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Original Article

Suprapatellar Entry Intramedullary Nailing in Adult Tibial Shaft Fractures: A Retrospective Clinical Study

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ABSTRACT

Objective: The tibia is one of the most commonly fractured long bones and is frequently exposed to high-energy trauma. Selecting an appropriate treatment method is essential for successful outcomes and improved patient quality of life. In recent years, the suprapatellar entry intramedullary nailing technique has gained attention as a promising surgical approach. The aim of this study was to evaluate the clinical and radiological outcomes of suprapatellar intramedullary nailing in the treatment of adult tibial shaft fractures.

Methods: This retrospective study included adult patients with tibial shaft fractures treated with the suprapatellar intramedullary nailing technique. Fractures were classified using the Arbeitsgemeinschaft für Osteosynthesefragen classification system. Both open and closed fractures were included, and open fractures were classified according to the Gustilo–Anderson classification. Clinical and radiological outcomes were evaluated during follow-up.

Results: The mean postoperative fracture healing time was approximately 9 months. Most patients reported minimal anterior knee pain, with only occasional cases of limited knee motion. Observed complications included superficial infections, minor angular deformities, and small limb length discrepancies. Dynamization was required in two patients. The average operative time was approximately 52 minutes.

Conclusion: Suprapatellar intramedullary nailing represents a reliable and effective surgical option for the treatment of adult tibial shaft fractures. The technique may facilitate fracture reduction and result in favorable clinical outcomes with acceptable complication rates.

Keywords: Tibial shaft fracture, intramedullary nailing, suprapatellar entry

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INTRODUCTION

Tibial shaft fractures are among the most common long bone fractures in the adult population and are predominantly the result of high-energy trauma.[1] The primary goals in the treatment of these fractures are to achieve stable union while preserving limb length, alignment, and rotation, and to restore the patient's functional capacity as early as possible.[2] Accurate classification is essential for treatment planning, and the AO classification system remains the most widely used method in clinical practice (Figure 1).[3]

Traditionally, tibial intramedullary nailing has been performed through an infrapatellar entry portal with the knee in a flexed position. However, the infrapatellar approach has been reported to complicate fracture reduction, particularly in proximal and distal tibial shaft fractures, and to increase the risk of malalignment.[4,5] In addition, this approach has been associated with the development of postoperative anterior knee pain.[5] For these reasons, the suprapatellar entry technique performed with the knee in a semi-extended position has gained increasing attention in recent years.[4,6]

The suprapatellar approach has been reported to offer several surgical advantages, including easier fracture reduction, improved fluoroscopic visualization, and better

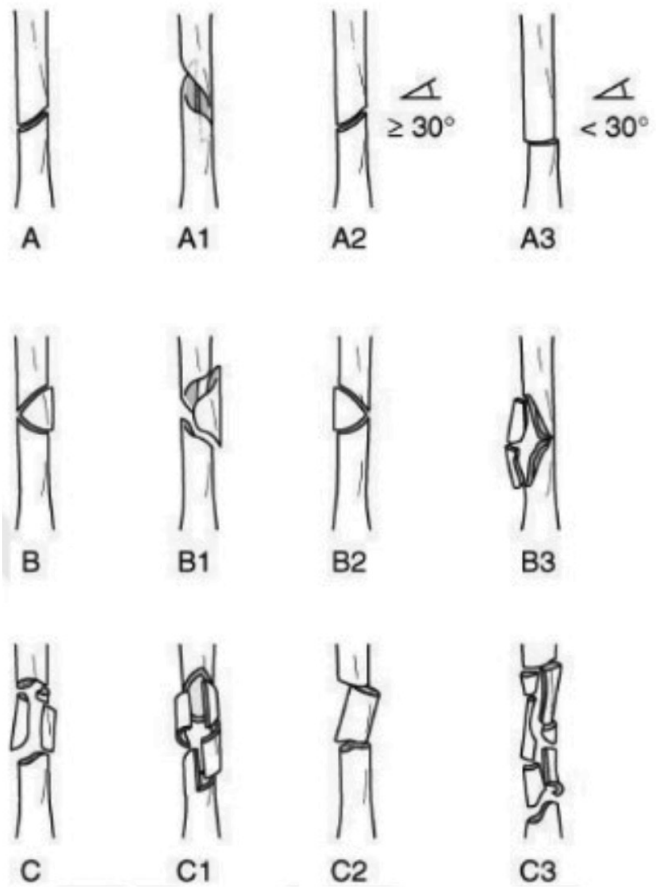

Figure 1. AO classification of tibial fractures

AO: Arbeitsgemeinschaft für Osteosynthesefragen

control of the mechanical axis.[6,7] Clinical studies have demonstrated that suprapatellar nailing may reduce the rate of malalignment compared with the infrapatellar technique while providing at least equivalent functional outcomes.[8,9] Furthermore, recent systematic reviews and meta-analyses support the suprapatellar approach as a safe and effective alternative, particularly for proximal and distal tibial shaft fractures, demonstrating lower malalignment rates and comparable clinical outcomes.[9,10]

