Tips and Tricks: Semiextended Suprapatellar Intramedullary Nailing of the Tibia

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Background

The history of intramedullary nailing of long bone fractures is long and has evolved continuously for over 100 years. Initial treatments reported in German literature described the use of ivory pegs as intramedullary implants. During World War I, Hey Groves from England described placement of metallic rods for the treatment of gunshot wounds, but this technique did not gain popularity due to a high reported infection rate.[1] In 1931, Smith-Petersen described the use of stainless steel nails for treatment of femoral neck fractures.[2] During the same time, Gerhard Küntscher of Germany took the idea of the Smith-Petersen nail and developed the Küntscher nail which he popularized during World War II on many patients, including American soldiers. He later went on to develop flexible reamers allowing placement of larger nails, which helped advance fracture stability. Further advances came along in subsequent decades including interlocking screws and different nail designs. The 1990's signaled a major expansion with the indications of reamed and unreamed tibial nailing.[3]

Classically, placement of tibial nails was via an infrapatellar (IP) approach, either via a trans- or parapatellar exposure with the knee in flexion or hyper-flexion. This approach creates technical challenges for proximal third tibial fractures with the extensor mechanism complex extending the proximal fragment, resulting in a procurvatum deformity of the tibia. In addition, fluoroscopic intra-operative imaging can be challenging in visualizing the starting point with the knee in flexion. The semiextended technique, described by Tornetta *et al* in 1996, places the knee in approximately 15 degrees of flexion to combat these distracting forces.[4] This semi-extended technique evolved into a suprapatellar (SP) approach through the quadriceps tendon to access the proximal tibia, avoiding disruption of the patellar tendon and its retinaculum.

Initial concerns were raised about damage to the patellofemoral joint and possibility of septic arthritis of the knee. However, recent studies have mitigated these concerns. Cadaveric studies demonstrated nail insertion pressures below that for articular cartilage damage.[5] Clinical studies further showed some immediate cartilage changes on post-operative arthroscopy, but a normal MRI at 1 year with no clinical knee pain. Additionally, suprapatellar nailing has been shown to have a significantly decreased rate of distal tibia malalignment, improved reduction in the sagittal plane, less operative and fluoroscopic time, and decreased anterior knee pain.[6-9] With regards to concern for sepsis, a recent multi-center study demonstrated a very low (1.4%) but non-significant difference in the rate of septic arthritis of the knee with suprapatellar or infrapatellar approaches in open tibial fractures.[10]

This overview of suprapatellar intramedullary nail placement seeks to review tips and tricks to successful utilization of this technique to ensure good clinical outcomes.

Treatment Considerations

Preoperative Evaluation and Planning

Before deciding to proceed with semiextended SP nailing of the tibia, several factors need to be assessed. Preoperatively, radiographs of the knee should be reviewed with particular focus on the patellofemoral compartment to assess for any injury, arthritis, or other condition that may predispose to difficulty accessing this space. On clinical exam, adequate patellar mobility is essential in order to access the proximal tibia and accommodate the cannula and surgical instruments. Typically, two quadrants of patellar mobility are needed for adequate access to prevent iatrogenic damage and proper instrumentation.

Suprapatellar nailing of the tibia requires a specific set of instruments that is distinct from the IP set. Specifically required is the protective insertion sheath, made of PEEK or metal. A separate, specific jig is then utilized through the cannula underneath the patella to access the proximal tibia while preventing iatrogenic injury to the cartilage of the patellofemoral joint.

Operative Evaluation

Positioning

The patient is positioned supine on a radiolucent table with a bump under the ipsilateral hip to ensure the patella is facing upwards. Next, the injured extremity is positioned with the knee in approximately 10 to 20 degrees of flexion over radiolucent foam or a radiolucent bump. (Figure 1) This serves two purposes: to

Figure 1. Semi-extended positioning of operative leg

keep the knee in flexion and to keep the leg elevated allowing lateral radiography of the extremity. Proper positioning allows easy access to the proximal tibia for instrumentation, easier imaging as compared to an IP approach, and less difficulty with reductions, particularly when using adjuvant techniques for distal or proximal injuries.

Imaging

After proper positioning, fluoroscopic imaging is significantly easier as compared to IP nailing. As the limb is parallel to the floor, fluoroscopy does not need to be rotated and can shoot directly downwards, allowing easier operative access to the limb and less operative and fluoroscopic time. (Figure 2) A lateral can also be obtained in a standard fashion.

