it at a given height and using such a transparent ruler as earlier described. The only measure necessary is that of the distance of the tubercle to the connecting line. Measurement of the angle is not required, because its size is correlative to the depression of the tubercle.

Simple as such apparatus is, even these things may be omitted for ordinary work. A method that I suggest is to let the patient stand on his one foot and to have him place the other foot on an ordinary chair with the inner side of the foot facing the examiner. The weight of the body must be transmitted through the leg which is resting on the floor. Then the landmarks may be marked with a skin pencil (a good skin pencil is a grease paint pencil such as women use for painting eyebrows) and then a simple ruler or piece of string may be applied to the points marked on the internal malleolus and the head of the first metatarsal. From this the distance of the tubercle can easily be measured. This is all the accuracy that is necessary and requires no further apparatus. If such a box is used as has been described, it may be used both for the left and for the right foot simply by letting the patient stand on his other foot and by inverting the box. This being the method the simple rule is: Other things being equal, the foot is deformed according to the deviation of the scaphoid tubercle from the line connecting the internal malleolus with the lower tubercle on the head of the first metatarsal. In order to illustrate the practical applicability thereof, let me cite a few cases.

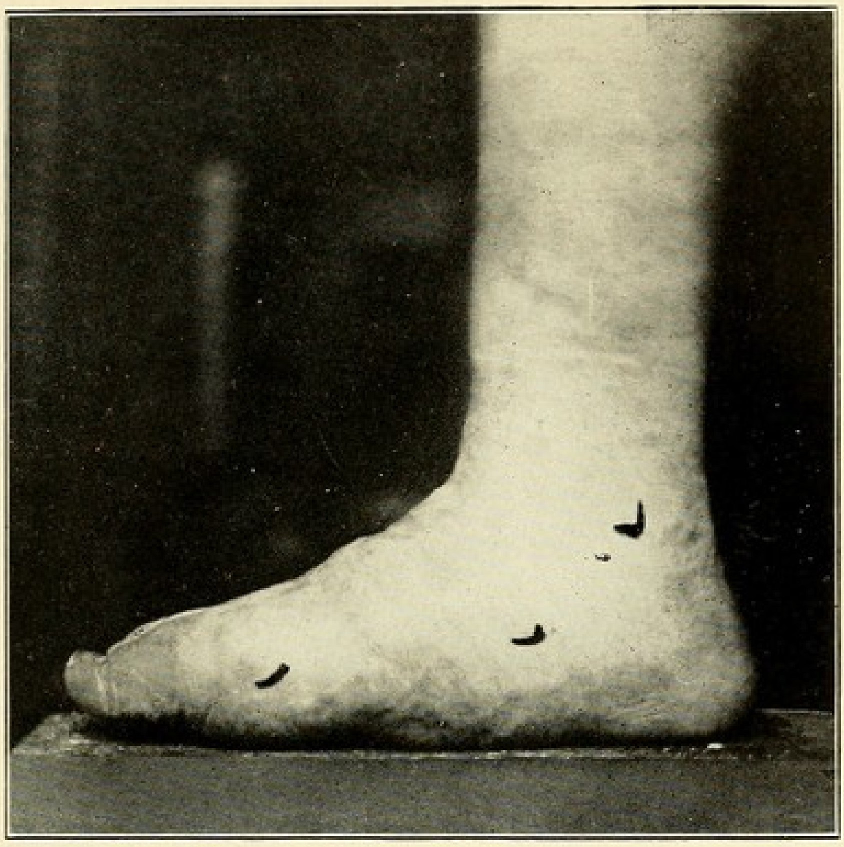

Fig. 17. Case III. Osteo-sarcoma. Note complete obliteration of arch out of proportion to amount of lowering of the scaphoid tubercle.

