



COMPARATIVE ANALYSIS OF SUPRAPATELLAR AND INFRAPATELLAR APPROACHES IN INTRAMEDULLARY NAILING OF TIBIAL SHAFT FRACTURES: A RETROSPECTIVE COHORT STUDY

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ABSTRACT

Background: Intramedullary nailing is the standard treatment for tibial shaft fractures. The infrapatellar approach has been widely used; however, it is associated with technical difficulties and a high incidence of anterior knee pain. The suprapatellar approach has emerged as an alternative, offering potential advantages in fracture alignment and functional recovery.

Methods: This retrospective comparative cohort study included 60 patients with tibial shaft fractures treated with interlocking intramedullary nailing. Patients were divided into two groups based on the surgical approach: suprapatellar (n=30) and infrapatellar (n=30). Functional and radiological outcomes were assessed over a follow-up period of six months using range of motion (ROM), Lysholm knee score, radiological union, operative parameters, and complication rates.

Results: Radiological union was achieved in the majority of patients in both groups, with no statistically significant difference. The suprapatellar group demonstrated significantly better functional outcomes, with higher ROM and Lysholm scores at six months ($p < 0.05$). Intraoperative blood loss and fluoroscopy exposure were lower in the suprapatellar group. Complications were more frequent in the infrapatellar group, particularly anterior knee pain.

Conclusion: Both approaches provide satisfactory fracture union; however, the suprapatellar approach is associated with superior functional outcomes, reduced complications, and improved intraoperative efficiency. It may be considered a preferred technique, especially in proximal tibial fractures.

Keywords: Tibial Shaft Fracture, Intramedullary Nailing, Suprapatellar Approach, Infrapatellar Approach, Functional Outcome, Anterior Knee Pain.

INTRODUCTION

Tibial shaft fractures are among the most frequently encountered long bone injuries in orthopaedic practice, accounting for a considerable proportion of adult fracture burden (1). Owing to the subcutaneous position of the tibia and its limited soft tissue envelope, these fractures are often associated with complications such as malalignment, delayed union, and infection, thereby posing significant challenges in management.

Intramedullary nailing (IMN) has evolved as the preferred method of fixation for tibial shaft fractures because it provides stable fixation while preserving the biology of the fracture site, facilitating early mobilization and functional recovery (2). Conventionally, the infrapatellar approach has been widely employed for nail insertion. However, this technique requires the knee to be maintained in a flexed position, which can complicate fracture reduction, particularly in proximal third fractures. The deforming forces exerted by the quadriceps muscle tend to displace the proximal fragment into extension and valgus, thereby increasing the risk of malalignment during fixation (3).



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In addition to technical difficulties, anterior knee pain remains a significant postoperative concern associated with the infrapatellar approach, with reported incidence varying widely in the literature (4). This complication can adversely affect patient satisfaction and long-term functional outcomes, prompting the need for alternative surgical approaches.

The suprapatellar approach, performed with the knee in a semi-extended position, has gained increasing attention as a viable alternative. This technique allows easier access to the tibial entry point, facilitates better fracture alignment, and avoids violation of the patellar tendon (5). Furthermore, the semi-extended position improves intraoperative fluoroscopic visualization and may reduce the risk of secondary displacement during the procedure.

Several studies have suggested that the suprapatellar approach may offer improved functional outcomes and a lower incidence of anterior knee pain when compared to the traditional infrapatellar technique (6). Nevertheless, concerns have been raised regarding potential intra-articular complications, including cartilage damage and knee joint irritation, due to the intra-articular nature of the approach.

Despite growing interest in the suprapatellar technique, the existing literature remains limited and largely retrospective, with no clear consensus regarding the superiority of one approach over the other (7). This lack of definitive evidence highlights the need for further comparative evaluation.

MATERIALS AND METHODS

Study Design and Setting

This study was designed as a retrospective comparative cohort study conducted at a tertiary care teaching hospital. The study period extended from July 2019 to October 2020, during which patients presenting with tibial shaft fractures were evaluated and managed surgically (8).

Study Population

A total of 60 patients diagnosed with tibial shaft fractures and treated with interlocking intramedullary nailing were included in the study. The patients were divided into two equal groups based on the surgical approach employed:

- **Group A:** Suprapatellar approach (n = 30)
- **Group B:** Infrapatellar approach (n = 30)

Patient selection was based on clinical and radiological evaluation, and all cases were followed up for a minimum duration of six months to assess outcomes (9).

