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Original Research Article

A Prospective Comparative Randomised Controlled Study On The Functional Outcome Between Suprapatellar Approach And Infrapatellar Approach of Intramedullary Nailing in Tibial Shaft Fractures

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Conflict of interest: Nil

Abstract:

Introduction: Tibial shaft fracture represents the most common long bone fracture which is usually a result of high energy trauma like road traffic accidents, fall from heights constituting 2% of all the fractures in adults. Intramedullary nailing with interlocking screws is reported to be a successful treatment modality for tibial fractures showing improved outcome in functional recovery. Here is a prospective comparative study to compare the outcome between suprapatellar and infrapatellar approach of intramedullary nailing in tibial shaft fractures.

Methodology: This is a prospective comparative study. Patients were divided into 2 group A and B using randomizer software. Group A was treated with suprapatellar approach (SP) of intramedullary nailing and group B with infrapatellar approach (IP) of intramedullary nailing.

Aims and Objectives: To assess clinical outcomes of suprapatellar vs infrapatellar approach in tibial fractures by measuring fluoroscopy time, operative time. To assess functional and radiological outcomes post operatively of suprapatellar approach vs infrapatellar approach in tibial fractures by visual analogue scale, Lysholm knee score and Radiological Union in Tibia Score.

Result: In our study, the average duration of surgery was 84.1 and 87.1 in SP and IP approaches respectively. Fluoroscopic time was 104.5 and 117.6 in SP and IP respectively. Blood loss was 155.7 and 163 in SP and IP. Lysholm knee score was higher in SP group however there was no difference in VAS score, ROM and RUST Score between the 2 approaches.

Conclusion: The suprapatellar approach for intramedullary nailing is superior to infrapatellar approach with regards to decreased post operative pain and better functional outcome with fewer complications.

Keywords: Tibial fractures, infrapatellar approach, suprapatellar approach, intramedullary nailing, radiological outcomes, functional outcomes.

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Introduction

Tibial fractures are the most common long bone fracture with approximately 2% of all fractures among adults[1,2]. They are associated with a wide range of mechanism and severity of injury. There are various treatment options available in managing tibial fractures based on the level and soft tissue injury. They include plating, intramedullary Nailing and external fixation[3]. Insertion of Intramedullary nail (IMN) along with interlocking screws for stability (axial and rotational) is a successful surgical method for treating stable and unstable tibial fractures that allows early functional rehabilitation[4,5]. Polyaxial locking screws helped to manage metaphyseal fractures using IMN. IMN provides the benefit of minimal dissection while preserving blood supply to fracture site. Conventional infrapatellar (IP) approach for tibia IMN is the gold standard surgery used in treating

tibial fractures. But, IMN insertion through IP approach is technically challenging because of displacement of proximal fracture fragments with knee in flexion which is due to the force of quadriceps muscle. It increases risk of procurvatum and valgus deformities in proximal shaft of tibia fractures[6,7]. Apart from that, chronic postoperative knee pain is one common complication after insertion and the incidence varies from 10 to 80%.[8] To solve these problems, semi extended approach for tibial IMN insertion was 1st reported by Tornetta et al.[9], which was later changed by Cole et al.[10] to suprapatellar (SP) approach via midline quadriceps tendon splitting. This new method suggests that valgus and procurvatum malalignment can be prevented when knee is maintained in extension. It also enables easier anteroposterior and lateral imaging of tibia[11,12]. But the main problem with this method is damage to patellofemoral articulation with knee pain after IMN fixation and patellofemoral joint (PFJ) arthritis[13]. There is no accurate evidence on incidence of PFJ damage, limiting its usage. One trial reported that SP approach to be beneficial compared to IP approach in treating tibial fractures with respect to functional outcomes[14]. However various studies found no significant differences in range of motion (ROM), pain or functional score between these two procedures[15,15] Till date, there is no consistent conclusion on which approach is best, especially in developing countries like India. Hence the current study was undertaken. Therefore, we developed the current study which was carried out at BMCRI, Bangalore to compare functional and radiological outcome of tibial fractures treated by intramedullary interlocking nailing using suprapatellar versus infrapatellar approach in our population.

Materials And Methods

Source of data: Patient of either sex who are above 18 years with extra-articular tibia shaft fractures admitted in hospitals attached to Bangalore Medical College and Research institute, Bangalore.

Study design: Randomized comparative study.

Study period: 18 months (April 2024 to October 2025).

Place of study: Victoria hospital and Bowring & Lady Curzon hospital Bangalore, BMCRI.