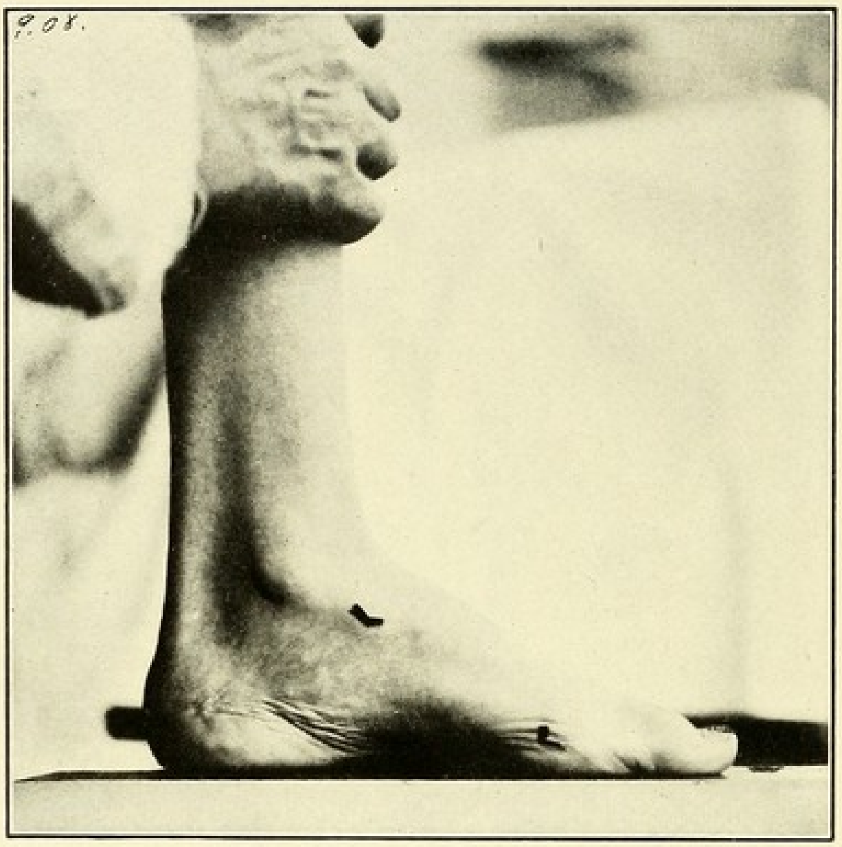

Fig. 18. Case V. Claw foot (non-weight-bearing) from infantile paralysis. Note elevation of scaphoid tubercle.

I. Feet Showing Assymmetry with Reference to the Elevation of the Scaphoid Tubercle

Tubercle on Unhealthy Side Lower Than on Healthy Side:

Case I. U. B. Age 22. Occupation a barber. Was first seen at my office Oct. 16, 1908; 3 months ago patient began to have trouble in his right foot after previous good health. This trouble consisting in disability, pain and swelling has grown steadily worse. There has been no history of injury. The left foot has not bothered him and has not become swollen.

Examination showed the patient limping on his right foot which was in a position of abduction. There was swelling in the region of the internal malleolus. The skin was somewhat clammy to the touch and the region of the swelling was bluish white. Marked stiffness in inversion.

Examination of the relation of the tubercle of the scaphoid to the line connecting the internal malleolus with the head of the first matatarsal showed it to be ⅞ inch below.

The left foot examined and the tubercle found to be ⅝ inch below the connecting line. There was no swelling and no signs of spasm in that foot.

It will therefore be seen that the lowering of the tubercle in this case as compared with that on the other side is correlative to other signs but the amount of lowering is of considerable help, showing the anatomic difference between the diseased and the other foot. The diagnosis here is acute flat foot (perhaps infectious) and irritated by occupation.

Case II. E. B. A business man. Age 24. This patient was first seen by me Sept. 21, 1908. The history was that several weeks ago he strained his feet playing tennis, before which time he had had no trouble amounting to much. The present trouble was pain in the right foot, especially on use. The pain was chiefly referred to the arch and the ball of the foot.

Examination of this patient's feet showed them well developed without spasm, without swelling and without calluses. No redness and no tenderness. In the right, however, the tubercle was found to be ⅞ inch below the connecting line and on the left foot, ⅝ inch below. The inner contour of the right foot bulges somewhat more than that of the left.

