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Comparative Study to Assess the Functional Outcome Between Suprapatellar and Infrapatellar Approaches for Tibial Fractures Treated with Expert Tibial Nail in a Tertiary Care Center

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Abstract: ***Introduction**: Tibial fractures are among the most common long bone fractures encountered in orthopedic practice. Intramedullary interlocking nailing remains the gold standard treatment. Traditionally, the infrapatellar approach has been widely used; however, the suprapatellar approach has gained increasing popularity due to improved fracture reduction and reduced anterior knee pain. **Aim of the study**: To compare the functional outcomes of suprapatellar and infrapatellar approaches for tibial fractures treated with Expert tibial nails. **Materials and Method**: This hospital-based prospective study was conducted from January 2024 to July 2025, involving 50 patients with tibial fractures treated with Expert tibial Nail by either the suprapatellar or infrapatellar approach. Data collected included patient demographics, mechanism of injury, clinical and radiological evaluations, and postoperative follow-up assessments using the Lysholm knee score and Lower extremity functional score. **Results**: The suprapatellar approach demonstrated significantly shorter operative time (79.88 ± 5.10 vs 100.76 ± 6.33 minutes; $t = 12.838$, $p < 0.001$), reduced fluoroscopy time (66.80 ± 5.92 vs 95.44 ± 8.91 seconds; $t = 13.382$, $p < 0.001$), and lower intraoperative blood loss (90.44 ± 7.78 vs 133.52 ± 10.41 ml; $t = 16.577$, $p < 0.001$) compared with the infrapatellar approach. Postoperative anterior knee pain was significantly more common in the infrapatellar group (73.9%) than in the suprapatellar group (26.1%) ($\chi^2 = 9.742$, $p = 0.002$). Overall satisfactory functional outcome was observed in 53.7% of patients in the suprapatellar group and 46.3% in the infrapatellar group, with no statistically significant difference between the groups ($\chi^2 = 1.220$, $p = 0.269$). **Conclusion**: The suprapatellar approach demonstrated improved fracture alignment, easier reduction, and lower incidence of anterior knee pain compared with the infrapatellar approach. The suprapatellar approach with expert tibial nail offers superior functional outcomes and represents a safe and effective alternative for tibial intramedullary nailing.*

Keywords: Tibial fracture, Intramedullary nailing, Suprapatellar approach, Infrapatellar approach, Lysholm score, Lower extremity functional score

1. Introduction

Tibial fractures constitute a substantial proportion of lower limb injuries encountered in orthopaedic practice and are associated with significant morbidity due to the tibia's subcutaneous location, weight-bearing function, and vulnerability to high-energy trauma such as road traffic accidents, falls, and sports injuries [1]. Because of the bone's anatomical length and relatively limited soft tissue coverage, fractures involving the proximal, diaphyseal, or distal tibia present considerable challenges in achieving stable fixation, early mobilisation, and optimal functional recovery [2]. Over recent decades, management strategies have evolved from conservative treatment to operative stabilisation, with **intramedullary nailing becoming the gold standard** for many tibial fractures owing to its biomechanical stability, minimal disruption of soft tissues, and facilitation of early weight bearing [3].

The outcome of intramedullary fixation depends not only on implant design but also on the surgical approach used for nail insertion. The chosen approach can influence fracture reduction, operative difficulty, complication rates, and postoperative knee function [4]. Traditionally, the **infrapatellar approach** has been the most widely utilised technique, allowing access to the proximal tibial entry point with the knee in flexion [5]. Despite its widespread use, this method has several limitations, including difficulty maintaining reduction in certain fracture patterns and a relatively high incidence of **postoperative anterior knee pain**, which can impair activities such as kneeling, squatting, stair climbing, and prolonged sitting [6,7]. The aetiology of this pain is multifactorial and may involve patellar tendon injury, infrapatellar nerve irritation, altered extensor mechanism biomechanics, or implant-related factors [8].

