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PROSPECTIVE RANDOMIZED COMPARATIVE STUDY OF SUPRAPATELLAR VERSUS INFRAPATELLAR INTRAMEDULLARY NAILING FOR TREATMENT OF TIBIAL SHAFT FRACTURES IN ADULTS AT A TERTIARY CARE CENTRE

Orthopaedics

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ABSTRACT

Background: Tibial shaft fractures constitute approximately 13.7% of all adult fractures. Intramedullary nailing (IMN) is the standard of care; however, the conventional infrapatellar (IP) approach carries significant rates of postoperative anterior knee pain. The suprapatellar (SP) approach — performed in knee semi-extension — was developed to overcome these limitations. **Methods:** A prospective randomized comparative study of 30 adults with tibial diaphyseal fractures. Patients were randomized to SPN (n=15) or IPN (n=15). Functional outcome was assessed by Lysholm Knee Score at 1, 3, 6, and 12 months. Operative parameters (surgical duration, fluoroscopy time, blood loss) and radiological union were recorded. **Results:** SPN demonstrated significantly shorter operative time (79.66±3.99 vs. 98.0±6.76 min; p<0.001), reduced fluoroscopy time (11.6±1.4 vs. 14.67±0.72 min; p<0.001), and lower blood loss (49.33±7.04 vs. 75.0±10.18 mL; p<0.001). Time to union was comparable (14.47 vs. 14.53 weeks; p=0.928). Final Lysholm scores were excellent in both groups (SPN: 95.57; IPN: 92.0; p=0.172). **Conclusion:** The suprapatellar approach offers significant intraoperative advantages without compromising functional outcomes or union rates, making it a superior and safe alternative to the infrapatellar approach for tibial diaphyseal fracture fixation.

KEYWORDS

Tibial Shaft Fractures; Suprapatellar Nailing; Infrapatellar Nailing; Intramedullary Nailing; Lysholm Knee Score; Randomized Controlled Study

INTRODUCTION

Fractures of the tibial shaft are the most common long bone fractures in adults, constituting approximately 13.7% of all fractures.[1] They predominantly affect young males engaged in road traffic, carrying significant socioeconomic consequences. The limited soft tissue envelope, subcutaneous medial tibial border, and precarious blood supply render these fractures susceptible to complications including non-union, malunion, and deep infection.

Among operative strategies — plating, external fixation, and intramedullary nailing — IMN with interlocking screws has become the gold standard for displaced, unstable tibial diaphyseal fractures.[2,3] IMN provides load-sharing fixation through a minimally invasive corridor, preserving the fracture haematoma and periosteal blood supply while permitting early weight bearing and rehabilitation.

The conventional infrapatellar (IP) approach is performed with the knee in hyperflexion, creating technical challenges particularly for proximal third fractures. The deforming force of the quadriceps muscle induces apex anterior angulation of the proximal fragment, necessitating repeated adjustments.[4] More significantly, postoperative anterior knee pain — the most frequent complication — affects 10%–86% of patients undergoing IP nailing.[5] This is attributed to patellar ligament injury, infrapatellar nerve damage, and protruding nail end irritation.

The suprapatellar (SP) approach, first described in the modern context by Tornetta and Collins (1996), employs a trans-articular entry through the quadriceps tendon with the knee in 20° of flexion.[6] The semi-extended position neutralises quadriceps deforming forces, simplifies proximal fracture reduction,segmental tibia shaft fractures, provides superior fluoroscopic visualisation, and theoretically avoids the patellar tendon injury responsible for anterior knee pain.

This prospective randomized study compares the suprapatellar and infrapatellar approaches for IMN of tibial diaphyseal fractures with respect to intraoperative parameters, functional outcomes, radiological union, and complications at a tertiary care orthopaedic unit.

MATERIALS AND METHODS

Study Design and Setting

This prospective randomized comparative study was conducted in the Department of Orthopaedics, gmc gondia, Maharashtra University of Health Sciences (Nashik). Enrolment ran from january 2024 to december 2025; follow-up and data analysis through april 2026. Institutional Ethics Committee approval was obtained prior to commencement.

Sample Size and Randomization

Thirty eligible patients were serially numbered 1–30. Simple random sampling was applied: odd-numbered patients were assigned to the suprapatellar nailing (SPN) group (n=15) and even-numbered patients to the infrapatellar nailing (IPN) group (n=15). Written informed consent was obtained from all participants.

Eligibility Criteria

Inclusion: skeletally mature adults of either sex with closed or Grade I/II open tibial diaphyseal fractures willing to consent. Exclusion: Grade III open fractures, intraarticular fractures, metaphyseal fractures, pathological fractures, and paediatric patients.