It is then apparent in this foot that if the measurement was accurately made, a slight deformity was present as compared with the other foot, and it is plain that the plantar ligaments must have been weakened and stretched.

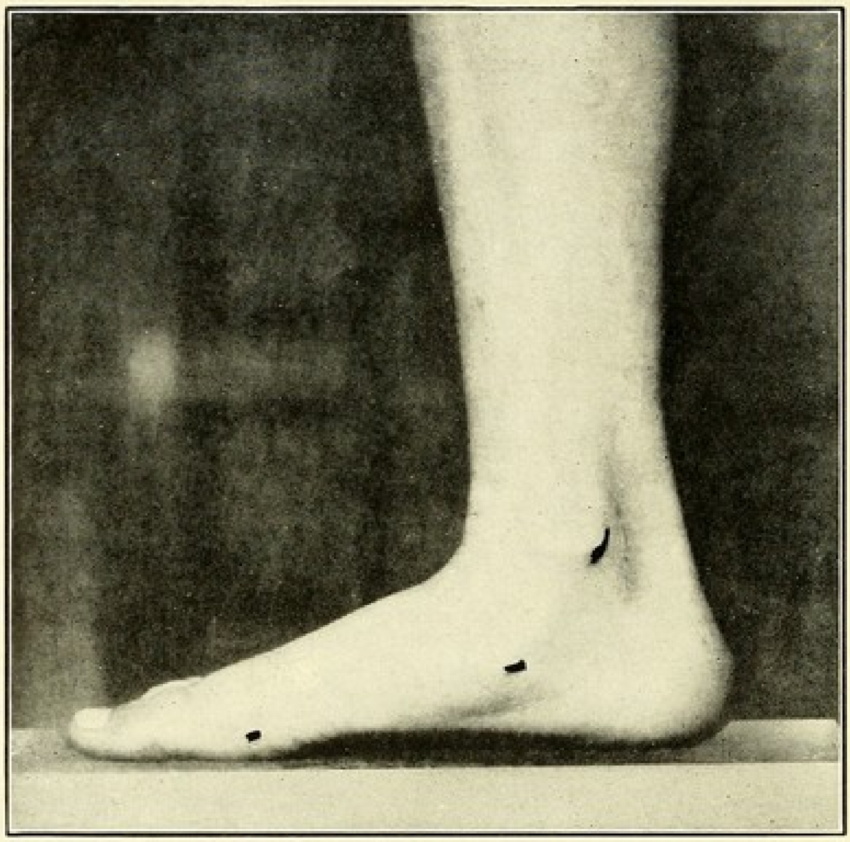

Fig. 19. Case VI. Flaccid flat foot of moderate degree (non-weight-bearing). Tubercle ¾ inch below connecting line. Age 10 years.

