

Further studies upon the arch of the foot in infancy and childhood / by John Dane.

Contributors

Dane, John.
Royal College of Surgeons of England

Publication/Creation

[Philadelphia] : [publisher not identified], 1898.

Persistent URL

<https://wellcomecollection.org/works/ck62pfyw>

Provider

Royal College of Surgeons

License and attribution

This material has been provided by This material has been provided by The Royal College of Surgeons of England. The original may be consulted at The Royal College of Surgeons of England. where the originals may be consulted. This work has been identified as being free of known restrictions under copyright law, including all related and neighbouring rights and is being made available under the Creative Commons, Public Domain Mark.

You can copy, modify, distribute and perform the work, even for commercial purposes, without asking permission.



Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
<https://wellcomecollection.org>

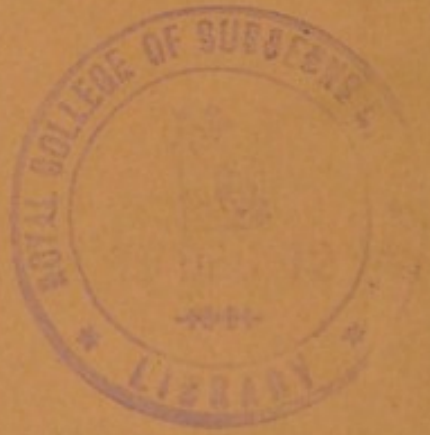
To 1833.

6.

FURTHER STUDIES UPON THE ARCH OF THE FOOT
IN INFANCY AND CHILDHOOD.

BY

JOHN DANE, M.D.,
BOSTON.



FROM THE TRANSACTIONS OF THE
AMERICAN ORTHOPEDIC ASSOCIATION.

1898.



[Reprint from "Transactions of the American Orthopedic Association, vol. xi., 1898.]

A NEWLY MODIFIED SPLINT FOR KNOCK-KNEE AND BOW-LEG,

BY JOHN DANE, M.D., BOSTON.

The number of forms of apparatus for the correction of bow-legs and knock-knees is already so large that in presenting a new one it is necessary to state, as quickly and as plainly as possible, what advantages can be claimed for it. This can possibly best be done by considering for a moment some of the difficulties found in applying the splints now in common use. Such splints consist essentially of a single rigid upright running from the sole of the foot to the upper part of the thigh. To this the leg is drawn inward or outward, as the case requires, by a series of straps and buckles. This description applies equally well to the braces made by the instrument makers; for though they are provided with two uprights, one on each side of the leg, but one can be used against which to pull.

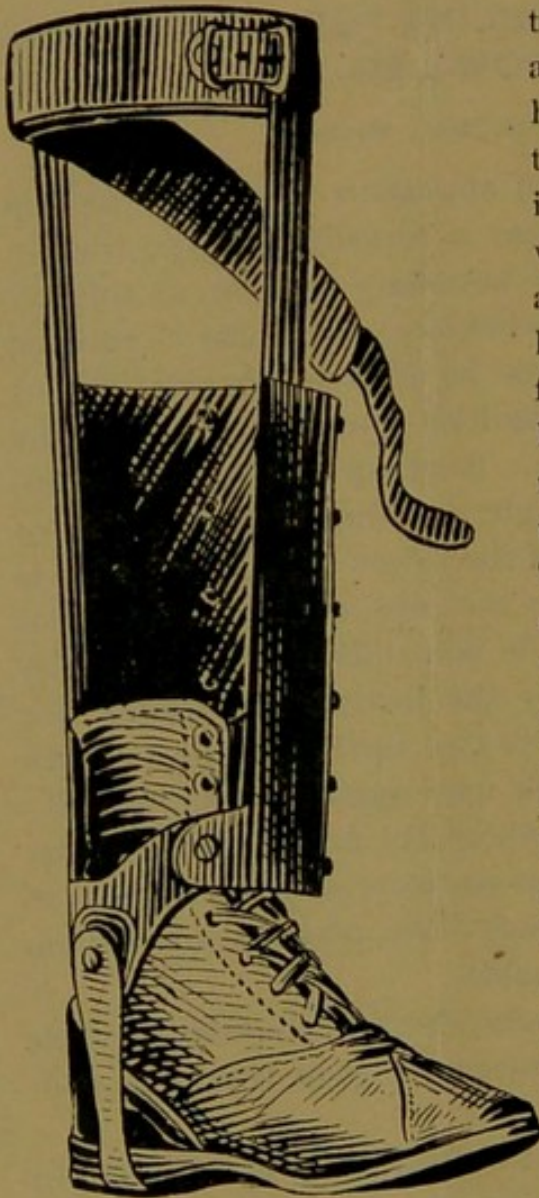
The disadvantages of such braces are of three kinds:

(1) The points of counter-pressure above are often so small that they cut into the soft parts, which renders them both insecure and uncomfortable.

