



Contents lists available at ScienceDirect

The Journal of Foot & Ankle Surgery

journal homepage: www.jfas.org

Lesser Metatarsophalangeal Joint Pathology Addressed With Arthrodesis: A Case Series



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ARTICLE INFO

Level of Clinical Evidence: 4

Keywords:

arthritis
deviation
plantar plate
syndrome predislocation
toe

ABSTRACT

Lesser metatarsophalangeal joint pathology is a common condition facing the foot and ankle surgeon, often beginning as a mild subluxation of the toe and progressing to a full dislocation of the metatarsophalangeal joint. In severe or recalcitrant deformities, traditional conservative and surgical methods can fail to resolve the issue. We report on 4 patients with 5 severely dislocated lesser metatarsophalangeal joints with varied etiologies and comorbidities who underwent arthrodesis of these joints using screw and plate fixation. All patients achieved radiographic and clinical signs of union at an average of 16.4 weeks.

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Lesser metatarsophalangeal (MTP) joint pathology is a complex and multifactorial issue. There are many causes of pain and subluxation/dislocation at these joints, including trauma, avascular necrosis, inflammatory arthropathies, infection, congenital conditions, and biomechanical abnormalities (1–14). The pathomechanics of the foot and the progression of the disease from predislocation syndrome to cross-over toe deformity and dislocation have been intensely studied in the literature (9,13,15).

Stability of the lesser MTP joints is accomplished through a combination of static and dynamic resistance. The most stabilizing structure of the lesser MTP joints is the plantar plate (16). This fibrocartilagenous structure originates at the plantar aspect of the metatarsal just proximal to the articular surface as a continuation of the plantar fascia (17). It attaches strongly to the plantar aspect of the proximal phalanx and works directly in static resistance to hold the toe in a rectus position. It is also indirectly involved in dynamic resistance through its attachments to the intrinsic and extrinsic tendons of the foot (15,17,18). The plantar plate is a continuation of the plantar fascia. Acting together, they contribute to the windlass mechanism during the propulsive phase of gait. With attenuation/rupture of the plantar plate or the surrounding collateral ligaments, the joint loses stability. This instability can lead to many clinical issues, such as pain and subluxation/dislocation

of the toe with or without medial/lateral deviation (13). Damage to the cartilaginous surfaces of the metatarsal head and the proximal phalanx through trauma, systemic arthropathies such as rheumatoid arthritis, avascular necrosis, and infection can lead to arthritic pain even without associated soft tissue damage (4–8).

Yu et al (13) first reported on the “predislocation syndrome” to describe instability of the joint as a result of attenuation/rupture of the plantar plate. They developed a classification system to describe their findings: stage 1, mild edema and extreme tenderness of the joint without anatomic malalignment; stage 2, moderate edema of the toe with radiographic and clinical deviation of the digit; and stage 3, moderate edema of the toe with more pronounced deviation of the toe and with or without subluxation/dislocation. Coughlin et al (19) have published extensively on the topic and described a classification system to grade plantar plate tears from mild attenuation to complete tears with dislocation of the toe. Coughlin (12) described 2 major patient groups that suffer from plantar plate issues, which included sedentary middle-aged women and young athletic men and women. He suggested that long-term heel use may predispose middle-aged women to plantar plate disruption. In many patients, this instability can be a result of biomechanical deformities including an elongated second metatarsal and can be corrected with a shortening osteotomy as described by Weil et al (15,20).

Conservative measures often prove to be inadequate in the presence of a true plantar plate disruption or failure (21,22). A variety of surgical approaches have been studied. Both joint salvage and joint destructive procedures have been advocated depending on the stage of the disease.

Financial Disclosure: None reported.

Conflict of Interest: None reported.

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Many of the surgical methods that have been described are aimed at correcting the underlying pathology that has caused the joint disease through direct plantar plate repair, shortening metatarsal osteotomies, and/or tendon transfers. However, one of the major issues encountered with anatomic correction in the more advanced cases is the persistence or recurrence of the deformity and associated recalcitrant pain (23–26). In these situations, joint destructive procedures are often required. Despite successful outcomes of first MTP joint fusion, few reports have been published regarding arthrodesis for lesser MTP joints (27–30). To our knowledge and after a literature review, there have been 2 retrospective case series published that have described techniques and outcomes for lesser MTP joint arthrodesis (31,32). Therefore, we present this retrospective case series to describe our surgical technique and to report our outcomes of lesser MTP joint arthrodesis. We report on 4 patients with 5 lesser MTP joint fusions. We performed the procedure on patients with varied etiologies causing lesser MTP joint deformity and persistent pain including trauma/infection (n = 1), avascular necrosis (Freiberg's infarction; n = 1), and collagen elasticity disorders (n = 2).

