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Research Article

Comparative Study of Suprapatellar Vs Infrapatellar Approach for Proximal 1/3rd Fracture of Tibia Managed by Intramedullary Interlocking Nail

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ABSTRACT

Introduction:
Tibial shaft fractures, particularly those involving the proximal third, are challenging to manage due to alignment difficulties and high complication rates with traditional approaches. Intramedullary nailing via the infrapatellar (IP) route has been the standard but is associated with anterior knee pain and malalignment. The suprapatellar (SP) approach, introduced more recently, offers potential advantages in surgical ease, alignment, and postoperative recovery. This study compares clinical and functional outcomes between SP and IP approaches in proximal third tibial shaft fractures.

Material and Methods:
A prospective study compared suprapatellar (SP) and infrapatellar (IP) approaches in 40 patients with proximal one-third tibial shaft fractures (n=20 each) treated with intramedullary nails. Parameters assessed included operative time, blood loss, complications, healing time, and Lysholm Knee Scores. Statistical analysis used SPSS with $p<0.05$ as significant.

Results:
Both groups were demographically similar ($p > 0.05$). The SP group had significantly shorter operative time (102.0 ± 10.5 vs. 118.0 ± 16.1 min; $p = 0.001$) and fewer complications (90% vs. 45% complication-free; $p = 0.005$). Ankle stiffness occurred only in the IP group (25%; $p = 0.016$). Functional outcomes favored SP but were not statistically significant; blood loss and healing time were comparable.

Conclusion:
The suprapatellar (SP) approach for tibial intramedullary nailing is a safe and efficient alternative to the infrapatellar (IP) technique. It offers reduced operative time and fewer complications, with functional outcomes that are comparable or superior. This makes the SP approach a favorable option for proximal third tibial shaft fractures.

Keywords*: Tibial shaft fracture, Infrapatellar approach, Intramedullary nailing, Anterior knee pain, Surgical time.*

INTRODUCTION

Tibial shaft fractures are among the most frequently encountered long bone fractures in adults, accounting for approximately 13.7% of all fractures. These injuries are commonly the result of high-energy trauma, such as motor vehicle accidents or falls from height [1]. Multiple treatment options are available, including conservative management, external fixation, plate osteosynthesis, and intramedullary nailing (IMN). Among these, IMN has emerged as the gold standard for

most diaphyseal tibial fractures due to its favorable biomechanical properties, minimal soft tissue disruption, and potential for early mobilization [2].

The **infrapatellar (IP) approach**, which involves nail insertion through a transtendinous or paratendinous route with the knee in flexion, has traditionally been the most commonly used technique. While it is generally effective, the IP approach is associated with several notable complications. These include a high incidence of anterior knee pain—reported in up to 47% of cases—as well as malalignment and malunion, particularly in proximal third tibial fractures. These complications are often attributed to the influence of the quadriceps muscle on the proximal fragment during knee flexion, which can lead to difficulties in maintaining proper alignment during the procedure [3].

To overcome these challenges, the **suprapatellar (SP) approach** was introduced by Tornetta and Collins in 1996. This method allows for intramedullary nail insertion with the knee in a semi-extended position, thus minimizing the deforming forces of the quadriceps and facilitating more accurate fracture reduction. The approach involves a small incision above the patella, a longitudinal split in the quadriceps tendon, and the use of a protective cannula system to access the tibial entry point through the suprapatellar pouch [4].

Recent studies and systematic reviews have highlighted several advantages of the SP approach over the traditional IP technique. These include improved coronal and sagittal alignment, reduced operative and fluoroscopy times, and a lower incidence of anterior knee pain and malunion. These benefits are particularly significant in proximal or comminuted fractures, where maintaining reduction in the flexed knee position can be technically demanding [5,6].

Despite its advantages, the SP approach has raised concerns about potential damage to the patellofemoral joint. Because surgical instruments are introduced through the knee joint, there is a theoretical risk of cartilage injury, synovitis, and infection, especially in cases involving open fractures. Long-term effects such as patellofemoral arthrosis and persistent anterior knee pain remain subjects of ongoing research and clinical debate [7].

Although numerous studies, including randomized controlled trials, have compared the SP and IP approaches, most have been limited by small sample sizes and methodological heterogeneity. As a result, the evidence remains inconclusive regarding which technique provides superior functional outcomes and fewer complications. Further research is therefore warranted to better understand the clinical implications of each approach and guide surgical decision-making.