(2) The straps and leathers which necessarily encircle almost the entire leg must cause a series of band-like constrictions.

(3) It is very difficult with them to prevent a slight flexion of the knee. Such a bending having taken place, the limb can at once be made to lie parallel with the splint without the least pressure from the straps, thus doing away with all the correction forces that should be directed against the deformity.

Turning now to the new splint, — much more easily understood from the picture (fig. 1) than from any printed



description, — it will be seen that the two light uprights are placed in front and behind the leg instead of on the sides. In this way flexion of the knee is easily prevented. These two uprights are joined together by two half circles of thin steel three fourths of an inch wide, the lower one at the level of the malleoli, the upper as high up the thigh as possible. These give a wide base for counter pressure and are very comfortable. Practically it was found best to curve the lower one upward a little in front (as is shown in the figure) to allow of dorsal flexion of the foot without pressure against the iron. The splint is united to the shoe by means of a flat piece of steel fastened to the lower band by a single pivot joint, and extending down to the sole, where it is

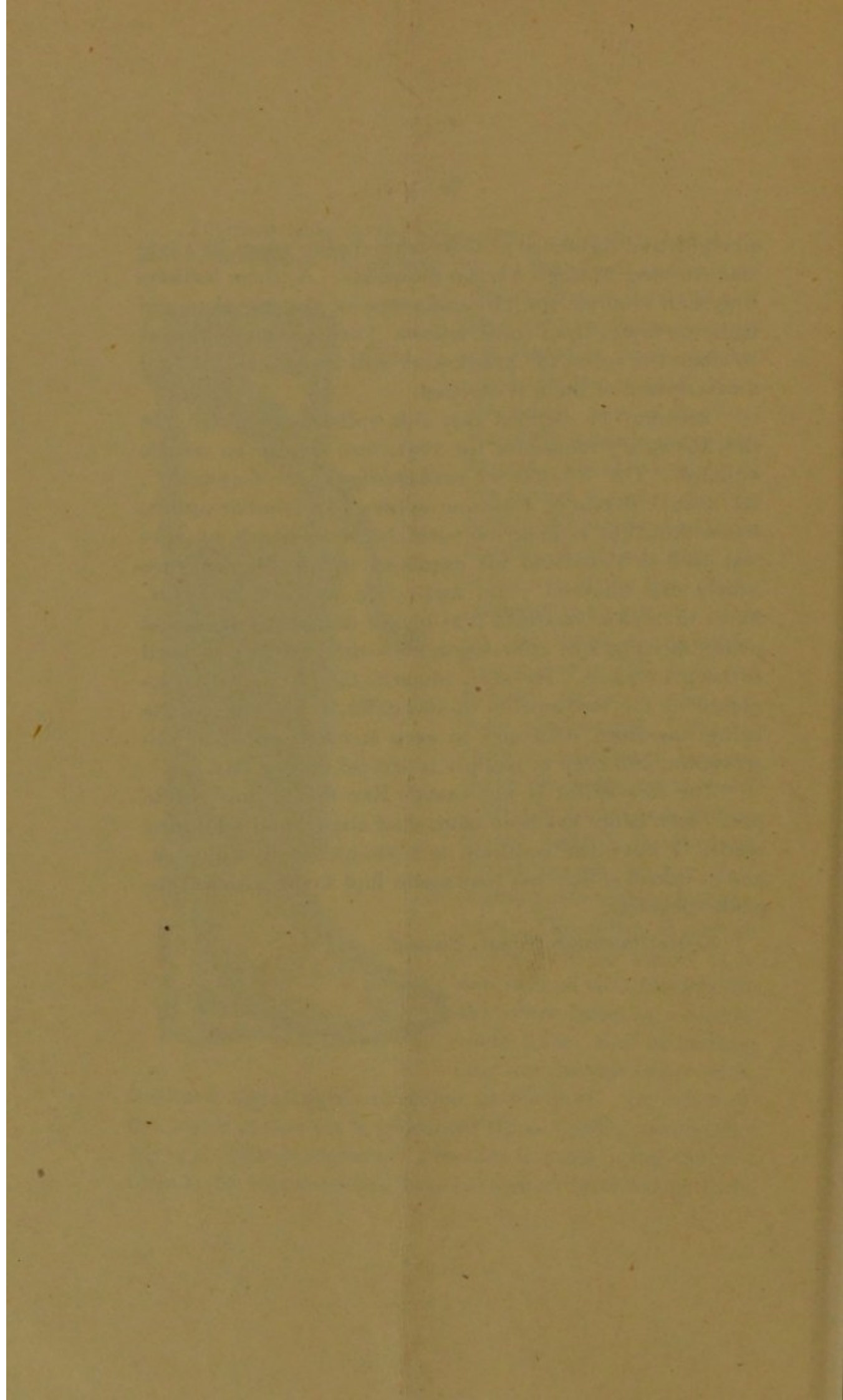
bent at a right angle and nailed to the heel. In this way the whole apparatus is prevented from slipping around the leg in a circular manner. Pressure is made upon the deformity by means of two flaps of leather fastened to each


