

March 2011 . Volume 10 . Number 1

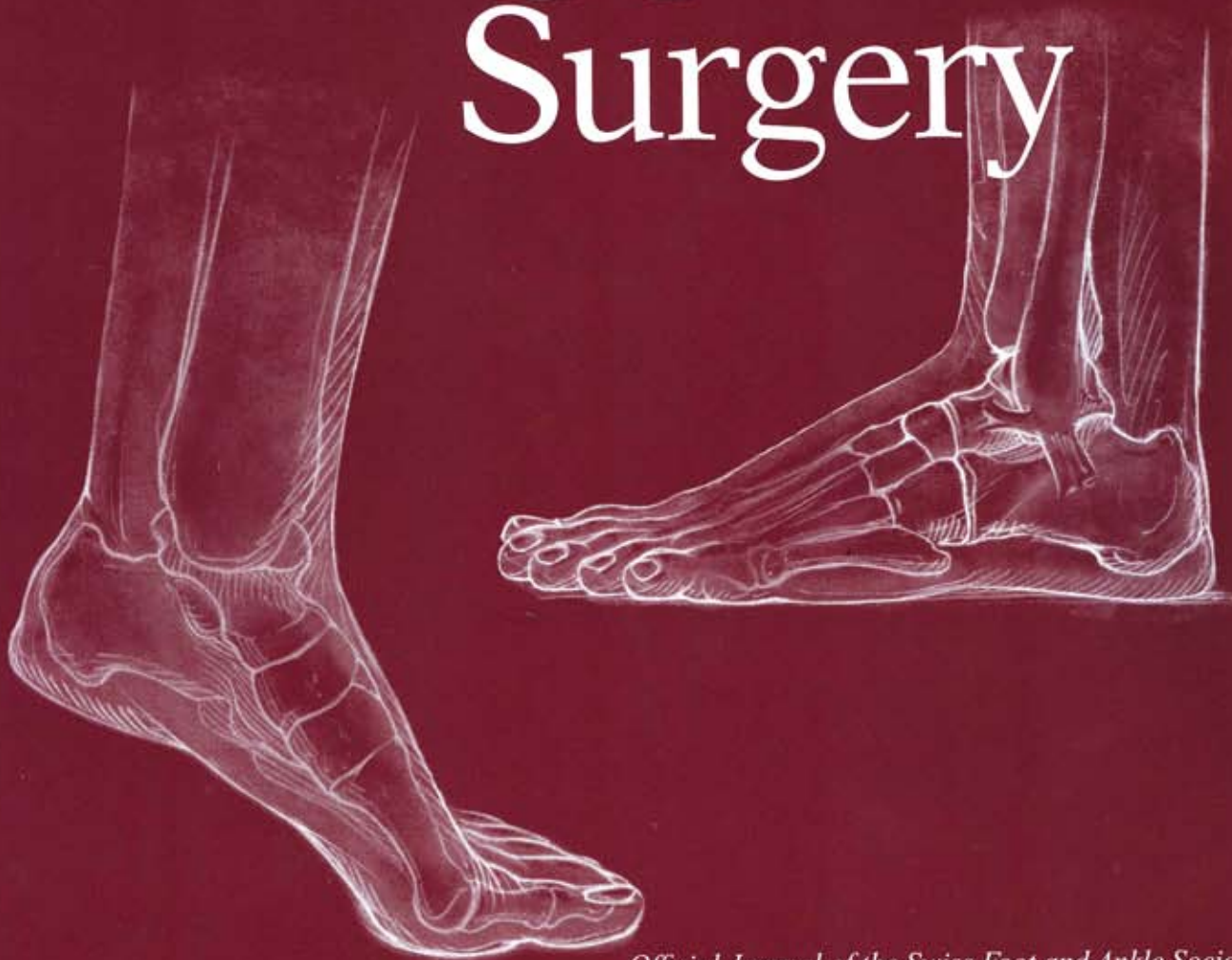
ISSN 1536-0644

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Techniques in
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Official Journal of the Swiss Foot and Ankle Society

