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Original Research

A Modified Fixation Technique for a Decompressional Shortening Osteotomy: A Retrospective Analysis

Jessica L. Herzog, DPM, AACFAS [1], W. David Goforth, DPM, AACFAS [1], Paul A. Stone, DPM, FACFAS [2], Matthew H. Paden, DPM, FACFAS [3]

[1] Resident, Highlands-Presbyterian/St. Luke's Podiatric Medicine and Surgery Residency Program, Colorado Health Foundation, Denver, CO
[2] Director of Research, Highlands-Presbyterian/St. Luke's Podiatric Medicine and Surgery Residency Program, Colorado Health Foundation, Denver, CO
[3] Program Director, Highlands-Presbyterian/St. Luke's Podiatric Medicine and Surgery Residency Program, Colorado Health Foundation, Denver, CO

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ABSTRACT

A long metatarsal and/or metatarsophalangeal joint dislocation associated with a digital contracture is a surgical challenge. Without appropriate surgical correction, the patient will be predisposed to numerous complications, including persistent subluxation or dislocation, recurrent metatarsalgia, dorsiflexory contracture of the digit, transfer lesions, and inadequate pain relief. The results of the present surgical treatment options have varied, with the most common complication being a floating toe. The purpose of our study was to introduce a decompression, shortening, lesser metatarsal osteotomy with a modified fixation technique using a T-plate and to report our results. Additionally, we have discussed trigonometric analysis of metatarsal declination and shortening. We retrospectively reviewed the outcomes of 30 consecutive patients with 33 osteotomies who had been treated surgically for pathologic features associated with a long metatarsal and varying biomechanical abnormalities. Before surgery, all the patients had been treated conservatively for a minimum of 3 months. The surgical procedure included a dorsal to plantar V-shaped shortening osteotomy of a lesser metatarsal that was fixated with a T plate. The patients were assessed radiographically and using the American Orthopaedic Foot and Ankle Society Lesser Metatarsophalangeal–Interphalangeal Scale and visual analog scale. The mean age at surgery was 53 (range 37 to 75) years, with a mean follow-up period of 9.1 (range 6 to 15.4) months. The average shortening of the metatarsal was 2.7 mm. One patient (3%) had had asymptomatic delayed union and 2 patients (6%) hypertrophic nonunion. No incidence of malunion or avascular necrosis was identified. Five cases (15.2%) of hardware failure occurred. The mean American Orthopaedic Foot and Ankle Society score was 76.7 postoperatively. The visual analog scale score had improved from 6.7 to 1.7. Of the 30 patients, 72% rated the overall surgical experience as excellent or good. In conclusion, the modified fixation technique for decompression, shortening metatarsal osteotomy using a T plate is a viable option when choosing a procedure to address a long, prominent metatarsal and/or digital contracture at the metatarsophalangeal joint and results in a low incidence of floating toe complications.

A long, prominent metatarsal and/or digital contracture at the level of the metatarsophalangeal joint (MTPJ) can be a surgical dilemma when addressing deformities of the first ray or attempting to re-establish the normal metatarsal parabola. If the issue is not addressed, patients can experience the painful and debilitating condition so vaguely termed "metatarsalgia." Numerous procedures have been described to address the parabola of metatarsal length and the subsequent abnormal weightbearing stresses. Villadot (1) identified 3 types of normal metatarsal length patterns. The most common pattern (56%) has been the index minus foot with a length pattern of $1 < 2 > 3 > 4 > 5$. The index plus–minus foot pattern (28%) is $1 \geq 2 > 3 > 4 > 5$. Finally, the index plus foot pattern (16%) is $1 > 2 > 3 > 4 > 5$.

A vast array of research has been performed to determine which metatarsal osteotomy and fixation could offer the most simplistic technique, reliable results, and best patient satisfaction. Some of the more commonly described procedures have included the distal, oblique Helal osteotomy (2); the double V-neck Jacoby osteotomy (3); the basilar dorsally based wedge Mau (4); the proximal V; and the Weil osteotomy (5). Regardless of the procedure choice, the outcomes can be fraught with complications. These have included recurrent

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Address correspondence to: Paul A. Stone, DPM, FACFAS, Highlands-Presbyterian/St. Luke's Podiatric Medicine and Surgery Residency Program, Colorado Health Foundation, 1721 East 19th Avenue, #520, Denver, CO 80218.
E-mail address: pstonehighlandspslresidency@comcast.net (P.A. Stone).

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Fig. 1. Dissection is extended down to bone between the long and short extensor tendons, exposing the dorsal aspect of the metatarsal. Care should be taken not to disrupt the intra-articular metatarsophalangeal joint structures.

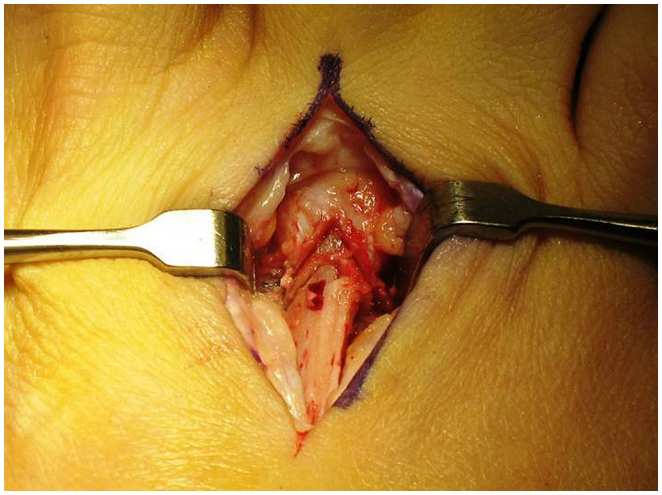

Fig. 2. The osteotomy is made at the neck of the metatarsal just proximal to the plantar condyles of the metatarsal.

metatarsalgia, transfer lesions, malunion or nonunion, and the lack of toe purchase, described as a floating toe.