Patients and Methods

Operative Technique

Each patient was placed on the operative table in the supine position. Sedation with local anesthesia was used for all cases. An ankle tourniquet set at 225 mm Hg was used in all cases. A curvilinear incision was made over the involved lesser MTP joint. The incision was carried distally if simultaneous proximal interphalangeal joint (PIPJ) arthrodesis was performed. A z-lengthening of the extensor digitorum longus tendon at the proximal edge of skin incision was performed. Dissection was bluntly carried down to the MTP joint. Sharp dissection was carried through the capsule and extensor hood. A McGlamry elevator was used to release the plantar lesser MTP joint adhesions. After the MTP joint was exposed, the joint surfaces were prepared by removing the cartilage of the base of the proximal phalanx and the head of the operative metatarsal in a reciprocal fashion with a small osteotome and rongeur. Subchondral drilling was performed after cartilage removal with a 0.045 Kirschner wire. The lesser MTP joints were fused in 0° in the transverse and frontal planes. The sagittal plane position was determined by the sagittal position of the adjacent lesser MTP joints, between 5° and 15° of dorsiflexion. A straight locking plate with a minimum of 2 screws on both sides of the joint was placed from dorsal to plantar in typical locking fashion using 1.5-mm or 2.0-mm screws of varying lengths, between 8 and 14 mm. A PIPJ arthrodesis was performed in the usual fashion and fixated with a 1.5-mm cannulated screw if needed. Of these 4 patients, 2 had bone matrix allograft interposed in the arthrodesis site (Table 1).

After the surgery, the patients were followed by the operating surgeon. Demographic characteristics, etiology of the MTPJ pathology, adjunct procedures, complications, radiographic features of the arthrodesis, and the duration of follow up were thereafter considered in the retrospective study.

Results

The group in this series consisted of 1 (25%) male and 3 (75%) females with 1 (35%) bilateral case. The mean average age was 62.3 (range 44 to 74) years. The mean body mass index was 26.2 (range 22 to 32.6). The mean duration of follow-up time was 21 (range 15 to 34) months. None of the patients were smokers. The activity level of the

patients varied greatly. The 3 female patients were retired but active walkers. And at the time of surgery, the male patient was an active duty police officer.

There were multiple etiologies for the lesser MTP joint pathology. One (25%) patient, a 44-year-old male, suffered a traumatic fall, impacting directly on the second MTP joint. This injury resulted in a rigidly dislocated second toe. The patient underwent 2 failed direct joint relocating procedures by another provider; he developed infections postoperatively after both procedures. This complication led to further damage of the cartilaginous structures of the joint. Another patient (25%), a 74-year-old female, had avascular necrosis of the third MTP joint with total joint destruction, chronic pain, and joint dislocation. The remaining 2 (50%) patients had initially undiagnosed collagen elasticity disorders, later diagnosed by a specialist, resulting in dorsal dislocation of the second MTP joints. Concurrently, 1 (25%) of these 2 patients had a hallux varus deformity and the other had a severe hallux abductovalgus deformity (Figs. 1, 2, and 3). The surgical technique for the lesser MTP joint arthrodesis procedure in all these patients were the same as that described elsewhere in this article.

Several adjunctive procedures were also performed, including first MTP joint arthrodesis, hallux interphalangeal joint arthrodesis, arthroplasties or arthrodesis of the lesser toes at the PIPJ, metatarsal shortening osteotomies, plantar plate repair of unrelated lesser MTP joints, and tendon lengthening procedures.

One (25%) patient developed a superficial necrosis of the distal aspect of the involved toe that resolved with local wound care. There was 1 (25%) patient with a minor incision dehiscence that resolved with local wound care. There was 1 (25%) patient with nonunion of the involved joint that resulted in broken, painful hardware. This patient underwent a revision procedure with bone allografting and went on to radiographic and clinical union. There were no postoperative infections and no hypertrophic scar formations. The mean time to radiographic union was 16.4 weeks (Table 1). All patients achieved radiographic and clinical unions.