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Corrections of Second MTP Joint Instability Using a Weil Osteotomy and Dorsal Approach Plantar Plate Repair: A New Technique

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Abstract: Second metatarsophalangeal joint instability is a challenging disorder for the foot and ankle surgeon. Abnormal metatarsal length parabola and retrograde pressure from a contracted hammertoe deformity are often cited as etiologic factors in the development of this condition. The authors believe that disruption to the plantar plate is common and should be considered for repair in conjunction with the hammertoe and metatarsal deformity. We have developed a new technique for an anatomic primary plantar plate repair using the surgical approach of a Weil metatarsal osteotomy. As the metatarsal osteotomy is performed, the plantar plate tear can be directly visualized, repaired, and anchored into the base of the proximal phalanx using nonabsorbable suture.

Key Words: plantar plate repair, metatarsalgia, metatarsophalangeal joint instability, lesser toe dislocation, Weil metatarsal osteotomy

(Tech Foot & Ankle 2011;10: 33–39)

HISTORICAL PERSPECTIVE

As the principle stabilizer of the metatarsophalangeal (MTP) joint, the integrity of the plantar plate is essential to stabilize the proximal phalanx of the lesser toes, and its attrition often results in metatarsalgia, plantar swelling, hammertoe deformity, and lesser toe subluxation.^{1–4} Earlier reported causes of plantar plate attrition include trauma,^{5,6} synovitis,³ and inflammatory arthritis.⁷ Surgical repair of plantar plate ruptures has evolved with increased appreciation of the anatomy.^{2,8–10} Primary repairs that involve direct visualization of the plantar plate injury may involve an incision through the plantar of the foot.^{11,12} Other procedures that address MTP instability can include the use of anchors,¹² extensor tendon lengthening,^{3,13,14} flexor tendon transfers,^{14–18} metatarsal osteotomies,^{19–22} and total joint implants.²³ However, there is still considerable controversy regarding the operative correction for this pathology.^{17,18}

Powless and Elze²⁴ showed that with arthrogram studies of 15 postoperative patients anatomic repair of the MTP joint capsule could directly address the pathology of MTP instability. Ford et al²⁵ compared the primary plantar plate repair versus the flexor with the extensor tendon transfer on freshly frozen cadaver specimens and found no significant differences between the repaired techniques. However, the

authors still advocated an anatomic repair of the plantar plate as a viable alternative with the advantage of addressing the MTP instability anatomically.

We believe that idiopathic, inflammatory plantar plate attrition is most commonly found with propulsive phase metatarsalgia due to an elongated metatarsal^{3,17} and complicated by a contracted hammertoe deformity and insufficiency of the first ray, especially, hallux strength. Plantar plate injuries may be subtle and undiagnosed by foot and ankle surgeons treating intractable metatarsalgia, especially those associated with hammertoe deformity.

INDICATIONS AND CONTRAINDICATIONS

Second MTP joint plantar plate pathology presents clinically as focal pain, under the second metatarsal head where it articulates with the proximal phalanx. With the toe held in extension, palpation of the base of the proximal phalanx, will usually elicit pain. The pain is most noticeable during ambulation that subsides at rest. Patients typically complain of swelling under the metatarsal, spreading of the toes, and feeling as if they are walking on a stone or lump in the absence of a plantar lesion. On physical examination, the digit may be medially or laterally deviated with or without hammertoe deformity development (Fig. 1). A positive dorsal drawer sign, when compared with the contralateral side, is the hallmark diagnostic sign of MTP instability and is suggestive of plantar plate pathology (Fig. 2). Radiographic indicators of plantar plate pathology are obvious when a complete dislocation is present but should also include evaluation of the metatarsal parabola secondary to a long second metatarsal or third metatarsal and localized swelling surrounding the affected MTP. It is very important to evaluate the contralateral foot at the same time to rule out an anatomic variation between feet (Fig. 3). When the diagnosis is equivocal, the use of sonography or magnetic resonance imaging may prove to be invaluable, especially when the differential between a plantar plate pathology and neuroma is considered.