upright, and tightened at their overlapping edges by a lace line running through a series of eyelets. As these leathers only half encircle the circumference of the leg they can cause no injury from constriction. The necessary changes to adapt the splint for knock-knee will be so evident that a description of them is omitted.

It cannot be claimed that this splint is original. In the *Révue d'Orthopédie* for 1892, vol. iii., in an article entitled "*Du Traitement orthopédique des Cagneux*", Dr. Henri Martin of Lusanne speaks of a similar splint, but without the connection with the shoe, which he says was used by Venel and his pupils in treating knock-knee nearly one hundred years ago. He appears, however, never to have so modified it as to use it for bow-legs, and owing to its lack of connection with the shoe it was hard to keep in place. He says, himself, that it is easily displaced by the movements of the child, and speaks of its being, therefore, necessary to keep it under constant observation, and even to reapply it several times a day.

The new splint is not exactly like this in any single part; each detail has been somewhat altered and additions made. I hope the resultant is a simple, easily adjusted, and powerful splint that may again find favor with orthopedic surgeons.

29 Marlborough Street, Boston.





FURTHER STUDIES UPON THE ARCH OF THE FOOT IN INFANCY AND CHILDHOOD.

BY JOHN DANE, M.D.,

BOSTON.

WHEN one examines the foot of a healthy infant during the first two years or so of life, he cannot fail of being impressed with certain rather striking differences that it presents when compared with the foot of a normal adult or older child. The whole foot seems shorter and much thicker; moreover, the sole appears perfectly flat. This latter fact is still further confirmed if we have the child run over a board floor with wet feet, or stand upon the glass top of one of our new examination-tables. The imprint is unquestionably that of a flat foot. This is not, however, true of all children's feet; in some of the thin, ill-nourished ones we find the foot apparently as well formed and arched as in later life. Again, in rarer cases, we see the whole foot pronated at the ankle-joint and the bones as much displaced as in any case of pes valgus in the adult. But both of these latter classes are rare; most infant feet are as first described. This superficial resemblance to the true flat-foot—and I hope to be able to prove to you later that it is only superficial—has found its way into literature unchallenged, as the following quotations from the leading text-books on orthopedics will quickly show:

Taking those in German first, we find that Shreiber,¹ in speaking of "pes planus," says that "the foot of the new-born infant is always flat, and we may consider pes planus the outcome of absence of that phase in growth which leads to the arching of the foot." Hoffa,² in his *Lehrbuch*, says: "It now remains for us in a few words to speak of the so-called 'plattfuss.' This plattfuss, the 'pes planus,' is characterized by the absence of the outer foot-arch."

¹ Shreiber: "General Orthopedics." Translated in Wood's Medical Monographs, p. 257.

² *Lehrbuch der Orthopädischen Chirurgie.* Dr. Albert Hoffa. 1st Auflage, 1891, Seite 691.

It would seem, however, that he refers to the inner arch as well, for a few lines further on he describes it as having the "tuberosity of the scaphoid rest upon the underlying base and forming the lowest point of the inner edge of the foot." He goes on to say that "The foot of the new-born is always flat. First, at an early stage of life, during the exercise of function, the bones of the outer row are built up into an arch through the process of growth. The plattefuss is, therefore, to be regarded as a failure in that process of growth; accordingly, in a way, as an arrest of development." Lorenz,¹ in his wonderful monograph, looks at it in the same way, saying: "We must, therefore, regard pes planus as the result of a failure in the process of growth through which the child's foot, always a perfectly flat foot, through its function, and even in spite of its function, raises itself into an arch." In France the general opinion is well shown by the following, taken from the *Chirurgie Orthopédique* of Redard.² He says: "In the new-born the foot is flat; we can even find in some subjects, in place of a slight concavity, a well-marked convexity of the sole of the foot. The plantar arch forms only when the children begin to walk."