Sample size: 20 cases in each group satisfying the inclusion and exclusion criteria admitted in the Dept. of Orthopaedics in the hospitals attached to BMCRI, during the study period from February 2021 to August 2022 will be included.

Inclusion Criteria :

- Patients with Extra-articular tibial shaft fractures.
- Patients who are 18 years and above and willing to give written informed consent (Annexure 1).
- Closed and Compound Gustilo Anderson type 1,2 and 3A.

Patients who have attained skeletal maturity

Exclusion Criteria:

- Intra-articular proximal tibia fractures
- Compound GradeIIIb, IIIc fractures
- Segmental fractures of the tibia.
- Pathological fracture
- Co-morbid conditions not permitting major surgical procedures.
- Un-cooperative patients and patients not willing for surgery

Methodology: This is a prospective comparative study. Inpatients of hospitals with tibia fractures fulfilling the inclusion/exclusion criteria will be taken into the study after obtaining written informed consent. Patients will be divided into 2 group A and B by randomizer software[14]. Group A will treated with suprapatellar approach of intramedullary nailing and group B with infrapatellar approach of intramedullary nailing. Demographic data, history, clinical examination and details of investigations and interventions will be recorded in the study proforma Fluoroscopy time, length of hospital stay, operative time, blood loss and complications will be recorded and compared. Visual analog score (VAS), Lysholm knee score, range of motion (ROM), Radiological Union in Tibia Score (RUST) and post operative complications will be reviewed at immediate post-op, 6 weeks, 3 and 6 months post-operatively.

Assessment tools:

- Scales – Visual analog score
- Clinical functional outcome - Lysholm score
- Radiological outcome- RUST score

Post-operative protocol:

- At the end of 48 hours - Static Quadriceps and Ankle movements started.
- When Pain reduces – Active Knee ROM exercises were started.
- Suture removal was done on 14th Post-operative day.
- Toe touch weight bearing is initiated 48 hours after surgery

- Weight bearing is started when there is evidence early callus formation(4 to 6 weeks) in fractures without axial stability
- Full weight bearing started when there is radiological union of 3 cortices

Surgical Technique

Infrapatellar Approach: Position of patient – supine and knee in either flexion or hyperflexion and inserting the nail through either a patellar tendon-splitting or patellar tendon-sparing technique. Make a 5-cm incision on the anterior aspect of the tibia, beginning at the inferior border of the patella and extending the incision down to just above the tibial tubercle. Patellar tendon is split and retracted. The insertion point is taken in line with medullary canal (3 mm medial to tibial crest). Guide wire insertion, serial reaming, fracture reduction confirmed by fluoroscopy, placement of appropriate size of nail, insertion of proximal screw with custom made proximal jig, insertion of distal screw by free hand technique under fluoroscopy, wash and closure of sutures.

Figure 1: Positioning for IP approach by 90 degree flexion

Figure 2: Incision, reaming and fluoroscopy for tibial nailing via IP approach

Suprapatellar Approach: Position of patient - supine, 20 degree knee flexion incision – midline at the superior pole of patella longitudinal split of quadriceps tendon, knee joint entered from above custom made trocar and protective sleeve inserted entry points just medial to the lateral tibial spine guide wire insertion, Serial reaming, fracture reduction confirmed by fluoroscopy, placement of appropriate size of nail, insertion of proximal screw with custom made proximal jig, insertion of distal screw by free hand technique under fluoroscopy, wash and closure of sutures.

Figure 3: Positioning for SP approach in 20 degree flexion

Figure 4: Incision, reaming and fluoroscopy for tibial nailing SP approach

Postoperative protocol and followup

- Exercise to encourage the knee and ankle range of motion should be initiated as soon as possible
- Suture removal on the 2nd week.
- Weight bearing is determined by the axial stability of fracture pattern. If there is good axial stability as seen in noncomminuted diaphyseal fracture pattern, then immediate weight bearing as tolerate dis usually instituted.
- Non weight bearing with crutches or walker for at least 6 weeks after discharge for highly comminuted fracture pattern
- Partial weight bearing till radiological union

Patients were followed at 1,2,3,6 and 12 months after surgery. AP and lateral Xray films are taken at each follow up for evaluations of fracture healing, implant position and the general condition of the fracture site

Results

The study included 40 patients with tibial fractures. Twenty patients underwent intramedullary nailing (IMN) through the suprapatellar (SP) approach and 20 through the infrapatellar (IP) approach. The results are presented for demographic variables, perioperative parameters, functional outcomes, and radiological union.