Contraindications include open plantar wounds, uncontrolled infections, inadequate soft tissues, or dysvascularity of the foot. These patients must have their issues resolved before surgical reconstruction.

PREOPERATIVE PLANNING

A comprehensive history and physical examination should include advanced imaging modalities such as, magnetic resonance imaging with and without contrast dye. These advanced imaging modalities can help delineate the amount of repair necessary. Plantar plate pathology is almost always present with propulsive phase metatarsalgia (unless of acute trauma) and often present in addition to other forefoot deformities such as, hallux valgus and hammertoe deformity.

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Financial Disclosures: The authors note no conflict of interest with regard to this study.

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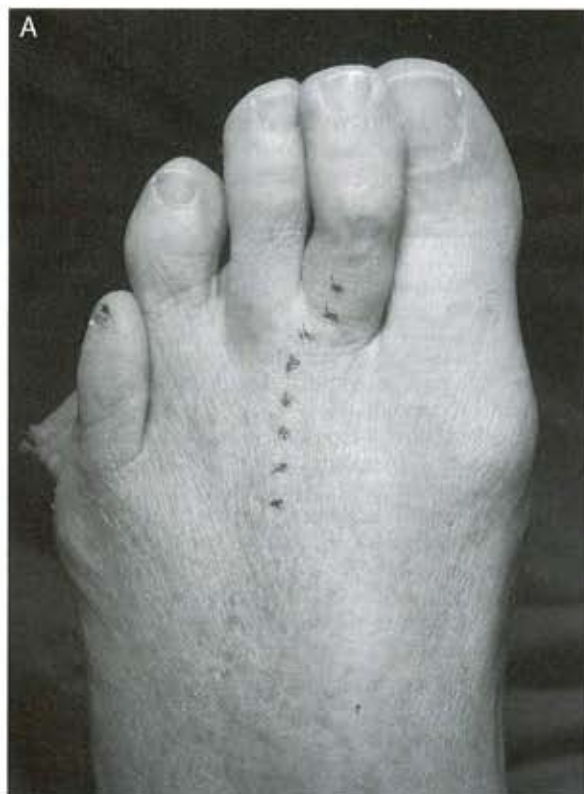


FIGURE 1. A and B, On physical examination, the digit may be medially or laterally deviated with or without hammertoe deformity development.

In addition, having a neuroma simultaneously with a plantar plate rupture is not a rare occurrence.

The patient should also be evaluated for the ability to attend follow-up appointments and understand postoperative instructions, especially those dealing with physical therapy and splinting of the affected joint.

TECHNIQUE

The procedure is performed under intravenous anesthesia with 0.5% bupivacaine, field blocks. After anesthesia is induced, the



FIGURE 2. A positive dorsal drawer sign is the hallmark diagnostic sign of a plantar plate rupture.

patient is placed in a supine position and a pneumatic ankle tourniquet is inflated to 250 mm Hg.

A curvilinear incision is made just medial or lateral to the second MTP joint (Fig. 4), and sharp dissection is carried subcutaneously to expose the metatarsal head and base of the proximal phalanx. A linear incision to bone can be made, with special care taken to split the interval between the extensor digitorum longus and extensor digitorum brevis tendons. A self-retaining retractor is positioned and secured between the extensor tendons (Fig. 5). A small McGlamry elevator is



FIGURE 3. Standard weight bearing anteroposterior radiograph of the foot showing the dislocated second digit with a long second metatarsal.



FIGURE 4. A curvilinear incision is made overlying the second metatarsophalangeal joint.

carefully used to free soft tissue attachments between the second metatarsal head and plantar plate (Fig. 6).

