Summary: Surgical treatment of fibula fractures associated with unstable ankle injuries traditionally involves an extensile exposure, direct reduction of the fracture, and fixation with a plate and screw construct. Some patient populations may benefit from less invasive approaches and indirect reduction associated with fibular rods. The aim of this report is to demonstrate successful treatment of an unstable ankle injury in a geriatric patient with insulin-dependent diabetes using a fibular rod.

Key Words: fibula fracture, lateral malleolus fracture, fibular rod

INTRODUCTION
Distal fibula fractures caused by rotational injuries to the ankle are common injuries treated by orthopaedic surgeons. When the injury results in disruption of the normal tibiotalar relationship with subsequent lateral subluxation of the talus, the injury is considered unstable. Surgical treatment of unstable ankle fractures with open reduction and internal fixation (ORIF) of the distal fibula has led to improved patient outcomes when compared with nonoperative treatment.1–3 The technique of surgical fixation usually involves surgical exposure to the fibula sufficient to allow for direct reduction of the fracture fragments but also extensile enough to accommodate plate fixation. Complications associated with ORIF of the distal fibula have been reported as high as 25% and include wound complications, deep infection, implant failure, and symptomatic implants.4–7 These complications are reported to be higher in geriatric patients and patients with diabetes.8–10

Medullary fixation with a fibular rod (intramedullary [IM] fixation) is an evolving alternative to traditional ORIF. Potential advantages of IM fixation over traditional ORIF include decreased wound complications as insertion of the fibular rod and associated interlocking screws is typically performed through smaller incisions. Limited biomechanical studies suggest IM fixation can lead to lower implant failure rates, particularly in the osteoporotic bone.11 Intramedullary placement of the implant can lead to less symptomatic implant complications. Finally, recent reports suggest that distal fibula fractures treated with IM fixation can be allowed to bear weight immediately, potentially allowing accelerated mobilization of patients, and protection of patients unable to comply with non–weight-bearing restrictions.12

Treatment of distal fibula fractures with fibular rod fixation requires understanding of an appropriate insertion and interlocking technique to protect at-risk anatomic structures, avoidance of potential pitfalls of indirect reduction of the distal fibula, and limitations of the technique. The purpose of this report is to illustrate the use of the IM fixation technique in treating distal fibula fractures.

PATIENT INFORMATION
A 65-year-old woman with insulin-dependent diabetes without neuropathy suffered an open ankle fracture dislocation in a fall from a ladder. She had a 10-cm transverse tension failure-type laceration over the medial ankle (Fig. 1). She underwent reduction and splinting in the emergency department with appropriate and timely administration of antibiotics and tetanus toxoid. The on-call orthopaedic surgeon urgently treated the patient in the operating room with irrigation and debridement of the open wound and spanning external fixation. She was then transferred to the orthopaedic trauma service for definitive treatment.

SURGICAL TECHNIQUE
Preoperative plain film imaging revealed an open bimalleolar ankle fracture dislocation with closed comminuted lateral
malleolar fracture and open medial malleolar fracture consistent with a pronation–abduction type injury mechanism. In the operating room, the patient was placed supine on the operative table with a bump under the ipsilateral hip to allow for neutral limb rotation. A nonsterile tourniquet can be used, if desired, although the author has found tourniquet use unnecessary for hemostasis in these cases. The leg was then prepped and draped in a sterile fashion.