Table 1: Age distribution

Age group	IP n (%)	SP n (%)	χ^2 (df)	p-value
≤20 years	2 (10)	0 (0)	6.31 (3)	0.097 (NS)
21–40 years	7 (35)	12 (60)		
41–60 years	8 (40)	8 (40)		
61–80 years	3 (15)	0 (0)		
Total	20 (100)	20 (100)		
Mean age ± SD (years)	43.35 ± 17.91	39.10 ± 11.13		

Table 2: Gender distribution

Gender	IP n (%)	SP n (%)	χ^2 (df)	p-value
Male	15 (75)	18 (90)	1.558 (1)	0.212 (NS)
Female	5 (25)	2 (10)		
Total	20 (100)	20 (100)		

Table 3: Mode of injury

Mode of injury	IP n (%)	SP n (%)	χ^2 (df)	p-value
Road traffic accident	17 (85)	19 (95)	1.11 (1)	0.292 (NS)
Slip and fall	3 (15)	1 (5)		
Total	20 (100)	20 (100)		

Table 4: Comorbidities

Comorbidity	IP n (%)	SP n (%)	χ^2 (df)	p-value
Diabetes mellitus	1 (5)	0 (0)	1.11 (3)	0.292 (NS)
Hypertension	4 (20)	1 (5)		
DM + HTN	1 (5)	2 (10)		
None	14 (70)	17 (85)		
Total	20 (100)	20 (100)		

Table 5: Perioperative parameters

Parameter	IP group	SP group	p-value	Interpretation
Duration of surgery (min), mean ± SD	87.10 ± 11.74	84.15 ± 19.24	0.561	NS
Blood loss (mL), mean ± SD	163.0 ± 25.56	155.7 ± 26.36	0.379	NS
Fluoroscopy time (sec), mean ± SD	117.6 ± 14.93	104.5 ± 19.86	0.024	Significant

Table 6: Duration of hospital stay

Hospital stay	IP n (%)	SP n (%)	χ^2 (df)	p-value
3 days	5 (25)	1 (5)	6.50 (3)	0.092 (NS)
4 days	0 (0)	0 (0)		
5 days	14 (70)	13 (65)		
6 days	0 (0)	2 (10)		
7 days	1 (5)	4 (20)		
Total	20 (100)	20 (100)		

Table 7: Lysholm Knee Scoring Scale (LKSS)

Follow-up	IP mean ± SD	SP mean ± SD	p-value
6 weeks	67.60 ± 7.53	76.85 ± 5.06	<0.001
12 weeks	77.70 ± 8.86	87.55 ± 5.23	<0.001
24 weeks	87.90 ± 7.15	95.30 ± 3.65	<0.001

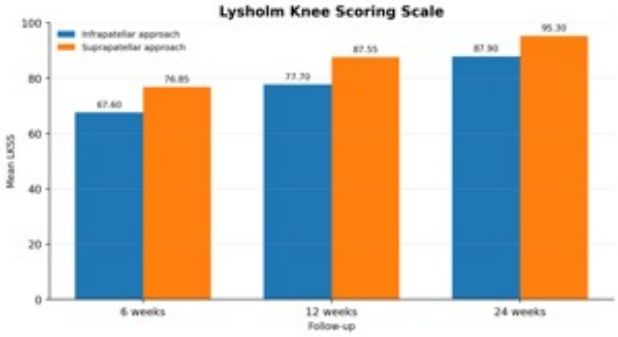


Table 8: Visual Analogue Scale (VAS)

Follow-up	IP mean ± SD	SP mean ± SD	p-value
6 weeks	3.05 ± 0.75	2.85 ± 0.745	0.445 (NS)
12 weeks	1.35 ± 0.48	1.35 ± 0.489	1.000 (NS)
24 weeks	0.50 ± 0.513	0.35 ± 0.489	0.343 (NS)

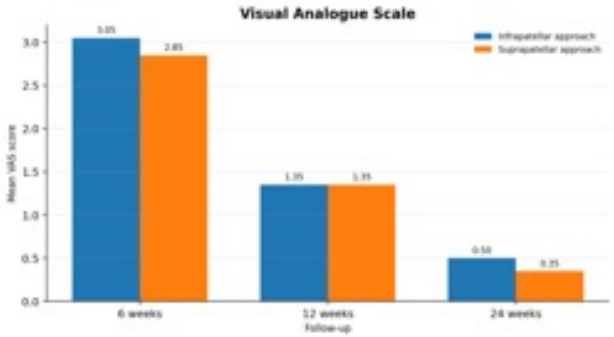


Table 9: Range of motion (ROM)