A Weil metatarsal osteotomy is performed, and while using parallel cuts, a small bone slice is removed to prevent plantarization of the capital fragment (Fig. 7). Next, the capital fragment is retrograded under the distal one-third of the metatarsal, and it is held in temporary position with a smooth 0.045 (1.1 mm) wire (Fig. 8). A phalangeal bone-clamp is placed on the base of the proximal phalanx distracted distally (Fig. 9). This allows for increased exposure to the plantar plate and the flexor tendons. The plantar plate is thus visualized at its insertion into the base of the proximal phalanx and inspected using a blunt, curved hemostat. If the insertion at base of the proximal phalanx appears to be disrupted, the plantar plate is fully mobilized distally and freed of any residual attachments. If the plantar plate is significantly attenuated or torn, the flexor tendons are often used to augment the repair of the plantar plate.



FIGURE 5. A self-retractor is positioned and secured between the extensor tendons.



FIGURE 6. A small McGlammy elevator is carefully used to free soft tissue attachments between the second metatarsal head and plantar plate.

Using the Opus Smart Stitch System (Arthocare Corporation, Austin, TX), the plantar plate is grasped proximally and a no. 1 nonabsorbable suture is used to create a mattress stitch (Fig. 10). Two tunnels are made with 0.062 (1.6 mm) threaded wires into the base of the proximal phalanx: dorsal-medial to plantar-lateral and dorsal-lateral to plantar-medial (Fig. 11). Using monofilament wire, the suture attached to the plantar plate is then passed through the tunnels (Fig. 12). It is through these bone tunnels that the sutures act as a pulley, engaging the plantar plate onto the base of the proximal phalanx.

The temporary pin holding the capital fragment of the metatarsal head is removed and the metatarsal head is reduced distally, aligned to anatomic contour, and fixated with a 2.5 mm threaded head screw (Fig. 13). The suture on the dorsal surface of the proximal phalanx is then tied dorsally with the digit firmly held in plantar flexion while the second MTP is



FIGURE 7. A Weil metatarsal osteotomy is performed.



FIGURE 8. The capital fragment is retrograded under the distal one-third of the metatarsal and is held in temporary position with a smooth 0.045 (1.1 mm) wire.

reduced and stabilized (Fig. 14). Finally, an extensor longus tendon is evaluated and a Z-lengthening is performed to release any tension placed upon the tendon postprocedure. The flat surface can be placed firmly against the foot so over tightening is avoided.

Copious irrigation is carried out with sterile saline solution. Deep structures are apposed with multiple 3-0 absorbable sutures. Skin edges are apposed and secured using a subcuticular 5-0 absorbable suture (Fig. 15). Lastly, the incision is reinforced with steri-strips, sterile compression dressings holding the toe in plantar flexion (Fig. 16). Postoperative radiographs are taken (Fig. 17).