Inclusion and Exclusion Criteria

Inclusion Criteria

- Patients aged between 18 and 65 years
- Closed tibial shaft fractures
- Patients managed with interlocking intramedullary nailing

- Availability of complete clinical and radiological follow-up

Exclusion Criteria

- Open fractures with severe soft tissue compromise
- Pathological fractures
- Patients with associated neurovascular injury
- Pre-existing knee pathology or deformity
- Incomplete follow-up data (10)

Surgical Techniques

All procedures were performed under standard aseptic precautions with the patient under appropriate anaesthesia. The choice of surgical approach was based on surgeon preference and fracture characteristics.

Suprapatellar Approach

In the suprapatellar technique, the patient was positioned supine with the knee maintained in a semi-extended position. A longitudinal incision was made proximal to the patella, and entry into the tibial canal was achieved through the quadriceps tendon. This approach allowed direct alignment of the nail with the medullary canal, facilitating reduction, especially in proximal third fractures. The semi-extended position also aided in maintaining fracture alignment during reaming and nail insertion (11).

Infrapatellar Approach

In the infrapatellar approach, the patient's knee was flexed, and the entry point was established either through or adjacent to the patellar tendon. Fracture reduction was achieved manually, followed by sequential reaming and insertion of the intramedullary nail. Although widely practiced, this technique required careful handling to avoid malalignment, particularly in proximal fractures due to deforming muscular forces (11).

Postoperative Protocol

All patients were managed with a standardized postoperative protocol. Early mobilization was encouraged with initiation of knee range-of-motion exercises as tolerated. Weight-bearing was progressively advanced depending on fracture stability and radiological evidence of healing. Regular follow-up assessments were conducted at defined intervals, including immediate postoperative, one month, and six months post-surgery (12).

Outcome Measures

Patients were evaluated using both functional and radiological parameters:

- **Radiological Union:** Assessed using serial radiographs at follow-up intervals
- **Range of Motion (ROM):** Measured at the knee joint
- **Lysholm Knee Score:** Used to evaluate functional outcome
- **Blood Loss:** Estimated intraoperatively

- **Radiation Exposure:** Assessed using fluoroscopy duration
- **Complications:** Including anterior knee pain, infection, and non-union

These parameters were compared between the two groups to determine the effectiveness of each surgical approach (12).

Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS) software, version 29.0 (IBM Corp., Armonk, NY, USA). Descriptive statistics were used to summarize the data. Continuous variables such as age, range of motion (ROM), Lysholm knee score, blood loss, and fluoroscopy time were expressed as mean $\pm$ standard deviation or median with interquartile range, depending on data distribution. Categorical variables such as sex, mode of injury, fracture type, and complications were presented as frequencies and percentages.

The normality of continuous data was assessed using the Shapiro–Wilk test. For normally distributed variables, comparisons between the two groups were performed using the independent samples t-test. For non-normally distributed data, the Mann–Whitney U test was applied.

Categorical variables were analyzed using the Chi-square test or Fisher’s exact test where appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Demographic Characteristics

A total of 60 patients were included in the study, with 30 patients in each group. The study population predominantly consisted of younger individuals, with a higher proportion of patients below 30 years of age. The mean age was marginally higher in the suprapatellar group compared to the infrapatellar group. There was a clear male predominance, with a male-to-female ratio of approximately 5:1.

The detailed demographic profile and mode of injury distribution are presented in Table 1.

Fracture Characteristics

Based on the AO/OTA classification, type A fractures (simple fracture patterns) were the most commonly encountered. Among these, subtype A1 fractures constituted a considerable proportion.

With respect to fracture location, the suprapatellar approach was more frequently utilized for proximal third fractures, whereas the infrapatellar approach was predominantly used for middle third fractures. These fracture characteristics are summarized in Table 2.

Radiological Union

Radiological union was achieved in the majority of patients in both groups. At six months follow-up, approximately 95% of fractures demonstrated satisfactory union.

The few cases of non-union were associated with infection and were more commonly observed in the infrapatellar group. No statistically significant difference was observed between the two groups with respect to fracture union.

The comparative analysis of radiological union is presented in Table 3, with representative radiographs shown in Figure 1 and Figure 2.

Functional Outcomes

Range of Motion (ROM)

Patients treated with the suprapatellar approach demonstrated better early postoperative knee mobility, which was maintained throughout the follow-up period. At six months, the suprapatellar group showed superior range of motion compared to the infrapatellar group.

