Fibula Fracture Stabilization With a Guide Wire as Supplementary Fixation in Tibia Fractures

Derek Dombroski, MD, John A. Scolaro, MD, Nicholas Pulos, MD, Daphne M. Beingessner, MD, FRCSC, Robert Dunbar, MD, and Samir Mehta, MD

Abstract

The tibia is the most commonly fractured long bone. Although the goals of fracture management are straightforward, methods for achieving anatomical alignment and stable fixation are limited.

Type of management depends on fracture pattern, local soft-tissue involvement, and systemic patient factors. Tibial shaft fractures with concomitant fibula fractures, particularly those at the same level, may be difficult to manage because of their inherent instability. Typically, management of lower extremity fractures is focused on the tibia fixation, and the associated fibula fracture is managed without fixation.

In this article, we describe a novel technique for intramedullary fixation of the fibula, using a humeral guide wire as an adjunct to tibia fixation in the setting of tibial shaft fracture. This technique aids in determining length, alignment, and rotation of the tibia fracture and may help support the lower extremity as whole by stabilizing the lateral column. In addition, this technique can be used to help maintain reduction of the fibula when there is concern about the soft tissues of the lower extremity secondary to swelling or injury.

Our clinical case series demonstrates the safety, effectiveness, and cost-sensitivity of this technique in managing select concurrent fractures of the tibia and fibula.

Dr. Dombroski is Orthopaedic Surgeon, Orthopaedic Specialty Associates, Fort Worth, Texas.
Dr. Scolaro and Dr. Pulos are Residents, Department of Orthopaedic Surgery, Hospital of University of Pennsylvania, Philadelphia, Pennsylvania.
Dr. Beingessner and Dr. Dunbar are Associate Professors, Department of Orthopaedic Surgery, Harborview Medical Center, University of Washington, Seattle, Washington.
Dr. Mehta is Assistant Professor of Orthopaedic Surgery and Chief, Orthopaedic Trauma and Fracture Service, Department of Orthopaedic Surgery, Hospital of University of Pennsylvania.

Address correspondence to: Samir Mehta, MD, Division of Orthopaedic Trauma, Hospital of University of Pennsylvania, 2 Silverstein Pavilion, 3400 Spruce St., Philadelphia, PA 19104 (tel, 215-432-7432; fax, 215-349-5890; e-mail, samir.mehta@uphs.upenn.edu).

Am J Orthop. 2012;41(5):209-212.

Multiple factors affect tibial shaft fracture healing. These factors include systemic injury, injury to local soft-tissue envelope, host factors (eg, diabetes, immunodeficiency, nicotine abuse), and fixation construct stability. Anatomical alignment and stable fixation using intramedullary nailing are the mainstays of managing diaphyseal tibia fractures to restore function after injury. Given the success of intramedullary nailing for tibial shaft fractures, fibula fixation with appropriate indications may result in improved tibia reduction and soft-tissue stabilization.

"In an effort to optimize fracture fixation and healing of a displaced fibula fracture, we propose using a small-diameter guide wire as an inexpensive intramedullary nail for the fibula."

Diaphyseal tibia and fibula fracture management is often focused on tibia fixation and ignores the fibula fracture.[1] Tibia fixation alone can be challenging in the setting of bone loss or comminution and may lead to loss of fracture reduction and deformity.[2,3] Malunion of the tibia can lead to poor outcomes, including increased contact pressures, accelerated osteoarthritis in the surrounding joints, and ankle stiffness.[4,5] Furthermore, biomechanical studies have demonstrated decreased torsional stiffness when the tibia is stabilized alone.[6] Morrison and colleagues[2] proposed fibula fixation as an adjunct method for managing fractures of the tibia and fibula. Fibula fixation by plate osteosynthesis, particularly in the setting of distal tibia fractures, has been found to help maintain tibia fracture reduction.[7] Recently, intramedullary management of fibula fractures in pilon fractures was described as safe and effective, particularly in cases in which the lateral and posterolateral soft tissues are compromised.[8]

In an effort to optimize fracture fixation and healing of a displaced fibula fracture (Figure 1), we propose using a

Figure 1. Anteroposterior (A) and lateral (B) radiographs of Gustilo type I open proximal tibia and fibula fracture.

