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Technical Tip: "Toe Rodeo" for Closed Reduction and Percutaneous Fixation of Forefoot and Midfoot Fractures and Dislocations

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Introduction

Metatarsal and phalangeal fractures and dislocations account for 35% of all foot fractures and 3% to 7% of all fractures.[2] Metatarsal fractures are typically caused by a direct blow or repetitive stress.[2,4] Severe forefoot and midfoot injuries may include fractures or dislocations associated with open soft tissue disruption; ligamentous injuries such as traumatic tarsometatarsal joint instability (Lisfranc injury); comminution resulting in instability, angulation, and shortening of the medial and/or lateral columns of the foot impairing stance and gait; and malunion resulting in plantar prominence and sequelae including toe ulceration and metatarsalgia.[4] Metatarsal shaft fractures associated with Lisfranc injuries as well as isolated head or neck fractures appreciably shortened >4 mm or deviated >10 degree in the coronal or sagittal plane may be indicated for operative stabilization to optimize forefoot function by restoring native anatomy and facilitating metatarsal fracture healing in an anatomic position.[4] Conversely, metatarsal fractures of the central 3 rays in isolation are typically managed conservatively with good to excellent results.[2,4]

Closed reduction and percutaneous fixation (CRPF) with Kirschner wires or Steinmann pins permits restoration and maintenance of normal forefoot alignment with minimal disruption of the adjacent soft tissue and metatarsal blood supply. Variations include retrograde pinning through the phalanges or metatarsal head, antegrade-retrograde pin insertion, transverse pinning, and combinations with external fixation.[3,8] Forefoot and midfoot CRPF can be deceptively challenging as a result of difficulty simultaneously controlling the proximal intact segments, distal fracture fragment, and fixation independently with 6 degrees of freedom. Manual manipulation of the forefoot for CRPF with use of fluoroscopy exposes surgeons and/or assistant(s) to greater amounts of ionizing radiation, particularly to the hand and digits.[6]

We describe the "toe rodeo," a simple, effective technique for closed reduction and retrograde percutaneous fixation of metatarsal and phalangeal fractures and dislocations. This technique is intended to make a frustrating procedure more efficient, eliminating the need for an assistant and potentially reducing direct radiation to the surgeon's and/or assistants' hands.

Technique

Required Instruments

- 1.6-mm or 2.0-mm smooth trochar tip Steinmann pins and/or Kirschner wires

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Figure 1. "Toe rodeo" technical tip for metatarsal fracture pining. A single Prussik hitch loop is fashioned from laparotomy sponge, looped around the first and second toes, and controlled by tension with the second through fourth fingers against counterpressure on the forefoot using the index finger of the nondominant hand.

- Wire collet and small battery drive
- Laparotomy sponge(s) with loop
- Sterile bump or radiolucent triangle
- Blanket stack or leg ramp foam radiolucent positioning device

The patient is positioned supine on a regular operating table with radiolucent extension. A bump is placed under the ipsilateral hip to internally rotate the lower extremity to a neutral position. The operative leg is placed on a blanket stack or leg ramp foam radiolucent positioning device. After prepping and draping, the leg is placed on a sterile bump or radiolucent triangle optionally with the forefoot on a stack of sterile towels to facilitate imaging in plane of the tarsometatarsal joints.[5] This bump/triangle can be removed to obtain a Harris heel image, for example, to assess the bicortical position of a calcaneal Schanz pin applied for lateral column external fixation of the foot.

The loop of laparotomy sponge is folded once about itself to create a "lasso"—technically, a closed 1-turn Prussik slide and grip friction hitch[1]—which may be placed around the phalanges of a single toe or around 2 adjacent toes with 1 loop on each (Figure 1). The absorbent portion of the sponge is then grasped in the nondominant hand with the thumb and ulnar 3 digits, with the index finger free to apply a counterforce to the foot. The laparotomy sponge is tensioned with the nondominant upper extremity for axial traction. The surgeon can then adduct, abduct, plantarflex, dorsiflex, and rotate the distal fracture segment(s) as well as translate these segments using a counterforce applied with the index finger. The dominant hand is thus free to manipulate the trajectory and advancement of the wire/pin using the driver. This is an off-label use of a laparotomy sponge not approved by the United States Food & Drug Administration.

