Plantar Plating for the Treatment of Proximal Fifth Metatarsal Fractures in Elite Athletes

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Abstract: Proximal fifth metatarsal fractures, zones II and III, are commonly treated surgically, especially in elite athletes. Intramedullary screw fixation remains the most used construct despite nonunion and refracture. High tensile forces on the plantar-lateral aspect of the fifth metatarsal are difficult to control, and intramedullary screw fixation depends on ideal screw position, length, and width. The authors present a plantar plating technique with cancellous bone autograft for zones II and III proximal fifth metatarsal fractures. Rotational instability and plantar-lateral gapping are resisted by applying a compression plate to the tension side of the fracture, eliminating causes for failure. [Orthopedics. 2017; 40(3):e563-e566.]

The proximal aspect of the fifth metatarsal is repeatedly subjected to peak tensile forces with loading of the fifth metatarsal head.¹ Demands on elite athletes often result in fractures of this region (Figure 1), which faces a challenging avascular healing environment.²-⁵ The benefits of surgical treatment for acute and stress-related proximal fifth metatarsal fractures are well established.²-⁵,⁶ Surgical treatment results in shorter time to union and reduced nonunion rates.⁵ Intramedullary screw fixation is the most widely applied operative treatment (Figures 2-3).²⁵ Unfortunately, nonunion and refracture remain concerns (Figure 4).⁶,⁷ Plantar gapping has been prognostic of nonunion in athletes,⁸ while the role of rotational instability is unclear. Failures seen with intramedullary screw fixation may indicate that this construct does not optimally counteract these forces at the fracture site. The authors present plantar-lateral...
plating with cancellous bone autograft for the treatment of zones II and III proximal fifth metatarsal fractures.

**INDICATIONS**

Initially, indications for plantar-lateral plating of proximal fifth metatarsal fractures were limited to revision of zone II or III fracture nonunions or refractures in athletes. Bone grafting with calcaneus autograft was incorporated to improve biologic conditions for bone healing. Following success in the revision setting, the indication was extended to include primary fracture fixation. The goal of a plantar-lateral tension side plate is to create a fixation construct with improved resistance to torsion and plantar gapping. Gaining control over the fracture’s tension side may improve healing and reduce risk of refracture. A contraindication is a zone I tuberosity avulsion, which is better suited for hook plate fixation because of limited proximal bone availability.

**SETUP AND PATIENT POSITIONING**

The procedure is typically performed in an outpatient surgical suite under general anesthesia. A regional ankle block with 0.5% ropivacaine is administered for postoperative pain control. The patient is positioned supine with both heels reaching the end of a flat table. An ipsilateral hip roll, either commercially available or fashioned by rolling 2 folded bed sheets and securing them with tape, is used. The lateral aspect of the foot is visible, accessible, and mobile for fluoroscopy. A mobile mini-fluoroscopy C-arm (GE OEC Mini 6600; OEC Medical Systems, Salt Lake City, Utah) is placed opposite the surgical site. A pneumatic calf or ankle Esmarch tourniquet may be used to control bleeding.

**AUTOGRAFT HARVEST**

Autograft cancellous bone is used in all revision cases and may be beneficial in primary cases. The authors describe a technique for local graft harvesting. A 1-cm incision is made over the lateral calcaneal tuberosity, approximately 1.5 cm anterior to the Achilles tendon, midway between the dorsal and plantar cortices. Subcutaneous dissection is bluntly continued to the periosteum of the calcaneus, which is then incised. A small punch is used to dimple the cortex. A 6-mm core reamer (Bone Graft Harvest System; Acumed, Hillsboro, Oregon) is passed and the bone graft collected. Passes are made from the same starting point until sufficient autograft is collected (a single pass is generally all that is required). The site is irrigated and closed with a superficial nylon suture.

**EXPOSURE**

The proximal fifth metatarsal is palpated on the lateral aspect of the foot and marked. Fluoroscopic imaging is used to mark fracture location. A longitudinal 4-cm incision centered over the fracture site is made on the lateral-plantar aspect of the fifth metatarsal, along the glabrous junction. Careful blunt soft tissue dis-
section is performed to prevent injury to the sural nerve, while exposing the fifth metatarsal. The abductor digit minimi is retracted inferiorly and the fracture site is identified (Figure 5). A dental pick is used to gently distract and curette the fracture site, followed by irrigation. Cancellous autograft from the calcaneus is then packed in and around the fracture site.

