Intramedullary Fixation for Fractures of the Distal Fibula

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Introduction

Ankle fractures are among the most common injuries seen by orthopedists comprising 9% of all fractures,4 and the incidence continues to rise because of the epidemic of osteoporosis in the aging population.9 Of these fractures, more than 90% involve the distal fibula.4 The most common ankle fractures result from torsional stress about the ankle, which leads to oblique fractures of the distal fibula.3 Little has changed in the fixation strategies of distal fibular fractures since osteosynthesis was first introduced. The posterior plate has been proposed as a substitute for the lateral plate, trading the concern of hardware prominence for that of peroneal irritation. Locking technology has been utilized in patients with poor bone stock or very distal fragments. These 2 methods of fixation carry an overall complication rate up to 30%,11 with wound infections seen in 26% to 40%.6

Intramedullary fixation of fibula fractures was first described by the use of the Inyo nail in 1986.12 This device was made with malleable stainless steel and attempted to maintain rigid fixation using a triflange wedge fit. This technique was fraught with complications secondary to nail migration and malunion. In other early intramedullary designs, rotational and length instability continued to lead to malreduction and poor radiographic results. Modern design changes and the use of locking screw technology have been used in an attempt to overcome many of the shortcomings of early-generation devices.

Exposure for intramedullary fixation of fibular fractures requires less soft tissue dissection2 and inherently less hardware prominence and periosteal stripping. This technique offers an alternative to traditional plating and looks to improve on the most common complications. Intramedullary fixation is a load-sharing device, and in a recent biomechanical study, it provided a higher load to failure than traditional plate fixation in osteoporotic bone.16

Indications

Indications for intramedullary fixation of the fibula are similar to traditional indications for open reduction internal fixation, which include patients with radiographically proven unstable isolated closed fractures of the distal fibula. Other indications include associated bimalleolar and trimalleolar fractures treated in conjunction with this type of fibular fixation. Intramedullary devices, which allow syndesmotic fixation through the nail, are also indicated in fibular fractures with associated syndesmotic instability. Transverse fractures that are length stable are best suited for intramedullary fixation; however, this technique can also be used for oblique and comminuted fractures.

In addition to more common ankle fractures, length-stable fibula fractures have been successfully treated with intramedullary fixation in the setting of distal tibia pilon fractures.17 Regardless of fracture pattern, these devices are most commonly used in elderly patients with osteoporotic bone, and patients who are at high risk for hardware failure or skin and soft tissue complications, including diabetic patients and smokers.13

Contraindications

General contraindications for the use of intramedullary fixation of the fibula are open fractures, pathological fractures,
comminuted fractures, and extremely distal fibular fractures. We recommend operative management within 7 to 10 days of injury if a completely percutaneous approach is to be utilized as fracture callus increases the difficulty of fragment manipulation.

**Technique**

1. Preoperative templating is available for most intramedullary nail systems to ensure the proper diameter and length device is used when options exist.
2. The intramedullary fixation of the distal fibula fracture is performed under general anesthesia or intravenous sedation with a supplemental regional nerve block.
3. The patient is positioned supine on a radiolucent operating room table. A soft bump is placed beneath the ipsilateral buttock to bring the ankle to a slightly internally rotated position.
4. Prophylactic intravenous antibiotics are administered prior to insufflation of the tourniquet.
5. The extremity is then prepped and draped above the knee.
6. The distal fibula is palpated, noting the fracture site. The bony architecture is marked using a sterile skin marker.

7. Fluoroscopic preoperative images are obtained to help identify the bony landmarks and fracture site (Figure 1).
8. If the surgeon elects to use a tourniquet on the leg, it is exsanguinated and a tourniquet of choice is placed.
9. Reduction can be performed in 1 of 3 ways:
   a. Percutaneous use of reduction forceps utilizing small stab incisions both anterior and posterior using fluoroscopic guidance.
   b. A small incision over the fracture site is often used when fractures are more than 1 week old to remove any callus, which may impede reduction followed by placement of reduction clamps.
   c. Our preferred reduction method is via a percutaneous pin distraction device (Figure 2):
      i. Avoiding the implant’s planned path, 2 small (1.6- or 2.0-mm) K-wires are placed along the anterior cortex above and below the fracture site and Hintermann distractor applied.
      ii. Using the Hintermann, the reduction is performed and the Hintermann locked (Figure 3).
      iii. If the distal portion of the fibula continues to be unstable, the distal K-wire can be driven into the talus.
10. A longitudinal 1- to 2-cm skin incision is made 1 cm distal to the tip of the fibula (Figure 4).
   a. Care is taken to avoid deep sharp dissection as the peroneal tendons lie deep to this incision and the tip of the distal fibula identified under fluoroscopy.

