Original Article

Suprapatellar Nailing Versus Infrapatellar Nailing for Tibial Shaft Fractures – Alignment and Clincial Outcome Study

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Abstract

Background: Intramedullary interlocking nailing is the preferred treatment for displaced tibial shaft fractures. The conventional infrapatellar approach may be associated with malalignment and anterior knee pain, whereas suprapatellar nailing in the semiextended position may improve fracture reduction and functional recovery. The objective is to compare functional outcomes and fracture alignment following suprapatellar and infrapatellar intramedullary nailing of tibial shaft fractures. **Material and Methods:** This randomized controlled study included 50 adults with tibial shaft fractures treated at Basaveshwara Medical College Hospital and Research Centre from August 2022 to May 2024. Patients were randomized into suprapatellar and infrapatellar groups, with 25 patients in each. Functional outcomes were assessed using Lysholm, SF-36, and VAS scores at 3, 6, and 12 months. Knee range of motion, time to union, coronal and sagittal alignment, anterior knee pain, and postoperative complications were also evaluated. **Results:** Both groups were comparable at baseline. Lysholm and SF-36 scores were significantly higher in the suprapatellar group at all follow-up visits, while VAS pain scores were significantly lower ($p<0.001$). Mean knee range of motion was 129.0° in the suprapatellar group and 115.0° in the infrapatellar group ($p<0.001$). Malalignment greater than 5° occurred in 8% and 36% of patients, respectively ($p=0.017$). Coronal and sagittal deviations were significantly lower in the suprapatellar group. Anterior knee pain was present in 4% of suprapatellar cases compared with 36% of infrapatellar cases. Mean time to union and complication rates were comparable. **Conclusion:** Suprapatellar nailing resulted in better functional recovery, lower pain, improved knee movement, and superior fracture alignment compared with infrapatellar nailing, without affecting union time or increasing complications.

Keywords: Tibial shaft fracture, suprapatellar nailing, infrapatellar nailing, intramedullary nail, anterior knee pain, fracture alignment.

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Introduction

Tibial shaft fractures are among the most common long bone fractures encountered in orthopedic practice, accounting for a significant proportion of trauma admissions. The increasing incidence of high-energy road traffic accidents, sports injuries, and falls has contributed to the rising frequency of these fractures. Owing to the subcutaneous location of the tibia and its relatively poor soft tissue coverage, tibial shaft fractures are frequently associated with soft tissue injury, delayed union, malunion, infection, and functional impairment.[1,2]

Intramedullary interlocking nailing (IMIL) has become the gold standard for the management of displaced tibial shaft fractures because it provides stable fixation, preserves fracture biology, facilitates early mobilization, and achieves high union rates. However, the optimal surgical approach for nail insertion remains controversial. The conventional infrapatellar (IP) approach, performed with the knee in flexion, has been widely used but is often associated with technical difficulties in fracture reduction, malalignment of proximal and distal fractures, and postoperative anterior knee pain.[3,4]

To overcome these limitations, the suprapatellar (SP) approach has been introduced as an alternative technique. The semiextended position of the knee during suprapatellar nailing allows easier maintenance of fracture reduction, improved fluoroscopic visualization, and better alignment of the nail with the medullary canal. Tornetta and Collins first described the semiextended technique and demonstrated its advantages in reducing deforming forces acting on proximal tibial fractures during nail insertion.[5] In addition, Hernigou and Cohen highlighted that accurate determination of the entry point is essential for achieving satisfactory alignment while minimizing intra-articular damage and postoperative complications.[6]

Proper fracture alignment is one of the most important determinants of long-term functional outcome following tibial intramedullary nailing. Malalignment greater than 5° in the coronal or sagittal plane may lead to altered biomechanics, persistent pain, impaired function, and early degenerative

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changes. Freedman and Johnson demonstrated that technical factors related to nail insertion significantly influence postoperative alignment and emphasized meticulous surgical technique to minimize malreduction.[7]

Although both suprapatellar and infrapatellar approaches are widely practiced, there remains ongoing debate regarding their comparative effectiveness with respect to fracture alignment, knee pain, fracture union, range of motion, and functional recovery. Therefore, the present study was undertaken to compare the functional outcomes and fracture alignment following suprapatellar and infrapatellar intramedullary interlocking nailing in patients with tibial shaft fractures.

Materials and Methods

Study Design and Setting: This randomized controlled trial was conducted in the Department of Orthopaedics, Basaveshwara Medical College Hospital and Research Centre over 22 months (August 2022–May 2024).

Sample Size and Sampling: A total of 50 patients with tibial shaft fractures meeting the eligibility criteria were enrolled. Patients were selected by convenience sampling and randomized using computer-generated random numbers into:

- **Suprapatellar (SP) group:** 25 patients
- **Infrapatellar (IP) group:** 25 patients

Inclusion Criteria

- **Patients** aged **≥18 years**.
- AO/OTA type 42-A1, A2, A3, B1, B2, B3, C1, C2, and C3 tibial shaft fractures involving the proximal, middle, or distal third of the tibia.
- Written informed consent.

