Plantar Plate Repair of the Second Metatarsophalangeal Joint: Technique and Tips

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Since diagnostic arthrography of the second metatarsophalangeal joint (MTPJ) has been popularized by Karpman and MacCollum (1), the relationship between plantar plate integrity and digital instability is better understood. Yao et al (2) suggested that an arthrogram of the second MTPJ exhibiting opacification of the flexor tendon sheath is pathognomonic for a plantar plate tear. The plantar plate is the principal stabilizer of the MTPJ and any compromise to its integrity creates instability to the joint (3–5). The plantar plate stabilizes the lesser toes via the plantar fascia windlass mechanism. Insufficiency of the plantar plate is implicated in the pathogenesis of chronic MTPJ and toe subluxation/dislocation. Primary repair of the plantar plate has been gaining attention recently and has been advocated for tears or ruptures that result in instability to the MTPJ (6–8). Powless and Elze (7) have included plantar plate tears in their classification system of lesser MTPJ capsular tears. The technique for isolated primary plantar plate repair of the lesser MTPJ is limited in the literature.

Indications and Diagnosis

Isolated primary repair of the plantar plate has limited indications. It is reserved for a torn, ruptured, or attenuated plantar plate resulting in digital sagittal instability with a reducible MTPJ. An unstable MTPJ is clinically identified with a modified Lachman dorsal drawer test showing either 2 mm or 50% dorsal joint displacement at the MTPJ (9). Transverse plane instability may also be visualized with weightbearing; however, there is not an accepted clinical maneuver to quantify this problem. More often, transverse plane instability occurs in conjunction with sagittal plane instability. Additionally, clinical instability at the MTPJ is not pathognomonic for a plantar plate rupture. This may be identified in patients with ligamentous laxity and chronic plantar plate attenuation.

The authors believe that reduction of the digit at the MTPJ with a Kelikian push-up test is the strongest diagnostic predictor of postsurgical outcome. Isolated plantar plate repair is most successful in digits with a reducible MTPJ. A semireducible MTPJ may require concomitant procedures to reduce the deformity, such as a dorsal capsular release, extensor tendon lengthening, collateral ligament release, and/or possibly metatarsal shortening osteotomy (9, 10). Depending on the degree of reducibility, the authors may instead perform a flexor tendon transfer to the toe because digital circulation may be compromised with large dorsal and plantar dissections around the MTPJ. Flexor tendon transfers have been found to successfully stabilize the unstable MTPJ but are criticized for causing stiffness and prolonged swelling (6, 11–14).

In our experience, most damage to the plantar plate occurs in close approximation to the phalangeal base. The weakest plantar plate attachment is to the metatarsal neck via a loose synovial fold that completes this portion of the capsule (15–17). Interestingly, chronic ruptures do not occur proximally; rather, they occur near the stronger attachment into the phalanx. Based on Deland et al's (17) histologic description, a thin central area exists close to the plantar plate attachment into the phalangeal base. We have coined this area the rupture zone (Figs 1 and 2). However, further studies are needed on both a histologic and clinical level to determine the location and types of plantar plate pathology.

Conventional arthrography is the gold standard to identify incontinence of the second MTPJ. Because the plantar plate is continuous with the flexor tendon sheath, diagnosis is confirmed with an arthrogram showing extravasation of dye into the flexor sheath (1, 7, 8) (Fig 3). The integrity of the plantar plate can also be identified on magnetic reso-

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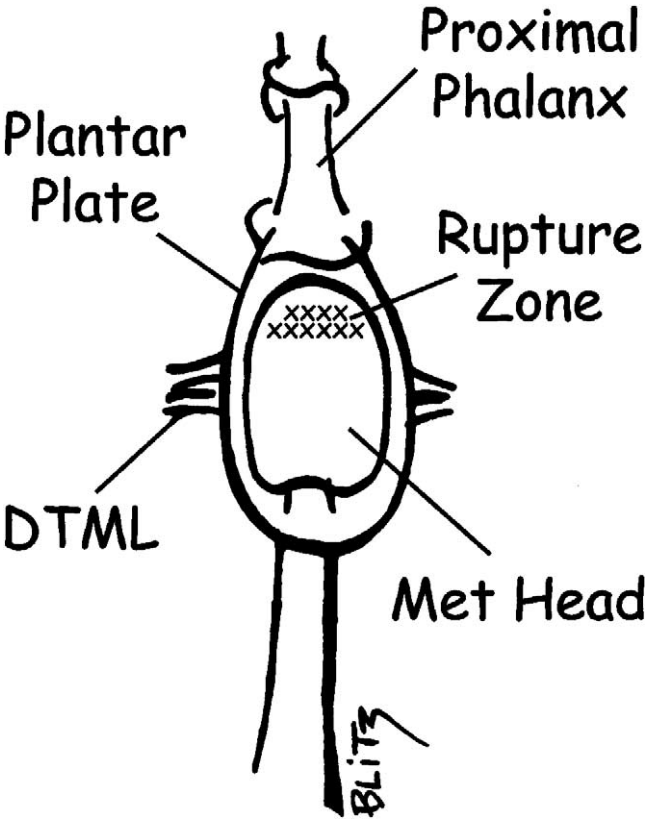

