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TREATMENT OF PLANTAR FASCIITIS AND CALCANEAL SPURS WITH THE UC-BL SHOE INSERT[1, 2]

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The UC-BL Shoe Insert (Fig. 1) was developed at the Biomechanics Laboratory in San Francisco as a part of several research projects on the mechanisms of the human foot. The ability of the insert to modify and control these mechanisms led to its application to many foot problems. For example, it was considered that the insert should be able to take over, at least in part, the contribution of the plantar aponeurosis to longitudinal arch stability. Consequently, the tension on this fascia would be reduced.

It was felt that a reasonable approach to test this theory was to fit patients who had plantar fasciitis. If there were little or no tension on the plantar aponeurosis the symptoms of stress and pain should be alleviated. To this end a clinical program was initiated to have local physicians send to the laboratory those patients with plantar fasciitis whose condition was resistant to treatment by usual methods. A number of patients were fitted over the years with a statistically significant degree of success, which not only proved that it was possible to unload the stress on the plantar aponeurosis in weight-bearing, but that use of the shoe insert constituted an ideal treatment for plantar fasciitis. Coincidentally, a number of patients with painful heel spurs were fitted to test the theory that the basic cause of both conditions was the

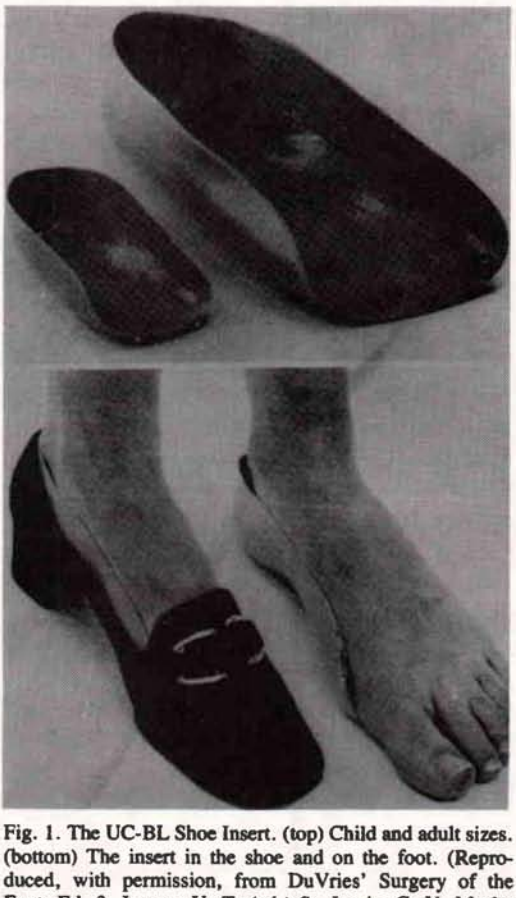

Fig. 1. The UC-BL Shoe Insert. (top) Child and adult sizes. (bottom) The insert in the shoe and on the foot. (Reproduced, with permission, from DuVries' Surgery of the Foot. Ed. 3. Inman, V. T. (ed.) St. Louis, C. V. Mosby Co., 1973.)

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same. The rate of success was extremely high for both conditions. This work was continued at the University of California, Los Angeles, with similar results, and is now included in the Prosthetic-Orthotic Education Program for Physicians, Therapists, Orthotists and Prosthetists.

PRESENT CONCEPTS

Plantar fasciitis and painful heel spurs of nonsystemic origin have been thought of as two separate entities. Plantar fasciitis was considered a simple strain. In the case of the painful heel spur many physicians considered that the heel spur itself injured the tissue on weight-bearing. The diagnosis was made by palpating the length of the plantar fascia and by x-ray. When x-ray revealed a heel spur and the area of the spur was painful the diagnosis was a painful heel spur, but when there was no heel spur, regardless of where the pain was elicited anywhere along the plantar aponeurosis, including its attachment to the calcaneus, a diagnosis of plantar fasciitis was made.

There is a second, more recent school of thought that attributes both conditions to a simple strain and maintains that a heel spur is just a further development of plantar fasciitis. The concept of this school is that when the strain occurs at the calcaneal attachment the resultant inflammatory process may stimulate a proliferation of bone into the fascia to secure the attachment, with the development of a heel spur. The continuing pull of the fascia in weight-bearing perpetuates the inflammation and a chronic situation develops.