Since its introduction in the 1990s, the Weil osteotomy has been a well-established surgical technique for the treatment of metatarsalgia. However, it has commonly been associated with the complication of a floating toe. A review by Highlander et al (6) studying the data from 1,131 Weil procedures found the most common complication to be a floating toe, with a 36% incidence. Trnka et al (7) analyzed the incidence of dorsiflexion contracture after Weil osteotomy and concluded that depression of the plantar fragment occurs after a Weil osteotomy. This depression changes the center of rotation of the MTPJ, and the interosseous muscles then act more as dorsiflexors than as plantar flexors. Kummer and Jahss (8) and Lauf and Weinraub (9) described mathematical and trigonometric analyses that might better help predict this change in the level of the metatarsal head.

The purpose of our study was to introduce a decompression, shortening, lesser metatarsal osteotomy with a modified fixation technique using a T-plate and report our results. In addition, we have described the trigonometric analysis that can explain the amount of metatarsal elevation one can expect with our described osteotomy.

Patients and Methods

A retrospective analysis of radiographs and subjective data from 30 consecutive patients (33 procedures) who had been treated surgically for a long metatarsal and/or associated dislocated MTPJ was performed. All surgeries had been performed by 1 surgeon. All patients had undergone various conservative modalities for a minimum of 3 months, with inadequate symptom relief. The exclusion criteria consisted of previous metatarsal surgery, rheumatoid disease, and neuropathic feet. Patients were not excluded if they had undergone previous foot surgery not involving the metatarsal nor if additional procedures had been performed concurrent with the decompression osteotomy. The mean age at surgery was 53 (range 37 to 75) years. Of the 30 patients, 28 were females and 2 were males; 3 patients had undergone 2 osteotomies each. We concurrently addressed hallux valgus, hallux limitus, hammertoes, and equinus deformities. The concomitant procedures included 9 first metatarsal head or shaft osteotomies, 5 first metatarsal closing base wedge osteotomies, 6 first metatarsal–cuneiform fusions, 14 osseous hammertoe corrections, 5 soft tissue hammertoe corrections, and 1 gastrocnemius recession.

Surgical Technique

With the patient supine, a longitudinal incision is made over the metatarsal while carefully retracting the neurovascular structures. The incision is extended down to the bone between the long and short extensor tendons, exposing the dorsal aspect of the metatarsal (Fig. 1). The T-plate is positioned on the metatarsal for temporary placement of the distal screws before performing the osteotomy. The location of the planned osteotomy was at the metatarsal neck, just proximal to the metatarsal condyles. The 2 locking screws at the top of the T are inserted distal to the osteotomy site. These 2 screws and the plate are subsequently removed to perform the osteotomy. Early during the study period, we did not preplace the distal screw holes. Temporary placement of the plate and distal screws before performing the osteotomy obviated the need to place the screws in an unstable capital fragment and eased the technical performance of the procedure. With an oscillating saw, the dorsal to plantar V osteotomy is performed at approximately 45°, oriented perpendicular to the metatarsal and with the apex located distally. A second V osteotomy is made just proximal and parallel to the first osteotomy at both wings, removing a V wedge of bone approximately 2 mm in thickness (Figs. 2 and 3). The size of the wedge can be adjusted according to the length of the metatarsal and patient foot structure. The capital fragment then decompresses this distance. The metatarsal length is then checked using intraoperative fluoroscopy to assess the metatarsal parabola before final fixation.

For fixation, we first used the VariAx® Hand 6-hole Locking T-plate (Stryker®, Kalamazoo, MI) from the small bone plating system. This plate is constructed from titanium, is available in 1.7- and 2.3-mm sizes, and can be cut to the proper length. We first used the 1.7-mm plate and then changed to the 2.3-mm plate because of hardware failure. Distally, at the top of the T, we placed two 2.3-mm locking screws. Proximally, 2.3-mm nonlocking screws were placed. The hole at the level of the osteotomy site just proximal to the T was left unfilled (Fig. 4). Four of the 1.7-mm plates and 16 of the 2.3-mm plates were used. Later in our research, we changed the fixation system to the Modular Mini Fragment LCP® System (Synthes®, West Chester, PA). The stainless steel plate is available in 2.0-, 2.4-, and 2.7-mm screw sizes and can be cut to the proper

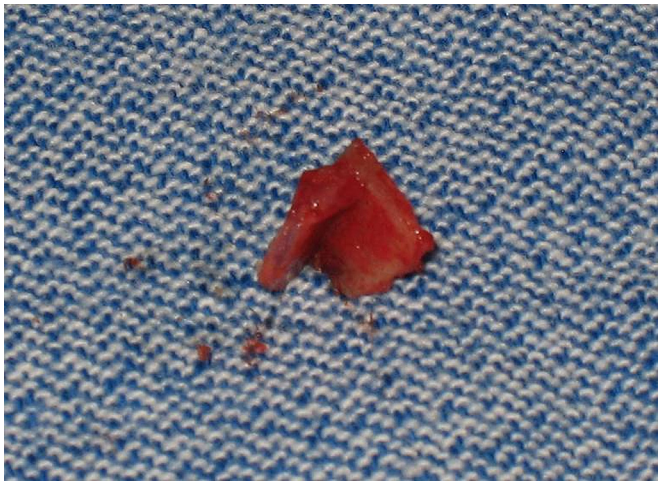

Fig. 3. The segment of bone removed from the osteotomy site.