Extra-Articular Technique for Semiextended Tibial Nailing

Erik N. Kubiak, MD, Benjamin J. Widmer, MD, and Dan S. Horwitz, MD

Summary: Intramedullary nailing is a widely accepted technique for the stabilization of unstable diaphyseal tibia fractures. When this method of stabilization is applied to proximal and distal metadiaphyseal fractures, achieving and maintaining fracture reduction is more difficult. The intramedullary nailing of proximal metadiaphyseal fractures in semiextension has been advocated to make stabilization less difficult. The intra-articular nature of this technique makes it less appealing. We present a nailing technique that facilitates extra-articular semiextended tibial nailing. The technique simplifies intraoperative imaging, fracture reduction, and maintenance of reduction during nail insertion and locking.

Key Words: tibia fracture, extra-articular, extended nailing, intramedullary nailing

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INTRODUCTION

Tibial shaft fractures are the most common long bone injury. This fracture pattern occurs approximately 26 times per 100,000 persons per annum[1] and accounts for 77,000 hospitalizations per year in the United States.[2] Intramedullary nailing is the preferred treatment for diaphyseal tibia fractures and is commonly used to stabilize those tibia fractures that extend into the proximal and distal metaphyses.

Over the past several years, there has been a renewed interest in the use of a semiextended nailing technique for the stabilization of tibial shaft fractures. Semiextended tibial nailing is indicated for the treatment of proximal quarter and segmental tibia fractures. This technique was originally described by Tornetta for the treatment of proximal tibia fractures.[3]

The technique described by Tornetta uses a medial arthrotomy with exposure of the trochlea. Recently, some have advocated a suprapatellar arthrotomy and a retropatellar instrumentation of the tibia through the patellar femoral joint (Dr. Erik Fulkerson and Dr. Roy Sanders, personal communication). With this modified approach, special instruments are required to prevent damage to the patellofemoral articulation. Additionally, there is limited access to the knee for the removal of reamer debris. These limitations have led some clinicians to indicate this approach for unreamed tibial intramedullary nailing only.

We describe a novel technique for semiextended tibial nailing that does not violate the knee, stays clear of the patellar tendon, and requires no special instrumentation. We feel that this technique offers advantages for intramedullary nailing of not only proximal quarter fractures, but all diaphyseal and distal metaphyseal fractures as well as a result of the ease of positioning, reduction, clamp application, placement of Poller screws, and imaging.

TECHNIQUE

The patient is positioned supine on a radiolucent table. A bump is placed under the ipsilateral hip from the scapula to the ilium. The patient's ipsilateral arm is brought across the chest and secured in a well-padded fashion. We routinely pad and secure the contralateral lower extremity to prevent it from being pushed off the operating table during the procedure.

A preformed foam ramp or towel/blanket ramp is placed beneath the affected extremity such that the hip and knee are flexed approximately 30° (Fig. 1). The operating table is manipulated so that the tibia is parallel to the floor. The fluoroscopy unit is placed on the contralateral side and the fluoroscopy monitor is placed at the foot or head of the bed depending on the vantage point of the surgeon. The patient is then prepped and draped per surgeon preference.

Placing and maintaining the tibia at 0° along the Y-axis, ie, parallel to the floor, maintains the conventional three-dimensional axis that operating personnel are more accustomed to working with. Positioning of the image intensifier parallel to the floor also minimizes the impingement of the C-arm on the operating table or the patient's knee. This increases the rapidity and reproducibility of image intensifier views that in turn simplifies the identification of nail insertion points, clamp application for reduction, maintenance of reduction during reaming, and locking of the nail. Additionally, if stabilization of the fibula is indicated, the leg does not need to be repositioned for fibular fixation.

Reduction may be obtained directly or indirectly as dictated by the fracture pattern. Rotation, flexion, extension, and length can be readily adjusted with thin wire traction in the calcaneus. We have found this to be especially helpful for distal fractures in which traction must be applied manually through the foot.

An image intensifier and guide pin are used to determine the ideal starting point for the nail relative to the tibial tubercle. Once the starting point has been determined, the medial and

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FIGURE 1. A ramp or towels should be placed beneath the affected extremity such that the hip and knee are flexed approximately 30°.

lateral laxity of the patella is taken into consideration. The path of least resistance, as directed by patellar laxity and patient anatomy, determines whether a medial or lateral patellar approach is made (Fig. 2). A medial or lateral incision is made depending on which incision will allow for the easiest access to the appropriate starting point just medial to the lateral tibial spine at the anterior articular margin.[4,5] Figure 2 demonstrates the incision planning when increased lateral patellar laxity is present. Conversely, when a patient has markedly increased medial patellar laxity, a lateral incision would be chosen.