**Fixation**

Fracture reduction is performed using a pointed reduction clamp to compress the fracture (often no clamp is necessary). A low-profile, 4-hole, 3.0-mm straight plate (AR-8952TS-04; Arthrex, Naples, Florida) is then preliminarily contoured to the plantar aspect of the fifth metatarsal. While the fracture is compressed with a reduction clamp, the plate is secured with a cortical screw proximal to the fracture site. Once proper placement is confirmed via fluoroscopy, a second proximal screw, typically locking, is placed. Next, a distal compression screw is placed eccentrically in the compression slot in the plate, followed by a more distal locking screw (Figure 6). To avoid plantar hardware prominence, the surgeon must carefully confirm that the plate is fully reduced against the cortex. The final construct includes at least 1 locking screw on either side of the fracture to improve resistance to torsion and hardware prominence. Fluoroscopy is used to confirm fracture reduction and plate placement and to check for proximal intra-articular screw placement. The fifth tarsometatarsal joint must not be violated during proximal screw placement (Video).

**Wound Closure**

After irrigation, the incision is closed using interrupted inverted subcutaneous absorbable sutures followed by 4-0 nylon interrupted horizontal mattress sutures. Additional local anesthetic may be applied to assist with postoperative pain. Nonadherent dressing and bacitracin ointment are applied to the wound, followed by compressive soft dressing. The patient is then placed in a mid-calf fracture boot.

**Postoperative Care**

The patient is kept non-weight bearing in a fracture boot for the first 2 weeks, allowing for incisional healing. Gentle active and passive range of motion are also permitted. Once sutures are removed at 2 weeks, the patient may bear weight as tolerated in the fracture boot, while progressively increasing resistive training using land bike and pool rehabilitation for 4 weeks. The patient spends the following 6 weeks in a normal shoe, fit with a custom total contact orthotic with a carbon fiber plate, while slowly resuming impact activities. Full release to cutting and pivoting is granted at 12 weeks postoperatively, with continued use of the custom total contact orthotic. Radiographs are obtained at 2, 6, and 12 weeks postoperatively. This progression depends on the absence of clinical symptoms and presence of radiographic healing (Figures 7-8).
DISCUSSION

There have been reports of nonunion after primary fixation with intramedullary screws.\(^3,5,6\)

More concerning are reports of refracture after radiographic union of surgically treated proximal fifth metatarsal fractures in elite athletes.\(^3,6,7\)

Wright et al\(^6\) reported a series of refractures in elite athletes, stating that larger screws and postoperative orthosis should be used to prevent refracture. In a series of revisions for nonunion or refractured proximal fifth metatarsal fractures, Hunt and Anderson\(^1\) emphasized that the use of a solid screw with proper diameter, length, and position was necessary for optimal fixation. A screw with too much length may cause distraction at the fracture site, yet one too short compromises compression.\(^9\) Similarly, if screw diameter is too small, fixation is inadequate.\(^9\) However, increasing diameter of the intramedullary screw increases the risk of iatrogenic fracture of the distal segment.\(^9\)

Even with optimization of multiple variables of percutaneous intramedullary screw fixation, refractures occur.

Tension-side plating has been used to treat anterior tibial stress fractures in athletes.\(^10,11\)

After reports of anterior knee pain and persistent fracture nonunion with tibial nailing, Zbeda et al\(^10\) applied compression plating in a tension band construct for the treatment of anterior tibial stress fractures, which yielded excellent results. Anterior tibial stress fracture patterns show tension gapping, distraction forces, and poor vascularity similar to proximal fifth metatarsal fractures. Tension band wiring has been used for Jones fractures; however, more than half of patients undergo hardware removal.\(^12\)

The goals of the current technique were to resist plantar gapping of proximal fifth metatarsal fractures using a planlar-lateral plate with cancellous autograft, improve fracture stability and biologic environment, promote healing, and reduce nonunion and risk of refracture. This construct directly resists plantar gapping on the fracture’s tension side, while minimizing risk to the blood supply entering the anteromedial aspect of the proximal fifth metatarsal. Careful open dissection limits risk of injury to the sural nerve.\(^4,13\)

To optimize healing, the addition of cancellous autograft from various donor sites has been described.\(^2,3\)

Use of calcaneal autograft allowed biologic optimization while using a single operative field. Previously reported complication rates for percutaneous calcaneal autograft harvest have been low.\(^14\)

The recommended postoperative protocol is comparable to those previously published: early weight bearing with progressive return to sport.\(^2,3\)

Hardware prominence is a potential complication of this technique. However, low-profile plates and screws properly contoured to the cortex reduce this.

CONCLUSION

By stabilizing the tension side of the fifth metatarsal fracture and providing torsional stability, this plating technique can lead to successful fracture union, reducing nonunion and refracture in high-demand patients. Further research with a larger series is needed to investigate the full potential of this technique.

REFERENCES