To address these limitations, the **suprapatellar approach** has gained increasing attention as an alternative technique. In this method, the nail is inserted through the quadriceps tendon with the knee maintained in a semi-extended position, reducing quadriceps tension and facilitating improved fracture alignment, particularly in proximal and distal tibial fractures [9,10]. This approach may also decrease stress on the patellar tendon and infrapatellar structures, potentially

reducing anterior knee pain and improving postoperative knee function [11]. However, concerns regarding possible intra-articular cartilage injury and patellofemoral joint damage remain and require careful evaluation [12].

With advancements in implant technology, systems such as the **Expert Tibial Nail** offer multiplanar locking options and improved fixation for various fracture configurations [3,10]. Contemporary orthopaedic practice increasingly emphasises **functional outcomes**, including knee pain, range of motion, and the ability to perform daily activities [4,7]. Therefore, the present study aims to compare the **functional outcomes and knee-related morbidity between suprapatellar and infrapatellar approaches** for tibial fractures treated with Expert Tibial Nail, thereby contributing to evidence-based optimisation of surgical management [1,4,12].

2. Materials and Method

Study Design and Setting

This hospital-based **prospective comparative study** was conducted in the Department of Orthopaedics at **Navodaya Medical College Hospital and Research Centre, Raichur, Karnataka**, a tertiary-care teaching hospital serving both urban and rural populations of North Karnataka. The study was designed to compare the functional outcomes of tibial shaft fractures treated with **intramedullary interlocking nailing using either the suprapatellar or infrapatellar approach**. Standardised operative techniques, postoperative care, and follow-up protocols were applied to all participants to ensure uniformity.

Study Duration

The study was conducted over a period of **18 months**, including patient recruitment, surgical intervention, and follow-up. Patients were evaluated postoperatively at **1 month, 3 months, and 6 months** for clinical and radiological outcomes.

Participants

All **skeletally mature patients (≥18 years)** presenting with **closed tibial shaft fractures** suitable for fixation with an **Expert Tibial Nail** were considered for inclusion. Patients provided written informed consent before enrolment.

Inclusion Criteria

- Age ≥18 years
- Closed tibial shaft fractures amenable to intramedullary nailing
- Patients willing for surgery and follow-up

Exclusion Criteria

- Age <18 years
- Open or pathological fractures
- Extensive soft tissue injury
- Pre-existing knee disorders (osteoarthritis, rheumatoid arthritis, gout)
- Previous tibial fractures, neurovascular compromise, pregnancy, or unwillingness for follow-up

Sample Size and Sampling

Sample size was calculated using the standard formula for estimating proportions with **95% confidence level and 12% precision**, resulting in a minimum required sample of **47 patients**, which was rounded to **50**. A **consecutive non-probability sampling method** was used, and eligible patients presenting during the study period were enrolled.

Study Groups

The study included **50 patients**, divided into two groups:

- **Group A (Suprapatellar group):** Intramedullary nailing performed via the suprapatellar approach with the knee in a semi-extended position.
- **Group B (Infrapatellar group):** Intramedullary nailing performed via the traditional infrapatellar approach with the knee flexed to approximately 90°.

Surgical Procedure and Postoperative Care

All surgeries were performed under spinal or combined spinal–epidural anaesthesia on a radiolucent table with **C-arm fluoroscopic guidance**. In the suprapatellar approach, nail insertion was performed through a small incision above the patella via the quadriceps tendon with the knee semi-extended. In the infrapatellar approach, the entry point was created

below the patellar tendon with the knee flexed. In both groups, **proximal and distal interlocking screws** were inserted under fluoroscopy. Postoperatively, patients received intravenous antibiotics, analgesics, and early knee mobilisation exercises. **Partial weight bearing** was initiated once callus formation was evident, progressing to **full weight bearing by 10–12 weeks** depending on fracture healing.