Dissection is carried sharply through the dermis, and electrocautery is used for hemostasis (Illustration 1A). The patellar retinaculum is identified and freed from overlying soft tissue. The retinaculum is then carefully elevated from the underlying synovium (Illustration 1B). This plane is developed along the entire length of retinaculum, which is then divided sharply leaving a 2- to 3-mm cuff of tissue for repair along the patellar border (Fig. 3).

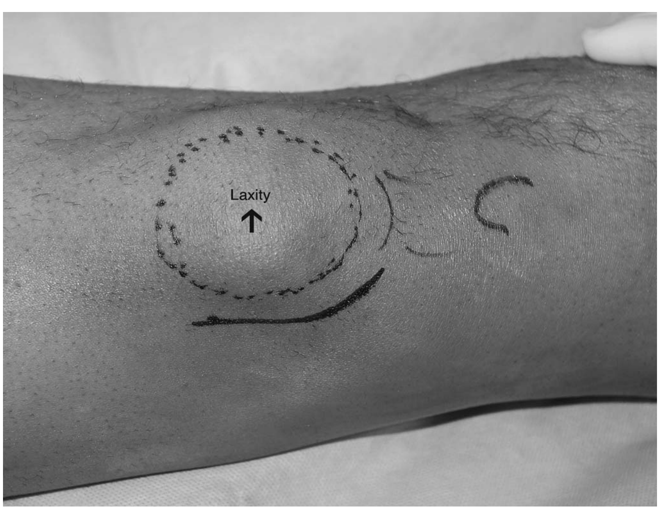
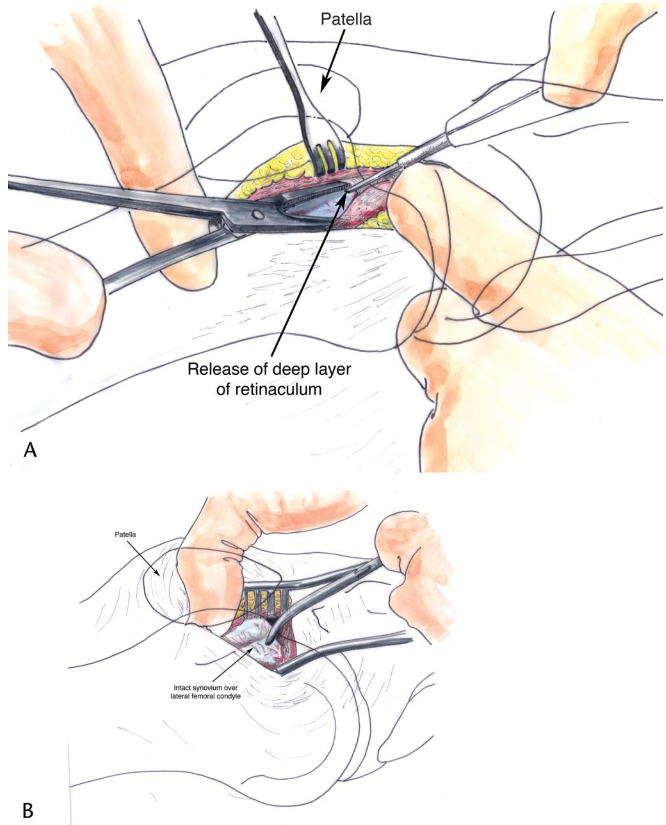


FIGURE 2. Incision planning. The tibial tubercle, patellar tendon, patella, and joint line are outlined on a patient with increased lateral patellar laxity. The curvilinear incision begins at the medial border of the proximal third of the patellar tendon. It extends proximally to the medial border of the patella and then to the level of the proximal pole.



ILLUSTRATIONS. (A-B) Illustrations depict the location of the patella, femur, and tibia in relation to the curvilinear incision. Coloration identifies important anatomic layers: yellow is subcutaneous fat, red is retinacular tissue, and blue is the synovium.

