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PLANTAR PROTRUSION OF THE METATARSAL HEADS

Conservative Treatment by a New Principle

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The myth of the existence of an anterior transverse arch of the foot has persisted in international, and not least Swedish, orthopaedics for at least half a century, in spite of repeated indications to the contrary. It is mentioned, for instance, in the latest edition of Nordisk lärobok i Ortopedi (Hierton 1969) (Figure 1).

As long ago as 1930 Morton wrote: "There is no such arch or arch conformation in this particular region of the foot, for each bone has direct contact with the ground through the intervening tissues". The same or similar views (Figure 2) have been presented by, among others, Abramson (1927), Bankart (1935), Basler (1927), Bruce & Walmsley (1938), Elftman (1934), Jones (1941), Kelikan (1965) and Lake (1943). Kelikan (1965) pointed out the absence of a suitable designation or diagnosis for plantar dislocations of the metatarsal heads seen in orthopaedic practice and often giving rise to corns and/or intense pains on loading of the foot.

Consistent with the erroneous hypothesis on the existence of an anterior transverse arch, the conventional orthopaedic treatment has been an attempt to maintain such an arch, as is familiar to all orthotists, orthopaedists and many patients. This treatment consists in providing an anterior arch support; the purpose of this is to raise the three middle metatarsal bones by exerting pressure on them 2–5 cm behind the metatarsal heads, thereby producing an anterior vault with the heads suspended or in any case not involved in transmission of weight to the ground.

In some mild cases this device can help to relieve the pain, but in many others it is worthless, and may even aggravate the discomfort by exerting pressure on an area not designed for loading. While there is no anterior vault at the level of the metatarsal heads, further back

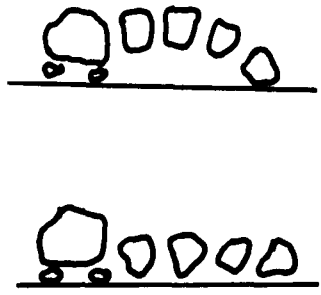

Figure 1. Above. Normal anterior arch at the level of the metatarsal heads. Below. Pes transverso-planus. According to Nordisk lärobok i ortopedisk kirurgi (1969).

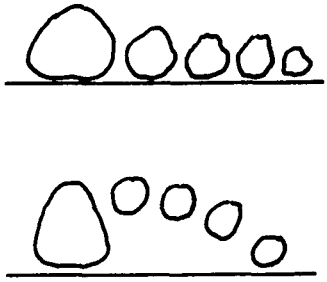

Figure 2. Above. Normal anterior arch at the level of the metatarsal heads. Below. The anatomic anterior arch in the zone between the proximal and middle third of the metatarsal bones. According to Kelikian (1965).

there is an anatomic vault of the diaphyses of the metatarsal bones, which ensures that the muscles, tendons, vessels and nerves function unhindered by compression (Figure 2-below).

The anterior arch support will exert pressure within this region, and the resulting pain will not infrequently add to the patient's general misery, as will the discomfort of pinching shoes. From an analysis of the mechanical conditions in the anterior part of the foot it is evident that there is a more effective way of relieving the load on the painful sites, including any corns.

The depression of a metatarsal head that can be observed in such patients is illustrated in Figure 3. With normal function of the anterior part of the loaded foot it is obvious that the movements of the metatarsal bones in Lisfranc's joints are arrested by ligaments (and/or muscles) in full dorsiflexion, so that in normal cases the metatarsal heads 2–5 are loaded to about the same extent and the first one slightly

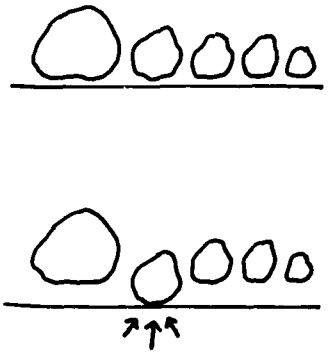

Figure 3. Above. Normal anterior arch at the level of the metatarsal heads. Below. Protrusion of the second metatarsal head. According to the authors (1973).

more. In the disorders considered here the dorsiflexion of one or more of the heads (sometimes including the first and fifth) will stop before that of the others. In such an overloaded area the pads will be exposed to such great pressure that they will atrophy, and inflammation and hyperalgesia is elicited. The causal mechanism is thus a plantar contracture of at least one metatarsal bone in Lisfranc's joints in relation to the other metatarsal bones. Theoretically, the metatarsal bone displaying plantar protrusion may be conceived as having a normal range of motion in Lisfranc's joints and the others as having a pathologically increased range of dorsiflexion, but in practice this would seem unlikely. We propose, however, that this disorder be designated *plantar protrusion of the metatarsal heads (protrusio capatis metatarsalis)* instead of pes transverso-planus/metatarsalgia. The metatarsal heads that have a plantar protrusion will be responsible for transfer of the whole force between body and ground, while the others will retain their dorsiflexion mobility and hence assume little if any load.

