

Original Research Article

Radiological and functional assessment of closed tibial shaft fractures treated with interlocking nails through suprapatellar approach: a hospital-based observational study

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ABSTRACT

Background: Tibial shaft fractures are among the most frequently encountered long bone injuries. Due to limited soft tissue coverage and subcutaneous location, the tibia is prone to complications such as non-union, infection and malalignment. The suprapatellar approach for intramedullary nailing has recently gained favour for its potential benefits over the traditional infrapatellar method, reducing anterior knee pain and facilitating easier intraoperative imaging. The aim of this study was to assess the radiological and functional outcome of closed tibial shaft fractures treated with interlocking nails through suprapatellar approach.

Methods: This prospective observational study was conducted in the Department of Orthopaedics, National Institute of Traumatology and Orthopedics Rehabilitation (NITOR), Sher-E-Bangla Nagar, Dhaka, Bangladesh, from March 2022 to March 2023. Total 33 patients with closed tibial shaft fractures were included in the study.

Results: The study included 33 patients (mean age 38.3 ± 11.6 years), predominantly male (69.7%). Right-sided fractures were more common (60.6%). Most injuries (81.8%) were due to motor vehicle accidents. AO type 42A fractures were most frequent (54.5%). Anterior knee pain was minimal, with a mean VAS of 0.5. Radiological union occurred in 90.9% within 21 weeks (mean 17.9 ± 3.5). Complications were rare (12.1%). Most patients achieved a ROM of $130-139^\circ$, with fair to good functional outcomes in over 90% of cases.

Conclusions: Suprapatellar nailing offers a reliable and minimally painful solution for managing closed tibial shaft fractures with favourable radiological and functional outcomes.

Keywords: Closed tibial shaft fractures, Interlocking nails, Radiological and functional assessment, Suprapatellar approach

INTRODUCTION

Tibial shaft fractures are one of the most frequent long bone fractures globally, with an annual incidence ranging from 16.9 to 36.7 per 100,000 individuals and present in approximately 4% of all fractures.^{1,2} They usually occur in high-energy mechanisms such as road traffic accidents among young people or low-energy falls among elderly people and they result in an immense strain on orthopedic trauma care systems worldwide.³ Their management remains challenging due to the subcutaneous location of the tibia and the limited soft tissue envelope that renders the fracture vulnerable to complications like infection, non-union and malunion, particularly with open fractures or delayed union.⁴

Intramedullary nailing (IM) is an old gold standard for closed tibial shaft fracture fixation due to the fact that it is minimally invasive, has statically stable load-sharing characteristics, preserves periosteal blood supply and maintains mechanical alignment.⁵ Its popularity is attributed to consistent results showing earlier mobilization, lower rates of infection and less malalignment compared to plate fixation and external fixation.^{6,7} Nevertheless, conventional IMN techniques typically form the infrapatellar approach either using the medial parapatellar or transtendinous method with 90-degree knee flexion. Although effective, this method is technically demanding, particularly for proximal-third fractures and has also been reported to be associated with greater intraoperative radiation exposure, fracture reduction loss and a higher rate of post-operative anterior knee pain due to repeated patellar tendon manipulation.^{8,9}

Because of these limitations, the suprapatellar technique for tibial nailing, which is performed in the semi-extended knee position, has become more and more popular over time. It provides greater control of the mechanical axis during insertion of the nail, especially in fractures of the proximal third of the tibia. It further increases fluoroscopic exposure and reduces intraoperative radiation exposure through minimized need for extreme knee flexion and repetitive limb repositioning.^{10,11} Moreover, by not traumatically traumatizing the patellar tendon, the suprapatellar approach also appears to reduce the incidence of postoperative anterior knee pain, an important cause of patient dissatisfaction after infrapatellar IMN.¹²