The aim of this study is to evaluate the clinical and radiological outcomes of suprapatellar-entry locked intramedullary nailing for the treatment of adult tibial shaft fractures and to discuss the findings in the context of the current literature. Particular emphasis was placed on coronal and sagittal alignment parameters, functional outcomes, and the incidence of anterior knee pain, which remain critical concerns in intramedullary nailing and are frequently addressed in comparison with the traditional infrapatellar approach.

METHODS

Study Design and Patient Selection

This retrospective observational study was conducted at a single tertiary referral center. A total of 25 adult patients with tibial shaft fractures who underwent suprapatellar intramedullary were including in the study. Patients younger than 18 years, those with fractures exhibiting intra-articular extension, those with type III open fractures, or those with pseudoarthrosis following surgery were excluded from the study. All eligible patients were invited for follow-up evaluation, and the 25 patients who attended the final assessment constituted the study cohort. Among the patients, 7 were female and 18 were male. The mean age was 45 years (range: 18–68) among female patients and 40.1 years (range: 20–75) among male patients. Two fractures were open, and 23 were closed. According to the Gustilo–Anderson classification, one open fracture was type I and another was type II. Fractures were classified according to the AO classification system as type A in 14 patients (56%), type B in 6 patients (24%), and type C in 5 patients (20%). Based on fracture location, 7 fractures (28%) were proximal, 10 (40%) were mid-shaft, and 8 (32%) were distal. Radiological evaluation included assessment of coronal and sagittal alignment on standard anteroposterior and lateral radiographs. Malalignment was defined as an angular deformity of ≥5° in any plane. Rotational alignment was assessed clinically and radiographically by comparing limb positioning and cortical continuity. Leg length discrepancy was measured using orthoradiographic imaging, and shortening of ≥1 cm was recorded. All radiographic evaluations were performed at final follow-up. With regard to associated injuries, one patient had a rib fracture, another had a distal radius fracture, and a third had a proximal humerus fracture. The remaining patients had isolated tibial fractures. The patient with a rib fracture did not have a pulmonary contusion; therefore, reamed intramedullary nailing was not contraindicated. All patients underwent surgery within the first week following injury.

The study protocol was approved by the Sakarya University Ethics Committee (approval number: 71522473/050.01.04/35, date: 28.02.2017).

Radiological Evaluation

Radiological assessment was performed using standardized anteroposterior and lateral radiographs at the final follow-up. Coronal and sagittal alignment was evaluated by measuring the angulation between proximal and distal fracture fragments.

Malalignment was defined as an angular deformity of ≥5° in either the coronal or sagittal plane. Rotational alignment

was assessed clinically by comparing the foot progression angle and limb symmetry, and radiographically by evaluating cortical continuity.

Leg length discrepancy was measured using orthoradiographic imaging, and shortening of ≥1 cm was considered clinically relevant.

Surgical Procedure

All procedures were performed under general, spinal, or epidural anesthesia without the application of a tourniquet. With the knee in approximately 10–15° of flexion (semi-extended position), a longitudinal incision approximately 3 cm in length was made proximal to the patella (Figure 2). Access to the patellofemoral joint was achieved through the quadriceps tendon, and a cannula was introduced into the anterior cortex of the proximal tibia under fluoroscopic guidance. A guidewire was advanced across the fracture site to the distal tibia under fluoroscopic control (Figure 3). After appropriate positioning was confirmed, sequential reaming of the medullary canal was performed, and a preselected locked intramedullary nail was inserted. Reduction and alignment were assessed fluoroscopically. Distal locking screws were placed using the free-hand technique, followed by placement of proximal locking screws. All fractures were treated with closed reduction and statically- or dynamically- locked nails as indicated.