Great care is taken to preserve the synovium and prevent incidental arthrotomy. When they occur, incidental arthrotomies are routinely repaired with 3-0 absorbable monofilament suture.

The patella is then subluxated laterally or medially to allow direct access to the proximal tibial starting point. With the patella subluxated, a threaded guide pin is placed deep to the patellar tendon and superficial to the synovium at the appropriate starting point slightly lateral to the center of the tibial tubercle[4,5] (Fig. 4A). Depending on surgeon preference, this may be performed with fluoroscopic guidance or under direct visualization. A proximal tibial starting portal is then created and expanded with a cannulated awl or cannulated reamer.

After satisfactory fracture reduction is attained and maintained, the ball-tipped guidewire is advanced down the reduced tibia. Guidewire placement is verified fluoroscopically, reduction is monitored, and then reamers are passed sequentially until appropriate cortical contact is obtained.

Reamers are not started until the tip is within the proximal metaphysis. Note that the intact synovium protects the trochlea and medial facet of the patella from mechanical trauma and prevents intra-articular introduction of reaming

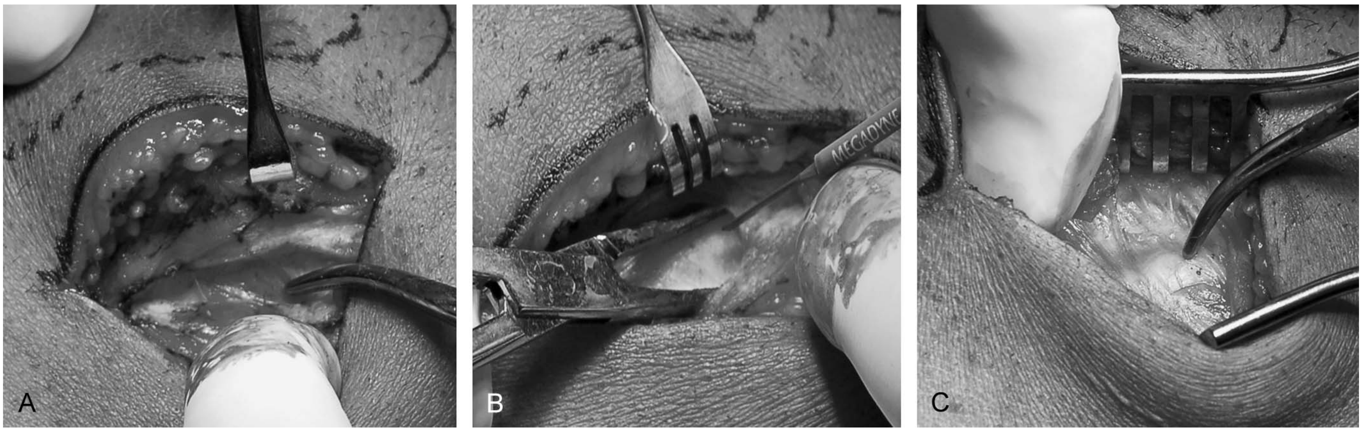


FIGURE 3. Identification and release of the medial superficial retinacular tissues (A). Release of the inferior deep retinacular bands (B) is critical to allow for the easy subluxation of the patellar, which then reveals an easy access to the trochlea, which is demonstrated at the tip of the Kelly clamp (C). Note the intact synovium draped over the trochlea.

debris. It is important to irrigate the reamer shaft to prevent the adhesion of the synovium to the spinning reamer shaft, thereby preventing synovial disruption (Fig. 4B).

After reaming, a nail of appropriate length and diameter is selected and placed within the intramedullary space. The nail should also be irrigated to protect against accidental tearing of the synovium. Again, the intact synovium protects the articular surfaces from mechanical trauma. During nail insertion, it may be necessary to lift up on the nail introduction handle to avoid impingement on prominent femoral condyles and/or inadvertent damage to the articular surface (Fig. 5).

After the nail has been locked proximally and distally, the insertion point is copiously irrigated to remove all reamer debris from behind the patellar tendon. The retinacular tissues are repaired with interrupted absorbable suture. The dermis and skin are reapproximated per surgeon preference. Generally, we do not place drains when the synovium is intact or accurately repaired.