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**Figure 1.** Fluoroscopic imaging which demonstrates using image guidance to mark the site of fracture and distal tip of the fibula.

**Figure 2.** Guide wires are placed using the Hintermann retractor into the proximal and distal aspects of the fracture.
11. The starting point on the distal tip of the fibula is confirmed in both the anteroposterior (AP) and lateral fluoroscopic views (Figures 5-7).
   a. Similar to other intramedullary fixation, the starting point is considered one of the most critical aspects of the procedure, which is slightly medial to the most distal portion of the fibula on the AP view.
   b. On the lateral view, it is slightly anterior to the center of the fibular canal.
12. After confirmation of the starting point, the 0.062-in. guide wire is then placed from the distal tip into the intramedullary canal proximally with a slight medial angle to preserve the lateral cortex of the fibula during reaming.
   a. If the K-wire starts off course, it is often difficult to redirect away from this path. A stout guide wire inserter can be used to assist the redirection of the more flexible K-wire past the previous track.
13. While protecting the soft tissues with the provided tissue protector, a cannulated tapered reamer is driven over the K-wire to open the distal 4 cm of the fibula (this measurement varies depending on system) (Figures 8 and 9).

14. Care should be taken to not remove the K-wire with the opening reamer.

15. While maintaining reduction and location of the guide wire, the intramedullary canal is then reamed to the appropriate diameter generally with a smaller reamer to the appropriate length determined by pre-operative templating.

16. The fibular nail and targeting guide is set up on the back table. The guide should be checked carefully to ensure that the targeted screws remain in line with the locking holes on the device (Figure 10).
17. The insertion guide is placed over the guide wire and fluoroscopic confirmation of intramedullary placement is obtained (Figures 11 and 12).
   a. The inner sleeve and the guide wire are removed.

18. The device is inserted under fluoroscopic guidance. It should be rotated approximately 25 degrees posteriorly to allow for the anatomic placement of lateral screws or suture button fixation into the tibia. A K-wire placed through the distal aspect of the jig allows for visualization of the level of the nail under fluoroscopy (Figures 13 and 14).

19. Once the device is buried into the fibula, small proximal/distal adjustments are then made to optimize purchase into both the proximal and distal bone.
Depth is gauged with the use of a C-arm to appropriately locate the device.

a. Our preferred device (Fibulock, Sonoma Orthopedics, Buffalo Grove, IL) utilizes K-wires placed through the jig to allow for distraction and rotational adjustments. (There are numerous devices commercially available for intramedullary fixation, and each has specific steps that are followed according to their technique guide.)

20. Using the aiming guide, a 1.6-mm K-wire is used to confirm that the depth of the device allows proper syndesmotic screw placement.

a. On a mortise view, the K-wire is confirmed to be 5 to 10 mm proximal to the joint line.

21. In our preferred device (Fibulock, Sonoma Orthopedics), the triangulation talons are expanded by turning the activation driver clockwise approximately 20 full rotations until a positive “click” is felt. This is confirmed by fluoroscopy (Figure 15).

22. At this point, it is determined whether compression should be utilized. The aiming arm of our preferred device has the ability to adjust to accept a screw in either mode. Approximately 2.5 mm of compression can be applied using the compression driver into the outrigger after the appropriate distal screw is placed.

23. A second neutralization screw is placed in either an AP or lateral direction following a compression screw. All screws should engage, but not penetrate, the second cortex (Figure 16).

24. If there is medial ankle pathology, it is addressed at this time.

25. When indicated, a syndesmotic screw or suture button device is then placed through the nail using the outrigger.

a. Prior to fixation, a large periarticular clamp is applied using fluoroscopy to ensure a proper reduction is obtained utilizing fluoroscopy (Figure 17).