The soft-tissue injury to the medial side underwent repeat irrigation and debridement. The soft tissues were deemed closable, and the injury was classified as a type 3A open injury according to the Gustilo–Anderson classification system. The medial malleolus was directly reduced and provisionally secured with a pointed reduction clamp. Traditional ORIF would require an extensile approach to the fibula to accommodate a long plate construct. This was deemed undesirable in a geriatric patient with insulin-dependent diabetes, and therefore, IM fixation with indirect reduction was selected as the mode of treatment. A 2.0-mm Kirschner wire (K-wire) was then placed percutaneously into the start point of the nail. The author finds a slightly more medial placement on the anteroposterior (AP) fluoroscopic view prevents lateral wall blowout by the nail and lateral malreduction of the fracture by the nail. In the talar lateral view, the K-wire is centered on the distal fibular fracture fragment and fibular medullary canal. The posterolateral position of the wire is avoided to prevent injury to the peroneus brevis tendon. Once the starting point was identified, a formal 1-cm incision was made along the course of the K-wire. A soft-tissue protector was placed over the wire down to the fibula, and an entry reamer was used under power to enter the distal fibula. Reamer and K-wire were removed. With the soft-tissue protector in place, the fibular canal was reamed using a hand reamer. The hand reamer was also used to select the implant length. A fibular rod measuring 3.0 × 180 mm (Acumed Fibula Rod System; Acumed, Hillsboro, OR) was then impacted in to place. Impaction will generally shorten the fracture, and usually, after the implant placement, length and internal rotation of the distal fragment is required if indirect reduction methods are used. Therefore, care is taken to be sure that a transfibular-transstibial fixation screw or syndesmotic-type screw can be placed after reduction of the distal segment. Appropriate position of the fibular rod was confirmed fluoroscopically. Two unicortical anterior to posterior interlocking screws are placed using the associated jig. A single 1.5-cm incision was made over the anterior fibula, a double trochar was placed in the first interlocking screw guide, and a pilot hole was predrilled and measured. A unicortical interlocking screw was placed by power and hand tightened. A unicortical screw position is preferred to prevent potential injury to the peroneal tendons. A similar technique was used for the second interlocking hole. Once the distal fibular fragment was secured, length and rotation were restored under fluoroscopic guidance. The medial malleolar fracture reduction was then reassessed and secured with 2 unicortical cannulated screws. This was performed before placement of the transfibular-transstibial screw. This allowed for final changes of the fibular rotation and length for anatomic reduction of the medial malleolar fragment. Locking the nail before reducing and fixing the medial malleolus can lead to malreduction. After fixation of the medial side, the jig was again used to place a transfibular-transstibial screw in a unicortical fashion. The syndesmosis was not directly visualized or tested before screw placement. Jigs were removed, and final fluoroscopic images were obtained (Fig. 2). Wounds were irrigated and closed. The patient was then placed in a controlled ankle motion boot to protect the repaired open wound and lateral incisions and allowed to bear weight as tolerated. Sutures were removed at 3 weeks, and ankle range of motion was started. Final imaging at 7 months after definitive fixation showed healed fracture with maintained alignment and implant positioning (Fig. 3).

DISCUSSION

Surgical treatment of lateral malleolus fractures associated with unstable ankle injuries has been shown to improve patient outcomes over nonoperative management.1–3 Surgical approach, direct or indirect fracture reduction, and fixation techniques may depend on fracture pattern, soft-tissue injuries, and host comorbidities. The fibular rod is a relative stability implant that allows for stable restoration of fibular length, alignment, and rotation with less soft-tissue trauma when compared with traditional ORIF, and may be preferable in certain fracture patterns and patient populations. Recent studies have evaluated patient outcomes, biomechanics associated with the fibular rod, as well as safety and technical considerations to be considered by surgeons when treating patients with this implant.

Bugler et al13 reported the results of 105 patients treated with fibular rod fixation over an 8-year period. Early fibular rod constructs did not include all interlocking screws. The authors reported only 66% of fractures treated with rod (no interlocking screws) had adequate stability. Addition of a medial to lateral or anterior to posterior distal interlocking screw improved satisfactory stability in 91% and 96% of patients treated, respectively. The ultimate construct recommended by the authors includes anterior to posterior distal interlocking screws with a transfibular-transstibial interlocking screw to maintain length and rotation. The authors reported satisfactory stability on all patients treated with that construct. The
same group recently reported the results of a prospective randomized controlled trial comparing IM fixation with traditional ORIF in elderly patients. One hundred patients with an average age of 74 years were randomly assigned fixation method and followed for 12 months. There were no nonunions or malunions in either group. No differences in scar satisfaction, and no significant differences reported by the patients using the Olerud and Molander outcome scores. The authors did not report on the fracture patterns treated in the study, and no description is provided of direct or indirect reduction techniques used for the fibular rod group. In addition, although reduction criteria are described in the methods, no comment is made on the quality of reduction achieved in the study making interpretation of the results difficult.

A recent topical review on IM fixation reviewed 8 studies reporting on patient outcomes when treated with a fibular rod. Although the type and quality of the study varied considerably, union rates were reported between 97% and 100% after treatment with a fibular rod. In addition, fibular rod fixation was found to have a lower complication profile when compared with traditional ORIF. Finally, despite a heterogeneous set of patient outcome scores used, fibular rod fixation was at least equal to, if not superior to traditional, ORIF in the groups tested. The authors note although initial data suggest IM fixation is a viable technique, additional studies with improved power are needed to clarify the results of the limited number of studies available with small numbers of patients.