These two schools of thought imply radically different treatment. If the first school is right and the heel spur irritates the soft tissue and causes the inflammation, then the logical approach is to remove the offending spur surgically. This treatment is questionable because of the varying degrees of success reported by surgeons and the number of times spur regrowth occurs.

If we consider the second school of thought, that the tissue is continually embarrassed by the forces applied to the fascia on weight-bearing, then another approach is implied; that is, if we can reduce the tension on the plantar fascia in weight-bearing, injury will not recur and the healing process can take place.

THE FIRST HALF OF STANCE PHASE

The first consideration usually presented is that plantar fasciitis is most often observed in persons with at least some degree of pes planus. Since many people still associate this condition with weak intrinsic and extrinsic musculature, it is believed that exercise will strengthen these muscles and thereby maintain the arch and relieve the other soft structures. This concept is not supported by research done by electromyography. Basmajian (*1*) made simultaneous electromyograms of six muscles of a group of 20 subjects under static load of 45.4 to 181.4 kg. The muscles tested were the tibialis anterior and posterior, peroneus longus, flexor hallucis longus, abductor hallucis, and flexor digitorum brevis. The contribution of these muscles was considered insignificant until the load reached 181.4 kg, and even then some muscles remained inactive. Basmajian concluded that the passive structures (bone and ligament) are the only ones capable of sustaining an unremitting load. "The first line of defense of the arches is ligamentous" (p. 1190).

Mann and Inman (*6*) found that there was little if any significant activity of the intrinsic musculature during quiet standing. They also found that the plantar intrinsic muscles did not elicit a significant response until 30 percent of the gait cycle (midstance), or just prior to heel rise. Therefore, in the first half of stance phase the entire weight of the body is borne by the passive structures (bone and ligaments). At this point the arch has descended to its lowest point.

Cunningham (*2*) found that at about 15 percent of the gait cycle (foot flat) the foot is subjected to 120 percent of the body weight. This loading occurs before the intrinsic muscles are active. With such loads supported only by the passive structures, fatigue and injury to the ligaments and particularly the plantar fascia should be common, as indeed they are — to the point that when standing for any length of time, a person shifts his weight to the outside of the feet, muscularly raising the arches, and relieving the ligaments, or he rises up on the toes to gain relief. In fact, when true injury occurs the patient may walk on his toes all the time.

THE SECOND HALF OF STANCE PHASE

In 1954 Hicks (*4*) described the powerful contribution of the plantar fascia in stabilizing the foot from heel rise to toe-off. Since the attachment of the plantar fascia is distal to the metatarsophalangeal joints, extension of these joints such as occurs with dorsiflexion of the toes causes tension on the fascia (Fig. 2). Hicks

Fig. 2. Dorsiflexion of the toes causing tension on the plantar fascia. (Reproduced, with permission, from DuVries' Surgery of the Foot. Ed. 3. Inman, V. T. (ed.) St. Louis, C. V. Mosby Co., 1973.)

called this mechanism the windlass effect of the plantar aponeurosis. If this is true why do we rise on our toes to relieve the plantar fascia? There are two events in this part of the walking cycle which have modified the previous situation. First, obviously, the intrinsic muscles have assumed some of the load as they all contract in the second half of stance phase. Second, the arch is now at its highest point, held there by the plantar fascia and the intrinsic muscles, both acting as the truss of the bony arch. At this high-arch position the tension on the truss required to support the arch is less than it would be in a low-arch position. This can be demonstrated in the model in Figure 3. As the toes are dorsiflexed the arch must rise and the effective length of the truss (intrinsic musculature and plantar fascia) is shortened. The mechanics of an arch held in a fixed position by a truss supporting a given weight are that the tension in the truss is dependent on the angle a and the length of the truss b. A more acute angle a, with the resultant shortening of the truss b, reduces the tension in the truss necessary to support a given weight. Therefore, not only is the tension on the truss divided between the plantar fascia and the intrinsic musculature,