Discussion

Lesser MTP joint subluxation/dislocation is a complex and difficult issue for the foot and ankle surgeon to address. This issue becomes even more difficult to address in severe deformities with complicating factors or comorbidities, as described in our case series. There are multiple anatomic structures that play a role in stabilizing the lesser MTP joints and when these structures are damaged or continually degenerate, the toe will classically begin to deviate and ultimately dislocate. In many mild to moderate cases, this situation can be addressed with traditional surgical techniques. Most recently, direct plantar plate repair with or without a metatarsal osteotomy has become an anatomically sound method for correcting the deformity (23,26,33–35). Cook et al (36) have recently published a case control study that retrospectively compares direct, anatomic repair of the plantar plate structure with

Table
Summary of procedures and time to radiographic union (N = 5 fusions in 4 patients)

Patient	Age (y)	Gender	MTP Arthrodesis	Adjunct Procedures	Graft	Radiographic Union (wk)	BMI	Duration of Follow-up (mo)
1a	64	Female	Left second MTP joint	First MTP joint arthrodesis, second and third toe PIPJ arthrodesis	Auto/allograft	6	25.7	34
1b	67	Female	Right second MTP joint	First MTP joint arthrodesis, second and third toe PIPJ arthrodesis	None	6	25.7	19
2	44	Male	Left second MTP joint	Hallux IPJ arthrodesis, EHL lengthening, second toe PIPJ arthrodesis, third MTP joint Weil and PP repair	Allograft	26	32.6	15
3	67	Female	Left second MTP joint	Third EHL lengthening	None	28	24.6	18
4	74	Female	Left third MTP joint	Second and third PIPJ arthrodesis, second and fourth EHL lengthening	None	16	22	22

Abbreviations: BMI, body mass index; EHL, extensor hallucis longus; IPJ, interphalangeal joint; MTP, metatarsophalangeal; PP, plantar plate; PIPJ, proximal interphalangeal joint.



Fig. 1. Preoperative image of the right foot of a 68-year-old female with a severely dislocated second metatarsophalangeal joint with a severe hallux abductovalgus deformity. (A) Preoperative clinical view. (B) Preoperative anteroposterior radiograph.

more traditional capsule-tendon balancing procedures. The traditional balancing procedures included MTP joint capsulotomy, capsulorrhaphy, plantar plate release, extensor hood releases, arthrodesis of PIPJ, Z-tendon lengthening, skin lengthening procedures, flexor tendon transfers, pinning, and osteotomies of the metatarsal. The anatomic repair involved a dorsal approach to the plantar plate with plication of the tissue and reattachment to the proximal phalanx with physiologic tension. The primary outcome finding of this study was that the anatomic plantar plate repair group had 94% digital stability compared with the control group of traditional rebalancing procedures that had 60% digital stability (36). However, when these joint salvage procedures fail,

or when there is severe destruction of the cartilage, joint destructive procedures may be considered (37).

After a literature search, we came across only 1 report regarding isolated lesser MTP joint fusion as a means to resolve recalcitrant and severe deformities (31). Karlock (31) reported on 11 patients in whom he performed a second MTP joint arthrodesis with a 0.062 Kirschner wire and dorsal bone staple. For fusion position, the toe was held in slight dorsiflexion with parallel alignment to the hallux and with correction of any frontal plane rotation that was present. The patients were followed for an average of 19 months; 10 of the 11 patients reported good to excellent results and stated they would undergo the procedure again. A poor result was reported by



Fig. 2. Postoperative image of the 68-year-old female depicted in Fig. 1, status post first and second metatarsophalangeal joint arthrodesis with second and third proximal interphalangeal joint arthrodesis. (A) Postoperative clinical view. (B) Postoperative anteroposterior radiograph.



Fig. 3. (A) Preoperative and (B) postoperative anteroposterior radiographs of a third metatarsophalangeal joint arthrodesis in a 74-year-old female with history of Freiberg's infraction necrosis.

1 patient. Evidence of radiographic and clinical fusion at the final postoperative visit was seen in 10 of these 11 patients. An asymptomatic nonunion was seen in 1 patient and 1 patient had a symptomatic fracture of the distal aspect of the proximal phalanx. Karlock (31) concluded that this surgical procedure was a viable option in severe crossover toe deformities and as a direct alternative to amputation.