Taking up now the American text-books on this subject, we find in Bradford and Lovett³ the statement that "the sole of an infant is flatter than that of an older child. It is slightly turned in, and the absence of an arch may be seen by the tracing taken on smoked glass from the foot of a child ten months old. The arch begins to form at about the age of one year." A later work, that by Dr. Young,⁴ of Philadelphia, says: "It is, moreover, a well-established fact that all infants, on commencing to walk, are flat-footed, and do not acquire a perfect plantar arch until they have exercised some time and the leg muscles have become developed." He then refers to a piece of work done on the subject of the so-called building up of the arch, published by me in 1892, which I shall criticise later. Our latest work, that by Dr. Moore,⁵ of Minneapolis, has the statement that, "in children, the arch of the foot does not begin to form until after the first year. Weak ankles of children are really a form

¹ Die Lehre vom Erworbenen Plattfusse, Dr. Adolph Lorenz, 1883, S. 54.

² Traité Pratique de Chirurgie Orthopédique, par le Dr. P. Redard, 1892, p. 799.

³ A Treatise on Orthopedic Surgery, by E. H. Bradford and R. W. Lovett, 1890, p. 729.

⁴ A Practical Treatise on Orthopedic Surgery, by James K. Young, 1894, p. 339.

⁵ Orthopedic Surgery, by James E. Moore, M.D., 1898, p. 134.

of valgus, due to lack of development of the arch and to weakness of the tibialis anticus, tibialis posticus, and plantar muscles. These children are free from pain, but have a characteristic gait, and frequently fall and sprain the ankle."

Turning now to the British works, we find, in general, the same statements, yet with just a hint of something else. Thus, in Walsham and Hughes:¹ "The feet of new-born children are flat, and although there is an inherent tendency for the bones in their development to take the shape and position of the bones in the normal adult foot, it is not until the child begins to walk and the muscles are brought into vigorous action that the arch is fully formed. In the normal foot of the infant, however, there is no valgus—*i. e.*, eversion or abduction; indeed, the foot naturally assumes a slight tendency toward the varus position—*i. e.*, it is rather adducted than abducted, inverted than everted. The absence of the arch of the foot in the infant does not constitute the condition known as congenital valgus, or flat-foot. Some children, however, never develop a proper instep; the sole remains more or less flat, retaining, so to speak, the infantile form." Lastly, in his recent work on *Deformities*, Mr. Tubby² says: "In all young infants the arch of the foot is absent, so that the deformity may not become apparent until the child begins to walk." Again: "In infants the sole of the foot is always flat, on account of the presence of a large amount of fat in that situation, the small size of the tuberosities of the os calcis, and the absence of the arch. The latter originates from the stimulus of walking acting on the long and short muscles of the foot. A state of flat-foot is common among certain races, especially the Jew, Negro, and Kabyle, and is hereditary. It is a persistence of the normal state of the feet at birth."

Such is, without a single exception, the teaching of authority as regards the condition of the arch of the foot in infancy. It is said simply not to exist; it only comes into being as it is formed, little by little, by the action of the muscles as the growing child begins to use them. There is, indeed, a hint of something different in the last quotation given, that from Mr. Tubby, for he speaks of the presence of "a large amount of fat" in the infant's foot; but he seems to

¹ The Deformities of the Human Foot, by W. J. Walsham and W. K. Hughes, 1895, p. 387-88.

² Deformities: Treatise on Orthopedic Surgery, by A. H. Tubby, 1896, pp. 358, 361, 469.

regard this as nothing but an envelope, for he distinctly states that there is "an absence of the arch," and goes on to describe the arch as being built up just as his predecessors had done.

In my own earlier work¹ I was misled, to a great extent, in the same way. This was largely owing to the fact that I was working, for the most part, with the wet-tracing method. From the study of a series of about four hundred footprints, taken from children ranging from nine days to fourteen years, the following deductions were drawn: "At birth the foot does not seem to be flat, as is the general impression. There seems to be, on the contrary, a distinct arch in the feet of most infants, better formed in one foot than the other, and persisting until they are about eighteen months old. In this period the difference in the arch of the foot between males and females is not noticeable. After eighteen months there begins to be a distinct breaking down of the arch, which in most cases is wholly lost, the two feet suffering equally. For the next year and a half the feet remain distinctly flat, yet even during this period isolated tracings appear in which the arch is never lost. It is interesting to note that such are always females, and, therefore, presumably lighter children. During the next (third) year the arch is slowly rebuilt one foot improving before the other, and the females considerably earlier than the males. When the fourth year has been well entered upon the feet have nearly reached the adult condition; the two are about alike, and there is no marked difference between males and females." Figs. 1 and 2 are from a typical set of these footprint impressions as originally published.