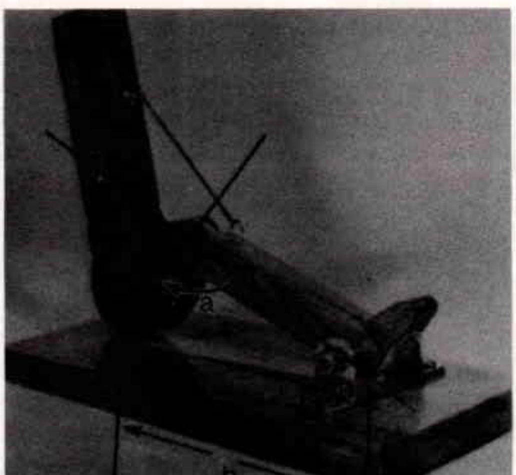

Fig. 3. Model illustrating how dorsiflexion of the toes, with shortening of the plantar fascia, raises the longitudinal arch of the foot. See text for explanation of mechanical factors involved.

there is also a mechanical advantage derived from the high-arch position in the second half of stance phase.

ELEVATION OF THE ARCH TO RELAX THE PLANTAR FASCIA

There are several ways to achieve an elevated arch. The most common usually occurs by accident, when the foot is wrapped in plaster after a spur has been surgically removed. This plaster wrap is commonly done in a non-weight-bearing position which automatically relieves the plantar structures; the rigidity of the plaster holds the foot in a relaxed attitude, relieving the tension on the soft structures, including the plantar fascia. When such a cast is made into a walking cast with a rubber heel the patient walks on a pylon or stilt with the lever action of the foot completely bypassed. We suspect that those surgeons who have had success with surgical removal of a heel spur obtained most of their good results not by surgery, but by leaving the postsurgical cast on long enough for the healing process to be completed. They might very well have been equally successful if they had omitted the surgical procedure and simply used a walking cast.

The second most common way to elevate the arch is the use of an arch support in its many variations. However, the arch support, although it may elevate the arch, does not relax the plantar fascia. Consider that the arch support is lifting the arch vertically through all the soft structures until it can make its effect on the bony structures. This produces a bowstring effect. The arch of a bow can be increased by pulling or pushing on the bowstring; however, one must increase the tension on the bowstring. Hypothetically, we can consider the bony arch of the foot as the bow and the soft structures (such as the plantar fascia) as the bowstring. The reacting force of the arch support pushing on these structures creates a tension which pulls the arch to a higher position (Fig. 4). This does not relieve the tension on the fascia and, therefore, raising the arch in this case does not create the desired effect.

THEORY OF THE UC-BL SHOE INSERT (AN ALTERNATE WAY TO ELEVATE THE ARCH)

Because of the oblique position of the axis of the subtalar joint, this articulation acts like a mitered hinge connecting the leg and foot. Rotation of the leg about a vertical axis causes the foot to pronate or supinate. This can be readily demonstrated on oneself or on a patient by rotating the leg and observing the behavior of the foot. External rotation of the leg causes the heel to invert and the forefoot to supinate while the longitudinal arch rises simultaneously. Palpation will reveal that with this maneuver tension is reduced in the plantar fascia. The theory of the UC-BL Shoe Insert is to hold the foot in a position that relieves tension on the plantar fascia; this is accomplished by holding the heel in inversion and applying forces against the navicular and the outer side of the forefoot, without direct pressure on the soft tissues under the longitudinal arch. In order to construct the insert properly, a plaster wrap of the foot is taken. Before the plaster cast sets, the patient is asked to stand with partial weight upon the involved leg. The leg is then externally rotated while the forefoot is held in pronation and slight adduction (Fig. 5). No pressure is applied to the plaster cast under the longitudinal arch.

When a plaster wrap is obtained, a plaster positive is made from this negative. Finally a plastic shell is made by laminating layers of nylon and fiber glass over the plaster positive. The plastic shell holds the foot in the position in which it was cast and it is thin enough to slip into the patient's shoe. For details of the whole casting and fabrication procedure, see Reference 3.

