Fibular Fracture Stabilization With a Guidewire 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

We present a novel technique of intramedullary fixation of the fibula using a humeral guide wire as an adjunct to tibial fixation, in the setting of tibial shaft fracture. Not only does this technique aid in determining length, alignment, and rotation of the tibial fracture, but it may also help the support of 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 for the soft tissues of the lower extremity secondary to swelling or injury. Our clinical case series demonstrates this safe, effective, and cost-sensitive technique to be used in the treatment of select concurrent fractures of the tibia and fibula.

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

Diaphyseal tibia and fibula fracture treatment often focuses on tibial fixation while ignoring the fibula fracture.[1] Tibial 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 of the surrounding joints, and ankle stiffness.[4,5] Furthermore, biomechanical studies demonstrate decreased torsional stiffness when the tibia is stabilized alone.[6] Morrison and colleagues[2] proposed fixation of the fibula as an adjunct method of treating fractures of the tibia and fibula. Fibular fixation by plate osteosynthesis, particularly in the setting of distal tibial fractures, has been shown to help maintain tibial fracture reduction.[7] Recently, intramedullary treatment of fibular fractures in pilon fractures has been described as safe and effective, especially when there is compromise of the lateral and posterolateral soft tissues.[8]

> "To optimize fracture fixation and optimize healing of a displaced fibula fracture, we propose the use of a small diameter guidewire as an inexpensive intramedullary nail for the fibula."

In an effort to optimize fracture fixation and optimize healing of a displaced fibula fracture (Figure 1), we propose the use of a small diameter guidewire as an inexpensive intramedullary nail for the fibula. In the setting of a concomitant fracture of the tibia and fibula, we propose that this technique be used when the fibular fracture is segmental in nature 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. In addition, by reducing the fibula, an indirect partial reduction of the tibia may be achieved, especially in highly comminuted

Dr. Dombroski is Orthopaedic Trauma Surgeon, Fort Worth, Texas.
Dr. Scolaro is Orthopaedic Trauma Fellow, Harborview Medical Center, Seattle, Washington.
Dr. Pulos is Resident, University of Pennsylvania, Philadelphia, Pennsylvania.
Drs. Beingessner and Dunbar are Associate Professors of Orthopaedic Surgery, Department of Orthopaedic Surgery, Harborview Medical Center, Seattle, Washington.
Dr. Mehta is Assistant Professor of Orthopaedic Surgery, Director of Orthopaedic Trauma, Division of Orthopaedic Trauma, Hospital of University of Pennsylvania.

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

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Figure 1. AP and lateral radiographs of a 34M who sustained this Gustilo Type I open proximal tibia and fibula fracture after he was tackled during a rugby game.

or multisegmental fractures. Fibular fixation will also provide suitable length to the fibula and return both the bone and soft tissues to a more anatomic position. The technique of fibular intramedullary nailing described here has been used reliably with limited complications.

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 prepped and draped.

The starting point for the guidewire 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, distal enough to allow the drill bit to drill in line with the fibula shaft. A sharp elevator clears the soft tissue at the tip of the fibula to create a landing zone for the drill bit. Using an image intensifier, a 3.5 mm drill bit is used to create an opening hole in the distal fibula (Figure 2A). It is essential to drill in line with the diaphysis of the fibula on both the anteroposterior (AP) and lateral images in order to facilitate passage of the guidewire. Having an assistant invert the foot by grasping the toes assists in placing the drill bit in the appropriate position by making the tip of the distal fibula more prominent. A drill sleeve should be used to protect the soft tissue and also help direct the drill.