A number of studies have provided empirical data in favor of the suprapatellar approach. A randomized control trial of Panda et al revealed that patients treated suprapatellarly had significantly better postoperative function and alignment based on Lysholm and VAS scores.¹³ Zhu et al also demonstrated a reduction in malalignment and occurrence of chronic knee pain with the suprapatellar technique in a multicenter review.⁸ Meta-analysis findings of Sepehri et al also attest to the excellence of the suprapatellar approach in patient surgical success and patient recovery, with shorter surgery time and quicker weight-bearing capacity.¹⁰ Sanders et al, also confirm these findings, with long-term radiological and

clinical results noted in patients who were reviewed for over 12 months post-surgery.¹⁴ Despite the growing evidence base, gaps in research exist mainly in hospital-based region-specific observational studies in lower- and middle-income countries like India and Southeast Asia. This gap filled, the present hospital-based observational study aims for radiological and functional evaluation of outcomes of closed tibial shaft fractures managed by the suprapatellar interlocking IMN technique.

Objectives

To evaluate the radiological and functional outcomes of patients with closed tibial shaft fractures managed using intramedullary interlocking nails via the suprapatellar approach.

METHODS

This prospective observational study was conducted in the Department of Orthopaedics, National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Sher-E-Bangla Nagar, Dhaka, Bangladesh, from March 2022 to March 2023. A total of 33 patients with closed tibial shaft fractures were included in the study.

The inclusion criteria encompassed adult patients aged 18 to 60 years presenting with closed tibial shaft fractures who underwent surgical fixation using the suprapatellar interlocking intramedullary nailing technique. Exclusion criteria included open fractures, pathological fractures, segmental fractures, fractures involving the proximal or distal 5 cm of the tibia, patients with polytrauma or those with previous ipsilateral knee injuries or surgeries. After obtaining informed consent, all patients underwent thorough clinical and radiological evaluation. Surgical procedures were performed under spinal or general anesthesia with the patient in the supine position. A suprapatellar approach was utilized, with the knee maintained in a semi-extended position using a radiolucent bolster. A standard medial parapatellar incision was made, followed by the introduction of a protective sleeve into the suprapatellar pouch to avoid damage to intra-articular structures.

Closed reduction of the fracture was achieved under fluoroscopic guidance and appropriate entry was made into the tibial canal. Reaming was done based on canal diameter and a statically locked intramedullary interlocking nail was inserted and secured proximally and distally. Postoperatively, patients were followed up at 6 weeks, 3 months and 6 months. Radiological assessment focused on fracture union, alignment and hardware position. Union was defined radiographically by the presence of bridging callus in at least three cortices on AP and lateral views. Functional outcomes were evaluated using validated scoring systems including the Lysholm knee scoring scale and the visual analogue scale (VAS) for anterior knee pain. Any complications such as infection, implant failure or malunion were documented. Data were

analyzed using descriptive and inferential statistics. Categorical variables were expressed as frequencies and percentages, while continuous variables were summarized as means and standard deviations. The statistical analysis was performed using SPSS version 26.0. A p value of <0.05 was considered statistically significant.

RESULTS

Table 1 presents baseline characteristics of the study patients. The study included 33 patients diagnosed with closed tibial shaft fractures, treated surgically with the suprapatellar intramedullary interlocking nail technique. The patients had a mean age of 38.3 ± 11.6 years (range: 21–60), with the highest concentration (33.3%) in the 21–30-year age group. This was followed by 24.2% in the 31–40-year group and 21.2% each in the 41–50 and 51–60-year groups.

Male patients predominated (69.7%) over females (30.3%). With respect to laterality, the right leg was affected in 60.6% of cases and the left in 39.4%. Figure 1 illustrates the distribution of patients by mode of injury. The vast majority of injuries (81.8%) resulted from motor vehicle accidents, while other mechanisms included falls from height (12.1%), falls on the ground (3.0%) and sports-related injuries (3.0%). Figure 2 demonstrates the distribution of patients by type of fracture, based on AO classification. Type 42A fractures were most common, observed in 54.5% of patients, followed by 42B (24.2%) and 42C (21.2%) types.