As the study was carried further, however, two sets of facts argued against the truth of these deductions: first, a series of measurements relative to the height of the tuberosity of the scaphoid above the level of the sole of the foot; and, second, an examination of hardened sections of such infants' feet as could be obtained for that purpose. Table I. shows in detail the measurements taken in a series of thirty-eight cases. These were made in the following way: Three points were marked upon the skin of the inner side of the foot—one over the metacarpo-phalangeal joint of the great toe, a second over the tuberosity of the scaphoid, and the

¹ "A Study of Flat-foot." Boston Medical and Surgical Journal, October 27th, November 3d and 10th, 1892.

FIG. 1.



Tracings of female feet; ages four weeks, three months, fifteen days, one year, one year six months, two years, two years six months, three years, three years six months, four years, five years one month, six years, eight years.

FIG. 2.



Tracings of male feet; ages four weeks, three months, one year two months, one year ten months, two years, two years six months, three years, three years six months, four years, five years seven months, six years three months, seven years.

third as nearly over the hindmost point of the bearing surface of the inner tuberosity of the os calcis as could be determined. A flat piece of wood was pressed firmly against the sole of the foot, while the knee and thigh were controlled by the hands of an assistant. It was then easy to measure the height above this plane of the point over the tuberosity of the scaphoid, thus getting the actual height of the arch. The span of the arch was found by measuring the distance in a straight line between the outer two points. The average height for infants of one year or under was found to be 1.651 c.m.; between one and two years, 1.510 c.m. (For details, see Tables I. and II.). Or, taking the proportion of the height of the arch to its

FIG. 3.

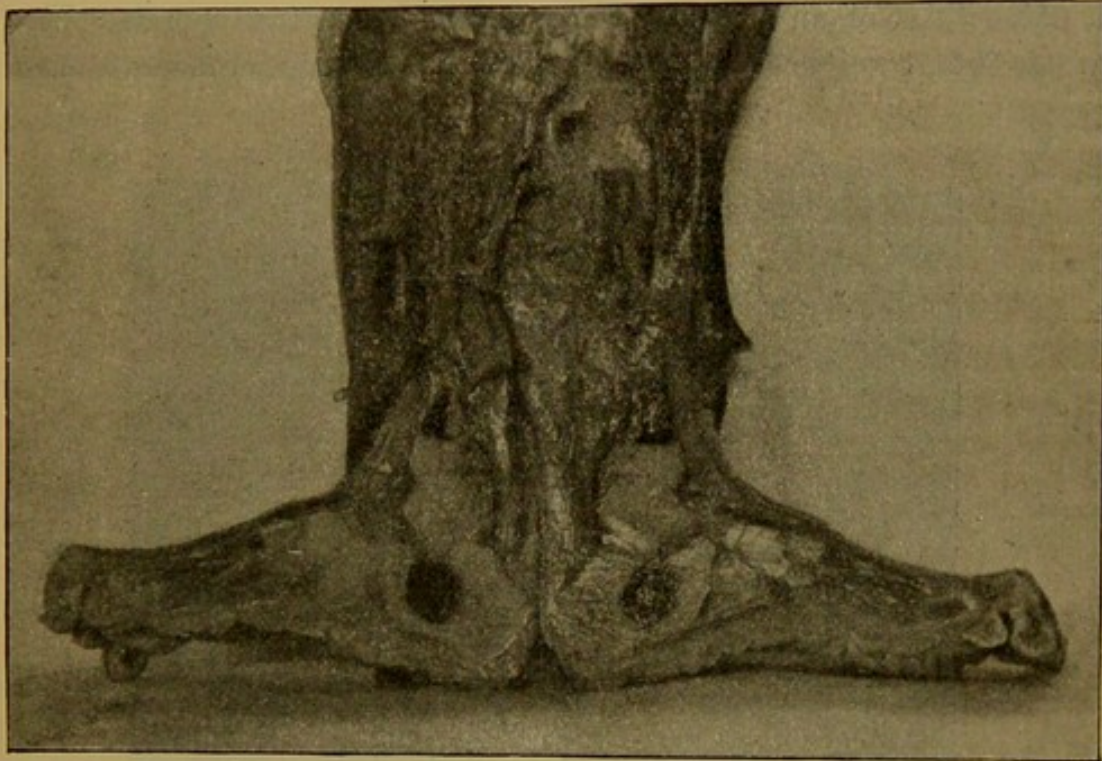


Feet from an infant, premature at the seventh month. Died one week after birth.

length, we have the fractions 0.301 and 0.218 as the average for the same periods of time. The adult proportion is about 0.270. This is not exactly what one would expect to find if the feet were really flat; for it shows that the essential structure—that is to say, the arch formed by the bones—not only exists at the earliest period of life, but that it is fully as high proportionally at this as at any subsequent time.