If it is assumed, firstly, that the transfer of weight from body to ground (except that *via* the heel) will be effected by the metatarsal heads 1–5, which with their pads are designed for this purpose, and, secondly, that the pressure is distributed uniformly between the 4 lateral heads, with a slightly greater weight on the first, it will be evident that in plantar protrusion of the metatarsal heads such a transfer will best be effected if the shape of the support for this region provides the desired distribution. This means schematically that the support should be congruent with the loaded surfaces of the anterior part of the foot.

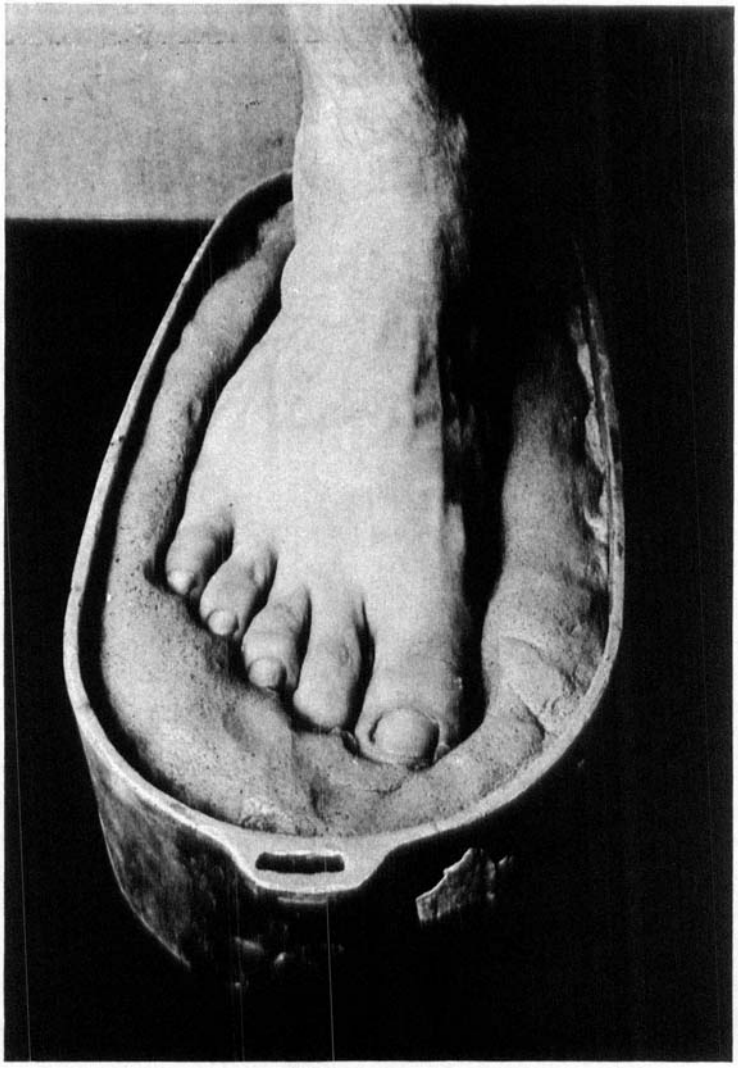

Figure 4. Impression of sole of foot under load.