CASE PRESENTATIONS

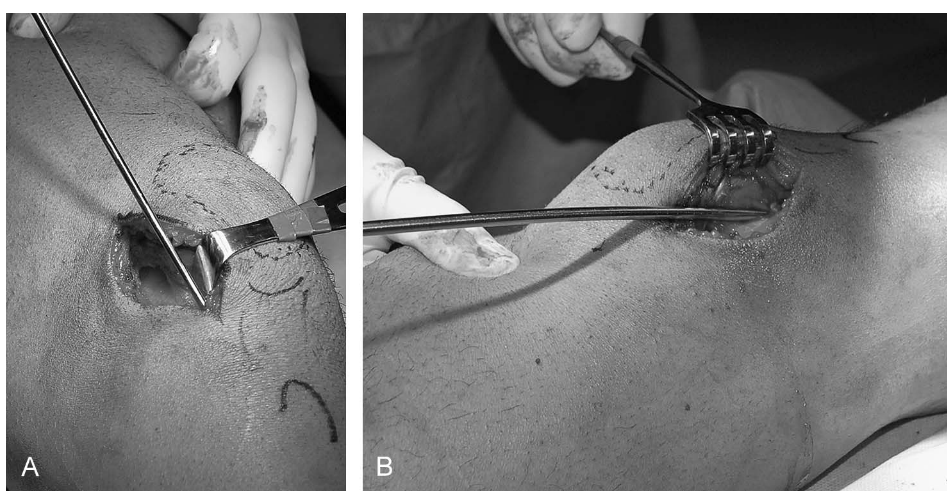
Over the last 12 months, we have performed 26 tibial nailings using this technique. Eight were proximal, seven were open fractures, and the remaining 11 were distal fractures with intra-articular extension. One patient with severe dementia and a proximal quarter fracture ambulated immediately and was revised to locked lateral plate fixation after collapsing into valgus and extension. There were no complications related to soft tissue healing in these patients. Small capsular tears occurred in three of the 26 referenced cases (approximately 12% of patients). These tears were repaired with 3-0 absorbable monofilament suture. Knee pain scores are not available for these patients; however, the authors noted that patients reported knee pain issues at a similar rate as with other methods of tibial nailing.

Both proximal and distal tibial fracture stabilization with intramedullary nails can be facilitated by the semiextended technique. Figure 6 demonstrates a distal fracture pattern nailed using this technique. Also, we have found that this approach facilitates easy placement of clamps and/or supplementary fixation when necessary.

DISCUSSION

Transpatellar, medial, and lateral parapatellar approaches with the knee in a flexed position are the most commonly used approaches for intramedullary stabilization of tibia fractures.[5,6] These approaches require the flexion of the knee to prevent injury to the patella during reaming and nail insertion. The commonly observed postfixation flexion

FIGURE 4. (A) Correct position of the 2-mm guidewire is facilitated by patellar subluxation. (B) Reaming is not initiated until the reamer tip is contained within the proximal tibia. Continuous irrigation of the reamer shaft prevents adhesion and subsequent tearing of the synovium. Irrigation during nail insertion is also important for the same reasons. Alternatively, a soft tissue protector can be used to pass the reamers safely until seated in the proximal tibia.



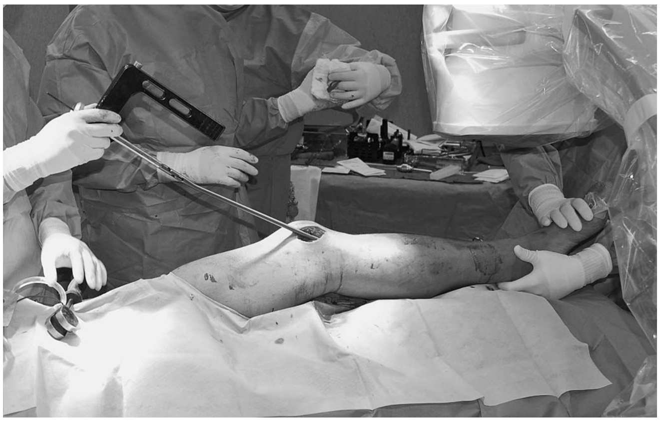


FIGURE 5. Image shows insertion of the tibial nail in the semiextended position using a percutaneous jig. However, a standard jig works just as well for this approach.

deformity of proximal tibia fractures has been attributed, in part, to approaches that require a flexed position for intramedullary stabilization of proximal tibia fractures.[7,8] This has led some authors to advocate the semiextended approach for intramedullary stabilization of proximal quarter tibia fractures.