Surgical Technique

All procedures were performed under spinal or general anaesthesia. Prophylactic cefuroxime 1.5 g IV was given perioperatively. SPN: patient supine, knee at 20° flexion; midline incision at superior pole of patella; longitudinal quadriceps tendon split; custom trocar and protective sleeve for articular cartilage protection; entry point just medial to lateral tibial spine on AP, at tibial plateau–slope junction on lateral. IPN: patient supine, knee in hyperflexion on angle frame; midline infrapatellar incision; entry point just medial to the lateral tibial spine above the tibial tuberosity. In both groups, nail sizing, reaming, fracture reduction, and interlocking were performed under fluoroscopic guidance. A suction drain was placed following SPN.

Postoperative Care and Follow-up

Three postoperative antibiotic doses, suture removal at two weeks, and early range-of-motion exercises were standard. Weight bearing was permitted immediately for stable fracture patterns and delayed 6 weeks for comminuted patterns. Follow-up evaluations were conducted at 1, 3, 6, and 12 months postoperatively.

Outcome Measures

Primary functional outcome: Lysholm Knee Scoring System (scored 0–100; excellent ≥95, good 84–94, fair 65–83, poor <65). Intraoperative parameters: surgical duration, fluoroscopy time, and estimated blood loss. Radiological outcome: time to union (bridging callus on ≥3 cortices on AP and lateral radiographs).

Statistical Analysis

Data were analysed with SPSS v22.0 (IBM, USA). Categorical data are reported as frequency (%). Continuous data as mean ± SD. Intragroup temporal changes in Lysholm score were assessed by paired t-test and RMANOVA. Intergroup comparisons used independent-samples t-test. p<0.05 was considered statistically significant.

RESULTS

Demographics and Fracture Characteristics

The mean patient age was 36.23 years (SD ±11.39; range 19–55). Males constituted 80% (n=24) and females 20% (n=6). The 31–40-year age group was most represented (36.67%, n=11). All 30 fractures resulted from road traffic accidents. Right tibia was involved in 57% (n=17) and left in 43% (n=13). Fracture location: distal 56% (n=17), proximal 27% (n=8), midshaft 17% (n=5). Associated injuries were present in 9 patients (30%), most commonly head injury (44.4%).

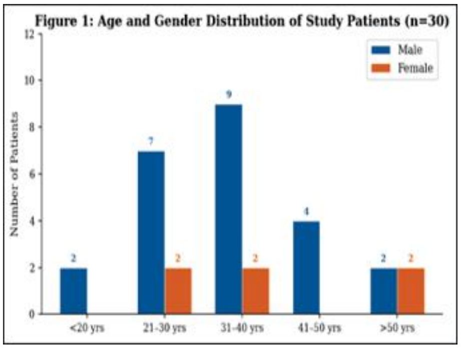

Figure 1: Age and Gender Distribution of Study Patients (n=30)

Table 1: Baseline Demographics and Fracture Characteristics

Parameter	SPN (n=15)	IPN (n=15)
Mean age (years)	35.8 ± 10.9	36.6 ± 12.1
Male / Female	12 / 3	12 / 3
Right / Left tibia	8 / 7	9 / 6
Distal / Proximal / Midshaft	9 / 4 / 2	8 / 4 / 3
Mode of injury (RTA)	15 (100%)	15 (100%)

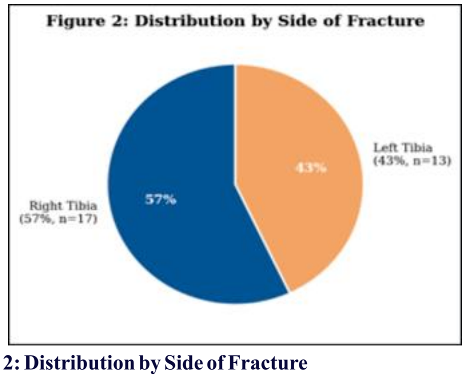

Figure 2: Distribution by Side of Fracture

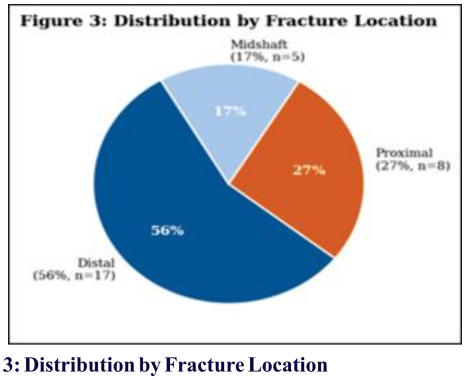

Figure 3: Distribution by Fracture Location

Intraoperative Parameters

The SPN group demonstrated statistically significant advantages in all three intraoperative parameters compared to IPN. Surgical duration was significantly shorter with SPN (79.66±3.99 vs. 98.0±6.76 min; p<0.001). Fluoroscopy time was significantly reduced with SPN (11.6±1.4 vs. 14.67±0.72 min; p<0.001). Intraoperative blood loss was significantly lower with SPN (49.33±7.04 vs. 75.0±10.18 mL; p<0.001).