Methodology

This 24-month prospective comparative study was conducted at Era's Lucknow Medical College and Hospital to assess functional outcomes and complications of suprapatellar versus infrapatellar approaches in intramedullary nailing for proximal one-third tibial shaft fractures. Forty patients (≥18 years) were enrolled and equally divided into two groups. Exclusion criteria included Gustilo-Anderson type II/III open fractures, pathological fractures, non-unions, malunions, prior knee surgeries, and patients <18 years. Sample size was determined based on expected differences in Lysholm Knee Scores. In the suprapatellar group, nailing was done in a semi-extended position via an incision above the patella using a protective sleeve; in the infrapatellar group, the knee was flexed and a midline/paratendinous incision was used. All surgeries were performed under fluoroscopy by senior orthopedic surgeons. Standard postoperative care included antibiotics, analgesics, physiotherapy, and radiographic monitoring. Follow-up was at 6 weeks, 3, 6, and 12 months, with assessments using Lysholm Knee Scores and complication records. Data were analyzed in SPSS using t-tests and chi-square tests, with $p < 0.05$ considered significant. Ethical approval and informed consent were obtained.

Results

In this study, the distribution of subjects was equal across the two treatment groups, with 50.0% (n=20) undergoing intramedullary nailing via the infrapatellar approach and 50.0% (n=20) treated using the suprapatellar approach. Age distribution was relatively balanced across both groups. In the infrapatellar group, 20.0% were aged 20–29 years, 20.0% were 30–39 years, 35.0% were 40–49 years, and 25.0% were 50–60 years. In the suprapatellar group, 25.0% were 20–29 years, 30.0% were 30–39 years, 25.0% were 40–49 years, and 20.0% were 50–60 years. The difference in age distribution between groups was not statistically significant ($\chi^2 = 0.96$, $p = 0.812$). Regarding sex distribution, males comprised 40.0% of the infrapatellar group and 25.0% of the suprapatellar group, while females made up 60.0% and 75.0% of the respective groups. The sex distribution difference was also not statistically significant ($\chi^2 = 1.03$, $p = 0.311$). This balanced demographic distribution supports the reliability of comparative outcome assessments between the two surgical approaches (Table 1).

The distribution of fracture patterns based on the AO classification revealed that type 42A fractures were observed in 30.0% (n=6) of patients treated via the infrapatellar approach and in 35.0% (n=7) of those treated using the suprapatellar approach, constituting 32.5% of the total cases. Type 42B fractures were more frequent in the infrapatellar group (45.0%) compared to the suprapatellar group (20.0%), while type 42C fractures were more commonly managed using the suprapatellar approach (45.0%) than the infrapatellar approach (25.0%). Despite these variations, the differences in fracture classification distribution were not statistically significant ($\chi^2 = 3.14$, $p = 0.208$). Regarding the laterality of the fractures,

50.0% (n=10) in the infrapatellar group and 45.0% (n=9) in the suprapatellar group had left-sided fractures, while right-sided fractures occurred in 50.0% and 55.0% of cases respectively. The difference in side of involvement between the two groups was not statistically significant ($\chi^2 = 0.10$, $p = 0.752$) (Table 2).

The analysis of associated injuries revealed that 40.0% of patients in the infrapatellar group sustained an isolated fibula fracture, 20.0% had both a fibula fracture and a distal end radius (DER) injury, and 40.0% had no associated injuries. In contrast, among those treated with the suprapatellar approach, 25.0% had a fibula fracture, 55.0% had both fibula and DER injuries, and only 20.0% had no associated injury. Although the suprapatellar group had a higher proportion of combined injuries, the difference in distribution was not statistically significant ($\chi^2 = 5.29$, $p = 0.071$).

Postoperative complication rates differed notably between the two groups. Ankle stiffness occurred exclusively in the infrapatellar group (25.0%), which was statistically significant ($p = 0.016$). Minor differences in the incidence of knee pain (10.0% vs. 5.0%), infection (10.0% vs. 5.0%), and non-union (10.0% vs. 0%) were observed but were not statistically significant. Importantly, a significantly higher proportion of patients in the suprapatellar group (90.0%) experienced no complications compared to only 45.0% in the infrapatellar group ($p = 0.005$).

Clinical outcomes, as measured at follow-up, showed no significant difference between groups. Both approaches yielded excellent outcomes in 40.0% of patients. Good outcomes were observed in 35.0% of suprapatellar cases versus 25.0% in the infrapatellar group. Conversely, fair outcomes were slightly more common in the infrapatellar group (35.0%) compared to the suprapatellar group (25.0%). The overall distribution was 40.0% excellent, 30.0% good, and 30.0% fair outcomes across all subjects, with no statistically significant difference between the two surgical techniques ($\chi^2 = 0.67$, $p = 0.717$) (Table 3).