Once the opening hole has been 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 starting hole previously drilled (Figure 2B). It is essential not to drill through the cortex as the drill is advanced proximally. It is also important not to drill into the medial cortex as the drill is advanced because the guidewire will follow the drill path and become incarcerated in this cortical window. A 2.4 mm stainless steel humeral guide wire (Synthes Inc, Paoli, Pennsylvania) is locked securely onto T-handle chuck. A mild bend (10°-15°) is placed approximately 1 cm from the distal tip of the guidewire to facilitate directing the guidewire across the fracture 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 guidewire can be controlled using a T-handle chuck, choking up on the guide wire, and resetting the chuck further back as the guidewire is advanced into the fibula. This control

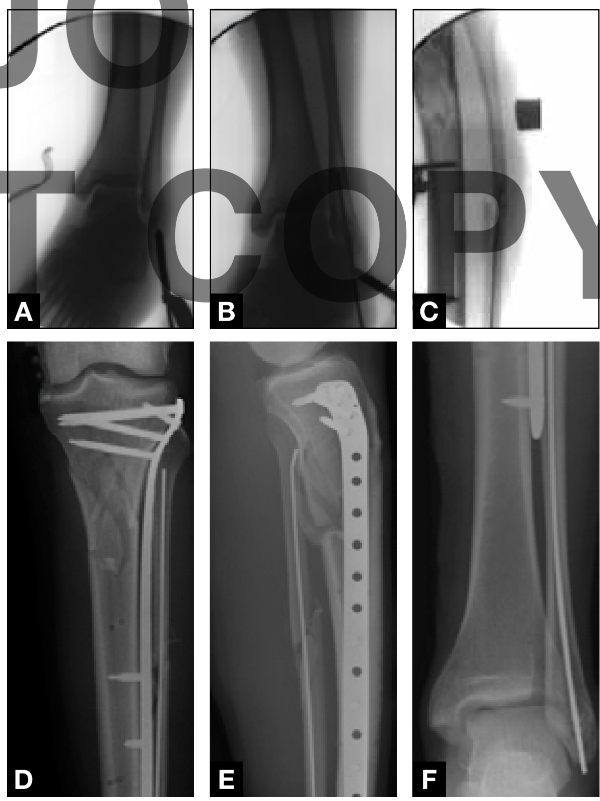

Figure 2. (A) Starting point on the distal fibula with the 3.5 mm drill bit and drill guide. (B) Entry into the distal fibula with the 2.5 mm drill bit to approximately 5 cm. (C) Passage of the humeral guidewire past the fracture site and utilization of a bone tamp to help reduce the fracture. (D, E) AP and lateral radiographs following passage of the guidewire past the fracture site and into the proximal fibula. (F) AP radiograph of the distal fibula showing the intramedullary guidewire left three to four millimeters proud to facilitate removal, if necessary.

also prevents the guidewire from bending outside of the wound. Biplanar fluoroscopy is used to ensure that the guidewire remains intramedullary until the fracture site. There should be minimal resistance with nail insertion and the T-handle should be rotated in 45° motions while malleting. 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 into the proximal fragment medullary canal. Closed reduction techniques, including axial traction or blunt manipulation of the fracture fragments, can be used to pass the guidewire. Percutaneous reduction techniques may also be employed, using dental picks, elevators, or other instruments, in segmental or difficult to reduce fractures. Advancement of the guidewire continues until the tip reaches the fibular head (Figures 2D, 2E). The guidewire is then pulled back approximately 2 cm, cut, and tapped in with a bone tamp so as to leave approximately 3 to 4 mm of guidewire proud of the distal tip of the fibula to assist with removal if necessary (Figure 2F). To prevent distal migration of the guidewire in the postoperative period, advancement of the wire into the fibular head helps seat the wire. In addition, the distal end of the guidewire can also 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 technique of intramedullary fibular stabilization in open tibia and fibula fractures, segmental fractures, fractures with soft tissue compromise, and in patients with certain medical comorbidities, such as diabetes mellitus and peripheral vascular disease, where there are concerns of wound healing. Our indications have also included revision fixation of malunions and nonunions of the tibia and fibula.

From August 2007 until June 2010, 14 patients were treated with humeral guidewire fixation of their fibular fracture. The average age of the patients treated with this fixation was 40 years (range, 22-80). At the time of their presentation, 3 patients had closed comminuted tibial shaft fractures, 2 patients had nonunions, 5 patients had open multisegmental fractures 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. Indication for fixation included concern about integrity of the interosseous membrane, anticipated nonunions, length assessment in tibial bone loss, and alignment in segmental fractures.