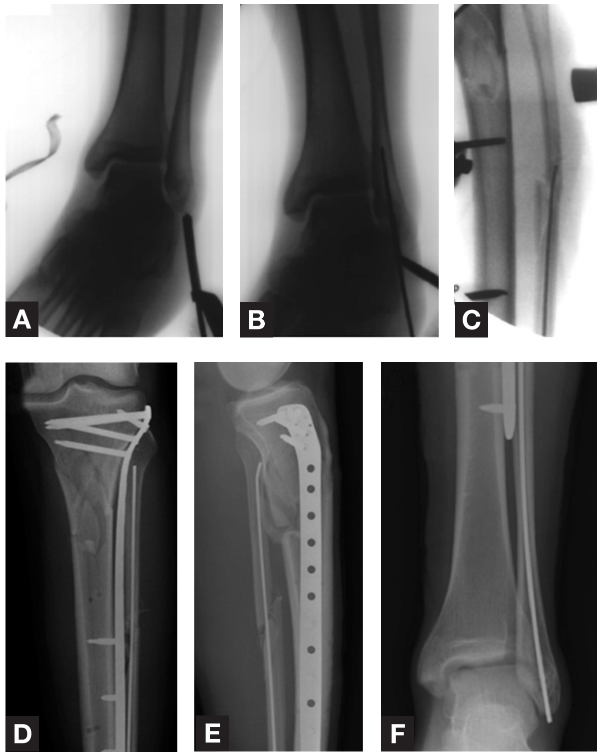

Figure 2. (A) Starting point on distal fibula with 3.5-mm drill bit and drill guide. (B) Entry into distal fibula with 2.5-mm drill bit to approximately 5 cm. (C) Passage of humeral guide wire past fracture site and use of bone tamp to help reduce fracture. Anteroposterior (D) and lateral (E) radiographs after passage of guide wire past fracture site and into proximal fibula. Anteroposterior (F) radiograph of distal fibula shows intramedullary guide wire left 3 to 4 mm proud to facilitate removal, if necessary.

small-diameter guide wire as an inexpensive intramedullary nail for the fibula. In the setting of concomitant tibia and fibula fractures, we propose that this technique be used when the fibula fracture is segmental or significantly displaced and axially stable once reduced. The theoretical advantage of intramedullary fixation is that it does not disturb the surrounding soft tissues and periosteal blood supply. Furthermore, with fibular reduction, indirect partial reduction of the tibia may be achieved, particularly in highly comminuted or multisegmental fractures. Fibula fixation will also restore length on a shortened fibula and returns both bone and soft tissues to a more anatomical position. The fibular intramedullary nailing technique described here has been reliably used and complications have been limited.

Surgical Technique

The patient is placed supine on a radiolucent table that allows the surgeon to operate from the foot of the table without impedance to the extremity. Our preference is a regular operating room table with a radiolucent extension at the foot. A bump is placed underneath the ipsilateral hip to prevent the usual external rotation of the limb and to provide access to the lateral side of the ankle. The entire limb is prepared and draped.

The starting point for the guide wire is the distal tip of the fibula. A small (approximately 2 cm) longitudinal incision is made approximately 2 to 3 cm distal to the tip of the fibula; it should be distal enough to allow the drill bit to drill in line with the fibular shaft. A sharp elevator clears the soft tissue at the tip of the fibula to create a “landing zone” for the drill bit. With the help of an image intensifier, a 3.5-mm bit is used to drill an opening hole in the distal fibula (Figure 2A). It is essential to drill in line with the diaphysis of the fibula on both anteroposterior and lateral images to facilitate passage of the guide wire. When an assistant inverts the foot by grasping the toes or calcaneus, and thereby makes the tip of the distal fibula more prominent, it is easier to place the drill bit in the appropriate position. In addition, a drill sleeve should be used to protect the soft tissue and to help direct the drill.