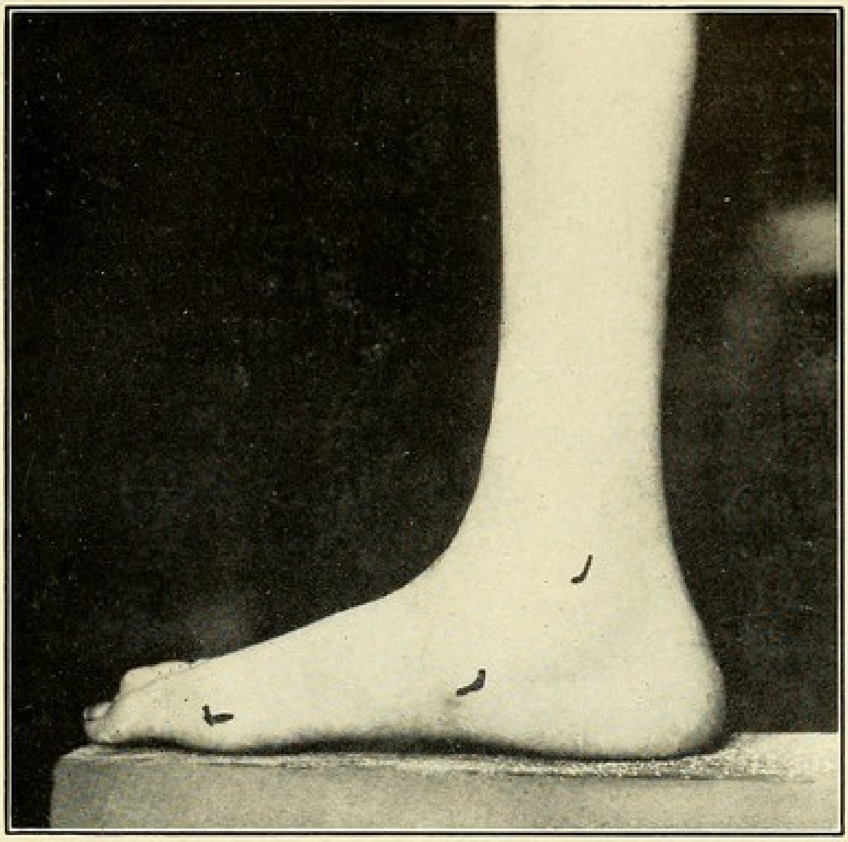

Fig. 20. Case VII. Rigid flat foot marked (non-weight-bearing), Tubercle 1 inch below the connecting line.

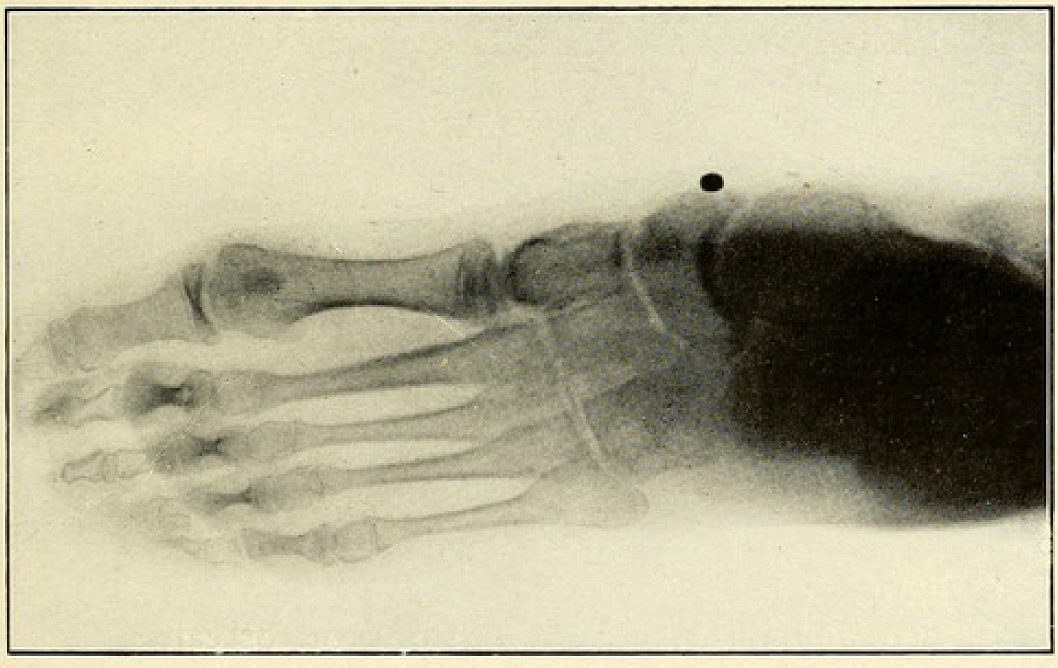

Fig. 21. Roentgen picture of Case VII. Metal mark shows position of the scaphoid tubercle.

Case III. F. F. Age 39. Laborer. This case was first seen at Lakeside Dispensary, Aug. 10, 1908. The history was that one year ago the right foot began to swell and he noticed his arch lowering. The swelling got worse and the arch grew flat. He had some pain and limped. He was treated for flat foot.