Of the 14 patients with this treatment, 1 died in the postoperative period due to pulmonary and cardiac complications from his associated injuries. The average follow-up for the patients in this series is 21 months (range, 6 months to 3.5 years). Fibular healing occurred in all 13 patients. Likewise, all tibial fractures not associated with segmental bone loss have healed without further intervention. All reductions of the fibula have been near anatomic (Figure 3).

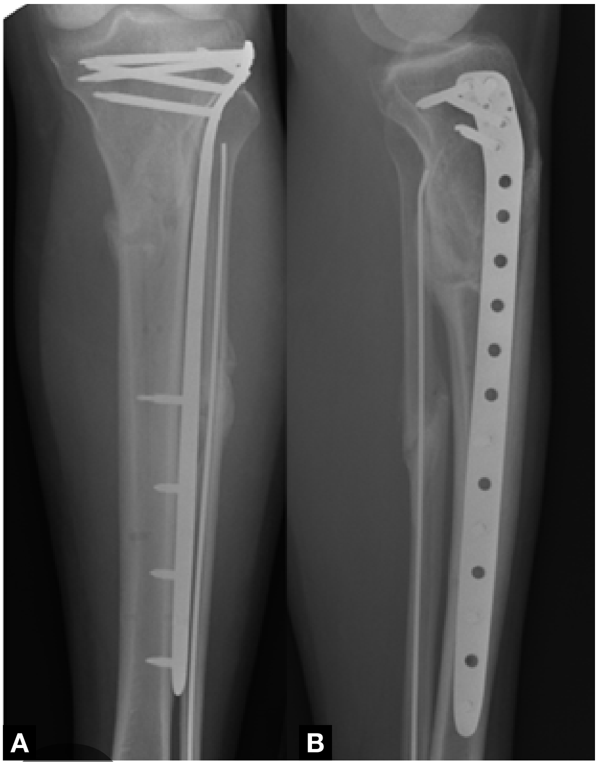

Figure 3. AP (A) and lateral (B) radiographs at 3 months showing a healed fibula fracture in near anatomic alignment.

While we acknowledge that the subcutaneous nature of the distal fibula could pose problems with prominent hardware, thus far, we have had no complication with retained hardware, and no patient has yet required or requested removal of the guidewire. There have been no complications with proximal or distal guidewire migration from within the medullary canal of the fibula. Further, there have been no superficial or deep infections associated with this procedure. In one instance, we were unable to pass the guidewire with sufficient ease. In this case, we elected to forego intramedullary fibular 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. Fractures of the tibia and fibula, particularly when the fibular fracture is at the same level as the tibia, may be inherently less stable and represent a higher energy injury than isolated fractures of the tibia. Indeed, radiographic evaluation of distal tibial fractures was judged to have greater injury severity in the presence of fibular fractures than in the absence of a fibular fracture.[9] Other studies in the distal tibia have shown benefits in concomitant fibular fixation. Egol and colleagues[7] retrospectively evaluated adjunctive fibular fixation in distal tibia fractures and found a loss of tibial alignment when the fibula was not fixed. With these principles in mind, we have started to treat select patients with complex diaphyseal and metadiaphyseal fractures (eg, multisegmental, bone loss), known or potential healing problems, open fractures, or patients who may potentially need 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 fibular rotation so is best used in segmental or axially stable fracture patterns, especially when there is significant displacement. This technique also helps facilitate reduction of the tibia. By performing the fixation with an intramedullary device, the surrounding soft tissue remains undisturbed. Moreover, this technique does not involve extensive reaming of the intramedullary canal. Thus, disruption of the endosteal blood supply of the fibula is minimal. Finally, commercially available fibular intramedullary nails can range in cost from $1200 to $2200. The cost of a humeral guidewire is less than $200.

We describe a technique of fibular nailing for treatment of lower extremity fractures utilizing a humeral guidewire. The technique is percutaneous with minimal soft tissue injury and limited complications. Restoration of the lateral column of the lower extremity can optimize tibial fixation by providing appropriate assessment of length, alignment, and rotation. Given the promising early results of our technique, it is likely that indications for its use will evolve and expand.

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