FIGURE 1 Drawing depicting the rupture zone of the plantar plate. DTML, deep transverse intermetarsal ligament; Met Head, metatarsal head.

FIGURE 2 Cadaveric specimen of the intact plantar plate. The rupture zone (X) is located just proximal to insertion of the plantar plate onto the base of the proximal phalanx (arrow). The incised flexor sheath (asterisks) is continuous with the plantar plate. The flexor tendons (arrow head) are retracted laterally.

FIGURE 3 Positive arthrogram for a plantar plate rupture exhibiting extravasation of dye into the flexor sheath.

nance imaging as a focal, intrasubstance increase in signal of the plate on a T2-weighted image (18–20). In some instances, a discrete tear may be visualized. A diagnostic examination confirming the clinical diagnosis is helpful before plantar plate repair is performed.

Surgical Technique

Repair of the plantar plate is approached through a plantar incision. The longitudinal incision is placed between the weightbearing metatarsal heads and curves more transversely at the level of the nonweightbearing sulcus and may extend onto the base of the digit to gain adequate exposure (Fig 4). Once through the skin, sharp dissection is carried down diagonally to the plantar aspect of the MTPJ. The neurovascular structures are in the intermetatarsal space and are easily avoided with this approach. The authors avoid blunt dissection because this may create excessive plantar scarring because of disruption of the organized fat septae (Fig 5). The tendon sheath of the long and short flexors is the first structure encountered. It is linearly incised, exposing the flexor tendons. Because the plantar plate forms the roof for the gliding function of the flexor tendons, an

FIGURE 4 Plantar incision placed between metatarsal heads to avoid the weightbearing surface.

FIGURE 5 Fat septae is sharply divided to minimize postoperative scarring.

obvious plantar plate lesion is immediately identified once the tendons are retracted (Fig 6).

The location, type of tear, and degree of digital deformity dictate the method of repair. Digits with mild deformity and simple tears are often repaired with a 2-0 or A 3-0 suture in a figure-eight fashion. The authors prefer an absorbable suture that does not penetrate the intraarticular portion of

FIGURE 6 Intraoperative photograph showing plantar plate rupture. The flexor tendons are retracted (arrow head). Plantar plate (asterisk) with oblique rupture, exposing the metatarsal head.

the plantar plate, although this is left to the surgeon's discretion. A tapered needle is used to prevent iatrogenic tears in the plantar plate when reapproximating the defect.

Complex or large tears are more difficult to treat with primary repair because much of the plate is involved. The diseased portion of the plate may be excised in a rectangular shape and repaired with suture (Fig 7). Tears directly adjacent to the phalangeal rim are reattached to the base of the proximal phalanx by using a bone anchor (Fig 8). In some instances, large tears require release of the collateral ligaments from the plantar plate to allow for advancement and reattachment of the plate. Chronic attenuation without tear is treated similar to a complex tear. A rectangular wedge in the plantar plate may be removed and reapproximated in a pants-over-vest fashion. Alternatively, the plantar plate may be reflected off its insertion and advanced on the proximal phalanx by using a mini-anchoring device.

Digits with a mild associated transverse plane deformity may be treated concomitantly by creating a trapezoidal

