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Authors
Lee, Ruth
Stull-Lane, Annica
Magana, Rosa
et al.

Publication Date
2024-04-01

Data Availability
The data associated with this publication are not available for this reason: NA

Comparing Approaches for Intramedullary Nailing for Tibial Shaft Fractures

Ruth Lee, Annica Stull-Lane, Rosa Magaña, Rahul Bhale, Madelyn Larson, Sean Campbell, Ellen Fitzpatrick, Gillian Soles, Mark Lee, Augustine Saiz

UC Davis School of Medicine | Department of Orthopaedic Surgery

ABSTRACT

Intramedullary nailing is considered the gold-standard treatment for tibial shaft fractures. The goals of treatment for these fractures are correction of axial and rotational alignment and adequate mechanical stability, allowing for optimal healing. The nail is secured in place using screws or other fasteners that are placed through the bone and into the nail itself.[2] Another benefit is the ability to preserve the soft tissue around the fracture to safeguard the extraosseous blood supply and minimize soft tissue damage.[3] In reference to tibial intramedullary nailing, a start point is the location where a hole is drilled in the tibia to insert the intramedullary nail. The ideal starting point for guide wire placement for the average tibia is described as 2 mm medial to the lateral tibial eminence on AP imaging and just anterior to articular surface and parallel to the anterior tibia cortex on lateral imaging.[6,7] It is a critical part of the procedure because it determines the trajectory and positioning of the nail within the medullary canal.[7] Having a good, ideal starting point can prevent valgus angulation and translation at the fracture site. If the start point is too far off center or at the wrong angle, the nail may be inserted incorrectly and not provide the necessary support for the bone to heal, leading to malalignment or nonunion.

It is believed that different approaches to tibial intramedullary nailing may have differing abilities to achieve an optimal start point due to associated anatomical visualization and access. These approaches include suprapatellar, parapatellar, and infrapatellar nailing. The suprapatellar approach involves making an incision above the patella and placing instruments across the patellofemoral joint, potentially damaging the joint surface. However, the nail can be inserted at the start point with the knee extended, which leads to better alignment and stability of the fractured bone. Most importantly, the main advantage of the suprapatellar approach is that it reduces anterior angulation by eliminating the extension force of the quadriceps and aids fracture reduction by preventing proximal fragment migration.[4,5] The parapatellar approach, proven to be effective and reliable, involves making a smaller incision below the patella with the knee in hyperflexion. This approach is less invasive than the suprapatellar approach regarding the patellofemoral joint, but the patellar tendon needs to be circumnavigated leading to potential for higher incidence of anterior knee pain.[6] Also, it can be more difficult to achieve proper alignment and increases the risk of apex anterior deformities.[4] The infrapatellar approach is split into transtendinous approach and paratendinous approach where the starting point is established by splitting the patellar tendon or making an incision on either side of the knee, respectively.[6] This approach provides good visualization, but it can increase the risk of damage to the patellar tendon and other soft tissue structures around the knee.

OBJECTIVES

The objective of this study was to compare the start points of patients who were treated with these approaches.

METHODS

After Institutional Review Board (IRB) approval, the Electronic Medical Record (EMR) was queried for patients (age 18+) who underwent intramedullary nail fixation for a tibial shaft fracture (OTA/AO type 42A-C) at a single academic level 1 trauma center from January 2014 – January 2023. Patients were excluded if they were under the age of 18 at the time of surgery, had a pathological fracture, or had combination plate-nail fixation.

Patient characteristics including age, sex, BMI, and smoking status were collected from the EMR. OTA/AO classification and injury characteristics were determined by a review of preoperative injury radiographs. The type of intramedullary nail approach used was noted, with options including suprapatellar, parapatellar, and infrapatellar. Complications were noted including infection, implant-related complications, and nonunion by serial evaluation of patient charts and postoperative radiographs. Subsequent revision surgeries were noted.

RESULTS

Of the 103 patients, the mean age was 44.8 years old. The mean BMI was 29.1, with 47.6% female patients. 50.5% of patients had a smoking history. The average follow-up length of time was 6.0 months. 6 patients (5.8%), 81 patients (78.6%), and 16 patients (15.5%) underwent the infrapatellar, suprapatellar, and parapatellar approaches, respectively.