Examination of the foot (Fig. 17) showed marked swelling including the whole tarsus from the ankle to the metatarsal region. The foot seemed completely flat. The bony landmarks could not be distinctly felt. What seemed to be the tubercle of the scaphoid was ½ inch below the connecting line, that on the other foot was about ¼ inch below the connecting line.

Here we had an apparent incongruity of facts. We had bulging of contour, marked flattening of the arch, marked swelling; whereas the tubercle, which if it were a flat foot, should have been markedly depressed, was only ½ inch below the line. Therefore a Roentgen picture was taken and showed plainly that a mass of bone and new tissue had formed including the whole tarsal region. The diagnosis of osteo-sarcoma was made. The seemingly contradictary evidence was the reason for taking the Roentgen picture, because if the arch were as flat as it seemed to be from inspection, the tubercle should have been much lower.

Tubercle on Unhealthy Side Higher Than on Healthy Side

Case IV. M. G. This patient, a servant, about 35 years old, was first seen at Lakeside Dispensary, Oct. 19, 1908. The history was that last April, she sustained a fall of 8 feet landing on the sole of the right foot. The foot became swollen and has disabled her since. She had been treated at another Hospital by having the foot strapped. There had been some relief. The pain was chiefly on the outer side of the foot.

Examination showed the right foot permitting almost no motion in inversion but fairly good motion in dorsal and plantar flexion. The restriction of motion seemed to be chiefly due to mechanical bony interference rather than spasm. Some induration was to be felt under the malleoli and on the dorsum near the cuboid.

Examination of the tubercle of the scaphoid showed that on the affected side, the right, it was ⅛ inch below the connecting line and on the good side ⅜ inch below.

A Roentgen picture was taken and showed a lesion of the calcaneo-astragular joint and signs of impaction in the astragulus with fusion of the calcaneo-cuboid joint. It seemed that in the original injury the astragulus had been crushed into the os calcis, indirectly injuring the cuboid. This anatomical lesion would explain very weil the relative elevation of the tubercle of the scaphoid on the affected