The comparison of perioperative timelines and surgical efficiency between the infrapatellar and suprapatellar approaches revealed both similarities and notable differences. The **mean time to surgery** was identical for both groups at **3.0 days**, with standard deviations of 1.0 and 1.4 for the infrapatellar and suprapatellar groups, respectively. An unpaired t-test confirmed no significant difference between the two groups ($t = 0.00$, $p = 1.000$). Similarly, the **mean follow-up duration** was statistically comparable: 25.16 weeks in the infrapatellar group and 24.54 weeks in the suprapatellar group ($t = 0.68$, $p = 0.498$), indicating uniformity in postoperative monitoring across the two techniques.

However, a significant difference was observed in **surgical time**. The suprapatellar approach demonstrated a shorter mean surgical time of **102.0 minutes** compared to **118.0 minutes** for the infrapatellar approach. This difference was statistically significant ($t = 3.72$, $p = 0.001$), suggesting that the suprapatellar approach may offer greater intraoperative efficiency (Table 4).

Comparison of intraoperative blood loss and fracture healing time between the two surgical approaches showed no statistically significant differences. The **mean blood loss** in the infrapatellar group was **63.1 ml** (SD = 9.0), slightly higher than the **59.2 ml** (SD = 8.0) observed in the suprapatellar group; however, the difference was not significant ($t = 1.42$, $p = 0.170$). Similarly, the **mean time to fracture healing** was **16.8 weeks** in the infrapatellar group and **16.3 weeks** in the suprapatellar group, with standard deviations of 1.2 and 1.1 weeks respectively. This difference was also not statistically significant ($t = 1.41$, $p = 0.165$). These results suggest comparable outcomes in terms of blood loss and healing duration between the two approaches (Table 5).

Table 1: Distribution of Study Subjects by Treatment Approach, Age, and Sex

Variable	Category	Infrapatellar (n=20)	Suprapatellar (n=20)	Total (n=40)	Significance
Approach		20 (50.0%)	20 (50.0%)	40 (100%)	–
Age Group	20–29 years	4 (20.0%)	5 (25.0%)	9 (22.5%)	$\chi^2 = 0.96$, $p = 0.812$
	30–39 years	4 (20.0%)	6 (30.0%)	10 (25.0%)	
	40–49 years	7 (35.0%)	5 (25.0%)	12 (30.0%)	
	50–60 years	5 (25.0%)	4 (20.0%)	9 (22.5%)	
Sex	Male	8 (40.0%)	5 (25.0%)	13 (32.5%)	$\chi^2 = 1.03$, $p = 0.311$
	Female	12 (60.0%)	15 (75.0%)	27 (67.5%)	

Table 2: Distribution of Study Subjects by AO Classification and Side of Fracture

Variable	Category	Infrapatellar (n=20)	Suprapatellar (n=20)	Total (n=40)	Significance
AO Classification	42A	6 (30.0%)	7 (35.0%)	13 (32.5%)	$\chi^2 = 3.14$, $p = 0.208$
	42B	9 (45.0%)	4 (20.0%)	13 (32.5%)	
	42C	5 (25.0%)	9 (45.0%)	14 (35.0%)	
Side of Fracture	Left	10 (50.0%)	9 (45.0%)	19 (47.5%)	$\chi^2 = 0.10$, $p = 0.752$
	Right	10 (50.0%)	11 (55.0%)	21 (52.5%)	

Table 3: Distribution of Associated Injuries, Postoperative Complications, and Clinical Outcomes

Parameter	Category	Infrapatellar (n=20)	Suprapatellar (n=20)	Total (n=40)	Significance
Associated Injury	Fracture Fibula	8 (40.0%)	5 (25.0%)	13 (32.5%)	$\chi^2 = 5.29$, $p = 0.071$
	Fibula + DER	4 (20.0%)	11 (55.0%)	15 (37.5%)	
	Nil	8 (40.0%)	4 (20.0%)	12 (30.0%)	
Complications	Ankle Stiffness	5 (25.0%)	0 (0.0%)	5 (12.5%)	$p = 0.016$
	Knee Pain	2 (10.0%)	1 (5.0%)	3 (7.5%)	$p = 1.000$
	Infection	2 (10.0%)	1 (5.0%)	3 (7.5%)	$p = 1.000$
	Non-union	2 (10.0%)	0 (0.0%)	2 (5.0%)	$p = 0.487$
	None	9 (45.0%)	18 (90.0%)	27 (67.5%)	$p = 0.005$
Clinical Outcome	Excellent	8 (40.0%)	8 (40.0%)	16 (40.0%)	$\chi^2 = 0.67$, $p = 0.717$
	Good	5 (25.0%)	7 (35.0%)	12 (30.0%)	
	Fair	7 (35.0%)	5 (25.0%)	12 (30.0%)	

Table 4: Comparison of Time to Surgery, Follow-up Duration, and Surgical Time between Two Approaches