Radiographic Parameters:

Radiographic parameters are summarized in Table 1. Radiographic start point parameters for the infrapatellar, suprapatellar, and parapatellar were wire angle (17.0°, 6.3°, and 10°; $p<0.05$), reamer angle (15.0°, 6.1°, and 5.5°, $p<0.05$), coronal deviation from tibial eminence (0.84 mm, 1.3 mm, 5.5 mm, $p<0.05$), coronal deviation from anatomic axis (4.0 mm, 1.9 mm, and 2.3 mm; $p=0.2$), and sagittal deviation from the anterior tibia edge (2.04 mm, 1.5 mm, 5.4 mm; $p<0.05$).

RESULTS (cont.)

Table 1: Radiographic start point parameters for infrapatellar, suprapatellar, and parapatellar approaches, along with P-values relevant to differences.

	Patients (N)	Wire angle	Reamer angle	Coronal Deviation from Tibial Eminence	Coronal Deviation from Anatomic Axis	Sagittal Deviation from Anterior Tibia Edge
Infrapatellar	6 patients	17.0°	15.0°	0.84mm	4.0mm	2.04mm
Suprapatellar	81 patients	6.3°	6.1°	1.3mm	1.9mm	1.5mm
Parapatellar	16 patients	10°	5.5°	5.5mm	2.3mm	5.4mm
P-Values		<0.05	<0.05	<0.05	0.2	<0.05

DISCUSSION

The optimal management of tibial shaft fractures remains a topic of significant interest in orthopedic surgery. Among the key considerations in IMN fixation is the identification of an ideal start point for nail insertion, which is pivotal for achieving adequate alignment and stability of the fracture. This study aimed to investigate whether suprapatellar, infrapatellar, and parapatellar approaches influence the attainment of an optimal start point and subsequent outcomes in tibial shaft fracture fixation.

This retrospective chart review of patients who underwent tibial shaft fracture fixation with IMN at single academic Level 1 Regional Trauma Center shed light on several aspects of IMN fixation in tibial shaft fractures. Radiographic parameters assessed include wire angle, reamer angle, coronal deviation from tibial eminence, coronal deviation from anatomic axis, and sagittal deviation from anterior tibia edge. During the 10-year period studied, 6 patients underwent IMN fixation with an infrapatellar approach. The infrapatellar approach produced the most optimal coronal deviation from tibial eminence though this approach also produced the least optimal wire, reamer, and coronal deviation from anatomic axis of the three approaches. The parapatellar approach produced the most optimal reamer angle, but the greatest coronal deviation from tibial eminence and sagittal deviation from anterior tibia edge. The suprapatellar approach gave the most optimal wire angle, coronal deviation from anatomic axis, and sagittal deviation from anterior tibia edge and, of the three approaches, was the most used. This suggests that the suprapatellar technique may offer better control over the trajectory of nail insertion, potentially leading to improved alignment and stability of the fracture.

However, it is important to note that the choice of surgical approach must also consider other factors beyond start point optimization. For instance, while the suprapatellar approach exhibited favorable radiographic parameters, concerns regarding potential damage to the patellofemoral joint and increased risk of anterior knee pain should be considered. Conversely, the infrapatellar approach, despite being less common, demonstrated promising results in minimizing coronal deviations from the tibial eminence. This highlights the importance of weighing the benefits and drawbacks of each approach based on individual patient characteristics and fracture patterns. Furthermore, the association between start point parameters and clinical outcomes such as fracture displacement and postoperative complications warrants attention. Although this study primarily focused on radiographic assessments, future research should aim to establish correlations between start point optimization and functional outcomes, including patient-reported pain, range of motion, and return to activity. Prospective studies with larger sample sizes and longer follow-up periods are needed to validate these findings and elucidate any potential long-term implications of start point optimization on patient outcomes.

CONCLUSION

This study contributes to our understanding of the role of surgical approach in achieving an optimal start point for IMN fixation in tibial shaft fractures. The findings underscore the importance of individualizing treatment strategies based on fracture characteristics and patient factors. Moving forward, a comprehensive evaluation of start point optimization alongside clinical outcomes will be essential for informing evidence-based decision-making in the management of tibial shaft fractures.

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ACKNOWLEDGEMENTS

Special thanks to my mentor, Dr. Augustine Saiz, the Department of Orthopaedic Surgery, and Ruth Lee.