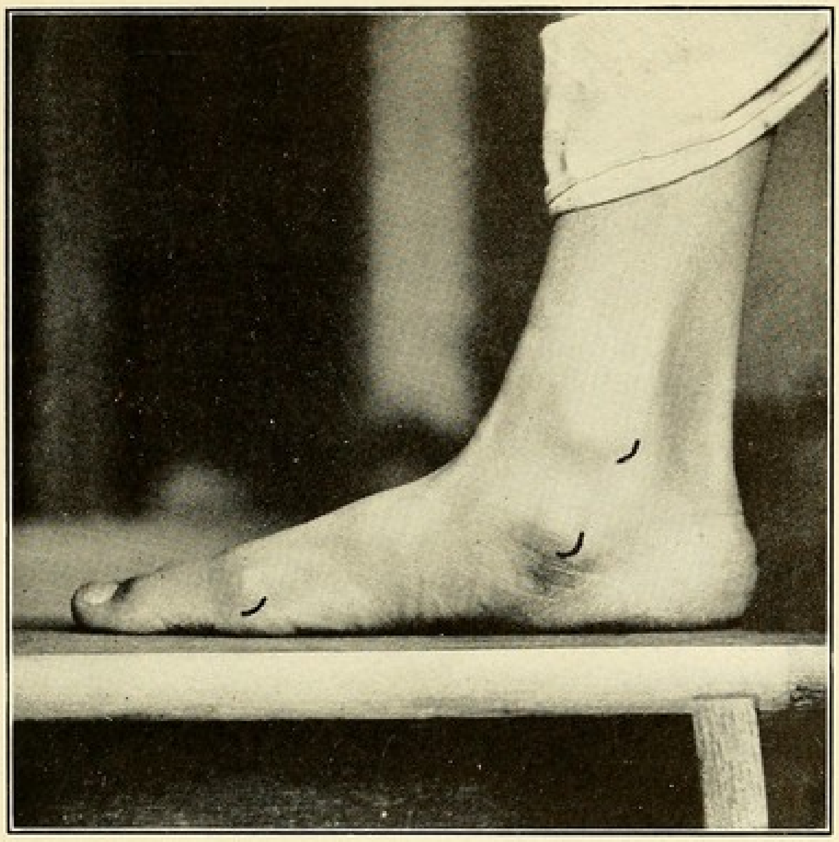

Fig. 22. Case VIII. Marked flat foot. In this the mid-point indicates not the tubercle of the scaphoid but the head of the astragulus.

side because the malleoli had been lowered by the crushing of the joint beneath, whereas the position of the scaphoid had not become altered.

Case V. M. K. (Lakeside Dispensary). This patient, a school boy about 12 years old, was taken with infantile paralysis when a child, causing the present deformities.

Examination showed the left foot in a position as seen in the cut (Fig. 18)—namely, with the dorsum very high, the toes markedly contracted, the dorsal flexors of the toes prominent, the arch extremely high, the ball of the big toe prominent and the plantar fascia very tense. This kind of a foot is immediately recognized as a claw foot or non-deforming club foot. The other foot was in equinus so that it could not be used as a healthy foot for comparison.

Measurement of the scaphoid tubercle on the claw foot showed it to be ¼ inch above the connecting line, indicating the extreme elevation of the arch.

The first three cases hardly require any more words than to call attention to the fact that the measurement of the relative depression of the scaphoid tubercle is of considerable help when making comparison with the other foot. In case IV. the reasoning from these landmarks should have carried with it a diagnosis of fracture even without a Roentgen picture. In case V, the tubercle is actually elevated above the connecting line. It might be thought that according to our rule in which it is stated that the foot is deformed according to the deviation of the scaphoid tubercle from the connecting line that there would be confusion in distinguishing such a foot from the "type" foot, but this case brings out the point on which I laid especial stress—namely, that other things have to be equal. Here to be sure, the scaphoid tubercle is markedly elevated and would by itself suggest beauty and function, but the cause of the high elevation—viz: the paralysis (namely, paralysis of the interossei) has also brought about coincidental deformities, i. e., contractures. In other words, other things are not equal. There are pathological signs which make up for the height of the arch, and the co-existence of these other pathological signs and symptoms would prevent us from calling such a foot a "type" foot.

II. Symmetrical Depression of the Scaphoid Tubercle

These are the most common group of cases and of course include the ordinary flat foot.

Case VI. F. M. 11 years old. This patient was seen at Lakeside Dispensary, March 15, 1908. Complained of pain in both feet for some time. No swelling noticed.