Fracture reduction and intraosseous, intramedullary internal fixation are visualized indirectly on anteroposterior, lateral, and oblique views (Figure 2). Orthogonal 45-degree oblique views can be particularly helpful if an assistant is not available to manage a sterile drape for true lateral imaging, although reduction and appropriate final pin position must be confirmed on a lateral image. Percutaneous placement of a dental pick or shoulder hook, also held in the nondominant hand, can facilitate reduction. Plantar metatarsophalangeal dislocations of the metatarsal head may require open reduction because of interposition of the plantar plate, deep transverse metatarsal ligament, flexor digitorum tendons, and lumbrical tendons.[7]

Case Series

Between June 2020 and June 2021, 5 male patients aged 24-65 years with complex midfoot injuries and associated forefoot fracture dislocations were treated with the "toe rodeo" reduction technique and percutaneous pinning using 1.6- and 2.0-mm smooth Kirschner wires and Steinmann pins as the index surgical procedure. Injuries included 4 tarsometatarsal joint disruptions (Lisfranc injuries), 1 metatarsophalangeal joint dislocation, 6 metatarsal neck fractures, 3 metatarsal shaft fractures, 7 metatarsal base fractures, 2 cuneiform fractures, 3 cuboid fractures managed with concomitant temporizing lateral column external fixation, and 1 navicular fracture dislocation managed with medial column eternal fixation. One patient had open injuries. Two patients required free flap coverage of dorsal wounds complicated by soft tissue necrosis. A dental pick was used as a percutaneous reduction adjunct in 1 case. The metatarsophalangeal joint dislocation required an open reduction. Two patients underwent staged open reduction internal fixation of their tarsometatarsal joint fracture dislocations and cuboid fractures. The average total fluoroscopy time was 190 seconds (SD = 106.10 seconds). This figure overestimates the fluoroscopy time of the toe rodeo technique alone as other procedures performed also used fluoroscopy. Pins used as definitive fracture fixation were removed at 6-8 weeks for fractures or 3 months for definitive tarsometatarsal joint stabilization. The lateral column fixator was retained as definitive management for 3 months for 1 cuboid fracture. No iatrogenic nail avulsions, phalangeal dislocations, or other injuries occurred. No pin site infections occurred. The mean time from last surgery to final follow-up was 134 days (range 10-362). Of the 4 patients who returned for follow-up, all healed uneventfully and returned to weightbearing within 3 months.

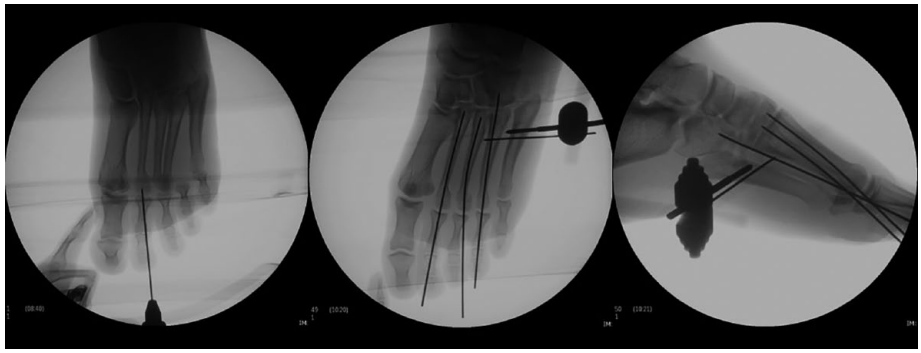

Figure 2. Anteroposterior, lateral, and oblique fluoroscopic images of percutaneous-assisted reduction and pinning of metatarsal 2-3 neck fractures and metatarsophalangeal 4 dislocation associated with a cuboid fracture using laparotomy sponge "lasso about the first and second toes, with application of lateral column external fixation.

Author Note

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Declaration of Conflicting Interests

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