26. The targeting arm is removed by unscrewing the distal attachment arm.

27. An end cap is placed into the distal portion of the device to lock the most distal screw (Figure 18).

a. It is useful to place a K-wire into the device to guide the end cap as it is cannulated.

Postoperative Protocol

0 to 2 weeks: The patient is placed into a well-padded short leg splint immediately after the operative procedure. The patient is strictly non-weight bearing with a focus on elevation.

2 to 6 weeks: Sutures are removed at 10 to 14 days. The patient is then transitioned into a controlled-ankle movement (CAM) boot or short leg cast for the following 4 weeks, remaining non-weight bearing for 2 more weeks. In the case of a neuropathic patient, this period

Figure 15. The talon deployment is confirmed on the radiograph on the proximal aspect of the nail; previous placement of distal locking screw can be appreciated.

Figure 16. Care is taken to prevent breaching of the second cortex while placing the distal interlocking screws.
of non–weight bearing can be as long as 3 months, at the surgeon’s discretion.

6 to 8 weeks: Radiographs are obtained at the 6-week postoperative visit. The hardware and reduction are assessed (Figures 19, 20, and 21). If appropriate healing is appreciated and there was no syndesmotic injury, the patient is then allowed to begin a home exercise program. If there was syndesmotic injury, weight-bearing progression is delayed for 2 to 4 weeks.

3 months: Radiographs are obtained at the 3-month visit and if appropriate healing is present then the patient is allowed to slowly return to activities as tolerated. Formal physical therapy is reserved for the deconditioned or high-functioning athlete for safe return to sport.

Complications

A recent systematic review of the available literature for intramedullary fixation alone reported a mean complication rate of 10.3%. The most common complications were post-traumatic osteoarthritis, malunion, fibular shortening after implantation, or implant failure. Less common were wound-related complications, ranging from 1.5% to 6%.

As the technique and modern nail design have developed, the incidence of significant complications has greatly decreased. The majority of the complications were implant-related and early design failures. The more contemporary designs allow locking holes as well as syndesmotic fixation. One group reported their experience with intramedullary fixation and described their technique iterations. After optimizing their construct with the addition of syndesmotic fixation and 2 distal locking screws, their complication rate fell from 21% to less than 5%.

Discussion

Intramedullary fixation of long bone fractures has become widely accepted as the preferred treatment because of its relatively lower morbidity and operative time. Using these techniques, fracture hematoma is not violated and minimal
additional periosteum is damaged. These concepts are currently being applied in smaller long bones. As devices and techniques are developed for this application, intramedullary nail fixation can be applied to the fibula with greater operative ease and ideally improved outcome. For these techniques to be widely accepted, they should demonstrate non-inferiority to the gold standard AO technique as well as provide significant benefits to justify the learning curve of a new technique.

Traditional open reduction and internal fixation of distal fibular fractures has a complication rate up to 30%, most of which is secondary to soft tissue breakdown and infection. This rate is significantly higher in certain high-risk patients such as patients over 65 years of age with poor soft tissue, diabetics, and smokers. Several studies reviewing intramedullary fixation of fibular fractures have reported significantly lower rates of wound breakdown and hardware irritation than seen traditionally with standard AO techniques. The majority of complications seen in early descriptions of the procedure were minimized as the technique evolved. For example, malunion in early, unlocked designs was as high as 20% compared to 5% in a more contemporary locked design.

A recent prospective randomized comparative series demonstrated significantly fewer complications with intramedullary fixation (7%) than with traditional plate fixation (56%). The minimally invasive approach allows for earlier operative intervention, where traditional approaches may have to be delayed to allow for improvement in soft tissue swelling.

Figure 20. Postoperative anteroposterior radiograph illustrating the use of a suture button device for syndesmotic fixation.

Figure 21. Postoperative mortise radiograph illustrating the use of a suture button device for syndesmotic fixation.
Summary

Intramedullary fixation of distal fibula fractures is an evolving technique, which demonstrates benefits compared to traditional AO techniques. In high-risk patients, this minimally invasive approach can reduce the most common complications such as wound breakdown and infection. It is proposed that this approach can lead to faster healing, accelerate rehabilitation, and decrease hospital stay, but more studies are needed to verify these findings.

Declaration of Conflicting Interests

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