

A Novel Technique for Percutaneous Removal of a Suprapatellar Intramedullary Nail

Jeffrey Leary, MD, Matthew Werger, MD, and Carlos Sagebien, MD

Abstract

Intramedullary nailing (IMN) of tibial shaft fractures is an excellent treatment option associated with low complication rates. Suprapatellar intramedullary nailing (SIMN) is a viable alternative treatment to traditional IMN, especially for proximal fractures of the tibia. There are, however, clinical concerns regarding SIMN removal that pose a challenge to a successful outcome. This article describes a novel percutaneous technique for the removal of a SIMN using the same instruments and incision used for nail insertion. This technical innovation offers a simple, reliable, and minimally invasive approach for the removal of any IMN, including nails inserted via a suprapatellar approach. The technique is demonstrated here on a cadaveric specimen as well as with a sawbones model.

Tibial fractures are the most common long bone fracture with an annual incidence of 492,000 fractures per year according to the National Center for Health Statistics.¹ Intramedullary nailing of displaced tibial shaft fractures is the standard of care. Non-articular proximal tibia fractures account for 5% to 11% of all tibial shaft injuries.² Surgical treatment options for proximal tibia fractures include external fixation, plate osteosynthesis, and intramedullary nails. There is no standard of care for the treatment of proximal tibia fractures and each treatment modality has a unique set of potential complications including malalignment.²⁻⁴ Recent advances in percutaneous plating techniques for proximal tibia fractures have facilitated the treatment of these fractures, however, proximal tibial plates are 3 times more likely to require hardware removal than intramedullary fixation.⁵ Although most orthopedic surgeons are familiar with intramedullary nailing of tibial shaft fractures, intramedullary fixation of proximal tibia fractures is twice as likely to result in an apex

anterior deformity following surgery, compared with percutaneous plating.⁵

The complications associated with the treatment of proximal tibial fractures with plates or nails have led to the development of the extended position suprapatellar nailing technique. With this technique, the fracture is reduced and the nail is inserted with the leg in a semiextended position. The use of the semiextended position was developed to facilitate fracture reduction of the proximal tibia by neutralizing the deforming forces of the extensor mechanism. The percutaneous option through the quadriceps spares the soft tissue dissection required for an arthrotomy and patellar subluxation that had been previously proposed for semiextended insertion.⁶ Although long-term studies are still lacking, suprapatellar intramedullary nailing (SIMN) has become a viable alternative to traditional intramedullary nailing (IMN) and plating techniques for proximal tibial fractures.

Although intramedullary nails are the standard of care for tibia fractures, they frequently need to be removed. Common reasons for the removal of tibial nails include nonunions, malunions, infections, and painful hardware. The need for a separate surgical approach for the removal of a suprapatellar nail

Figure 1. Instruments required for nail removal: semiextended entry tube, 2.8 mm guidewire, 7.3 mm cannulated drill, and the tapered extraction bolt.



Authors' Disclosure Statement: Dr. Sagebien wishes to disclose that he is an educational consultant for Smith & Nephew and Synthes. Drs. Leary and Werger report no actual or potential conflict of interest in relation to this article.

has been a significant clinical concern and potential disadvantage of this technique. Although recent cadaveric studies have shown that this approach poses no significant risks to either the articular cartilage or menisci, an equally safe percutaneous system for the removal of this nail has not been described.^{7,8} In fact, we are unaware of any literature regarding tibial nail removal via a suprapatellar approach.

We present a novel percutaneous technique for the removal of a SIMN. Because we utilize the same instruments and incision used during nail insertion, we feel that this is a safe and reliable technique.

Materials and Methods

A cadaveric specimen was obtained according to the guidelines of University of Medicine and Dentistry of New Jersey (UMDNJ)-Robert Wood Johnson Medical School (RMJMS). The study was performed in accordance with all the rules and regulations of the UMDNJ-RWJMS guidelines for studies on cadavers. The technique is also illustrated with the use of a sawbones model.

The lower extremity cadaveric specimen was placed in the semiextended position and draped in the same fashion as for a live surgical patient on a radiolucent table. The suprapatellar nail was inserted using the standard percutaneous method as described in the Smith & Nephew technique guide.

The instruments required for nail removal are the Smith & Nephew SIMN tray (Smith & Nephew, Memphis, Tennessee), the 7.3 mm Cannulated Screw Instrument Set (Synthes Inc, West Chester, Pennsylvania) and the Universal Nail Removal Set (Synthes Inc, West Chester, Pennsylvania) (Figure 1).

Figure 4. The semiextended nailing tube and 2.8 mm guidewire in the patellofemoral joint.



