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THE ANTERIOR TRANSVERSE ARCH  
OF THE FOOT.

*Its Obliteration as a Cause of  
Metatarsalgia.*

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## THE ANTERIOR TRANSVERSE ARCH OF THE FOOT: ITS OBLITERATION AS A CAUSE OF METATARSALGIA.<sup>1</sup>

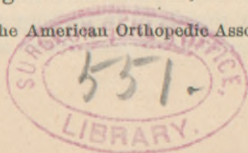
BY JOEL E. GOLDTHWAIT, M.D., OF BOSTON.

By far the most important feature of the human foot, when considered from a mechanical point of view, is the arrangement of the bones of the tarsus and metatarsus into arches, upon which the weight of the body is borne in standing or walking. These arches are arranged longitudinally and transversely, and the proper maintenance of both is important.

The longitudinal or antero-posterior arch is the larger and the more important. Anatomically it is thoroughly understood, its pathological conditions are well recognized, and the methods of treatment are well defined.

The transverse arch is smaller, less noticeable, and of much less importance in the large majority of cases. Anatomically it is recognized; but its pathological conditions have not been considered. It is most noticeable at the tarsus, where it is formed by the cuboid, scaphoid and the three cuneiform bones, but extends forward as far as the metatarso-phalangeal articulations, where, although much less clearly defined, it truly exists. Its presence at this point, a fact which has been denied by some authorities, has been proved to the satisfaction of the writer by the careful study of frozen sections of feet, and of impressions of the feet taken while supporting different degrees of the weight of the body. In the tarsus it is quite rigid, and is obliterated only as the longitudinal arch is obliterated, both being supported at this point by practically the same structures. In the anterior portion of the foot or at the metatarso-phalangeal articulations, it is less marked,

<sup>1</sup> Read by title at the American Orthopedic Association, Washington, May 30, 1894.



and is present only when the foot is at rest or supporting comparatively little weight.

When the foot is first placed upon the floor, the heel and the outer and inner portions of the ball form the points of contact. In this position the heads of the second and third metatarsal bones are in a plane distinctly above the others, and no weight is borne directly upon them. As more weight is added, the ball of the foot is gradually widened and the heads of the second and third metatarsal bones are lowered; these, together with the first metatarsal, forming the chief support when all of the weight of the body is thrown upon the foot. At the same time the foot rolls outward: partly owing to a yielding of the antero-posterior arch, which causes a slight lengthening of the foot, and partly owing to the way in which the weight is received upon an arch that is poorly supported on the inner side. In this way the inner side of the foot is brought nearer the floor, and the centre of bearing is moved toward the inner side, thus relieving the outer side from much pressure. When the foot is raised or the weight taken off, the reverse takes place; the foot shortens, owing to the re-forming of the longitudinal arch; the second and third metatarsal bones are raised — or the anterior transverse arch is re-formed; and the heel and the outer and inner portions of the ball of the foot form the last points of contact. From this it is seen that in walking the relations of the structures of the feet are constantly changing; the anterior transverse arch is continually being obliterated and re-formed, the longitudinal arch is alternately lower and higher, while the ligaments which are involved are constantly stretched and relaxed, and the muscles are in the state of alternate rest and contraction.

The anterior transverse arch is formed by the heads of the metatarsal bones; the first and the fourth and fifth (which act together) furnishing the base, while the second and third are raised above this plane, form-

ing, as seen upon cross-section, a low arch. This relation is maintained by the transverse ligament, the transversalis pedis muscle, and the tendons of the peroneus longus and the tibialis posterior muscles. The plantar fascia, which is reinforced in its anterior expansion by transverse fibres, and the tendon of the flexor longus digitorum muscle — from its insertion and its oblique course across the sole of the foot — undoubtedly also exert some influence.

After studying a considerable number of cases in which the symptoms were referred to the feet, and after experimenting with various lines of treatment, the author is convinced that the obliteration of this transverse arch is the direct cause of many of the symptoms, and that its restoration in these cases is of the same importance as is that of the longitudinal arch in the ordinary cases of valgus. With its obliteration, the weight is received directly upon the middle of the foot, the outer and inner sides no longer furnishing their normal support, so that nearly all of the impact comes upon the second and third metatarsal bones.

It is evident from the study of a large number of impressions of the feet that the obliteration of this transverse arch is very common — much more common than the flattening of the longitudinal arch — and that comparatively few persons suffer any inconvenience from it.