Exclusion Criteria

- Age <18 years.
- Pathological fractures.
- Polytrauma with major visceral injuries.
- Fractures extending into the knee or ankle joint.
- Gustilo-Anderson type IIIB and IIIC open fractures.

Preoperative Assessment: All patients underwent detailed clinical evaluation and standard anteroposterior and lateral radiographs of the knee, tibia, and ankle. Fractures were classified according to the AO/OTA classification.

Surgical Technique: All procedures were performed under spinal anesthesia with the patient in the supine position on a radiolucent table.

In the IP group, closed reduction and intramedullary interlocking nailing were performed through a longitudinal patellar tendon-splitting approach with the knee flexed to approximately 90°. In the SP group, nailing was performed through a semiextended suprapatellar approach using a protective cannula system with the knee maintained at approximately 20° of flexion. Sequential reaming and fluoroscopy-guided proximal and distal locking were performed in both groups using appropriate tibial IMIL nails.

Postoperative Care and Follow-up: Early knee, ankle, and toe mobilization was encouraged after surgery. Partial weight-bearing was initiated according to fracture stability and progressed to full weight-bearing after radiological evidence of union. Patients were followed clinically and radiologically at 3, 6, and 12 months.

Outcome Measures

Functional outcomes were assessed using the Lysholm Knee Score, Short Form-36 (SF-36), and Visual Analogue Scale (VAS) at each follow-up. Radiological evaluation included time to union, coronal and sagittal alignment, malalignment (>5°), rotational deformity (>10°), and implant-related complications. Clinical assessment included knee range of motion, anterior knee pain, wound healing, fracture union, and postoperative complications.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 25.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Student's *t*-test, Chi-square test, and Fisher's exact test were used as appropriate. A p-value <0.05 was considered statistically significant.

Results

A total of 50 patients with tibial shaft fractures were included and randomized equally into the infrapatellar and suprapatellar nailing groups, with 25 patients in each group. The mean follow-up duration was 12.1 months, ranging from 4 to 18 months. Both groups were comparable with respect to demographic characteristics, fracture pattern, site of fracture, mechanism of injury, associated injuries, and comorbidities.

Table 1: Baseline Demographic and Fracture Characteristics of the Study Groups

Parameter	Infrapatellar group (n=25)	Suprapatellar group (n=25)	p-value
Mean age, years (range)	52.65 (27–80)	50.72 (23–80)	>0.05
Sex			0.395
Male	15 (60.0%)	12 (48.0%)	
Female	10 (40.0%)	13 (52.0%)	
Fracture site			0.924
Proximal third	12 (48.0%)	12 (48.0%)	
Middle third	7 (28.0%)	8 (32.0%)	
Distal third	6 (24.0%)	5 (20.0%)	
AO fracture type			0.593
Type A	9 (36.0%)	6 (24.0%)	
Type B	10 (40.0%)	11 (44.0%)	
Type C	6 (24.0%)	8 (32.0%)	
Road traffic accident	21 (84.0%)	19 (76.0%)	0.350
Associated injuries	6 (24.0%)	7 (28.0%)	0.747
Comorbidities	4 (16.0%)	5 (20.0%)	0.713

The mean age was comparable between the infrapatellar and suprapatellar groups. Road traffic accidents were the predominant mechanism of injury in both groups. No statistically significant differences were observed in sex distribution, fracture site, AO fracture type, associated injuries, or comorbidities, indicating that the two groups were comparable at baseline

Table 2: Comparison of Functional Outcomes and Pain Scores During Follow-up

Outcome	Follow-up	Infrapatellar group Mean ± SD	Suprapatellar group Mean ± SD	t-value	p-value
Lysholm score	3 months	38.04 ± 2.20	55.10 ± 2.81	23.987	<0.001
	6 months	75.00 ± 5.80	89.00 ± 3.80	10.104	<0.001
	12 months	81.10 ± 4.22	93.00 ± 3.65	10.677	<0.001
SF-36 score	3 months	46.00 ± 2.90	58.00 ± 2.80	14.741	<0.001
	6 months	72.00 ± 3.70	84.00 ± 4.00	11.031	<0.001
	12 months	77.00 ± 3.95	89.10 ± 3.83	11.013	<0.001
VAS pain score	3 months	7.80 ± 0.60	5.10 ± 1.10	10.888	<0.001
	6 months	5.50 ± 0.80	2.10 ± 0.60	17.313	<0.001
	12 months	2.60 ± 0.40	0.80 ± 0.35	16.480	<0.001

Functional recovery was significantly better in the suprapatellar group at all follow-up intervals. Lysholm and SF-36 scores were consistently higher, while VAS pain scores were significantly lower in the suprapatellar group at 3, 6, and 12 months.