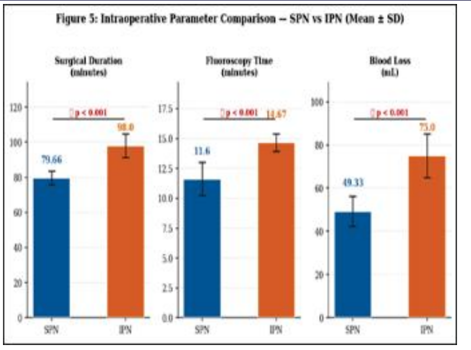

Figure 4: Intraoperative Parameter Comparison — SPN vs IPN (Mean ± SD; all p<0.001)

Table 2: Intraoperative Parameters — SPN vs IPN (*statistically significant)

Parameter	SPN (Mean ± SD)	IPN (Mean ± SD)	p-value
Surgical duration (min)	79.66 ± 3.99	98.00 ± 6.76	< 0.001*
Fluoroscopy time (min)	11.60 ± 1.40	14.67 ± 0.72	< 0.001*
Blood loss (mL)	49.33 ± 7.04	75.00 ± 10.18	< 0.001*

Functional Outcomes — Lysholm Knee Score

Both groups demonstrated significant progressive improvement in Lysholm scores over all four time points (p<0.001, RMANOVA). Scores were: at 1 month — SPN 36.21±4.41, IPN 37.60±4.87; at 3 months — SPN 58.64±9.97, IPN 53.47±11.62; at 6 months — SPN 80.79±5.94, IPN 75.60±8.81; at 12 months — SPN 95.57±4.15, IPN 92.0±6.63. Intergroup comparison showed no statistically significant difference (p=0.172), indicating equivalence of both approaches for functional recovery.

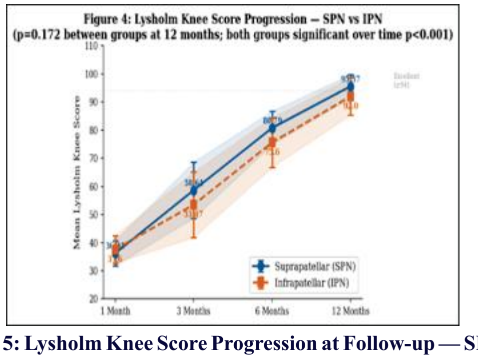

Figure 5: Lysholm Knee Score Progression at Follow-up — SPN vs IPN (Mean ± SD; p=0.172 at 12 months)

Table 3: Lysholm Knee Scores at Sequential Follow-up (NS = not significant)

Follow-up	SPN — Mean ± SD	IPN — Mean ± SD	p (intergroup)
1 Month	36.21 ± 4.41	37.60 ± 4.87	NS
3 Months	58.64 ± 9.97	53.47 ± 11.62	NS
6 Months	80.79 ± 5.94	75.60 ± 8.81	NS
12 Months	95.57 ± 4.15	92.00 ± 6.63	NS (p=0.172)

Radiological Union

Time to radiological union was comparable between groups (SPN: 14.47±1.96 weeks, IPN: 14.53±2.07 weeks; p=0.928).

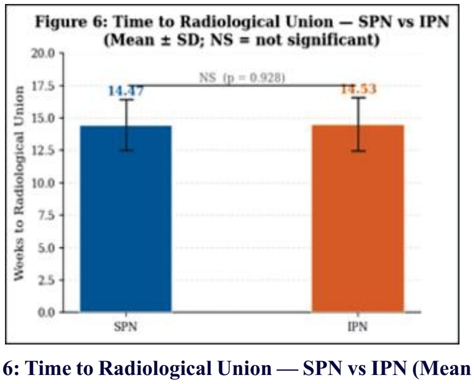

Figure 6: Time to Radiological Union — SPN vs IPN (Mean ± SD; p=0.928, NS)

Complications

Early anterior knee pain was reported by 8 patients (predominantly IPN) at the 1-month visit, resolving at subsequent reviews. One late complication per group: proximal screw infection in SPN requiring implant removal at 3 months; 5–7° external malrotation in IPN. No non-union, implant failure, or patellofemoral arthritis was recorded at 12-month follow-up.