RESULTS IN PATIENTS WITH PLANTAR FASCIITIS

In the last five years in the Biomechanics Laboratory, a total of 23 patients have been fitted with the UC-BL Shoe Insert for plantar fasciitis. In the last 15 months a total of 10

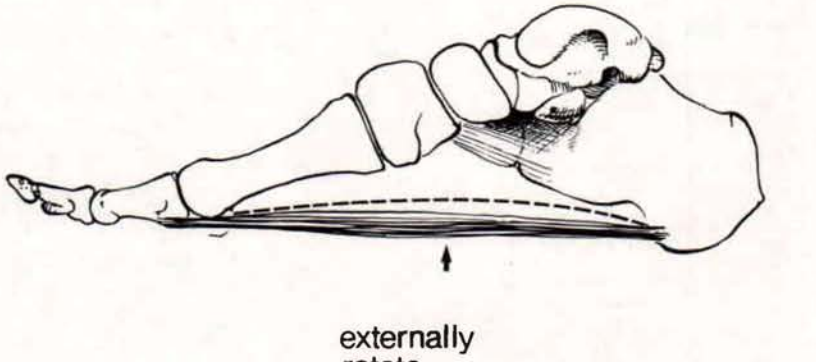

Fig. 4. Bowstring effect resulting from upward force on plantar fascia exerted by an arch support.

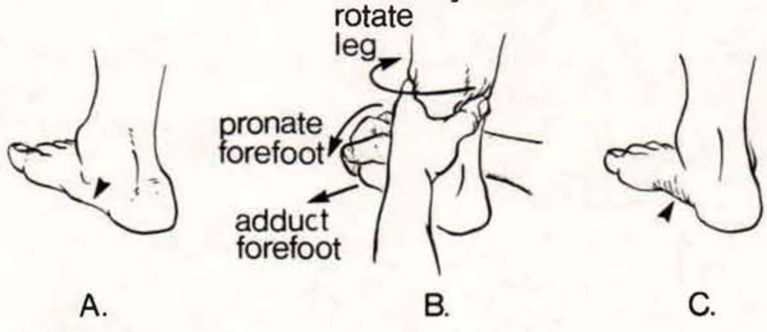

Fig. 5. Position of foot for taking plaster cast for shoe insert. A, Initial position of weight-bearing foot. B, Manipulation to desired position. C, No pressure exerted on plantar fascia and longitudinal arch.

patients have been fitted with the insert at the UCLA Rehabilitation Center in Los Angeles. Most of these patients had been treated previously with arch supports, heel cushions, steroids, and phenylbutazone, without success. In all but 2 cases the relief from discomfort with the shoe insert was almost instantaneous and the patients were able to bear weight on their heels. The two unsuccessful cases were those of a patient with an undiagnosed Reiter's syndrome and a patient who had arthritic changes in the talocrural joint.

Most patients with plantar fasciitis who are treated with steroids and phenylbutazone have relief, with no further treatment necessary. In the severe cases, however, only temporary relief appears to be obtained from these treatments, and the patients go on from one treatment to another and are finally reduced to sitting until the inflammation subsides. This severe type of condition is the one for which we have prescribed the UC-BL Shoe Insert. The majority of these people wore the insert from 1 to 3 months and were then able to walk unaided. However, since plantar fasciitis tends to recur the patients wear the insert at the first sign of recurrence and continue its use until the symptoms have abated.

REFERENCES

1. Basmajian, J. V., and Stecko, G.: The role of muscles in arch support of the foot: an electromyographic study. J. Bone Joint Surg. 45A:1184–1190, 1963.

2. Cunningham, D. M.: Components of Floor Reactions During Walking. Prosthetic Devices Research Project, Institute of Engineering Research, University of California, Berkeley. Series 11, issue 14. Berkeley, The Project, 1950. 3 pp. + tables + illus.

3. Henderson, W. H., and Campbell, J. W.: UC-BL Shoe Insert: Casting and Fabrication. Biomechanics Laboratory, University of California, San Francisco and Berkeley. Technical Report 53. San Francisco, The Laboratory, 1967. 22 pp. Reprinted in Bull. Prosthetics Res., BPR 10–11:215–235, Spring 1969.

4. Hicks, J. H.: The mechanics of the foot. II. The plantar aponeurosis and the arch. J. Anat. 88:25–30, 1954.

5. Inman, V. T.: The UC-BL Dual-Axis Ankle-Control System and UC-BL Shoe Insert: biomechanical considerations. Bull. Prosthetics Res. BPR 10–11:130–145, Spring 1969.

6. Mann, R., and Inman, V. T.: Phasic activity of intrinsic muscles of the foot. J. Bone Joint Surg. 46A:469–481, 1964.