Biomechanical studies of modern fibular rods are limited. One group compared IM fixation with traditional ORIF in a geriatric cadaveric model. The authors created an OTA/AO 44B type, or supination, external rotation (SER) fibula fracture pattern by dividing the anterior and posterior tibiofibular ligaments (anterior-inferior tibiofibular ligament and posterior-inferior tibiofibular ligament), the transverse ligament, and creating a superoposterior to anteroinferior fibular osteotomy. IM fixation was performed using a modern fibular rod (Acumed Fibula Rod System; Acumed) with both AP and transfibular-transtibial locking screw fixation. Traditional ORIF was performed with a 3.5-mm lag screw and lateral 1/3 tubular plate neutralization (Synthes, Paoli, PA). The constructs were then subjected to SER and tested to failure. The authors found the IM construct demonstrated greater torque to failure and better maintenance of fibular construct. As would be expected, traditional ORIF failed through the implant bone interface, whereas the IM fixation failed through disruption of the lateral ligamentous complex without loss of fibular fracture fixation. Switaj et al compared IM fixation with locked fibular plating in a cadaveric model simulating an OTA/AO 44C2 injury. In contrast to the previous study, this fibular injury was created by resecting a 1-cm segment of fibula 8-cm proximal to the tip of the lateral malleolus. After placement of IM fixation or locking the plate with single syndesmotic screw fixation, the anterior-inferior tibiofibular ligament, posterior-inferior tibiofibular ligament, transverse ligament, and deltoid ligaments were transected. The constructs were then subjected to external rotation and tested. The authors reported no significant difference in syndesmosis diastasis between the constructs before or after load cycling, and although rotational stiffness was superior in locking plate constructs across the syndesmosis, both constructs maintained syndesmotic reduction within acceptable limits.

Placement of surgical devices requires understanding of the relevant anatomy and respect for critical anatomic structures at risk during any procedure. This is especially true for percutaneous or limited approaches, where these structures may not be directly visualized or protected. Goss et al recently reported on anatomic structures at risk during placement of IM fixation in the fibula. Cadaver limbs were instrumented with a fibular rod and then dissected for proximity of incisions, and instrumentation to the sural nerve, superficial peroneal nerves, and peroneal tendons was digitally analyzed. The authors listed anatomic structures at risk during discrete steps in the procedure. The peroneus brevis tendon was at risk during initial skin incision, reaming, and rod insertion, the superficial peroneal nerve when inserting anterior to posterior interlocking screw, and the peroneus longus tendon during insertion of transfibular-transtibial interlocking screws. Despite these risks, the authors found no structures were injured. They did note that the superficial peroneal nerve and peroneal tendons were at highest risk.
The authors recommend adherence to sound surgical techniques, including skin only incisions, blunt dissection down to the bone, and use of trochar. Additional recommendations have been made to place anterior to posterior interlocking screws in a unicortical position to avoid posterior penetration into the peroneal tendons.13,16

Finally, the author of this report has found several technical tips useful to facilitate successful treatment of patients using the IM technique. First, when treating SER type fibular fractures, an initial closed reduction maneuver and close inspection of the distal fibular fragment with AP fluoroscopy is critical for determination of whether direct reduction of the fibula is required before fixation (Fig. 4). Once the fibular rod is placed and secured in the distal segment, slight corrections to length and rotation can be made with the rod in place. However, as with IM fixation of the tibia or femur, once the implant is placed, correction to the alignment of the fracture fragments is very difficult if not impossible to correct without removing the implant. Therefore, if after closed reduction of the ankle is performed, if alignment is not acceptable, a 2- to 3-cm incision can be made at the apex of the fracture to allow for the direct reduction of the fracture. The reduction is then held in place by either standard or pointed reduction clamps and placement of the fibular rod then proceeds as usual. Second, because this technique often relies on indirect reduction and fluoroscopic evaluation of length, alignment, and rotation, precise anatomic reduction is not expected. If a concurrent medial malleolar fracture is present, subtle adjustments of the fibula may be needed to allow for accurate reduction of the medial malleolar fragment. The technique this author uses is to reduce and fix the medial malleolar fragment after placement of the fibular rod and anterior to posterior interlocking screws but before placement of transfibular-transstibial interlocking screw to avoid problems with medial malleolar reduction. Finally, some authors have noted that immediate weight-bearing is permitted on placement of a fibular rod, whereas others recommend protected weight-bearing.12,15 To date, no study exists specifically evaluating weight-bearing restrictions after placement of fibular rods. The patient in this case example was allowed to weight bear as tolerated without loss of reduction or broken implants. However, surgeons treating patients with these implants should use caution and judgment until more studies can be performed.

CONCLUSIONS

The case presented here illustrates that a fibular rod can be used to successfully treat lateral malleolus fractures. In this case, the fibular rod allowed for minimal surgical insult to the lateral soft tissues of an insulin-dependent diabetic patient and placement of a potentially biomechanically superior implant compared with a traditional lateral plate that allowed for early weight-bearing in a geriatric patient.

FIGURE 3. Seven-month follow-up radiographs. AP (A), mortise (B), and lateral (C) demonstrating healed fracture with maintained alignment and implant placement.

FIGURE 4. Intraoperative fluoroscopy. Provisional closed reduction (A) demonstrating unacceptable fibular alignment with apex lateral displacement. Clamp mediated reduction (B) made through small incision at the apex of the fibula fracture correcting previous alignment.
REFERENCES


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