Outcome Measures

Primary outcome was **functional assessment using the Lysholm Knee Score and Lower Extremity Functional Scale (LEFS)** at each

Pre Operative Xray

Immediate Post Op Xray

12 months follow up x-ray

follow-up visit. Secondary outcomes included operative time, fluoroscopy time, intraoperative blood loss, postoperative anterior knee pain (VAS), time to full weight bearing, radiological union, and postoperative complications.

Clinical photo of follow up

3. Results

This study included 50 patients with tibial fractures treated with intramedullary nailing using either suprapatellar (n=25) or infrapatellar (n=25) approaches.

Baseline demographic and injury characteristics were comparable between the two groups, with no statistically significant differences in age, gender distribution, mode of injury, fracture type, or fracture location ($p>0.05$). Road traffic accidents were the most common mechanism of injury (48%), followed by falls (36%). Open type II fractures were the most frequent fracture pattern (44%).

Table 1: Distribution of patients according to age (years)

Age group (years)	Infrapatellar n (%)	Suprapatellar n (%)	Total n (%)
18–30	4 (40.0)	6 (60.0)	**10 (100.0)**
31–40	12 (54.5)	10 (45.5)	**22 (100.0)**
41–50	4 (30.8)	9 (69.2)	**13 (100.0)**
>50	5 (100.0)	0 (0.0)	**5 (100.0)**
Total	**25 (50.0)**	**25 (50.0)**	**50 (100.0)**
$\chi^2 = 7.505$, df = 3, p = 0.057			

Patients' ages were distributed as follows: 22 (44.0%) of the patients were between the ages of 31 and 40, while 13 (26.0%) were between the ages of 41 and 50. The suprapatellar technique was more frequently employed (60.0%) than the infrapatellar approach (40.0%) in the 18–30 age group. Using the infrapatellar technique, all patients over 50 received treatment. There was no statistically significant correlation between age group and surgical technique

Table 2: Mode of injury

Mode of injury	Infrapatellar n (%)	Suprapatellar n (%)	Total n (%)
Fall	10 (55.6)	8 (44.4)	18 (100.0)
Assault / others	4 (50.0)	4 (50.0)	8 (100.0)
Road traffic accident	11 (45.8)	13 (54.2)	24 (100.0)
Total	**25 (50.0)**	**25 (50.0)**	**50 (100.0)**
$\chi^2 = 0.389$, df = 2, p = 0.823			

With 24 (48.0%) instances, traffic accidents were the most frequent cause of injury. Falls came in second with 18 (36.0%) cases, and assault or other reasons with 8 (16.0%) cases. A greater percentage of individuals who experienced falls had infrapatellar nailing (55.6%) as opposed to suprapatellar nailing (44.4%). The suprapatellar technique was more frequently used (54.2%) than the infrapatellar method (45.8%) in patients involved in traffic accidents. There was no statistically significant correlation between the surgical method and the mode of injury

Table 3: Association between fracture location and surgical approach

Fracture location	Infrapatellar n (%)	Suprapatellar n (%)	Total n (%)
Proximal third	8 (44.4)	10 (55.6)	18 (100.0)
Middle third	10 (62.5)	6 (37.5)	16 (100.0)
Distal third	7 (43.8)	9 (56.3)	16 (100.0)
Total	25 (50.0)	25 (50.0)	50 (100.0)
$\chi^2 = 1.472$, df = 2, p = 0.479			

With 18 (36.0%) cases, proximal third fractures were the most frequent, followed by middle and distal third fractures with 16 (32.0%) each. Ten patients (55.6%) had proximal third fractures treated with a suprapatellar technique, whereas eight patients (44.4%) had an infrapatellar approach. Ten patients (62.5%) had middle third fractures treated with the infrapatellar technique, while six patients (37.5%) had the suprapatellar approach. There was no statistically significant correlation between the surgical method and fracture location

Table 4: Comparison of mean operative time between suprapatellar and infrapatellar groups