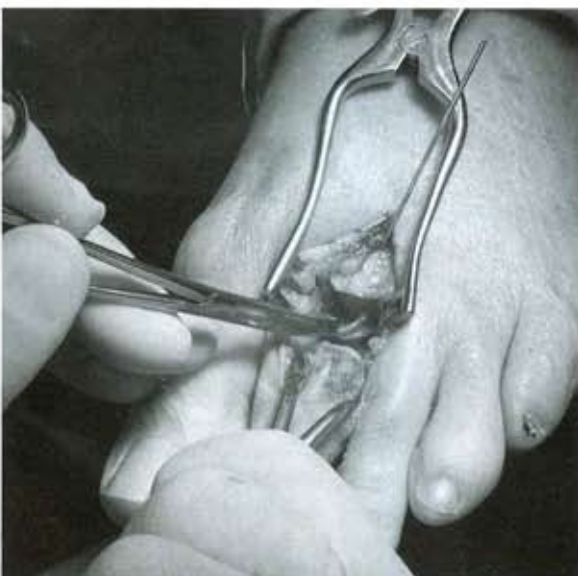
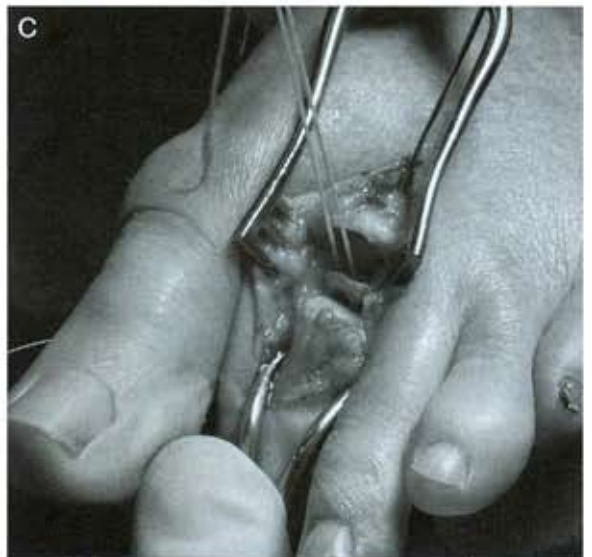
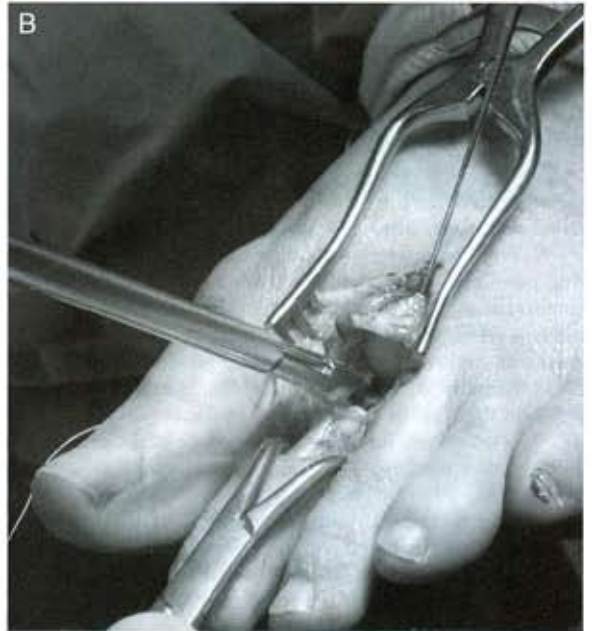


FIGURE 9. A phalangeal bone-clamp is placed on the base of the proximal phalanx distracted distally, allowing for increased exposure to the plantar plate.



FIGURES 10. A-C, Using the Opus Smart Stitch System (Arthocare Corporation, Austin, TX), the plantar plate is grasped proximally and a nonabsorbable suture is used to create a mattress stitch.

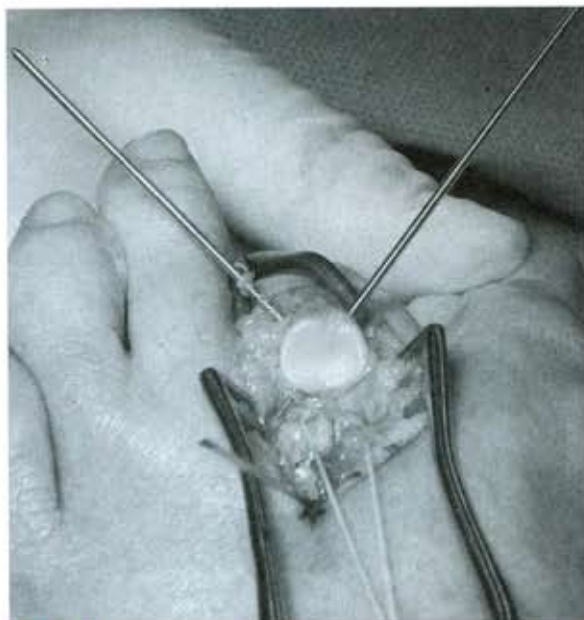


FIGURE 11. Dorsal-medial to plantar-medial and dorsal-lateral to plantar-lateral tunnels are made using 0.062 (1.6 mm) threaded wires into the base of the proximal phalanx.