After the opening hole is made, a long 2.5-mm drill bit is used to “ream” the distal fibula to approximately 5 to 6 cm. A soft-tissue sleeve for the 2.5-mm drill bit is inserted into the previously drilled starting hole (Figure 2B). It is essential to avoid drilling through the cortex while the drill is being advanced proximally. It is also important to avoid drilling into the medial cortex while the drill is being advanced, as the guide wire follows the drill path and becomes incarcerated in this cortical window. A 2.4-mm stainless steel humeral guide wire (Synthes, Paoli, Pennsylvania) is locked securely onto the T-handle chuck. A mild bend (10-15°) is made approximately 1 cm from the distal tip of the guide wire to facilitate directing the guide wire across the fracture and into the next fracture segment (Figure 2C). The nail is then placed into the starting hole distally and advanced proximally with controlled mallet strikes on the chuck. The humeral guide

Figure 3. Anteroposterior (A) and lateral (B) radiographs at 3 months show healed fibula fracture in near anatomical alignment.

wire can be controlled with a T-handle chuck, "choking up" on the guide wire and resetting the chuck farther back as the guide wire is advanced into the fibula. This control also prevents the guide wire from bending outside the wound. Biplanar fluoroscopy is used to ensure that the guide wire remains intramedullary until it reaches the fracture site. There should be minimal resistance with nail insertion, and the T-handle should be rotated in 45° motions while the mallet is used. Any increase in force required to advance the nail should alert the surgeon to nail incarceration or a potential cortical breach.

At the fracture site, the nail is advanced across the fracture and into the proximal fragment medullary canal. A closed reduction technique, such as axial traction or blunt manipulation of the fracture fragments, can be used to pass the guide wire. Percutaneous reduction techniques, involving dental picks, elevators, or other instruments, may also be used in fractures that are segmental or difficult to reduce. The guide wire is advanced until the tip reaches the fibular head (Figures 2D, 2E). The guide wire is then pulled back approximately 2 cm, cut, and tapped in with a bone tamp so as to leave 2 to 4 mm of wire proud of the distal tip of the fibula to assist with removal, if necessary (Figure 2F). The guide wire is advanced into the fibular head to help seat the wire, and thereby, prevent its distal migration after surgery. In addition, the distal end of the guide wire can be bent anteriorly and impacted into the lateral malleolus using a bone tamp to anchor the wire. This technique can also be used from the proximal end of the fibula, particularly in the setting of more proximal fibula fractures, but care must be taken not to damage the peroneal nerve. The wound is then irrigated and closed with nylon sutures.

Clinical Experience

We have used this fibular intramedullary stabilization technique in open tibia and fibula fractures, segmental fractures, fractures with soft-tissue compromise, and patients with certain medical comorbidities (eg, diabetes mellitus, peripheral vascular disease) in which wound healing is a concern. Our indications have also included revision fixation of malunions and nonunions of the tibia and fibula.

Between August 2007 and June 2010, 14 patients with fibula fracture were treated with humeral guide wire fixation. Mean age was 40 years (range, 22-80 years). At presentation, 3 patients had a closed comminuted tibial shaft fracture, 2 had a nonunion, 5 had an open multisegmental fracture of the tibia, 2 had significant tibial bone loss, 1 had an open pilon fracture, and 1 had significant soft-tissue injury over the lateral portion of the extremity. Indications for fixation included concern about the integrity of the interosseous membrane, anticipated nonunion, length assessment in tibial bone loss, and alignment in segmental fracture.

Of the 14 patients, 1 died after surgery from pulmonary and cardiac complications of associated injuries. Mean follow-up in this series was 24 months (range, 18 weeks-40 months). The fibula healed in all 13 patients. Likewise, all tibia fractures not associated with segmental bone loss healed without further intervention. All fibula reductions were nearly anatomical (Figure 3).

Although the subcutaneous nature of the distal fibula can present problems with prominent hardware, so far we have had no complications with retained hardware, and no patient has required or requested removal of the guide wire. There have been no complications with proximal or distal guide wire migration from within the medullary canal of the fibula. No superficial or deep infections were associated with this procedure. In one instance, we were unable to pass the guide wire with sufficient ease and elected to forgo fibular intramedullary stabilization for open reduction and internal fixation of the fibula.