Follow-up	IP mean ± SD (°)	SP mean ± SD (°)	p-value
6 weeks	107.0 ± 15.59	104.0 ± 10.95	0.579 (NS)
12 weeks	125.5 ± 6.04	123.50 ± 4.89	0.179 (NS)
24 weeks	129.5 ± 2.23	128.0 ± 4.10	0.157 (NS)

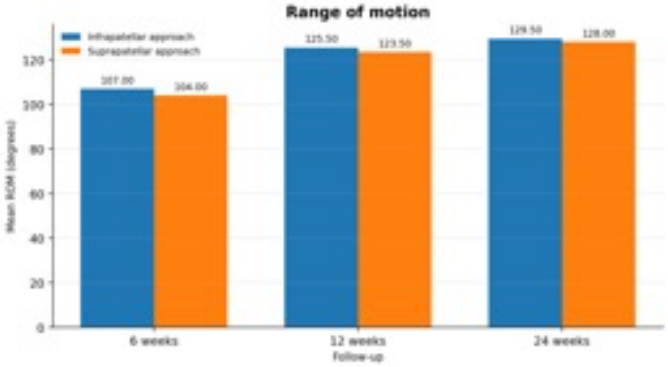
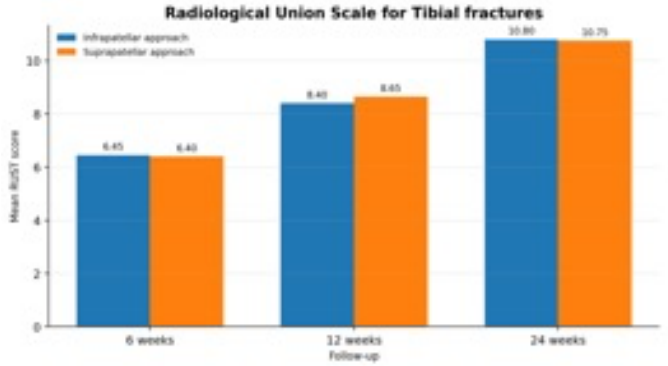


Table 10: Radiological Union Scale for Tibial fractures (RUST)

Follow-up	IP mean ± SD	SP mean ± SD	p-value
6 weeks	6.45 ± 0.75	6.40 ± 0.821	0.554 (NS)
12 weeks	8.40 ± 1.09	8.65 ± 1.26	0.547 (NS)
24 weeks	10.80 ± 0.76	10.75 ± 1.02	0.918 (NS)



The two groups were comparable with respect to age, gender, mode of injury, and comorbidities; no statistically significant baseline differences were reported. Mean operative duration was 87.1 minutes in the IP group and 84.15 minutes in the SP group, with no significant difference (p=0.561). Mean blood loss was 163.0 mL in the IP group and 155.7 mL in the SP group, with no significant difference in the tabulated result (p=0.379).Mean fluoroscopy time was significantly lower with the SP approach (104.5 ± 19.86 sec) than with the IP approach (117.6 ± 14.93 sec; p=0.024).Hospital stay did not differ significantly between groups (p=0.092). LKSS was significantly higher in the SP group at 6, 12, and 24 weeks (all p<0.001). VAS and ROM showed no statistically significant between-group differences at 6, 12, or 24 weeks. RUST scores showed no statistically significant between-group differences at 6, 12, or 24 weeks.

Discussion

The current study included 40 patients with tibial fractures. They underwent intramedullary nailing through supra and infrapatellar approaches.

Age of patients: The age of patients ranged from 18 to 76 years in IP group and 22 to 60 years in SP group. The mean age in IP 43 and SP 39. There was no significant difference in the mean age of patients

in both groups(p=0.097). Hence both groups are comparable with no age bias in our study. A study was done by Lu, Y et al., among 63 patients with distal fractures treated with IMN from 2014 to 2018. 27 patients underwent SP and 36 patients underwent IP approaches. The mean age of patients in SP approach was 42.6 years and in IP approach, it was 40.6 years. There was no significant difference in the mean age of patients between both groups(p=0.47), similar to our study.[17]

Gender: In our study, there were 15 males and 5 females in IP group and 18 males and 2 females in SP group. There was no significant difference in gender between both groups(p=0.212). In our study males were more compared to females in both groups, similar to a study done by Al-Azzawi et al.[18] In Lu, Y et al. study females were more in SP approach and males were more in IP approach. Overall, there were 32 females and 31 males.[17] There was no significant difference in gender between both groups in all these studies. This eliminates gender-related bias.