For the last 2 years this theoretical concept has been applied in practice by Nilsson, who is in charge of bandaging at the Department of Orthopaedics, Regional Hospital, Gävle. An impression of the anterior part of the loaded foot is obtained in a special compound of clay and glycerin (Radings ortopediska AB, Södra vägen 10, Göteborg (article nr 9822)) (Figures 4 and 5) and from this a plaster cast is made. This is used to make a sole from calfskin and a plastic compound

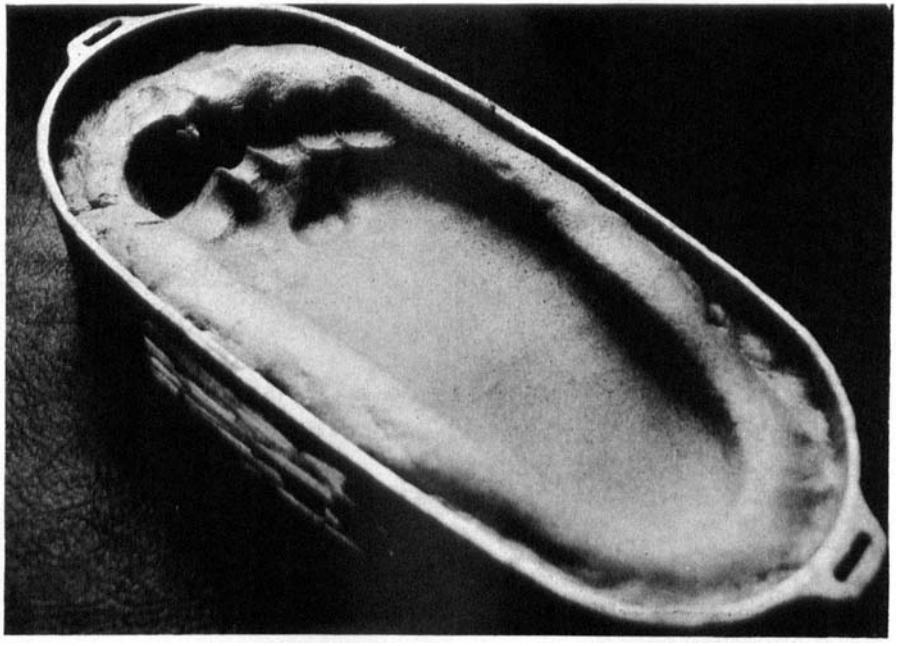

Figure 5. The negative impression.

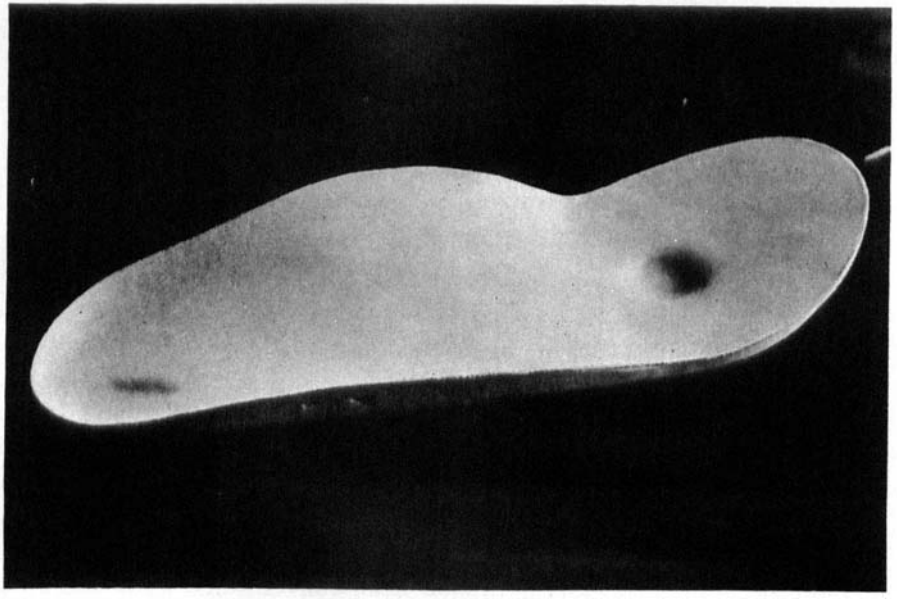

Figure 6. The finished sole.