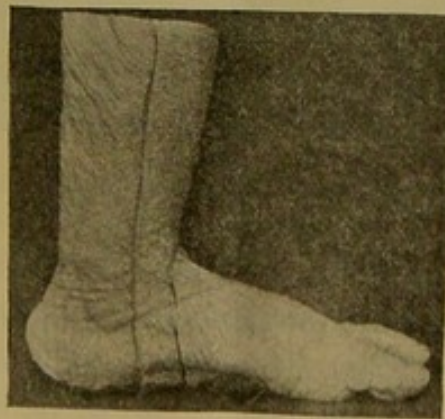
Turning now to the examination of the hardened sections, the explanation of the discrepancy between the measurements and the

FIG. 4.



Longitudinal section of the foot of an infant, premature at the eighth month. Died some days after birth.

FIG. 5.

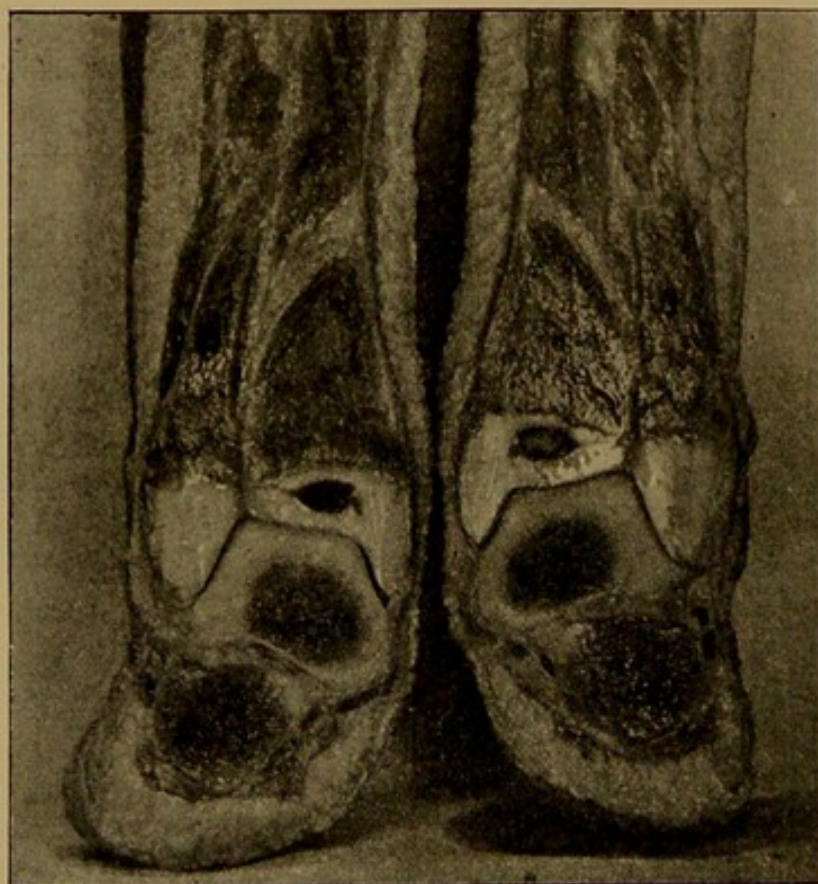


Left foot of a child eighteen months old.

wet tracings is not difficult to see. The space that in the adult and older child is bridged over by the arch of the foot is in the infant and young child, if it is at all fleshy, entirely filled up by a pad of

fat. It is the impression made upon the paper by this fat that has misled us into thinking that the foot of the infant had no arch. In thin children the pad is wanting, in which case the print of the foot strongly resembles that of the adult. Fig. 3 is a photograph from a pair of feet of an infant, premature at the seventh month. The whole infant weighed only a pound, but the feet are perfectly formed

FIG. 6.



Section of foot shown in Fig. 5, through ankle-joint.

and exquisitely arched. Fig. 4 shows a longitudinal section of the foot of an infant, premature at the eighth month. Fig. 5 shows the general appearance of a foot taken from a child eighteen months old. Figs. 6 and 7 are from sections of the same. Unfortunately, the child was far from plump, so that the pad of fat under the arch is not as well illustrated as I could wish; but the relation of the bones is well shown, and especially the upright position of the os calcis and the high level of the scaphoid. As a contrast, Fig. 8 (photographed from a specimen in the Warren Museum) shows the position of the

bones in a case of true congenital valgus. In studying this pad of fat I have found it present in a very few cases at birth. It is most in evidence from the first six months to the middle or end of the second year. It is then seen slowly to atrophy as the child grows older and the functions of the foot are more perfectly established.