In a limited number of cases, however, this condition, usually so simple and of so little importance, becomes more serious, and symptoms develop which at times are most distressing and render treatment necessary. The two symptoms which are most common and which are present to a greater or less degree in almost all of these cases are irregular attacks of pain, referred to the anterior portion of the foot, and the presence of a painful callous in the middle of the ball. The pain, which at times is constant and at other times paroxysmal (similar to that which has been described as anterior metatarsalgia) is usually re-

ferred to the centre of the foot, near the head of the third metatarsal bone. The location of the pain in the interspace between the fourth and fifth metatarsal bones — that which is described by Morton as being the common one — is certainly unusual, and the cases are strikingly few when compared with those in which the pain is referred to the middle of the foot. The callous, which may vary considerably in size, is formed directly under the heads of the second and third metatarsal bones, as the result of the undue pressure at this point, and at times is so painful as to render locomotion difficult.



FIG. 1.



FIG. 2.



FIG. 3.



FIG. 4.

Besides these two symptoms, which are such constant ones and of so much importance as diagnostic signs, the diagnosis can be confirmed, in the majority of cases, by impressions of the feet, as with the ordinary cases of flat-foot. In the normal foot there is a sharp re-entering angle where the impression of the ball of the foot joins that made by the outer side, as is shown in Figs. 1 and 2. Both represent normal feet: Fig. 1, a foot of the long, slender type; Fig. 2, the other extreme. When the transverse arch is lost the impression presents an entirely different appearance as is shown in Figs. 3 and 4. In place of the re-entering angle the tracing bulges at that point. In both of these cases the longitudinal arch is still present.

While it is possible to obtain an impression that is characteristic when the anterior arch is obliterated, this characteristic outline is lost if, at the same time, the longitudinal arch is destroyed. After some experimenting it was found that in the cases where the valgus deformity was not rigid, the impressions to determine the condition of the anterior arch could be taken with the same degree of accuracy as when the longitudinal arch was present, by simply varying the amount of weight supported upon the foot. The anterior arch, when obliterated, does not re-form, so that even the lightest pressure will develop almost as characteristic an impression as when the foot is firmly placed upon the floor. With the longitudinal arch this is not so. When the foot is at rest (unless the valgus is of the rigid type), the arch appears very much as normal: but as soon as pressure is put upon it, it gives way. Figs. 5 and 6 are impressions of the same foot, taken at the same visit. The first was taken with the foot supporting all of the weight of the body, both arches giving way; while, in the second, the weight supported was very much less. In the latter instance



FIG. 5.



FIG. 6.

the longitudinal arch remains, while the flattening of the transverse arch is clearly shown. The abduction of the foot which is present in the ordinary cases of flat-foot, does not, of course, occur when only the anterior arch gives way. This is also shown in Figs. 5 and 6, and is of importance in diagnosis.

The causes of flattening of the anterior transverse arch are much the same as the recognized causes of flattening of the longitudinal arch: excessive standing

or walking; injury, such as a sprain, or a fall in which the weight is received upon the front part of the foot; weakness following long sickness; and very probably improper shoes, chiefly those which are much too narrow.

The treatment of this condition naturally consists in the restoration of the parts to their normal relation — the re-formation of the arch. In some instances this has been accomplished by simply bandaging the foot tightly, a method which prevents the foot from widening when weight is borne upon it, and consequently the arch from lowering. In other cases it has been done by the use of felt pads, or leather inner soles so padded as to bring pressure just behind the heads of the second and third metatarsal bones. A metal plate has also been used in some cases, carried forward and raised to cause pressure, as with the inner soles. Pressure coming directly under the heads of the bones is, of course, to be avoided, as it would increase the sensitiveness of the callous. In connection with this mechanical treatment, exercises, massage and stimulating bathing are of value.

#### CONCLUSIONS.

At the metatarso-phalangeal articulations there is an arch, called by the writer the anterior-transverse arch. This, at times, becomes flattened, and symptoms develop which are characteristic.

The symptoms most commonly met with are pain, referred to the anterior portion of the foot — the so-called anterior metatarsalgia — and the presence of a painful callous in the centre of the ball of the foot.

The impression of the foot is typical, and can be developed in many cases, even when the longitudinal arch also is obliterated.

The treatment consists in the restoration of the arch by plates, pads or bandaging.







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