Surgical approach	N	Mean (minutes)	Standard deviation
Suprapatellar	25	79.88	5.10
Infrapatellar	25	100.76	6.33
t = 12.838, df = 48, p < 0.001			

The infrapatellar group's mean operating time was 100.76 ± 6.33 minutes, while the suprapatellar groups was 79.88 ± 5.10 minutes. The suprapatellar group's operative time was substantially shorter than the infrapatellar group's, according to the independent samples t-test. The two groups' average operating times differed by 20.88 minutes. A statistically significant difference was observed

Table 5: Comparison of fluoroscopy time between suprapatellar and infrapatellar groups

Surgical approach	N	Mean (seconds)	Standard deviation
Suprapatellar	25	66.80	5.92
Infrapatellar	25	95.44	8.91
t = 13.382, df = 48, p < 0.001			

The infrapatellar group's mean fluoroscopy time was 95.44 ± 8.91 seconds, whereas the suprapatellar group's was 66.80 ± 5.92 seconds. When the two groups' fluoroscopy times were compared, the suprapatellar group showed less radiation exposure. The groups' mean fluoroscopy times differed by 28.64 seconds. A statistically significant difference was observed.

Table 6: Postoperative recovery parameters

Parameter	Suprapatellar	Infrapatellar	p-value
Partial weight bearing (weeks)	4.70 ± 0.42	6.74 ± 0.58	<0.001
Full weight bearing (weeks)	10.94 ± 0.61	14.27 ± 0.91	<0.001
Radiological union (weeks)	15.71 ± 0.82	18.19 ± 1.05	<0.001
Hospital stay (days)	6.04 ± 0.84	7.88 ± 1.48	<0.001

Patients in the suprapatellar group demonstrated significantly faster postoperative recovery compared with the infrapatellar group. The mean time to **partial weight bearing** was **4.70 ± 0.42 weeks** in the suprapatellar group versus **6.74 ± 0.58 weeks** in the infrapatellar group. Similarly, the mean time to achieve **full weight bearing** was earlier in the suprapatellar group (**10.94 ± 0.61 weeks**) compared with the infrapatellar group (**14.27 ± 0.91 weeks**).

Radiological union was also achieved sooner in patients treated with the suprapatellar approach (**15.71 ± 0.82 weeks**) than in those managed with the infrapatellar approach (**18.19 ± 1.05 weeks**). Additionally, the **mean duration of hospital stay** was shorter in the suprapatellar group (**6.04 ± 0.84 days**) compared to the infrapatellar group (**7.88 ± 1.48 days**).

All these differences were **statistically highly significant (p < 0.001)**, indicating that the suprapatellar approach was associated with earlier mobilization, faster fracture union, and reduced hospital stay compared to the infrapatellar approach

Table 7: Functional outcome scores

Outcome	Suprapatellar	Infrapatellar	p-value
Lysholm Knee Score	92.40 ± 4.53	85.16 ± 6.95	<0.001
LEFS score	74.64 ± 2.45	64.12 ± 3.53	<0.001
Knee ROM ≥120°	73.5%	26.5%	<0.001
Return to activities <12 weeks	59.5%	40.5%	0.002

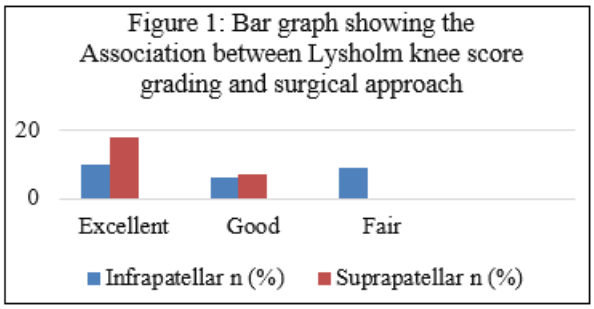

Figure 1: Bar graph showing the Association between Lysholm knee score grading and surgical approach