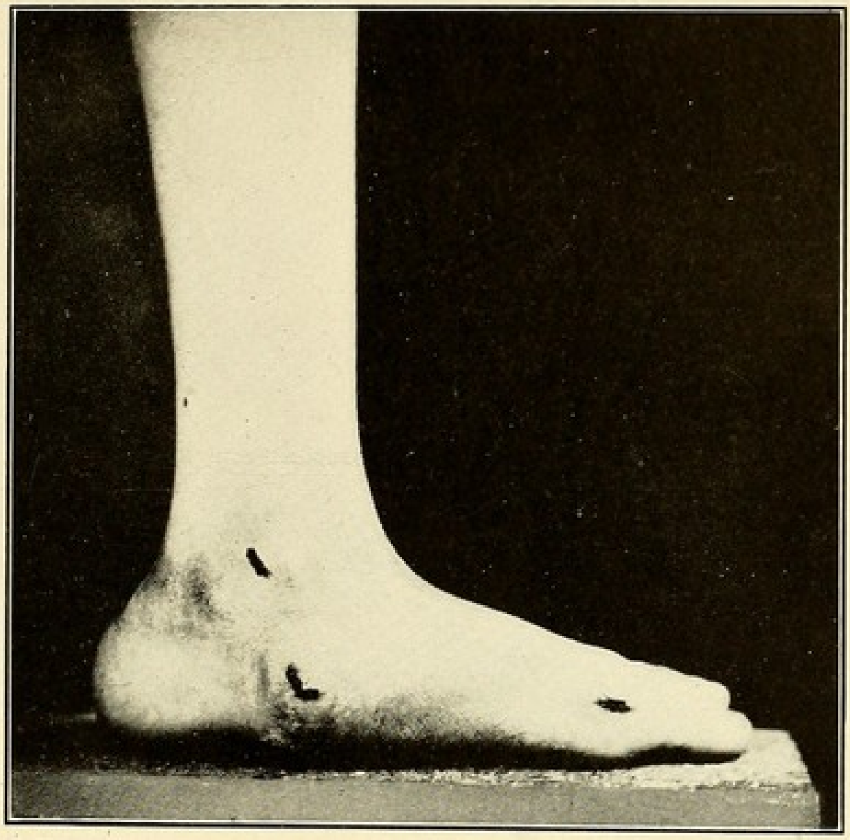

Fig. 23. Case IX. Severe valgus following infantile paralysis. Mid-point represents not the tubercle of the scaphoid but the head of the astragulus.

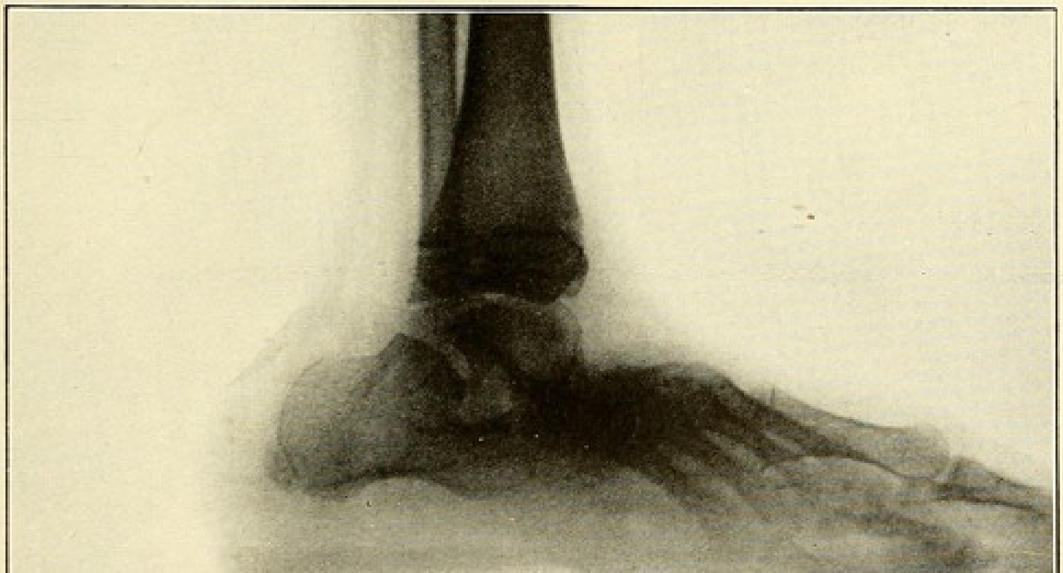

Fig. 24. Roentgen picture of the same case, showing the marked change in the position of the astragulus, explaining unusual displacement of scaphoid.