Lysholm Knee Score

Functional assessment using the Lysholm knee scoring system demonstrated improved outcomes in the suprapatellar group. The median score at six months was higher in this group, indicating better functional recovery and patient satisfaction.

The functional outcome measures, including ROM and Lysholm scores, are detailed in Table 3 and illustrated in Figure 2.

Operative Parameters

Blood Loss and Radiation Exposure

Intraoperative blood loss was observed to be lower in the suprapatellar group compared to the infrapatellar group. Similarly, fluoroscopy usage was reduced in the suprapatellar group, reflecting improved ease of fracture alignment and reduced intraoperative manipulation.

These operative parameters are summarized in Table 4, with graphical comparison shown in Figure 3.

Complications

A total of 22 patients experienced complications, with a markedly higher proportion occurring in the infrapatellar group.

Anterior knee pain was the most common complication and was predominantly associated with the infrapatellar approach. Other complications included infection and delayed union.

The detailed complication profile is presented in Table 5.

Statistical Analysis of Outcomes

Comparative statistical analysis demonstrated improved functional outcomes in the suprapatellar group, particularly with respect to Lysholm knee scores, which showed statistical significance. Radiological union rates between the two groups did not show a statistically significant difference, indicating comparable effectiveness in fracture healing.

DISCUSSION

The present study was undertaken to compare the functional and radiological outcomes of suprapatellar and infrapatellar approaches for

intramedullary nailing of tibial shaft fractures. The findings demonstrate that while both techniques achieve comparable rates of fracture union, the suprapatellar approach offers clear advantages in terms of functional recovery and complication profile.

In this study, the majority of patients belonged to a younger age group with a marked male predominance. This demographic pattern is consistent with the existing literature, where tibial shaft fractures are frequently associated with high-energy trauma, particularly road traffic accidents (13). The predominance of road traffic accidents as the primary mode of injury in this study further supports this observation and aligns with previously reported epidemiological trends (14).

Fracture pattern analysis revealed that simple fracture types (AO type A) were the most common, which is in agreement with earlier studies evaluating tibial shaft fractures in similar populations (15). The distribution of fracture location also influenced the choice of surgical approach, with the suprapatellar technique being preferred for proximal third fractures. This preference is supported by the biomechanical advantage offered by the semi-extended position, which minimizes deforming forces and facilitates better alignment during nail insertion (16).

Radiological union was achieved in the majority of patients in both groups, with no statistically significant difference observed between the suprapatellar and infrapatellar approaches. This finding indicates that both techniques are equally effective in achieving fracture healing, a conclusion that has been consistently reported in comparative studies (17). The few cases of non-union in this study were associated with infection, highlighting the importance of biological factors in fracture healing rather than the choice of surgical approach. Functional outcomes, however, showed a clear distinction between the two techniques. Patients treated with the suprapatellar approach demonstrated better range of motion and higher Lysholm knee scores at follow-up. This can be attributed to the avoidance of patellar tendon splitting and reduced soft tissue trauma associated with the suprapatellar technique. Similar findings have been reported in previous studies, where improved knee function and reduced postoperative pain were observed with the suprapatellar approach (18).

Anterior knee pain was the most common complication encountered, with a significantly higher incidence in the infrapatellar group. This observation is well supported in the literature, where the infrapatellar approach has been associated with persistent anterior knee pain due to tendon irritation, scarring, and altered biomechanics of the extensor mechanism (19). In contrast, the suprapatellar

approach minimizes disruption to the extensor mechanism, thereby reducing the incidence of this complication.

Operative parameters such as blood loss and radiation exposure were also found to be lower in the suprapatellar group. The semi-extended position allows easier fracture reduction and improved visualization under fluoroscopy, thereby reducing operative time and intraoperative manipulation. These advantages have been highlighted in earlier studies, which emphasize the technical ease and efficiency of the suprapatellar approach (16,18).

Despite these advantages, concerns regarding intra-articular damage associated with the suprapatellar technique have been raised. Cadaveric and clinical studies have demonstrated that although contact pressures within the knee joint may increase during nail insertion, they generally remain below the threshold required to cause significant cartilage injury (17). Moreover, the use of protective sleeves and refined instrumentation has further minimized the risk of intra-articular complications.

The findings of the present study support the growing body of evidence favoring the suprapatellar approach as a safe and effective alternative to the traditional infrapatellar technique. However, the choice of approach should be individualized based on fracture characteristics, surgeon experience, and patient-specific factors.