Postoperative Management and Follow-up

Postoperatively, no splinting was applied. Weight-bearing was gradually increased based on fracture characteristics and patient tolerance. Full weight- bearing without support was allowed after radiological evidence of union. The mean postoperative hospital stay was 4 days (range: 2–8 days). Patients were followed monthly with clinical and radiographic evaluations.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics for Windows software. Continuous variables were expressed as mean ± standard deviation, and categorical variables as number and percentage. The normality of data distribution was assessed using the Shapiro–Wilk test. Comparisons between male and female patients regarding fracture healing time, follow-up duration, Lysholm score, and Cincinnati score were performed using the independent samples t-test. A p value <0.05 was considered statistically significant. Parametric tests were applied because the continuous variables were normally distributed according to the Shapiro–Wilk test.

RESULTS

The clinical and radiological outcomes of the 25 patients who attended the final follow-up evaluation were analyzed. The average follow-up duration of our patients was 14.8 months (range: 6 to 24 months). The average fracture union time was 9.14 months (range: 6 to 15 months) (Table 1).

The patients were evaluated according to the Lysholm and Cincinnati functional scoring systems. The average Lysholm score was 90.8 (range: 64-100), and the average Cincinnati score was 26 (range: 15-30). Four patients experienced minimal patellofemoral pain, while the remaining patients experienced none. The patients were also assessed for joint range of motion limitations. Four patients had 110 degrees of knee flexion. Based on these results, all patients reported being satisfied with the surgery (Table 2).

Table 1. Some descriptive data of the patients

	Min	Max	Mean ± SD
Age (year)	18	75	42.6±16.33
Healing time (month)	6	15	9.14±2.98
Follow-up period (Month)	6	24	14.83±5.30
Lysholm	64	100	90.88±9.30
Cincinnati	15	30	26.83±3.81

SD: Standard deviation, Min: Minimum, Max: Maximum

Table 2. Comparison of healing time, follow-up duration, Lysholm, and Cincinnati scores according to gender

	Male	Female	p value
Healing time (month)	9.19±3.29	9±2	0.90
Follow-up period (Month)	15.18±4.29	14±7.59	0.63
Lysholm	91.06±10.59	90.43±5.68	0.88
Cincinnati	27.71±3.01	24.7±5.09	0.08

Figure 2. (a) Marking of the incision site. (b) Making the suprapatellar incision. (c) Surgical painting and draping procedures

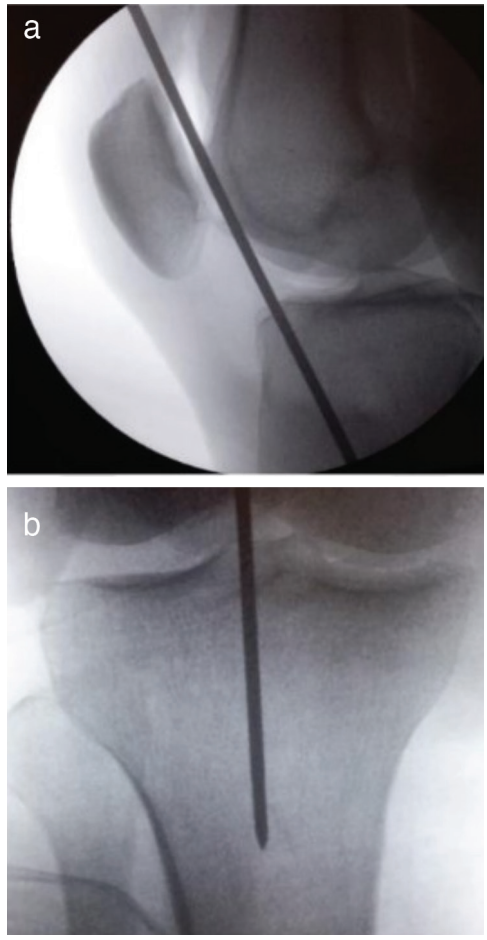

Figure 3. (a) The lateral fluoroscopic image of the guidewire sent as suprapatellar. (b) The anterior posterior fluoroscopic image of the guidewire sent as suprapatellar

Two patients reported discomfort only while sitting with their knees flexed. None of these patients developed compartment syndrome. In 1 patient (4%), a valgus deformity with an angulation between 5° and 10° was observed. Anterior displacement of the distal fragment of over 5° occurred in only 1 patient (4%); however, the patient had no clinical complaints. Only 1 patient (4%) had a 1 cm leg-length discrepancy, which was detected incidentally on an orthoradiogram. The patient had no clinical complaints. The functional outcome scores of patients with radiological malalignment or leg-length discrepancy were analyzed individually. These patients had Lysholm and Cincinnati scores within the overall cohort range and did not exhibit a statistically significant deterioration in functional outcome. The minor radiological deviations detected did not translate into clinically relevant functional limitations at the final follow-up. Superficial infections developed in only 2 cases (8%). These were open fractures, and the infections resolved with antibiotic therapy.