Figure 2. Fluoroscopic AP view of the semiextended entry tube in the retropatellar space (A). Fluoroscopic lateral view of the knee and semiextended entry tube in the retropatellar space (B).



Figure 3. Sawbones image of the knee with the semiextended entry tube and 2.8 mm guidewire in position.

For nail removal, the knee is placed in the same semiextended position as for nail insertion. The proximal interlocking screws are removed percutaneously, under fluoroscopic guidance if necessary. The distal interlocking screws are left in place until after the nail is securely engaged with the extrac-

Figure 5. The 7.3 mm cannulated drill within the proximal nail.

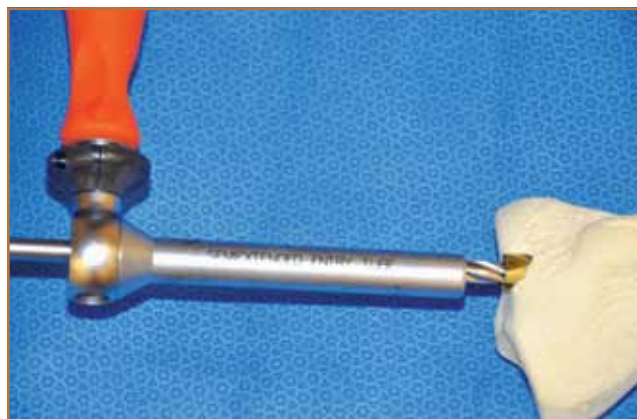




Figure 6. The tapered extraction bolt is prepared for insertion over the 2.8 mm guidewire.

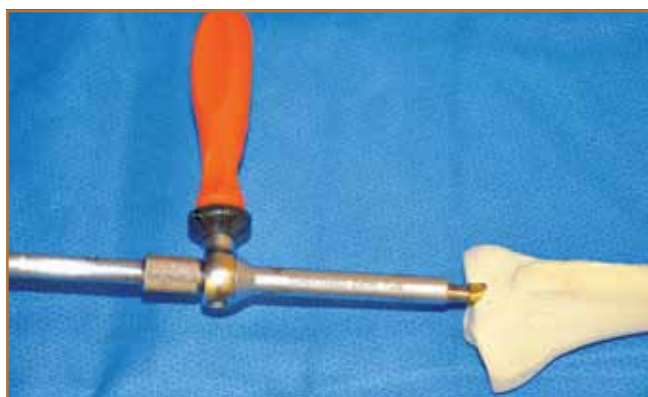


Figure 7. The tapered extraction bolt is passed over the 2.8 mm guidewire and is then threaded into the proximal nail.

tion bolt in order to prevent potential nail migration or rotation during the remaining portion of the procedure. After the proximal screws have been removed, a 3 cm skin incision is made through the original suprapatellar incision used

during nail insertion. At this point, the semiextended entry tube used to protect the patellofemoral joint during nail insertion is inserted in the retropatellar space (Figures 2A-B, 3). Using fluoroscopy, the proximal, threaded portion of the

Figure 8. Radiographic appearance of the nail engaged within the semiextended nailing tube as it is withdrawn from the tibia.



Figure 9. The nail is withdrawn until it engages the semiextended nailing tube, thereafter the nail and tube are withdrawn as a unit to protect the patellofemoral articular cartilage.

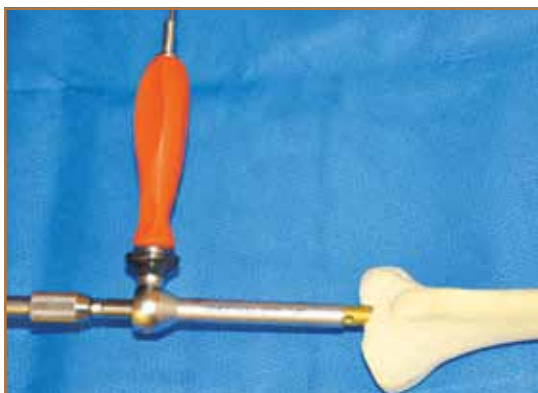


Figure 10. Cadaveric demonstration of the nail and the entry tube being removed as a unit.