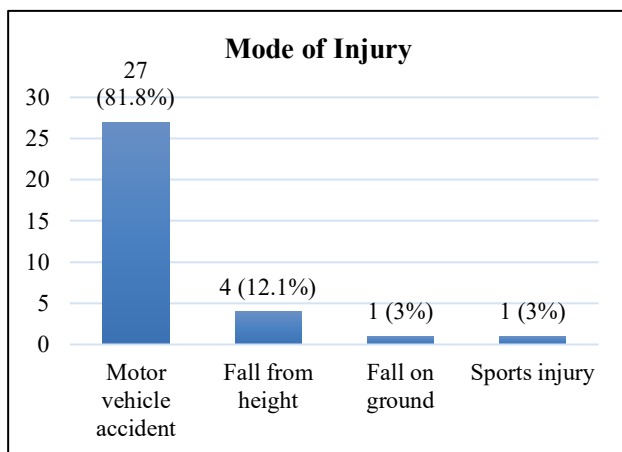


Figure 1: Distribution of patients by mode of injury (n=33).

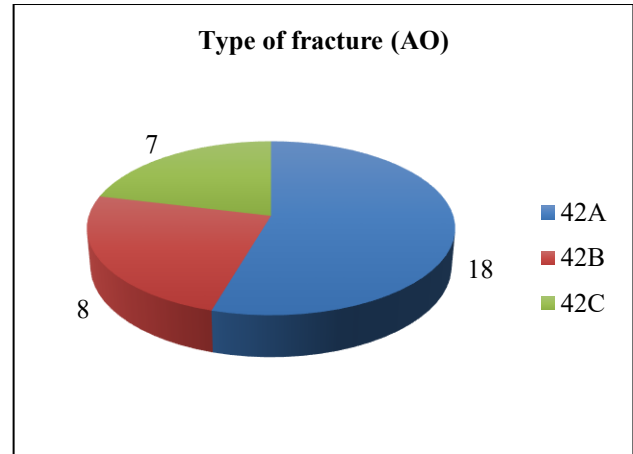


Figure 2: Distribution of patients by type of fracture (n=33).

Table 2 shows the distribution of anterior knee pain (according to VAS) among the study patients. The majority (84.8%) of patients reported no anterior knee pain (VAS=0), while only 15.2% experienced mild discomfort (VAS>0). The mean VAS score was low, at 0.5 ± 1.1 , with a range of 0–4, indicating minimal postoperative anterior knee discomfort following the suprapatellar approach.

Table 3 reveals that radiological union was achieved between 14 and 17 weeks in 51.5% of patients, while 39.4% united between 18 and 21 weeks. Only 2 patients (6.1%) experienced union in the 26–30 weeks range and none fell into the 22–25 weeks interval. The mean union time was 17.9 ± 3.5 weeks (range: 14–30). In terms of complications, 87.9% of patients experienced no adverse events. However, delayed union occurred in 2 patients (6.1%), nonunion in 1 patient (3.0%) and superficial surgical site infection in 1 patient (3.0%). Table 4 outlines the outcome variables at last follow-up. The range of motion (ROM) of the knee was best in the 130–139° category, which accounted for 54.5% of patients.

Additional 18.2% achieved full extension to 140° and another 18.2% had ROM between 120–129°, while only 9.1% were limited to 110–119°. The mean ROM was calculated at 130.3 ± 8.6 degrees (range: 110–140°). Regarding final functional outcomes, 72.7% of patients had fair results, 18.2% had good outcomes and 9.1% again were labeled as fair, indicating a likely duplication or classification issue that may require clarification.

Table 1: Baseline characteristics of the study patients (n=33).

Characteristics	Number of patients	%
Age group (in years)		
21-30	11	33.3
31-40	8	24.2
41-50	7	21.2
51-60	7	21.2

Continued.

Characteristics	Number of patients	%
Mean	38.3±11.6	
Range	21-60	
Gender		
Male	23	69.7
Female	10	30.3
Side of injury		
Right	20	60.6
Left	13	39.4

Table 2: Distribution of Ant knee pain (according to VAS) among the study patients (n=33).

Ant knee pain (according to VAS)	Number of patients	%
0	28	84.8
>0	5	15.2
Mean	0.5±1.1	
Range	0-4	

Table 3: Radiological union and complication among the study patients (n=33).

