

# Lesser Metatarsophalangeal Joint Instability



## Advancements in Plantar Plate Reconstruction

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### KEYWORDS

- Plantar plate • Collateral ligaments • Lesser metatarsophalangeal joint
- Lesser metatarsophalangeal joint instability • Plantar plate repair

### KEY POINTS

- The plantar plate and collateral ligaments are the primary stabilizers of the lesser metatarsophalangeal joints.
- Clinical history and examination is very reliable for diagnosing plantar plate pathology.
- Beyond plain radiographs, MRI should be reserved for ambiguous cases, and arthrogram with fluoroscopy and concomitant corticosteroid injection can be both diagnostic and therapeutic.
- The dorsal approach avoids a plantar scar and permits substantial flexibility with additional procedures including extensor tendon lengthening, Weil osteotomy, hammertoe correction, and a flexor-to-extensor transfer if the plantar plate is irreparable.
- The clinical results of a dorsal approach to plantar plate repairs are promising with respect to pain relief and patient satisfaction.

### INTRODUCTION

Plantar plate tears have been established as an underlying pathology for a range of lesser metatarsophalangeal (MTP) conditions including synovitis, metatarsalgia, instability, frank dislocation, crossover toe, and interphalangeal toe pathology, such as hammertoe and claw toe.<sup>1–3</sup> Anatomic and biomechanical studies have demonstrated the plantar plate and collateral ligaments to be the primary stabilizers of the lesser MTP joints.<sup>4–8</sup> Lesser MTP pathology that may have been previously treated with some combination of extensor tendon lengthening, MTP soft tissue release, Weil

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Disclosures: Dr F. Nickisch receives royalties from Smith and Nephew for the Hat-Trick Lesser Toe Repair System. Drs R.Y. Hsu and A. Barg have nothing to disclose.

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Foot Ankle Clin N Am 23 (2018) 127–143

<https://doi.org/10.1016/j.fcl.2017.09.009>

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osteotomy, flexor-to-extensor transfer, and K-wire transfixion, and may now be treated more anatomically by incorporating a plantar plate repair.<sup>1,2</sup> As clinical experience with plantar plate repair grows, the indications, role, and outcomes are becoming better defined.<sup>9–12</sup>

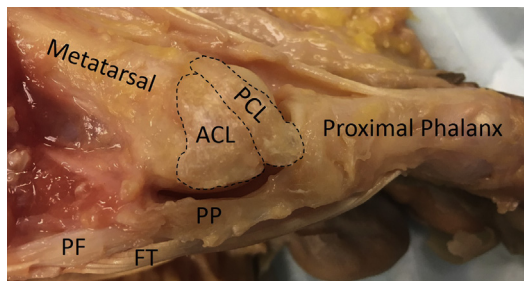
## ANATOMY AND BIOMECHANICS

### *Plantar Plate*

The normal anatomy of the plantar plate has been well-characterized in cadaveric studies (**Fig. 1**).<sup>4,5</sup> The normal plantar plate is a flexible but inelastic structure on average 19 mm in length and 2 mm thick.<sup>4,5</sup> It is trapezoidal in shape with an average width proximally of 11 mm at its metatarsal attachment and 9 mm at its proximal phalangeal attachment.<sup>5</sup> The dorsal aspect of the normal plantar plate is described as “articular appearing,” essentially an extension of the concave articular surface of the proximal phalanx, cupping the metatarsal head.<sup>4</sup> The plantar aspect of the plantar plate is centrally grooved, forming the dorsal aspect of the flexor tendon sheaths (**Fig. 2**).<sup>4,5</sup> Correspondingly, the medial and lateral aspects of the plantar plate are thicker than the central portion.<sup>4,5</sup>

Distally, the plantar plate has a firm fibrous attachment directly into the proximal phalanx immediately adjacent to the articular surface (**Fig. 3**).<sup>4,5,13</sup> Proximally, the direct attachment to the metatarsal just proximal to the articular surface has the appearance of thin connective tissue grossly and synovial tissue histologically.<sup>4,5</sup> Based on appearance alone, the mechanical contribution of this direct proximal attachment may be negligible. The accessory collateral ligaments provide a stouter indirect connection between the metatarsal and the plantar plate, creating a sling that supports the metatarsal head.<sup>4,5</sup> The other proximal mechanically relevant connections are primarily from other soft tissue structures. The plantar fascia terminates on stout insertions into the proximal plantar plate.<sup>4</sup> The deep transverse metatarsal ligaments span across adjacent plantar plates confluent with the plantar fibers of the proximal two-thirds of each plate, providing even more proximal restraint.<sup>4,5,14</sup> The lumbricals and interossei insert on the proximal phalanx, but also have fibers inserting into the distal plantar plate.<sup>4,5</sup>

Histologically, the plantar plate is fibrocartilage with the majority of fibers running longitudinally with some interwoven oblique fibers.<sup>4,5</sup> The collagen is 75% type 1 and there is minimal to no elastin.<sup>4,5</sup> Proximally, in the plantar one-third, fibers are positioned transversely, continuous with the deep transverse metatarsal ligament.<sup>4</sup>



**Fig. 1.** Medial dissection of a lesser metatarsophalangeal joint with the proper collateral ligament (PCL) released from the proximal phalanx and accessory collateral ligament (ACL) released from the plantar plate (PP). The attachment of the distal plantar fascia (PF) to the PP and relative position of the flexor tendons (FT) is also demonstrated.

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