

# THE INFLUENCE OF DIGITAL STABILIZATION ON LESSER METATARSALGIA

D. Scot Malay, D.P.M.  
Howard Hillstrom, Ph.D.  
Elaine G. Stanifer, B.S.  
Laura R. Lefkowitz, B.S.

## PURPOSE

The purpose of this study is to determine the influence of digital stabilization, via proximal interphalangeal arthrodesis, on the condition of lesser metatarsalgia associated with hammertoe deformity. Plantar weight bearing forces will be measured before and after surgical correction of hammertoe deformities. Weight bearing pressure measurements will be performed using the Musgrave pedobarograph. It is anticipated that analysis of the data collected will objectively reveal the effectiveness of digital stabilization on the reduction of pathological forces in the ball of the foot.

## MATERIALS AND METHODS

Subjects for this study will be selected from the patient pool of the Department of Surgery of the Pennsylvania College of Podiatric Medicine. The subjects will include only those patients with symptomatic lesser metatarsalgia in combination with pathological digital contractures, namely hammer-toes. Appropriate informed consent for both surgical intervention and participation in the study will be obtained.

Pressure measurements will be determined using the Musgrave pedobarograph, and performed in the Gait Study Center of the Pennsylvania College of Podiatric Medicine. This pedobarographic system incorporates over two thousand pressure sensors contained within a case (mat) upon which the subjects will walk. Each sensor measures load beneath a discrete area of the subject's foot and relays this data to a computer for analysis and record storage. The pedobarograph is noninvasive and only requires the subject to walk barefoot across the pressure sensitive mat. All of the subjects will be tested preoperatively, then again at three, six and twelve months postoperatively. The data will be compiled and statistically analyzed. Furthermore, all of the subjects will be subjectively evaluated regarding their preoperative symptomatology, as well as their postoperative status.

## DISCUSSION

Lesser metatarsalgia is a generic term for pain associated with metatarsals two through five, typically associated with the ball of the foot. Very commonly, lesser metatarsalgia is induced by pathological retrograde forces associated with contracted digits. Retrograde buckling at the metatarsophalangeal joint creates a plantar directed force on the metatarsal head and may effect pathological weight bearing stresses in the ball of the foot. Associated plantar hyperkeratotic lesions may or may not be present. When this relationship between the digits and metatarsus exists, treatment of lesser metatarsalgia should entail correction of the digital deformity. In many cases, lesser metatarsalgia is satisfactorily alleviated following correction of the associated digital deformity without the need for traditionally accepted lesser metatarsal osteotomy (Figure 1).

Many different procedures have been described for the treatment of lesser metatarsalgia. However, postoperative

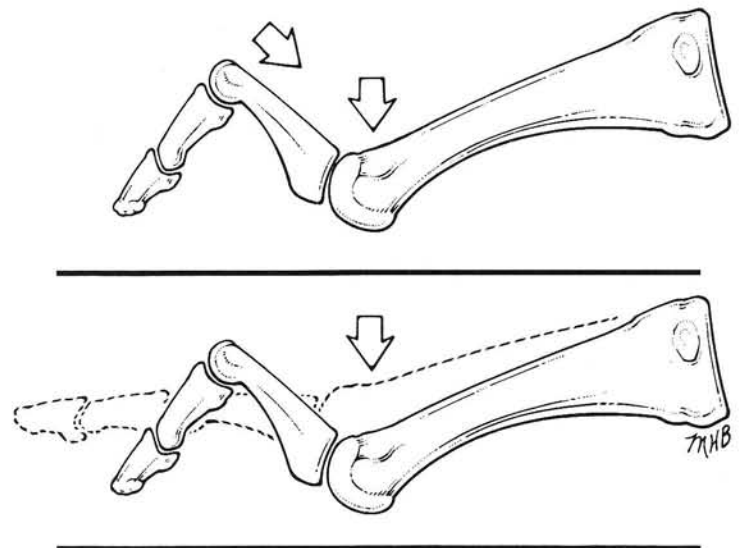


Fig. 1A. Schematic representation of retrograde metatarsophalangeal buckling.

complications following lesser metatarsal osteotomy are not uncommon.<sup>1,2,3,4,5,6</sup> The development of transfer lesions and recurrence of original symptomatology appear to be the most frequently encountered problems. In spite of a relatively high postoperative complication rate, lesser metatarsal osteotomy techniques persist as the mainstay of surgical intervention for the treatment of lesser metatarsalgia.