Parameter	Approach	Mean	SD	t-value	p-value
Time to Surgery (days)	Infrapatellar	3.0	1.0	0.00	1.000
	Suprapatellar	3.0	1.4		
Follow-up Time (weeks)	Infrapatellar	25.16	2.96	0.68	0.498
	Suprapatellar	24.54	2.70		
Surgical Time (minutes)	Infrapatellar	118.0	16.1	3.72	0.001**
	Suprapatellar	102.0	10.5		

Table 5: Comparison of Blood Loss and Fracture Healing Time between Two Approaches

Parameter	Approach	Mean	SD	t-value	p-value
Blood Loss (ml)	Infrapatellar	63.1	9.0	1.42	0.170
	Suprapatellar	59.2	8.0		
Fracture Healing (weeks)	Infrapatellar	16.8	1.2	1.41	0.165
	Suprapatellar	16.3	1.1		

Discussion

In this prospective comparative study, we evaluated the clinical and functional outcomes of the suprapatellar (SP) and infrapatellar (IP) approaches for intramedullary nailing in proximal one-third tibial shaft fractures. The two groups were evenly matched demographically, with no statistically significant differences in age or sex ($p = 0.812$ and $p = 0.311$, respectively). This demographic balance is critical, as it ensured a valid comparison of clinical outcomes without potential confounding from patient-related variables. Similar demographic uniformity has been reported in other studies, including those by Santhanam et al. [8] and Lu et al. [7], reinforcing the generalizability of our cohort.

The fracture distribution based on AO classification and laterality was also statistically comparable between groups. Although type 42B fractures were slightly more common in the IP group and type 42C in the SP group, these differences were not significant ($p = 0.208$). Likewise, right and left side involvement was balanced ($p = 0.752$). These findings support the idea that surgical outcomes can be reliably compared across groups without bias from fracture type or side.

A key observation was the lower complication rate in the suprapatellar group, with 90% of patients experiencing no complications, compared to only 45% in the infrapatellar group—a statistically significant difference ($p = 0.005$). Notably, ankle stiffness, which occurred in 25% of IP patients, was absent in the SP group ($p = 0.016$). Non-union was also observed only in the IP group, though not statistically significant. These results align with earlier findings by Yang et al. [12] and Jasti et al. [13], who reported lower complication rates and improved alignment with the SP technique. This supports the growing consensus that the SP approach reduces the risk of common postoperative issues.

In terms of functional outcomes, both groups demonstrated comparable distributions of excellent, good, and fair results ($p = 0.717$), with 40% of each group achieving excellent outcomes. However, the SP group had a slightly higher proportion of good outcomes and fewer fair results, suggesting a trend toward better recovery with the SP technique. Though this was not statistically significant, it reflects the broader literature, including studies by Nimavat et al. [11] and Lone et al. [10], where SP-treated patients consistently demonstrated better knee function and return to activity.

Operative efficiency was another area where the suprapatellar approach showed clear advantages. The mean surgical time in the SP group was significantly lower (102.0 ± 10.5 minutes) than in the IP group (118.0 ± 16.1 minutes, p = 0.001). This efficiency likely results from the semi-extended knee positioning in SP nailing, which allows for easier fracture alignment and reduced intraoperative fluoroscopy adjustments. These findings are in agreement with those of Lu et al. [7] and Nimavat et al. [11], who also reported shorter operating times with the SP approach.

Although blood loss and fracture healing time were slightly lower in the SP group (59.2 ml vs. 63.1 ml, and 16.3 weeks vs. 16.8 weeks, respectively), these differences were not statistically significant (p = 0.170 and p = 0.165). These results echo the findings of Lu et al. [7] and Santhanam et al. [8], indicating that while intraoperative efficiency may improve with SP nailing, it does not compromise hemostasis or bone healing.

Time to surgery and follow-up durations were nearly identical between groups, further validating the internal consistency of the study and allowing for unbiased outcome assessment. The mean time to surgery was 3.0 days in both groups (p = 1.000), and the follow-up periods were also statistically comparable (p = 0.498), ensuring similar timelines for recovery and evaluation.

Lastly, the significantly lower complication rate and shorter surgical duration in the SP group highlight the practical advantages of this approach. These findings are consistent with recent meta-analyses, including those by Yang et al. [12], which demonstrate improved alignment, less anterior knee pain, and faster rehabilitation with the SP technique.

Conclusion

In summary, our findings support the growing body of evidence favoring the suprapatellar approach for intramedullary nailing of proximal tibial fractures. It offers comparable functional outcomes with significantly fewer complications and shorter operative times. These benefits, combined with reduced technical difficulty in maintaining alignment during nailing, make the suprapatellar technique a preferred option in appropriately selected cases.

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