Discussion

Fracture healing is predicated on fracture stability. Restoration of length, alignment, and rotation with stable fixation is one of the tenets of long bone fracture care. Compared with isolated tibia fractures, concomitant fractures of the tibia and fibula, particularly those in which the fibula fracture is at the same level as the tibia, may be inherently less stable and may represent a higher energy injury. Indeed, radiographic evaluation showed that distal tibia fractures were more severe in the presence of fibula fractures than in their absence.[9] Other studies of the distal tibia have shown benefits in concomitant fibula fixation. Egol and colleagues[7] retrospectively evaluated adjunctive fibula fixation in distal tibia fractures and found a loss of tibial alignment when the fibula was not fixed.

Following these principles, we have begun treating select patients with complex diaphyseal and metadiaphyseal fractures (eg, multisegmental, bone loss), known or potential healing problems, open fractures, or a potential need for posterolateral bone grafting with a fibular retrograde intramedullary humeral guide wire. The goal of this procedure is to restore length and alignment to the fibula. This technique does not statically fix fibula rotation, so it is best used in segmental or axially stable fracture patterns, particularly when there is significant displacement. This technique also facilitates tibia reduction. Using an intramedullary device for the fixation avoids disturbing the surrounding soft tissue. This technique does not involve extensive reaming of the intramedullary canal, and, therefore, disruption of the endosteal blood supply of the fibula is minimal. Fibular intramedullary nails range in cost from $1200 to $2200, whereas a humeral guide wire costs less than $200.

For managing lower extremity fractures, we have described a fibular nailing technique that uses a humeral guide wire. This percutaneous technique causes minimal soft-tissue injury, and its complications are limited. Restoration of the lateral column of the lower extremity can optimize tibia fixation by providing appropriate assessment of length, alignment, and rotation. Given the promising early results of our technique, indications for its use likely will evolve and expand.

Authors' Disclosure Statement

The authors report no actual or potential conflict of interest in relation to this article.

References

1. Bone LB, Johnson KD. Treatment of tibial fractures by reaming and intramedullary nailing. *J Bone Joint Surg Am.* 1986;68(6):877-887.
2. Morrison KM, Ebraheim NA, Southworth SR, Sabin JJ, Jackson WT. Plating the fibula. Its potential value as an adjunct to external fixation of the tibia. *Clin Orthop.* 1991;(266):209-213.
3. Weber TG, Harrington RM, Henly MB, Tencer AF. The role of fibular fixation in combined fractures of the tibia and fibula: a biomechanical investigation. *J Orthop Trauma.* 1997;11(3):206-211.
4. Milner SA, Davis TR, Muir KR, Greenwood DC, Doherty M. Long-term outcome after tibial shaft fracture: is malunion important? *J Bone Joint Surg Am*. 2002;84(6):971-980.
5. McKellop HA, Sigholm G, Redfern FC, Doyle B, Sarmiento A, Luck JV Sr. The effect of simulated fracture-angulations of the tibia on cartilage pressures in the knee joint. *J Bone Joint Surg Am.* 1991;73(9):1382-1391.
6. Kumar A, Charlebois SJ, Cain EL, Smith RA, Daniels AU, Crates JM. Effect of fibular plate fixation on rotational stability of simulated distal tibia fractures treated with intramedullary nailing. *J Bone Joint Surg Am.* 2003;85(4):604-608.
7. Egol KA, Weisz R, Hiebert R, Tejwani NC, Koval KJ, Sanders RW. Does fibular plating improve alignment after intramedullary nailing of distal metaphyseal tibia fractures? *J Orthop Trauma.* 2006;20(2):94-103.
8. Evans JM, Gardner MJ, Brennan ML, Phillips CJ, Henley MB, Dunbar RP. Intramedullary fixation of fibular fractures associated with pilon fractures. *J Orthop Trauma.* 2010;24(8):491-414.
9. Barei DP, Nork SE, Bellabarba C, Sangeorzan BJ. Is the absence of an ipsilateral fibula fracture predictive of increased radiographic tibial pilon fracture severity? *J Orthop Trauma.* 2006;20(1):6-10.