Figure 1- Case of tibia shaft fracture with Infrapatellar IMILN tibia nailing

Figure 3- Case of segmental tibia shaft fracture managed with suprapatellar IMILN tibia nailing

Figure 4- Intra op clinical and C arm images :Use of multiple blocking k wires in the metaphyseal region in AP and mediolateral direction for better intramedullary nail placement and fracture reduction.

DISCUSSION

The demographic profile of our cohort — mean age 36.23 years, 80% male, 100% RTA mechanism — is consistent with the epidemiological pattern of high-energy tibial fractures in low-middle income countries. This is comparable to Courtney et al. (2015), mean age 38.5 years, and Ozgur et al. (2019), mean age 43.24 years.[7,8] The slightly lower mean age in our study may reflect the higher burden of motorised two-wheeler injuries in young adults in the Indian subcontinent.

The most striking finding of this study is the significant intraoperative advantage of SPN across all three operative parameters. The reduction in surgical duration (approximately 18 minutes shorter) with SPN reflects the ergonomic benefit of the semi-extended knee position: the surgeon can access, insert, and interlock the nail without repeated repositioning to maintain fracture reduction. Comparable reductions have been reported by Q. Sun et al. (2016) and Fu SP et al. (2017).[9,10] The learning curve associated with the trans-articular entry is real but is substantially offset by the technical advantages once the technique is mastered.

The significantly shorter fluoroscopy time with SPN (11.6 min vs. 14.67 min; $p<0.001$) has practical radiation safety implications for both the operative team and patient. The tibial axis is better coaxially aligned with the fluoroscope in semi-extension, yielding clearer images with fewer acquisition cycles. Williamson et al. (2018) and Allen JD et al. (2020) independently confirmed significantly reduced fluoroscopy times with SPN across different nail systems.[11,12]

Lower intraoperative blood loss with SPN (49.33 mL vs. 75.0 mL; $p<0.001$) is attributable to reduced soft tissue manipulation around the infrapatellar fat pad, patellar tendon, and tibial tuberosity periosteum required in the IP approach. Meta-analytic evidence (Yang L et al., 2018) reports a weighted mean difference of 7.92 mL favouring SP nailing, consistent with our findings.[13]

Despite clear intraoperative superiority, SPN did not produce significantly better functional outcomes as measured by Lysholm scores at any follow-up point. Both groups achieved excellent recovery — SPN 95.57 and IPN 92.0 at 12 months ($p=0.172$). This finding mirrors Ozgur et al. (2018) ($p=0.168$) and is broadly consistent with the systematic review by Wang et al. (2018), which found no significant difference in final functional scores on pooled analysis, though RCT subgroup data showed a marginal advantage for SPN.[6,7,8] Time to radiological union was equivalent (≈14.5 weeks in both groups), confirming that the choice of entry portal does not disturb the biological milieu of fracture healing. This was anticipated given that both approaches use the same intramedullary implant and rely on similar principles of minimally invasive fixation.

The concern regarding patellofemoral cartilage injury with the trans-articular SPN approach was not supported by our clinical outcomes. Gelbke et al. (2010) demonstrated biomechanically that patellofemoral contact pressures during SPN insertion remain below the 25 MPa threshold for cartilage injury.[14] Sanders et al. (2014) found no clinical or MRI evidence of cartilage damage at 12-month follow-up in 36 SPN patients.[15]

Limitations include small sample size (n=30), single-centre setting, and 12-month follow-up duration. Absence of a dedicated anterior knee pain questionnaire (e.g., Kujala score) at each time point is also acknowledged. Future multi-centre randomised trials with longer follow-up and patient-reported outcome measures are warranted.

CONCLUSION

The suprapatellar approach for intramedullary interlocking tibial nailing offers significant and reproducible intraoperative advantages over the conventional infrapatellar approach — including substantially reduced operative time, fluoroscopy exposure, and blood loss — without compromising functional recovery, radiological union, or complication rates at 12-month follow-up. Both approaches yield equivalent excellent Lysholm knee function scores at final follow-up. Suprapatellar nailing should be considered the preferred entry technique especially for proximal tibial fractures, polytrauma patients, and individuals with restricted knee flexion, and warrants integration into standard orthopaedic training programmes.

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