Table 3: Comparison of Knee Motion, Fracture Union, Alignment, and Anterior Knee Pain

Outcome	Infrapatellar group	Suprapatellar group	Test value	p-value
Knee range of motion at final follow-up, degrees	115.0 ± 7.35	129.0 ± 7.22	t=6.791	<0.001
Time to union, months	5.0 ± 1.1	5.2 ± 1.6	—	>0.05
Malalignment >5°	9 (36.0%)	2 (8.0%)	χ^2=5.711	0.017
Coronal plane deviation, degrees	5.60 ± 2.70	2.30 ± 1.57	t=5.271	<0.001
Sagittal plane deviation, degrees	5.20 ± 1.98	2.90 ± 1.03	t=5.162	<0.001
Anterior knee pain at final follow-up	9 (36.0%)	4 (16.0%)	—	<0.001

The suprapatellar group demonstrated a significantly greater final knee range of motion and better postoperative alignment in both coronal and sagittal planes. Malalignment exceeding 5° was considerably less frequent following suprapatellar nailing. The mean time to fracture union was comparable between the two groups. Anterior knee pain was more frequent after infrapatellar nailing.

Table 4: Postoperative Complications in the Two Study Groups

Complication	Infrapatellar group n (%)	Suprapatellar group n (%)
Wound dehiscence	2 (8.0%)	1 (4.0%)
Superficial wound infection	0	1 (4.0%)
Deep wound infection	1 (4.0%)	0
Deep vein thrombosis	0	0
Delayed union	0	1 (4.0%)
Non-union	1 (4.0%)	0

Postoperative complications were uncommon in both groups. Wound dehiscence occurred in two infrapatellar and one suprapatellar case. One deep infection and one non-union occurred in the infrapatellar group, while one superficial infection and one delayed union occurred in the suprapatellar group. None of these differences was statistically significant. Overall, suprapatellar nailing resulted in superior functional scores, lower pain levels, greater knee movement, and better coronal and sagittal alignment compared with infrapatellar nailing. Fracture union time and overall complication rates were comparable between the two approaches.

Discussion

The present randomized controlled study compared suprapatellar and infrapatellar intramedullary nailing in patients with tibial shaft fractures. Both groups were comparable with respect to demographic and fracture characteristics. The study demonstrated that suprapatellar nailing resulted in significantly better functional outcomes, lower pain scores, greater knee range of motion, and superior coronal and sagittal alignment, while fracture union and complication rates were comparable between the two techniques.

The semiextended suprapatellar approach facilitates easier fracture reduction and improves maintenance of alignment during nail insertion. Sanders et al. reported that this technique is particularly useful in minimizing malalignment during tibial nailing.[8] Similarly, Jones et al. demonstrated better radiological alignment and functional outcomes with the suprapatellar approach, while Avilucea et al. confirmed its advantages in achieving satisfactory alignment, especially in complex fracture patterns.[9,10] Consistent with these observations, malalignment greater than 5° was significantly less frequent in the suprapatellar

group in the present study.

Functional recovery was superior following suprapatellar nailing, with significantly higher Lysholm and SF-36 scores and lower VAS pain scores throughout follow-up. Chan et al. reported improved postoperative pain and early functional recovery with the suprapatellar approach, and Franke et al. also observed satisfactory clinical outcomes without compromising fracture stability.[11,12] Meta-analyses by Wang et al. and Gao et al. further confirmed that suprapatellar nailing provides better functional outcomes, improved fracture alignment, and reduced postoperative pain compared with infrapatellar nailing.[13,14]

Anterior knee pain was significantly lower in the suprapatellar group, a finding consistent with the study by MacDonald et al., who demonstrated a substantial reduction in postoperative anterior knee pain following suprapatellar nailing.[15] Likewise, Ponugoti et al. and Packer et al. concluded that suprapatellar nailing improves pain, function, and alignment without increasing complication rates.[16,17]

The mean time to fracture union was comparable between the two groups, indicating that the surgical approach had no significant effect on fracture healing. Väistö et al. similarly reported comparable union rates despite persistent anterior knee pain after infrapatellar nailing.[18] Katsoulis et al. suggested that anterior knee pain is multifactorial and is related primarily to the nail entry approach and soft tissue injury.[19]

Postoperative complications were infrequent and comparable in both groups. Panda et al. also demonstrated that suprapatellar nailing provides better functional and radiological outcomes without increasing infection, delayed union, or other major complications.[20]

Overall, the findings of the present study support suprapatellar intramedullary nailing as an effective technique that offers improved functional recovery, reduced anterior knee pain, and superior fracture alignment while maintaining comparable fracture union and complication rates.

Conclusion

Suprapatellar intramedullary nailing provided superior functional and radiological outcomes compared with infrapatellar nailing in patients with tibial shaft fractures. It was associated with higher Lysholm and SF-36 scores, lower VAS pain scores, greater knee range of motion, reduced anterior knee pain, and better coronal and sagittal alignment. The time to fracture union and postoperative complication rates were comparable between the two approaches. Therefore, suprapatellar nailing may be considered a safe and effective alternative to conventional infrapatellar nailing, particularly when maintaining fracture alignment is technically challenging.

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Conflicts of interest

There are no conflicts of interest.

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