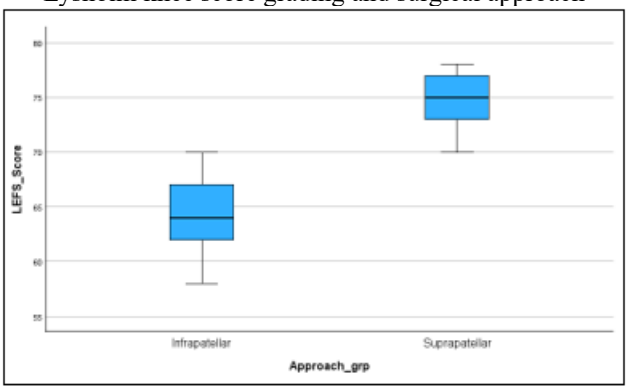

Figure 2: Boxplot of Lower Extremity Functional Scale (LEFS) scores between suprapatellar and infrapatellar groups

Functional outcomes were significantly better in the suprapatellar group compared to the infrapatellar group. The mean **Lysholm Knee Score** was higher in the suprapatellar group (**92.40 ± 4.53**) than in the infrapatellar group (**85.16 ± 6.95**). Similarly, the **Lower Extremity Functional Scale (LEFS) score** was significantly greater in the suprapatellar group (**74.64 ± 2.45**) compared to the infrapatellar group (**64.12 ± 3.53**).

A greater proportion of patients in the suprapatellar group achieved **knee range of motion ≥120° (73.5%)** compared with those in the infrapatellar group (**26.5%**). Additionally, **return to activities within 12 weeks** was observed more frequently in the suprapatellar group (**59.5%**) than in the infrapatellar group (**40.5%**).

All differences were **statistically significant**, indicating superior functional recovery with the suprapatellar approach.

Table 8: Complications and overall outcome

Parameter	Infrapatellar	Suprapatellar	p-value
Anterior knee pain	73.9%	26.1%	0.002
Infection	70%	30%	0.021
Malalignment	66.7%	33.3%	0.185
Delayed union	52%	48%	0.777
Overall satisfactory outcome	46.3%	53.7%	0.269

The incidence of **anterior knee pain** was significantly higher in the infrapatellar group (**73.9%**) compared to the suprapatellar group (**26.1%**) (p = 0.002). Similarly, **postoperative infection** occurred more frequently in the infrapatellar group (**70%**) than in the suprapatellar group (**30%**) (p = 0.021), showing a statistically significant difference.

However, the occurrence of **malalignment** (**66.7% vs 33.3%**, p = 0.185) and **delayed union** (**52% vs 48%**, p = 0.777) did not differ significantly between the two groups.

The proportion of patients with **overall satisfactory outcomes** was slightly higher in the suprapatellar group (**53.7%**) compared to the infrapatellar group (**46.3%**), although this difference was not statistically significant (p = 0.269).

The suprapatellar approach demonstrated significantly shorter operative time, reduced fluoroscopy time, and lower intraoperative blood loss compared with the infrapatellar approach (p<0.001). Postoperative recovery also favoured the suprapatellar technique, with earlier weight bearing, faster radiological union, and shorter hospital stay.

Functional outcomes measured using Lysholm Knee Score and Lower Extremity Functional Scale (LEFS) were significantly better in the suprapatellar group (p<0.001). Greater range of knee motion and earlier return to daily activities were also observed with the suprapatellar approach. Anterior knee pain and infection were more common in the infrapatellar group. However, overall satisfactory functional outcome did not differ significantly between the two techniques.

4. Discussion

The present study aimed to compare the functional outcomes of the suprapatellar and infrapatellar approaches in patients with tibial fractures treated with expert tibial nailing at a tertiary care centre. The study evaluated whether one approach offers advantages in terms of operative efficiency, postoperative recovery, radiological union, complications, knee function, and overall lower extremity performance.
Key parameters assessed included operative time, fluoroscopy duration, intraoperative blood loss, postoperative anterior knee pain, time to partial and full weight bearing, radiological union time, postoperative complications, Lysholm Knee Score, Lower Extremity Functional Scale (LEFS) score, knee range of motion, return to daily activities, hospital stay, and overall functional outcome.