Suprapatellar Nail Insertion

Starting one finger breadth from the superior pole of the patella and extending 2-4 cm proximally, an incision is carried down through the quadriceps tendon in line with the fibers and down to bone. The tendon is sharply incised and adhesions are freed in the suprapatellar pouch and intra-articularly to allow placement of the soft tissue guide. This step is key in allowing ease of passage of the soft tissue guide for proper starting point. Next, the soft tissue guide is inserted retropatellar above the trochlea, followed by a guidewire. A perfect AP and lateral of the knee is needed to ensure proper placement of the guidewire. (Figure 3) The guidewire should placed slightly medial to the lateral tibial spine on the AP, and at the junction of the anterior cortex and articular surface in line with the anterior cortex on the lateral x-ray. Keeping in line with the anterior cortex is key to prevent posterior cortex violation and to ensure the nail will be centered down the shaft of the tibia. (Figure 4) If the starting point is too anterior, there is risk for an iatrogenic fracture of the tibial tubercle. The guidewire is then provisionally advanced past the level of the tibial tubercle. Some systems allow placement of a separate guide pin through the jig and into the femur providing further stabilization of the jig and soft tissue guide thereby preventing it from backing out. This is an important step to prevent injury to the patellofemoral joint. After finding the proper starting point, the opening reamer used to open the proximal tibial cortex. (Figure 5) At this point, the ball tipped guide wire is introduced through the soft tissue guide in the jig. The fracture must now be reduced. If the fracture is an isthmus fracture, the ball tipped guide wire can simply be passed down the tibia. However, if the fracture is distal or proximal where the diameter of the intramedullary device will not "fill" the canal, then a near anatomic reduction utilizing closed, percutaneous, or open techniques is necessary. SP

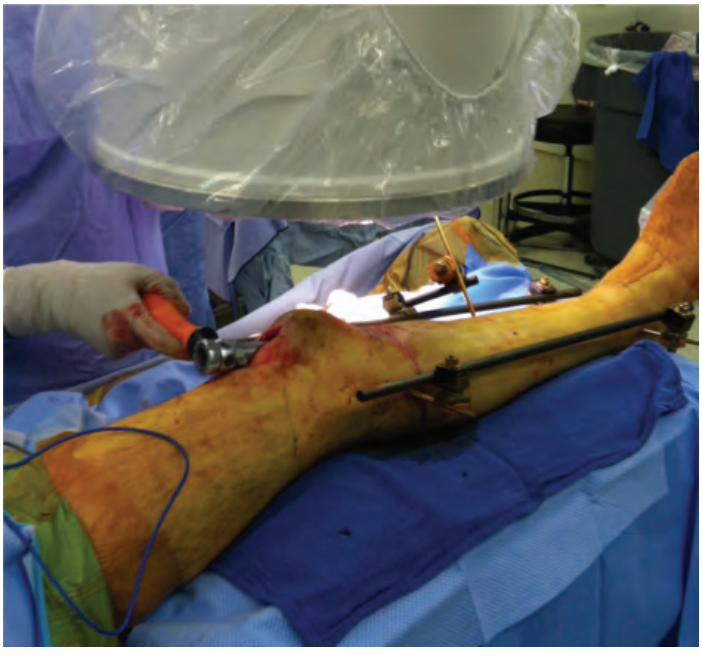

Figure 2. Positioning of fluoroscopy.

Figure 3. AP X-ray of the knee demonstrating proper starting point through soft tissue sleeve.

Figure 4. Lateral X-ray of the knee demonstrating suprapatellar approach through soft tissue sleeve.

Figure 5. Passage of opening reamer through soft tissue sleeve.

nailing facilitates fracture reduction, especially in proximal third tibia fractures.As the leg is flat on the operating table and not in hyperflexion, distracting muscular forces and gravity are neutralized allowing the fracture to be easily reduced and held. The guide wire is then passed and nail placement proceeds in a standard fashion with sequential reaming, nail placement, and interlocking screw fixation.

Conclusion

In summary, semiextended suprapatellar intramedullary nailing of the tibia is a safe and often advantageous approach to a common problem. SP nailing of the tibia has been shown to have decreased anterior knee pain, decreased operative and fluoroscopic time, improved sagittal alignment, and decreased malalignment in distal tibia fractures as compared to infrapatellar tibial nailing. Near term studies have demonstrated no clinical differences in knee outcomes. Further studies are needed to assess this approach long term. With focus on several key steps of the procedure, semiextended suprapatellar intramedullary nailing of the tibia can be a successful technique surgeons can use for treatment of these fractures.

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