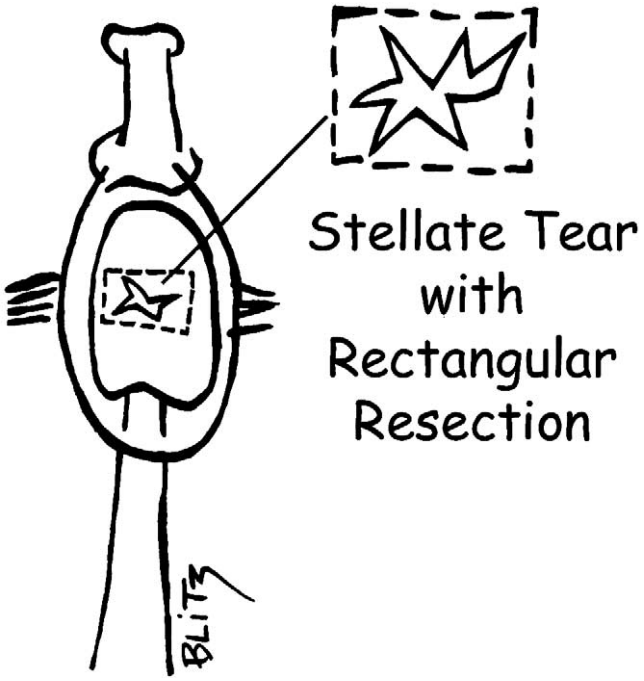

FIGURE 7 Larger or complex tears are treated by resection of the diseased portion of the tear to restore vascularity to margins before repairing the plantar plate.

shape when resecting the involved portion of the plantar plate. In many cases, a positional Kirschner wire is placed across the MTPJ until the repair has healed and it is removed at approximately 6 weeks.

In cases in which a tear may not be readily identified, the joint is distended with a methylene blue solution through a dorsal intraarticular injection. The location of the tear becomes obvious by the colored dye solution. If the dye does not extravasate from the joint, then the positive preoperative arthrogram may have been the result of iatrogenic advancement through the plate. More studies are needed to understand the variations in MTPJ arthrography results. A healed attritional tear will not show dye extravasation at the time of surgery.

After repair of the plantar plate, the flexor tendon sheath is typically not reapproximated to avoid stenosis, unless there is a strong propensity for flexor tendon subluxation. Subcutaneous closure is typically not performed to avoid unnecessary scarring. Rather, the skin and subcutaneous tissue are reapproximated together with wide vertical mattress sutures. The postoperative course involves nonweightbearing in a short-leg cast until the repair has healed, approximately 4 to 6 weeks. Complex tears are kept nonweightbearing for an additional 2 weeks. Structurally stable shoes and orthotics are usually recommended to avoid recurrence, particularly in nontraumatic causes.

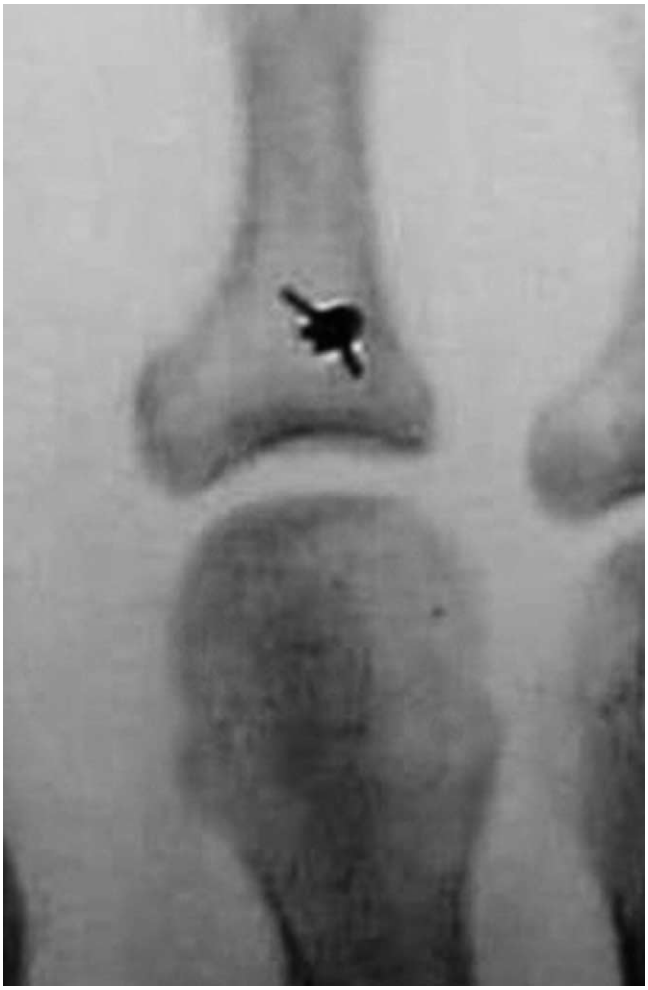

FIGURE 8 Fluoroscopic image showing placement of a small bone anchor into the base of proximal phalanx for reattachment of plantar plate.

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