Blood loss: In our study, the mean blood loss in SP approach was 155 ml and the mean blood loss in IP approach was 163 ml. This implies that blood loss is more in IP approach, but there is no significant difference in mean blood loss in both groups (p=0.397). In the study done by Cui Y et al., authors compared SP and IP approaches. Results showed no significant differences in laterality of fractures, and blood loss during surgery between the two groups.[19]

Operation time: The mean operative time in our study is 87.1 min, and 84.1 min in IP and SP groups respectively. There is no significant difference between both the groups similar to Courtney et al.[16], Cui et al.[19] and Sun et al studies. However, Al-Azzawi et al. showed a significant increase in operative time in IP compared to SP.[37]

Study	IP	SP	p-value
Current study	87.1	84.15	0.561
Courtney et al.[16]	145 min	147 min	0.884
Cui et al.[19]	65.7 min	66.4 min	0.794
Sun et al.[20]	73.26 min	71.01 min	0.183
Al-Azzawi et al.[18]	139 min	110 min	< 0.05

Fluoroscopy time: In our study fluoroscopic time in IP 117.6 and SP 104.5 . fluoroscopy time was signicant in our study like that of below mentioned studies between IP and SP approaches.

Study	IP	SP	p-value
Current study	117.6 sec	104.5 sec	0.024
Courtney et al.[16]	122.1 sec	80.8 sec	0.003
Williamson et al.[21]	129.7 sec	94.4 sec	0.002

Functional Outcome: In our study

LKSS: There is a significant difference in mean lysholm knee score between both groups at 6, 12, and 24 weeks in our study. Lysholm score was significantly higher in SP approach compared to IP approach in studies done by Sun Q et al., similar to our study. Lysholm score was more in SP approach in studies done by Chan et al, Ozcan et al but it is not significant. In a study done by Macdonald et al.,[38]there is no significant difference in LKS at 6 months but there is a significant increase in LKS in SP group at 1-year follow-up.

Study	Duration	Lysholm score- IP	Lysholm score- SP	p-value
Current study	6 months	87	95	<0.001
Sun Q et al.[20]	1 year	83.4	88.91	0.034
Ozcan et al.[22]	1 year	80.23	85.3	0.06
Macdonald et al.[23]	6 months	83	87	NS
	1 year	84	93	0.02

Visual Analog Score (VAS): There was no significant difference is VAS score in IP and SP approach in our study. VAS pain score was significantly lower in SPAG than in IPAG at six, 12 and 24 months post-operatively in Sun Q et al.[20]

Range of Movements (ROM): In our study, there was no significant difference in IP and SP approaches. Chan et al[11] reported an improved range of motion with the suprapatellar approach; however, there was no significant difference.

RUST score: There is no significant difference in the mean RUST score at 24 weeks between IP and SP approaches (p=0.80). The mean RUST was 10.8 in IP group and it was 10.75 in SP group in our study.

In the study done by Umur et al.[24], 61 patients with tibial fractures were included. There was no significant difference in RUST score in SP and IP approaches (p=0.45), similar to our study.

Post-operative complications: Anterior knee pain was the most common complication, seen in 4 patients out of which 3 patients were in IP group. Superficial infection at the entry site was seen in 1 patient. There were no cases of deep infection. In a study done by Sun Q et al., non-union is seen in 9 cases out of which 3 cases are in SP group and 5 in IP group, and malunion is seen in 7 cases out of which 2 cases in SP group and 5 in IP group. Some researchers hypothesized that post-operative knee pain occurs due to splitting of patellar tendon, protrusion of proximal nail, damage in intra-articular areas, and involvement of infrapatellar nerve, and SP helps to avoid these complications. Improved post-operative pain positively affects the ability to rehabilitate, and improved functional scores seen with SP group are likely to be attributable to the lower pain scores recorded.

Limitation: The limitations of this study is that it has a small sample size compared to other studies. The follow up duration was 6 months which was shorter when compared to other studies. Multiple surgeons were involved in the treatment of the study group which may have affected the OT duration, surgical technique, blood loss etc.

Conclusion

This randomised comparative study showed that there is statistically significant difference between the suprapatellar and infrapatellar approaches used for all kind of tibial fractures evaluated by Lysholm knee score and decreased fluoroscopic time.The suprapatellar approach for intramedullary nailing is superior to infrapatellar approach with regards to decreased post operative pain and better functional outcome with fewer complications. However we need bigger sample size and studies with longer follow up in the future.

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