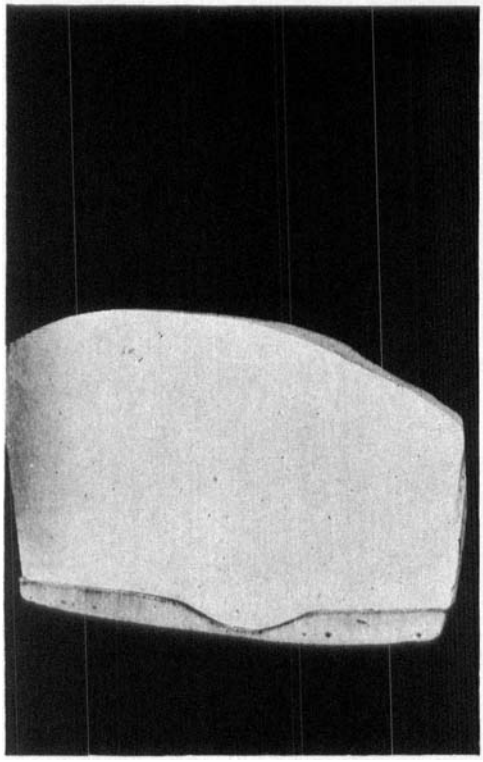

Figure 7. Cross-section at the level of the metatarsal heads during loading of the plaster foot, showing the close adaptation of the sole to the foot in the region of the protrusion.

(Podiasin, 3 M Company, or Plastozote, AB Ribea, Box 10008 Stockholm) (Figures 6 and 7). The anterior part of this sole will be slightly more resilient than a leather sole but more rigid in the heel region, when this is built up with full support. As the pain on loading is often quite troublesome the pressure is usually distributed over the whole of the sole, so as to minimize the average pressure on each part of the skin. This means that the posterior vault of the foot is modelled to the positive plaster cast so that the region where an anterior arch support is normally allowed to press is included, and takes its share of the pressure.

The sole is shaped to resemble an anterior arch support except that it bears the whole width of the foot and is not limited to the middle metatarsal diaphyses. All the metatarsal heads are then involved in carrying the weight. This sole is placed in an ordinary shoe or an orthopaedic shoe, depending on whether there are any other deformities of the foot, and as the sole is thicker than conventional ones (because of the depressions) a bigger last is needed.

RESULTS

The above procedure was used in 22 patients, complaining of pains and/or corns in the metatarsal head region, who over a number of years had used an anterior arch support or worn conventional orthopaedic shoes. After changing to this method for relieving the pressure, 17 of the patients reported a marked improvement or even complete relief, and 4 some improvement; only one found no improvement. Many patients expressed the view that the system afforded the greatest relief for many years.

DISCUSSION

Patients troubled with pain in the anterior part of the foot of the type considered here are often heard to complain that new shoes cause them discomfort for weeks or months until they have been worn in; the pain is felt at plantar as well as dorsal and lateral pressure points. Inspection of the old shoes invariably discloses small depressions in the sole, corresponding to the metatarsal heads; this bears out the logic of the form of treatment proposed here.

In the case of pronounced plantar protrusion a correction is rarely obtained with the conventional anterior arch support. A vicious circle results: pressure on a point produces atrophy of the pads, inflammation and hyperalgesia, and this leads to further difficulty in walking and tolerating weight on the tender metatarsal heads. An operation is then often required. By securing adequate relief of the load on these sites this circle is broken; the reactive changes regress and the areas are gradually able to tolerate greater pressure. A more uniform loading of all the metatarsal heads is then secured. This relief from hyperalgesia and the reduction of tenderness on exposure to pressure are confirmed by the patients themselves.

How is it that the conventional treatment consisting of providing an anterior arch support is sometimes effective and sometimes not? In the case of moderate overloading of any particular metatarsal head even the mild relief of the load obtained with a conventional support can lead to alleviation. A theoretically deleterious pressure in the region of the metatarsal diaphyses is tolerated so long as it is not excessive. In the case of pronounced plantar protrusion, however, relief is seldom obtained and the patient often continues suffering for the rest of his life—most of which may well be spent in the seated position.

SUMMARY

The alleged existence of an anterior transverse arch in the foot is refuted with reference to the literature on the subject. A mechanical analysis of the transfer of weight between the anterior part of the foot and the ground would seem to indicate that the pain and/or corns that sometimes arise under one or more metatarsal heads are due to plantar contraction in the Lisfranc's joints. To alleviate this pain a new type of supporting sole is proposed, which is shaped to the loaded foot by means of a special casting technique. The results obtained with this relief were good and the patients found the new shoes comfortable and definitely better than conventional orthopaedic shoes or anterior arch supports. The designation *protrusio capitis metatarsalis* is proposed as a replacement for pes transverso-planus/metatarsalgia.

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