CONCLUSION

The present study demonstrates that both suprapatellar and infrapatellar approaches for intramedullary nailing of tibial shaft fractures are effective in achieving satisfactory fracture union. However, the suprapatellar approach offers clear advantages in terms of functional outcomes and perioperative parameters.

Patients treated with the suprapatellar technique showed improved knee function, as evidenced by better range of motion and higher Lysholm knee scores at follow-up. In addition, this approach was associated with reduced intraoperative blood loss and lower radiation exposure, reflecting improved technical ease during the procedure. The incidence of anterior knee pain, a common and often debilitating complication, was also notably lower in the suprapatellar group.

These findings suggest that the suprapatellar approach provides a more favorable overall outcome, particularly in cases involving proximal tibial fractures where maintaining alignment can be technically challenging. While both techniques remain viable, the suprapatellar approach may be considered a preferred option in appropriate clinical settings.

Limitations

Despite the strengths of this study, certain limitations must be acknowledged. The retrospective design inherently introduces the possibility of selection bias and limits the ability to establish causal relationships.

The sample size, although adequate for preliminary comparison, remains relatively small, which may affect the generalizability of the findings. In addition, the follow-up period was limited to six months, which may not fully capture long-term functional outcomes or late complications, particularly those related to intra-articular changes.

Another limitation is the lack of advanced imaging modalities, such as magnetic resonance imaging, to objectively assess potential cartilage damage associated with the suprapatellar approach. Furthermore, the choice of surgical approach was based on surgeon preference rather than randomization, which may introduce procedural bias.

Future studies with larger sample sizes, longer follow-up durations, and randomized controlled designs are warranted to further validate these findings and provide more definitive recommendations.

Table 1. Demographic Characteristics and Mode of Injury

Variable	Suprapatellar (n=30)	Infrapatellar (n=30)	Total (n=60)
Mean Age (years)	33.25	27.75	—
Age <30 years	22	20	42
Male	25	25	50
Female	5	5	10
Mode of Injury			
Road Traffic Accident	28	27	55
Fall	2	3	5

Table 2. Fracture Characteristics

Variable	Suprapatellar (n=30)	Infrapatellar (n=30)	Total (n=60)
AO Type A Fractures	24	22	46
A1	8	9	17
A2	7	6	13
A3	9	7	16
Fracture Location			
Proximal 1/3	21	9	30
Middle 1/3	7	20	27
Distal 1/3	2	1	3

Table 3. Radiological and Functional Outcomes

Outcome	Suprapatellar (n=30)	Infrapatellar (n=30)	p-value
Radiological Union (6 months)	29 (97%)	28 (94%)	>0.05
ROM Day 1 (degrees)	108°	98.5°	<0.05
ROM at 6 months (degrees)	132°	115°	<0.05
Lysholm Score (median)	84	70.5	<0.05

Table 4. Operative Parameters

Parameter	Suprapatellar (n=30)	Infrapatellar (n=30)	p-value
Blood Loss (ml)	40	70	<0.05
Fluoroscopy (C-arm exposure)	25	45	<0.05

Table 5. Complications

Complication	Suprapatellar (n=30)	Infrapatellar (n=30)	Total
Anterior Knee Pain	2	13	15
Infection	1	3	4
Delayed Union	1	2	3
Total Complications	5	17	22



Figure 1. Radiographic Progression Demonstrating Fracture Union at Six Months Following Intramedullary Nailing

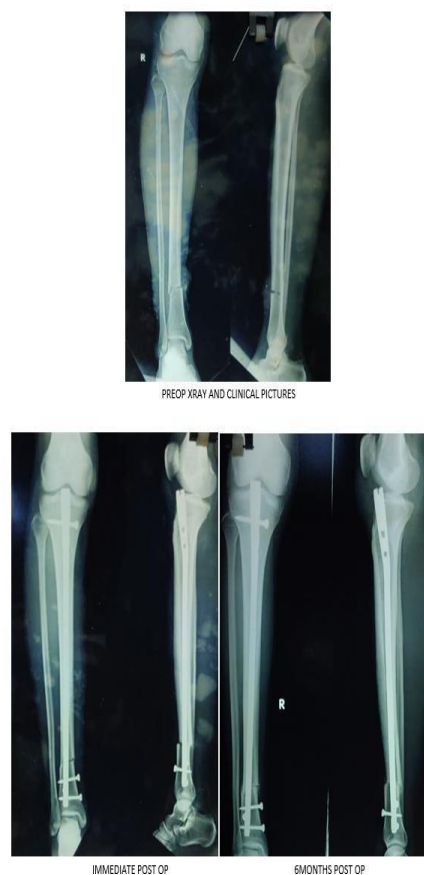


Figure 2. Radiographic Progression Demonstrating Fracture Union Following Infrapatellar Intramedullary Nailing