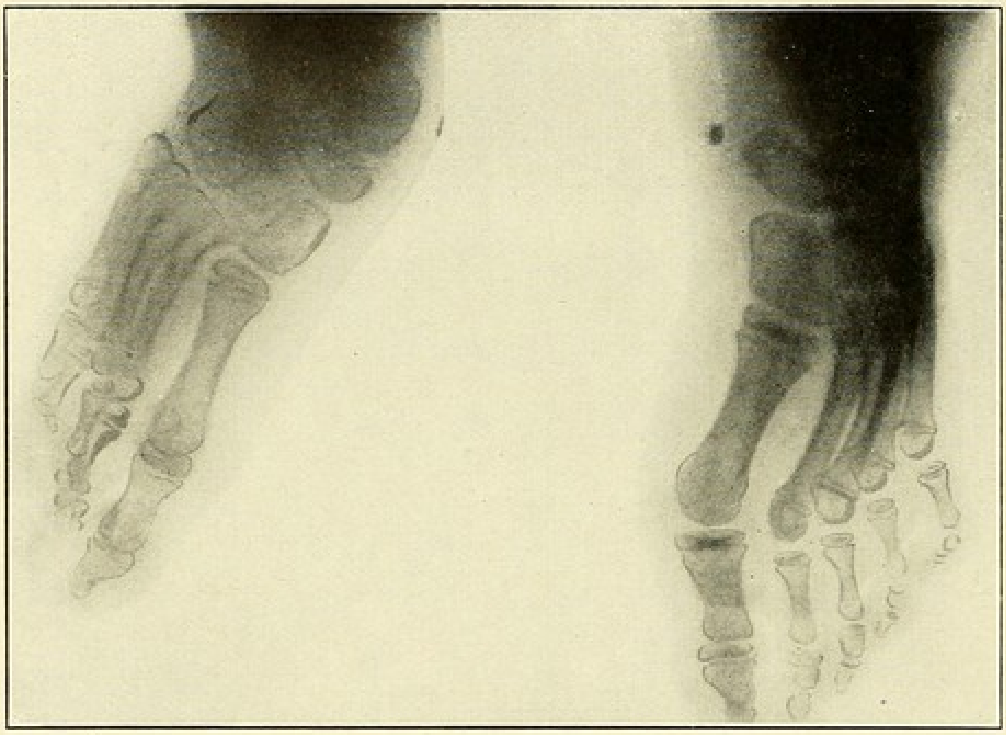

Fig. 25. Roentgen picture of same case, comparing the two feet and showing that the bony prominence in the one is due to the astragulus and in the other to the scaphoid.

Examination (Fig. 19) showed the feet long, lanky and abducted. There was no stiffness and the arch apparently low. Tubercle of the scaphoid about ¾ inch below the connecting line on each foot without weight-bearing. Diagnosis: Moderate flaccid flat foot.

Case VII. W. H. Five years ago this boy began to limp. His ankles and wrists became swollen. Since then he has stumped about with his feet in the same condition. Much pain and swelling.

Examination (Fig. 20) showed marked valgus, abduction and pronation at the ankles which are swollen and bluish. On palpation the tubercles of the scaphoid were found to be very low, about 1 inch below the connecting line. Peroneal tendons tight. Stiffness in all directions. Patient toed out when he walked. In this case we placed a metal mark on the tubercle and took a Roentgen picture which proved that this prominent point on the contour was really the tubercle (Fig. 21). Diagnosis: Extreme rigid flat foot.

Both these cases illustrate common types of flat foot and the relative significance of the depression of the scaphoid tubercle as suggesting the severity of the deformity.

Sources of Error

The sources of error are chiefly in identifying the wrong landmark for the tubercle of the scaphoid bone. The chief point which is liable to confuse us is the head of the astragulus. In the cut (Fig. 22) of a severe flat foot (Case VIII) we have marked the head of the astragulus suggesting the danger of being deluded by the point. The tubercle is anterior to it. Another case (Case IX) is that of a severe valgus from infantile paralysis (Fig. 23). Here a prominent point which might be taken for the tubercle was marked with a piece of metal and a Roentgen picture was made showing what bone is marked. It is plain that the astragulus and not the scaphoid caused the prominence under the skin. The reason for this is apparent in the Roentgen pictures (Figs. 24 and 25). The paralysis has been so extreme that a complete outward dislocation of the scaphoid has taken place so that it is not even palpable. This last case is an exceptional case and the deformity is so apparent that the diagnosis is perfectly plain. In fact for any case where flat foot is extreme as from bad injury, paralysis or disease, no geometric measure is necessary. It is rather in such cases as cited above (Cases I to VII) that the method has its chief value.