Tibial fractures are among the most common long-bone injuries encountered in orthopaedic practice, and intramedullary nailing remains the standard treatment for many of these fractures. However, the choice of surgical entry approach can influence surgical ease, fracture alignment, postoperative pain, and long-term knee function. While the infrapatellar approach is widely practiced, it is often associated with technical challenges and postoperative anterior knee pain. In contrast, the suprapatellar approach has emerged as a potentially advantageous alternative.

By systematically comparing both techniques using objective and functional outcome measures, this study provides clinically relevant evidence to guide surgical decision-making, optimize patient recovery, and support evidence-based selection of the most appropriate approach for tibial intramedullary nailing.

Previous literature supports several technical advantages of suprapatellar nailing. Panda et al. reported significantly lower fluoroscopy time and shorter operative duration with the suprapatellar approach while demonstrating comparable long-term functional outcomes in closed tibial shaft fractures [13]. Similarly, Santhanam et al. observed improved early Lysholm scores and lower incidence of anterior knee pain with suprapatellar nailing in extra-articular tibial fractures without differences in infection or union rates [14]. A meta-analysis by Gao et al. further demonstrated that suprapatellar nailing reduces intraoperative blood loss, fluoroscopy exposure, and postoperative knee pain without increasing the risk of infection or non-union [15].

The findings of the present study are consistent with these reports, demonstrating that suprapatellar nailing provides improved perioperative efficiency and favourable functional outcomes while maintaining comparable complication rates. The semi-extended knee position used in the suprapatellar technique allows easier fracture reduction, improved fluoroscopic visualization, and better control of the nail trajectory, which may contribute to improved alignment and reduced operative time. Furthermore, avoidance of excessive patellar tendon manipulation may explain the lower incidence of postoperative anterior knee pain observed in the suprapatellar group.

Although overall functional outcome categories did not demonstrate statistically significant differences, several clinically relevant parameters favoured the suprapatellar technique, including operative efficiency, postoperative pain reduction, and improved functional recovery. These findings support the growing body of evidence suggesting that suprapatellar intramedullary nailing may offer technical and functional advantages over the conventional infrapatellar approach.

5. Conclusion

The present study demonstrates that the suprapatellar approach for expert tibial intramedullary nailing offers improved perioperative efficiency, reduced fluoroscopy exposure, less intraoperative blood loss, lower incidence of postoperative anterior knee pain, earlier weight bearing, earlier radiological union, improved knee function, better lower extremity functional scores, greater final knee range of motion, earlier return to daily activities, and shorter hospital stay compared with the infrapatellar approach.

Although the overall functional outcome category did not show a statistically significant difference, most clinically relevant outcome parameters favoured the suprapatellar technique. Therefore, the suprapatellar approach can be considered a safe and effective alternative to the infrapatellar approach for the management of tibial fractures treated with expert tibial nailing in a tertiary care setting.

6. Limitations

Despite these findings, several limitations must be considered. The relatively small sample size of 50 patients may have limited the statistical power to detect differences in certain outcomes such as malalignment, delayed union, and

overall functional results. The single-center design may also limit generalizability to other clinical settings with different patient populations or surgical expertise.

Additionally, long-term patellofemoral joint status and cartilage-related complications were not assessed, which limits conclusions regarding long-term safety of the suprapatellar approach. Differences in time from injury to surgery between groups may represent a potential confounding factor influencing recovery outcomes. Some variables were categorized broadly, which may have reduced sensitivity to detect subtle clinical differences. Furthermore, factors such as surgeon learning curve, inter-surgeon variability, fracture complexity, rehabilitation protocols, patient-reported quality-of-life measures, and cost-effectiveness were not evaluated. These limitations should be considered when interpreting the results and applying them to broader orthopaedic practice**.**

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