Semiextended tibial nailing is a technique previously described for the stabilization of proximal tibia fractures. This can be done through a lateral or medial knee arthrotomy, as originally described by Tornetta and Collins,[3] or through a suprapatellar approach facilitated by the use of special cannulas (personal communication). The intra-articular nature of these techniques has led to some apprehension regarding widespread application to other tibia fractures. We described a modification of the semiextended nailing technique that allows for patellar subluxation and preservation of the synovium. This may decrease trochlear damage and eliminate

FIGURE 6. A 27-year-old man who sustained a crash while riding his all-terrain vehicle. Anteroposterior (AP) (A) and lateral radiographs (B) demonstrate open distal tibia and fibula fractures. Postoperative AP and lateral radiographs are also shown (C–D).

the concern about intra-articular reaming debris. We have found that this technique simplifies the nailing of all tibia fractures, not just proximal fractures.

Many surgeons will be familiar with the fundamental elements of this approach whether or not they have used a semiextended approach. The medial and lateral patellar starting points are not new concepts. They are well described in existing orthopaedic literature.[6,9] As research has shown, the relationship of the lateral tibial spine and the patellar tendon varies between individuals suggesting that limiting the surgical approach to a single side may result in a less than optimal entry site.[6] For our technique, using patient anatomy as well as inherent patellar laxity to choose the medial or lateral parapatellar approach simplifies the process of obtaining access to the optimal insertion point just medial to the lateral tibial spine and at the anterior margin of the articular surface.[4,5]

The crucial point of these two approaches is that they both allow for the subluxation of the patella when careful release of the skin and retinaculum is performed, thereby preventing nail and reamer impingement on the patella during reaming and decreasing the risk for iatrogenic injury to the patella. The effort spent maintaining the intact synovium has the added benefit of protecting the underlying trochlear cartilage. Additionally, the subluxation of the patella allows for nailing of the tibia in a semiextended position.

There are several advantages to using the semiextended position. Primarily, the ability to maintain the tibia rested on a horizontal surface throughout the reduction, reaming and intramedullary stabilization has additional benefits related to tibial stabilization and imaging. We have found that this tibial positioning allows for 1) simplified imaging of the proximal tibial for determination of entry position; 2) easier maintenance of fracture reduction; 3) simplified accurate placement of blocking screws; 4) facilitated maintenance of reduction of distal tibia fractures; 5) easier application of percutaneous clamps to reduce spiral fracture; and 6) easier application of supplemental fixation.

This position also places the tibia in an excellent position for supplemental open reduction and internal fixation of the fibula or tibia if deemed necessary. Additionally, we have found that nailing in the semiextended position encourages the placement of distal locking bolts before proximal locking bolt placement, because the nail insertion jig does not impinge on the patella. This may lead to the more frequent use of "back slapping" to eliminate residual fracture gap.[10,11]

However, it is important to note the difficulties that arise when using this approach. We have found that small capsular tears can occur that will require additional repair (tears are generally closed with 3-0 absorbable monofilament suture). Each of these tears has occurred for one of two reasons. First, tears can occur when the operative environment is not wet enough, ie, irrigation was inadequate during reaming or nail insertion. Second, insufficient retinacular release can result in a capsular tear by limiting patellar mobility. This occurs when the skin incision is too low or too small and causes the patella to impinge against the nail. There is also the risk of postoperative patellar instability secondary to failure of the retinacular repair. We have not observed this theoretical complication despite encouraging early knee range of motion activity with no limitations and no external bracing in the postoperative period.

Unfortunately, there is no evidence that this approach will provide relief for one of the most common complications of intramedullary nailing: anterior knee pain. The etiology of anterior knee pain remains elusive. Neither the medial or lateral patellar starting point has demonstrated significant decreases in knee pain over a standard patellar tendon splinting approach.[9] This technical tip does not attempt to assess the effect of semiextended tibial nailing on knee pain or surgical time.

CONCLUSION

The extra-articular tibial nailing technique, as described, is a novel refinement of a previously described technique that we believe is applicable to all tibia fractures. We have found that this technique simplifies and improves on the current techniques of tibial nailing by optimizing tibial positioning for reduction, maintenance of reduction, fluoroscopic imaging, and intramedullary nail insertion. This is particularly true for proximal and distal tibia fractures.

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