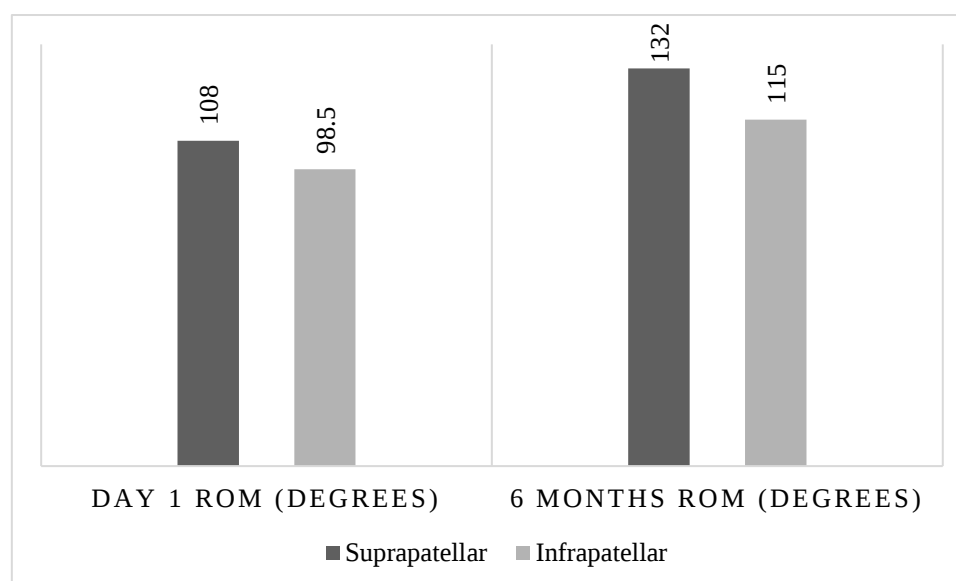


Figure 3. Functional Outcome Comparison Using Range Of Motion and Lysholm Knee Score

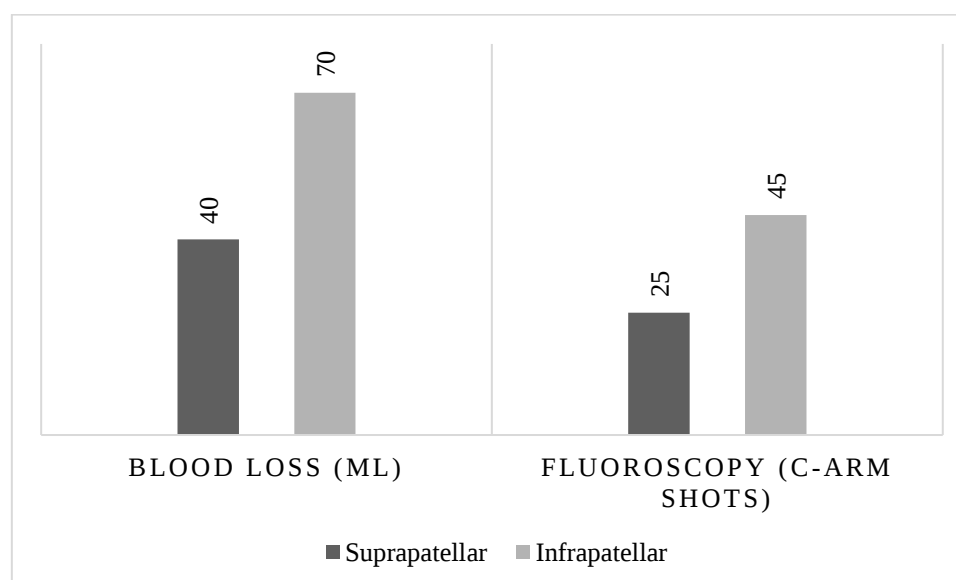


Figure 4. Intraoperative Comparison of Blood Loss and Fluoroscopy Usage

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