FIG. 7.

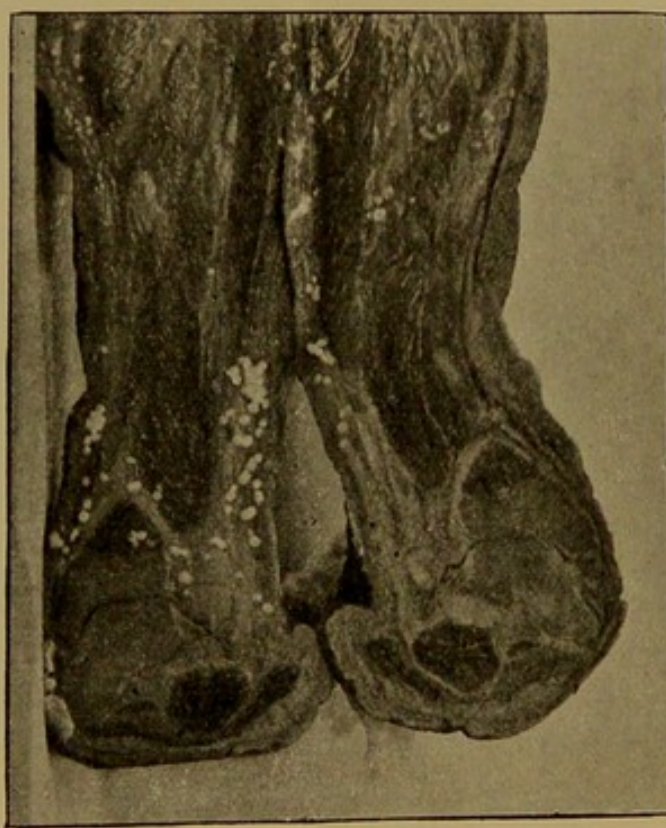


Section of same at medio-tarsal joint.

It seems, therefore, that we must readjust our theories of the formation of the arch of the foot, and say that it exists as a perfectly formed structure in the vast majority of feet at birth. It is in no wise dependent for its beginning upon the action of muscles, etc., which cannot be supposed to become a factor of much importance until after the child has begun to walk; but yet, during the whole period from birth to eighteen months, the bones are growing, with their mutual articulations so adjusted as to form an arch, even from the first. Were it otherwise, the so-called "formation of the arch" later would be a very difficult, if not impossible, operation. The arch, however, although well formed from the beginning, would be a very weak structure if it depended for its support solely upon

the ligaments binding the soft, cartilaginous bones together, even when reinforced by such addition as the feeble leg muscles of the infant could give it. Later in life the muscles should, of course, be amply strong enough to truss up the arch and render it capable of supporting the body-weight, even with the greater strain added by jumping and carrying burdens. Not so in the early period of life. The weight of the child would destroy the delicate structure of the arch long before the muscles were developed to a sufficient extent to prevent it, were it not for the *pad of fat* of which we have just

FIG. 8.



Section of a congenital valgus foot through middle of the ankle-joint. (Warren Museum.)

spoken. This pad fills in accurately all the hollow left by the bones, and gives a soft cushion upon which the bones rest until such time as the bones have become hard, the ligaments firm, and the leg muscles have, through exercise, gained sufficient strength to support the arch. Then, its use being over, the pad is gradually absorbed and the hollow formed by the arch appears in the wet tracing of the foot. Thus the arch can in no sense be considered as having "been formed" at this period; it has only been, as it were, uncovered.

TABLE I.—CHILDREN UNDER ONE YEAR—76 FEET.