COMPLICATIONS

The primary author has been performing this surgical technique for on more than 13 patients with a total of 3 complications. Joint stiffness and continued metatarsalgia of the second MTP was evident in 1 patient who did not satisfy the requirement of a formal physical therapy program postoperatively. This may have been avoided with better awareness preoperatively during the planning phase. The other

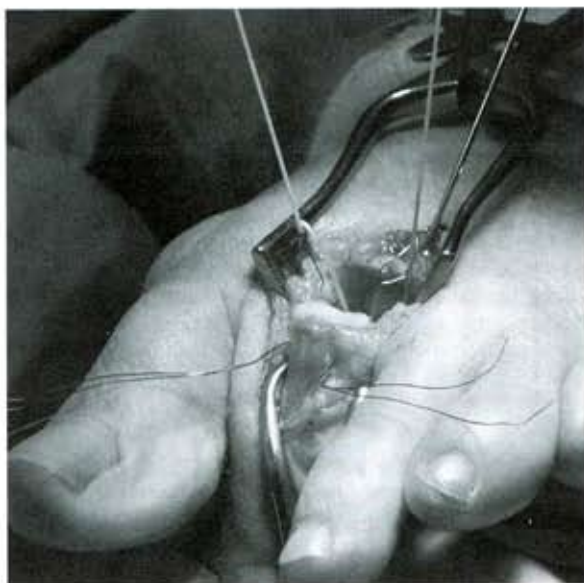


FIGURE 12. Using monofilament wire, the suture attached to the plantar plate is then passed through the tunnels. The sutures can then act as a pulley, engaging the plantar plate onto the base of the proximal phalanx.



FIGURE 13. A and B, The temporary pin holding the capital fragment of the metatarsal head is removed and the metatarsal head is reduced distally, aligned to anatomic contour, and fixated with a 2.5 mm threaded head screw.



FIGURE 14. The suture on the dorsal surface of the proximal phalanx is then tied dorsally with the digit firmly held in plantarflexion whereas the second metatarsophalangeal joint is reduced and stabilized.



FIGURE 15. Deep structures are apposed with multiple 3-0 absorbable sutures and skin edges are secured using an intercutaneous running stitch of 5-0 absorbable sutures.

complications regarded painful retained hardware from the metatarsal osteotomy. There were no cases of wound dehiscence, toe hyperextension, recurrence, or nonunion.

POSTOPERATIVE MANAGEMENT

Immediately after surgery, the patients are placed into a surgical walking shoe and allowed to guard, weight bearing as tolerated. This early, aggressive protocol prevents stiffness and maintains adequate range of motion for gait. The dorsal incisional approach decreases the chance of wound complications compared with a plantar incision. The patients remain in the surgical walking shoe for 1 week, after that time they progress to a sneaker. As skin closure uses subcuticular absorbable sutures, no sutures are needed to be removed, however the steri-strips are taken off by the patient once they begin showering or bathing at week 2 postoperatively. They are also enrolled into formal physical therapy. Once comfortable, patients discontinue formal physical therapy sessions and begin executing these exercises at home.



FIGURE 16. The incision is reinforced with steri-strips, sterile compression dressings holding the toe in plantarflexion.



FIGURE 17. Standard weight bearing anteroposterior radiographs taken postoperatively showing the second metatarsophalangeal joint correction.

POSSIBLE CONCERNS, FUTURE OF THE TECHNIQUE

To our knowledge, we are the first to report a technique for correction of second MTP instability with anatomic primary plantar plate repair in combination with a Weil metatarsal osteotomy. The most significant concerns with this technique are transfer metatarsalgia and painful retained hardware. With regards to the Weil metatarsal osteotomy, we believe that the failure to repair the plate to increase plantar stability may be one of the reasons for the “floating toe” commonly associated with the Weil metatarsal osteotomy. When performing a Weil metatarsal osteotomy, we now, always inspect the plantar plate for linear tears, attenuation, or ruptures, and repair as necessary.

Other advantages of the use of this technique include immediate weight bearing of patients postoperatively. We believe that a dorsal incision can be used to visualize the plantar plate to enhance repair while decreasing the chance of wound complications and plantar tissue trauma compared with a plantar approach.

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