A variety of analytical techniques have been described for the evaluation of weight bearing forces sustained by the foot. Scranton<sup>4</sup> used pressure sensitive cholesterol crystal force plates to measure sub-metatarsal forces following metatarsal osteotomy. Although the crystal force plate analysis provides a crude representation of the forces passing through the extremity, there is no differentiation for specific magnitudes of pressure nor data for forces affecting the ball of the foot. Grundy et al<sup>7</sup> used high sensitivity force plates with simultaneous filming of the sole of the foot to assess the centers of weight bearing pressure. However, piezoelectric force plate data provides very limited information with respect to the forces applied to every individual point on the plantar aspect of the foot. Also, it does not provide a differentiation in the magnitudes of forces sustained at each point in the ball of the foot. It should also be noted that electromechanical transducers attached to various locations on the plantar aspect of the foot (Electrodynamogram) are limited in their application due to the inaccuracies related to transducer location and relocation each time measurements are taken. Only pressure sensitive films provide crude comparative data relating to weight bearing forces sustained by the many discrete points that comprise the plantar aspect of the foot. The pedobarograph, with its high density of pressure sensors per unit area, is the ideal instrument for accurate and reproducible measurement of plantar weight bearing forces in the ball of the foot.

It is anticipated that this prospective study will provide objective data to support the theory that digital stabilization will significantly alleviate lesser metatarsalgia in patients with associated hammertoes. It is also anticipated that analysis of the data will provide reasonable guidelines for the appropriate use of lesser metatarsal osteotomies in the treatment of lesser metatarsalgia resistant to nonsurgical management. Using this data, the incidence of postoperative complications following lesser metatarsal osteotomy hopefully will be minimized.

## References

1. Hatchler R, Goller W, Weil LS: Intractable plantar keratosis: a review of surgical corrections. *J Am Podiatry Assoc* 68: 377-386, 1978.
2. Addante J: Metatarsal osteotomy as a surgical approach to the elimination of plantar keratosis. *J Foot Surg* 8: 36-38, 1968.



Fig. 1B. Pre-operative appearance of right foot with digital contractures and lesser metatarsalgia and post-operative appearance of left foot following digital stabilization.

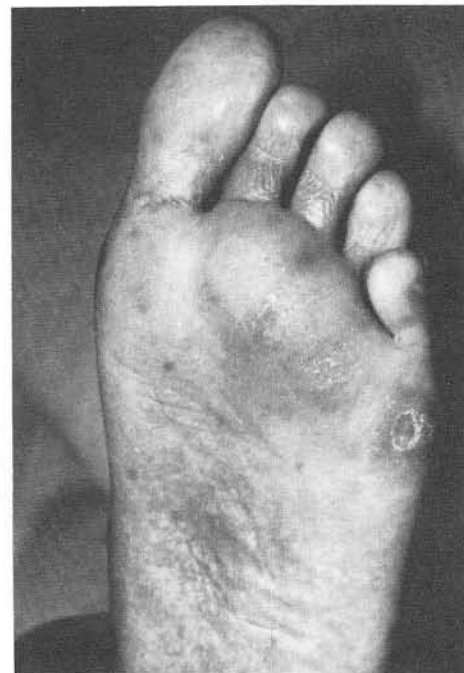


Fig. 1C. Resolution of punctate plantar keratoses left foot.

3. Young D, Hugar D: Evaluation of the V-osteotomy as a procedure to alleviate the intractable plantar keratoma. *J Foot Surg* 19: 187-198, 1980.
4. Scranton PE: Metatarsalgia: diagnosis and treatment. *J Bone Joint Surg* 63A: 723-731, 1980.
5. Costa A: Delayed union in metatarsal osteotomies. *J Foot Surg* 16: 127-131, 1977.
6. Hart D, Hart T: Iatrogenic metatarsal coalition: a postoperative complication of adjacent V-osteotomies. *J Foot Surg* 24: 205-208, 1985.
7. Grundy M, et al: An investigation of the centers of pressure under the foot while walking. *J Bone Joint Surg* 57B: 98-103, 1975.