No.	Length of arch.		Height of arch.		Age.	Sex.
	Right.	Left.	Right.	Left.		
1	4.2 c.m.	4.4 c.m.	1.3 c.m.	1.4 c.m.	6 weeks.	Female (Jew)
2	4.8 "	4.7 "	1.4 "	1.5 "	6 "	Male.
3	5.0 "	5.0 "	1.2 "	1.1 "	6 "	Female.
4	5.4 "	5.5 "	1.6 "	1.6 "	7 "	Male.
5	4.0 "	4.2 "	1.2 "	1.3 "	2 months.	"
6	4.8 "	5.2 "	1.2 "	1.6 "	2 "	"
7	5.0 "	5.0 "	1.3 "	1.4 "	2 "	"
8	5.2 "	5.0 "	1.7 "	1.6 "	2 "	"
9	5.4 "	5.2 "	1.5 "	1.4 "	3 "	Female.
10	5.4 "	5.4 "	1.7 "	1.5 "	3 "	"
11	6.2 "	5.8 "	1.7 "	1.6 "	3 "	Male.
12	5.3 "	5.5 "	1.5 "	1.5 "	4 "	"
13	5.4 "	5.3 "	1.6 "	1.6 "	4 "	Female.
14	5.6 "	5.6 "	1.5 "	1.7 "	4 "	Male (Jew).
15	5.8 "	5.7 "	1.8 "	1.6 "	4 "	"
16	4.7 "	4.7 "	1.4 "	1.5 "	4½ "	Female (Jew)
17	5.1 "	5.1 "	1.7 "	1.4 "	4½ "	"
18	6.2 "	6.0 "	2.0 "	1.8 "	5 "	"
19	5.5 "	6.0 "	2.0 "	1.8 "	6 "	"
20	5.6 "	5.8 "	1.7 "	2.0 "	6 "	Male.
21	6.4 "	6.4 "	1.8 "	1.7 "	6 "	Female.
22	4.8 "	5.0 "	1.8 "	1.2 "	7 "	"
23	5.4 "	5.7 "	1.5 "	1.6 "	7 "	Male.
24	5.8 "	5.5 "	1.7 "	1.7 "	7 "	Female.
25	5.8 "	6.2 "	2.0 "	2.0 "	7 "	"
26	6.0 "	6.0 "	1.8 "	1.8 "	7 "	"
27	6.0 "	6.0 "	2.0 "	1.8 "	7½ "	"
28	6.4 "	6.5 "	1.8 "	1.5 "	7½ "	Male.
29	5.0 "	5.0 "	1.5 "	1.6 "	8 "	Female.
30	5.0 "	5.2 "	1.4 "	1.4 "	8 "	Male.
31	5.1 "	5.0 "	1.8 "	1.4 "	8 "	"
32	6.6 "	6.6 "	2.0 "	1.7 "	8½ "	"
33	5.3 "	5.6 "	1.5 "	1.6 "	9 "	"
34	5.5 "	6.0 "	1.6 "	2.0 "	9 "	Female.
35	6.0 "	6.0 "	2.0 "	1.4 "	10 "	Male.
36	5.4 "	5.5 "	2.2 "	2.2 "	11 "	"
37	6.0 "	6.0 "	2.2 "	2.2 "	11 "	Female.
38	6.1 "	6.1 "	2.0 "	2.2 "	12 "	Male.

Average length of arch 5.481 c.m.
 " height of arch 1.651 "
 Proportion, length to height. 0.301 "

TABLE II.—CHILDREN BETWEEN ONE AND TWO YEARS.

No.	Length of arch.		Height of arch.		Age.	Sex.
	Right.	Left.	Right.	Left.		
1	6.0 c.m.	6.5 c.m.	1.8 c.m.	1.6 c.m.	13 months.	Male.
2	7.7 "	7.6 "	1.4 "	1.7 "	13 "	"
3	6.3 "	6.0 "	2.0 "	2.0 "	14 "	"
4	6.6 "	6.4 "	1.8 "	2.0 "	14 "	Female, negro
5	6.6 "	6.7 "	2.3 "	2.0 "	14 "	"
6	7.2 "	7.0 "	2.6 "	2.3 "	15 "	"
7	6.5 "	6.4 "	2.0 "	2.3 "	16 "	"
8	8.0 "	7.5 "	2.5 "	2.0 "	18 "	Male.
9	7.5 "	7.6 "	2.1 "	1.5 "	21 "	Female.
10	7.5 "	7.5 "	2.3 "	2.3 "	22 "	Male.

Average length of arch 6.905 c.m.
 " height of arch 1.510 "
 Proportion, length to height 0.218 "

As a practical conclusion, I would urge the use of the so-called "flat-foot plates" for children much more than I believe is at present the custom. Nature has shown us the principle by putting what may be called a physiological flat-foot pad in the feet of all stout, healthy children. Unfortunately, all children, as we see them in civilized life, are not healthy and fat, and in them the pad of fat under the arch is quite often wanting. It, therefore, seems to me our place as orthopedic surgeons to supply this deficiency at once by art, hoping thereby to save a useful and strong foot in place of one that will go on only too surely to flattening of the arch, pronation of the ankle, and all the series of troubles that accompany and follow these changes.