DISCUSSION

The principal finding of this study is that suprapatellar intramedullary nailing provided satisfactory coronal and sagittal alignment, favorable functional outcomes, and a low incidence of anterior knee pain in adult tibial shaft fractures.

Comparisons of suprapatellar and infrapatellar approaches for tibial intramedullary nailing have demonstrated broadly similar clinical outcomes, with differences primarily in alignment control and knee-related symptoms.[10] Meta-analytical data further suggest that the suprapatellar approach may facilitate maintenance of fracture reduction, particularly in fractures with a tendency toward malalignment.[11] In our study, satisfactory radiological alignment was achieved in the majority of patients, supporting the effectiveness of the suprapatellar technique in maintaining fracture reduction.

Functional outcomes following tibial shaft fracture fixation have been extensively evaluated in the literature. Systematic reviews have shown no significant differences in patient-reported outcome measures between suprapatellar and infrapatellar approaches.[12,13] Consistent with these findings, patients in our series achieved acceptable functional recovery without clinically relevant limitations in activities of daily living.

Anterior knee pain remains one of the most commonly reported complaints after tibial intramedullary nailing. Several comparative studies have suggested that suprapatellar entry may be associated with a lower incidence of anterior knee pain than infrapatellar entry.[14] Clinical investigations have also indicated that preservation of the extensor mechanism and avoidance of patellar tendon violation may reduce postoperative knee discomfort.[15] In our cohort, anterior knee pain was infrequent and mild, which further supports the potential benefit of the suprapatellar entry technique.

Rotational alignment is a critical determinant of long-term functional outcome after tibial shaft fracture fixation. Recent studies have demonstrated a lower prevalence of rotational malalignment with suprapatellar nailing compared with infrapatellar techniques.[16] Improved limb control and fluoroscopic visualization in the semi-extended position are thought to contribute to this advantage. In our study, no clinically significant rotational deformity was detected, consistent with these observations.

Concerns regarding the risk of knee sepsis associated with intra-articular instrumentation during suprapatellar nailing have been addressed in several clinical studies. Available evidence indicates that suprapatellar nailing is not associated with an increased incidence of postoperative knee sepsis, even in open tibial fractures.[17,18] In our study, no cases of septic arthritis occurred; superficial infections were limited in number and resolved with appropriate treatment.

Recent systematic reviews comparing suprapatellar, parapatellar, and infrapatellar techniques have concluded that suprapatellar nailing is a safe and effective option with acceptable complication rates and reliable alignment control.[19,20] Furthermore, contemporary reviews and technical descriptions have emphasized that refinements in surgical technique and instrumentation have enhanced the safety and reproducibility of the suprapatellar approach.[21] In our experience, the use of modern suprapatellar instrumentation facilitated accurate nail insertion and stable fixation, which likely contributed to the favorable clinical and radiological outcomes .

This study has several methodological limitations that should be acknowledged. First, the retrospective design may introduce potential selection bias and limit the ability to establish causal relationships. Second, the relatively small sample size may reduce statistical power and restrict the generalizability of the findings. Third, the absence of a comparative control group precludes direct comparison of the suprapatellar approach with alternative techniques, particularly the infrapatellar approach.

CONCLUSION

Suprapatellar entry intramedullary nailing provided satisfactory coronal and sagittal alignment, favorable functional outcomes, and a low incidence of anterior knee pain in adult tibial shaft fractures. The semiextended position may facilitate fracture reduction and improve intraoperative alignment control. Radiological deviations observed in this series were minimal and did not result in clinically significant functional impairment. Complication rates were acceptable, and no major implant-related or intraarticular infectious complications were observed.

Although the retrospective design and limited sample size restrict the strength of definitive conclusions, the findings of this study suggest that the suprapatellar approach is a reliable and effective surgical option for appropriately selected adult tibial shaft fractures.

Ethics

Ethics Committee Approval: The study protocol was approved by the Sakarya University Ethics Committee (approval number: 71522473/050.01.04/35, date: 28.02.2017).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: A.M.B., M.T., Concept: A.M.B., M.T., Design: A.M.B., Ö.L.K., Data Collection or Processing: A.M.B., Analysis or Interpretation: A.M.B., M.T., Literature Search: A.M.B., Ö.L.K., Writing: A.M.B., Ö.L.K.

Conflict of Interest: No conflict of interest was declared by the authors.

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