Hirose et al (32) presented an expert opinion case review of 5 patients who underwent a combined first and second MTP joint arthrodesis procedure for intractable second MTP joint pain. They specifically reported on a case of a 60-year-old female who had 2 prior joint salvaging procedures to correct a painful hallux valgus and second claw toe deformity with recalcitrant pain. The authors performed a first and second MTP joint fusion. They used reamers to denude the second MTP joint and fused the joint so that the second toe was spaced evenly between the first and third toes. They fixated the fusion site with a lag screw and dorsal plate. The single patient reported reduction in pain and the Coughlin satisfaction score was rated as excellent.

The typical clinical presentation of early predislocation syndrome is focal pain at the plantar aspect of the lesser MTP joint with increased pain on ambulation that increases with greater attenuation/rupture of the plantar plate. Yu et al (13) stated anecdotally that many patients also reported a recent minor trauma to the area. As the disease progresses, a variety of other pathologies may arise as a way to compensate for lesser MTP joint pain. In an effort to off-load the MTP joints, patients instinctively ambulate on the lateral aspect of their foot, placing increased pressure along the lateral column and the calcaneal-cuboid joint leading to compensatory pain in this area (13). On physical examination, a vertical stress test of the MTP joint will often be positive and is pathognomic for MTP joint instability (38). While holding the toe in 20° to 25° of dorsiflexion at the MTP joint, the vertical stress test is performed by attempting to translate the toe dorsally. If 2 mm of dorsal displacement occurs, it is considered a positive test (38). As the disease progresses, it often leads to a rigid crossover toe deformity (13).

Although many surgical procedures have been described, recurrence rates in joint salvage procedures have been an issue. Prissel et al (23) reported on 144 toes that underwent plantar plate repair from a plantar approach with or without a Weil osteotomy, but reported a 7.6% recurrence rate at the final follow-up visit. A review article by Highlander et al (24) evaluating the complications of Weil osteotomies showed a 15% recurrence rate. In an article by Haddad et al (25) comparing the results of an EDB tendon transfer and a flexor-to-extensor tendon transfer, it was found that 2 of 19 EDB tendon transfers had recurrence of the crossover toe deformity. A 7-year follow-up evaluation of Weil osteotomies showed 3 recurrences of subluxed or dislocated MTP joints at 7 years in 25 feet. Persistently elevated lesser digits can be uncomfortable for patients and can result in increased plantar pressures (26).

Joint destructive procedures have been advocated for the severe deformity. Conklin and Smith (37) reported on basal hemiphalangectomy of the proximal phalanx in atypical lesser toe deformities, but reported a 29% dissatisfaction rate with the procedure. Other articles have also described this technique, but recurrence of the deformity remains a concern (38–42). Implant arthroplasties of the lesser MTP joints have shown mixed results. Cracchiolo et al (43) reported a 63% subjective patient satisfaction, with transfer metatarsalgia being the main complication. In addition, amputation of the involved toe has been described, but the main concern with this procedure is subsequent drifting of the remaining lesser toes in the transverse plane (44).

In this case series, we reviewed 4 patients and 5 lesser MTP joints that underwent arthrodesis to correct for recurrent or severe abnormalities with long-standing deformity of the lesser MTP joints. The pathology in these patients had a variety of etiologies and all had risk factors for recurrence and potential for undesirable, suboptimal results if the lesser MTP joint arthrodesis procedure had not been performed. In 1 case, multiple joint salvage procedures were performed by a different provider and failed to correct the deformity in the long term. We believe that lesser MTP joint arthrodesis is a viable surgical option, but should be reserved for severe, recalcitrant deformities. All 4 patients eventually went on to complete radiographic and clinical union of the fusion site. There has been no recurrence of the deformity at an average of 21 months.

The limitations of this study include the lack of long-term follow-up and limited case numbers. Further research should be performed to evaluate a larger patient cohort to determine if this procedure should be performed more widely and if it provides long-term, viable outcomes. Other limitations include that all procedures were performed by a single surgeon (primary author) and that same author determined radiographic union. Post operative patient interviews were conducted by all the authors.

In conclusion, this is a case series review of 4 patients and 5 severely dislocated lesser MTP joints with associated complicating factors and comorbidities that were corrected with arthrodesis. This study suggests that arthrodesis of the lesser MTP joints is a viable option in severe or recalcitrant deformities in patients with varied etiologies. We realize that a review of 4 cases can only serve to describe the outcomes that we observed and serve to aid future investigators in their efforts to more rigorously investigate the results of lesser MTP joint fusion surgery for the treatment of persistent pain and deformity; no strong association can be inferred. In our experience, lesser MTP joint fusion has been successful in severe and recalcitrant cases of MTP joint instability in select patients.

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