IMN is cannulated with the 2.8 mm terminally threaded guidewire from the 7.3 mm Cannulated Screw Instrument Set (Synthes Inc) (Figures 3, 4). The 7.3 mm cannulated drill is then placed over the guidewire and advanced into the nail in order to remove any bony overgrowth or ingrowth around the proximal portion of the nail (Figure 5). Next, a reamer 0.5 mm greater than the actual diameter of the nail is passed over the guidewire in order to minimize proximal hoop stresses during removal. The long, tapered Conical Extraction Bolt (Synthes Inc, West Chester, Penn-

sylvania) is then placed over the guidewire and threaded into the nail until it is firmly attached (Figures 6, 7). Fluoroscopy is used to ensure collinear placement of the extraction bolt within the nail in order to properly engage the nail. Once the tapered extraction bolt is securely fastened to the nail, the distal interlocking screws are withdrawn and the nail is removed (Figures 8, 9). In order to protect the articular surface, the nail is withdrawn until it engages the inner aspect of the semiextended nailing tube. Once the proximal nail is within the tube, the tube and nail are safely removed as a unit (Figure 10).

Results

We successfully removed a tibial IMN inserted through a suprapatellar approach from a 60-year-old male embalmed cadav-

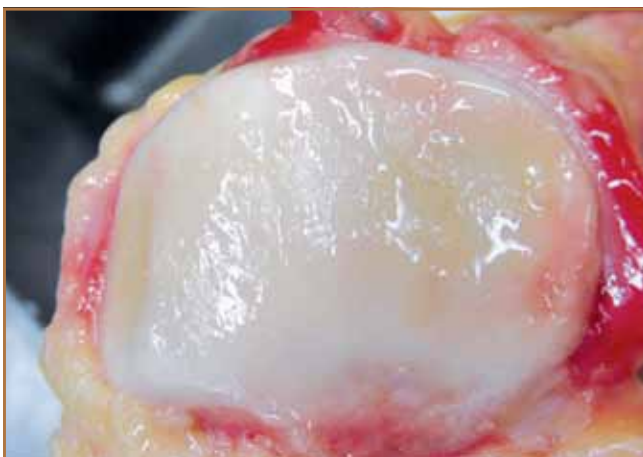


Figure 11. Gross examination of the distal femoral articular surface after nail removal.



Figure 12. Gross examination of the patellar articular surface after nail removal.

eric specimen. The above technique was performed without difficulty under fluoroscopic guidance in a surgical setting. Following nail removal, we dissected the knee and examined the articular cartilage, menisci, and intermeniscal ligament. We found no evidence of damage to any structures within the knee upon gross examination (Figures 11, 12).

Discussion

Common reasons for intramedullary nail removal include pain, nonunion, malunion, and infection. The rate of tibial nail removal secondary to pain has been shown to be as high as 55%.⁹⁻¹¹ Greater than 80% of patients can expect at least partial resolution of knee pain after tibial nail removal.^{12,13} Tibial nonunions can complicate up to 12% of tibial fractures.¹⁴ These nonunions are often treated with exchange nailing to a larger diameter reamed nail.^{12,13,15-17} Chronic or acute infections can also complicate fractures treated with intramedullary nails and nail removal is often required for the successful eradication of the infection.¹⁸

The successful removal of an intramedullary nail can be an arduous task. Bony overgrowth and scarring around the insertion site can make an otherwise straightforward nail removal a significant challenge. Large incisions with extensive dissection and with the removal of large amounts of bone during nail extraction can cause significant bleeding and damage to soft-tissue, cartilage, and bone.

A specific disadvantage of the suprapatellar nail has been the perceived need for a second incision for nail removal. A second incision is cosmetically displeasing and has the potential to cause more scarring and therefore more pain. The technique we present here is a simple method for the removal of a suprapatellar IMN without the need of a second incision. Because we use the same working cannula used during nail insertion, there is little risk to the patellofemoral joint. The insertion of a percutaneous guidewire under fluoroscopic guidance is a common technique to localize and cannulate the nail and requires no soft-tissue dissection. The use of the 7.3 mm

cannulated drill over the guidewire clears the inner channel of the nail, and obviates the need to visualize and clear the inner threads with curettes or other instruments. The use of a reamer 0.5 mm larger than the diameter of the implant ensures that a minimum amount of bone is removed for the safe removal of the nail. Finally, the use of a tapered extraction bolt simplifies the proximal capture of the nail without the need to actually visualize the proximal nail threads when inserting the extraction bolt. However, we do recommend a formal second incision and visualization of the proximal nail threads if there is any difficulty threading the extraction bolt into the proximal nail in order to avoid stripping the threads within the nail.

Our technique provides a percutaneous option for suprapatellar nail removal. While the benefits of using a percutaneous IMN in a semiextended position have been previously demonstrated, concerns regarding suprapatellar nail removal has detracted from the popularity of this technique. The technical innovation shown in this paper offers a simple, safe, reliable, and minimally invasive technique for the removal of any tibial intramedullary nail including nails inserted via a suprapatellar approach.

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