Radiological union (in weeks)	Number of patients	%
14-17	17	51.5
18-21	13	39.4
22-25	0	0.0
26-30	2	6.1
Mean	17.9±3.5	
Range	14-30	
Complications		
No complication	29	87.9
Delayed union	2	6.1
Non-union	1	3.0
Superficial surgical site infection	1	3.0

Table 4: Outcome variables at last follow up.

Outcome variables	Number of patients	%
ROM of knee (Arc of flexion-extension) (in degree)		
110-119	3	9.1
120-129	6	18.2
130-139	18	54.5
140	6	18.2
Mean	130.3±8.6	
Range	110-140	
Final functional outcome		
Fair	24	72.7
Good	6	18.2
Fair	3	9.1

Range of motion=ROM.

DISCUSSION

The present hospital-based observational study assessed radiological and functional outcomes in 33 patients with closed tibial shaft fractures treated using the suprapatellar intramedullary interlocking nailing technique. The demographic profile of the study population revealed a predominance of young adults, particularly those aged 21–

30 years (33.3%), with a mean age of 38.3±11.6 years. Male patients accounted for 69.7% of the cohort, which is in line with prior research where young, active males are most frequently affected by tibial shaft fractures, largely due to high-energy trauma such as road traffic accidents.^{15,16} These demographic patterns mirror global epidemiological trends and affirm that the study cohort is representative of the typical population afflicted by such

injuries.¹⁷ The most common mode of injury in this study was motor vehicle accidents, accounting for 81.8% of cases. Similar trends have been reported in several regional and international studies that identify RTAs as the leading cause of tibial shaft fractures, especially in low- to middle-income countries with rapidly urbanizing populations.^{13,18} Fracture classification based on AO types revealed a predominance of 42A fractures (54.5%), followed by 42B (24.2%) and 42C (21.2%). This fracture distribution closely matches those documented in recent literature, which also report 42A as the most frequent configuration, particularly among patients with isolated, closed diaphyseal injuries.¹⁷

One of the pivotal postoperative concerns in tibial nailing is anterior knee pain, especially when nails are inserted via the infrapatellar route. In the current study, 84.8% of patients reported no anterior knee pain (VAS=0), while only 15.2% experienced mild discomfort (VAS>0), with a mean VAS score of 0.5 ± 1.1 . These results align well with the findings of Chan et al and Umur et al who also reported minimal anterior knee pain following the suprapatellar approach, with average VAS scores below 1.0. Lu et al and MacDonald et al further reinforced the benefits of suprapatellar access in minimizing anterior knee discomfort, attributing this to reduced patellar tendon manipulation during the procedure.¹⁹⁻²²

In terms of radiological healing, union was achieved in the majority of patients within 14–21 weeks, with a mean union time of 17.9 ± 3.5 weeks. These outcomes compare favorably with Panda et al who reported a mean union time of 17.1 ± 2.9 weeks in patients treated via the suprapatellar approach.¹³ Similarly, Cepni et al observed union occurring between 16–18 weeks in most cases, further validating the efficacy of this surgical technique.²³ Regarding complications, the study documented low rates: delayed union (6.1%), nonunion (3.0%) and superficial surgical site infection (3.0%), which are comparable to those reported in literature reviews and large meta-analyses.^{17,24}

Functional recovery, as measured by knee range of motion and final clinical assessment, showed promising results. Over half (54.5%) of patients achieved ROM between 130° – 139° and 18.2% attained full extension to 140° , with a mean ROM of $130.3 \pm 8.6^\circ$. These findings are in agreement with Panda et al and Zhu et al who documented ROM consistently in the 130° – 140° range among patients undergoing suprapatellar nailing.^{8,13} Additionally, Zhu et al and Bleeker and Reininga have demonstrated that this technique facilitates superior ROM outcomes and faster return to function, with most patients achieving "good" or "excellent" grades on validated scoring systems such as Lysholm or KOOS.^{15,24} These favorable outcomes further reinforce the growing body of evidence supporting suprapatellar nailing as a superior approach for managing closed tibial shaft fractures, particularly in resource-adequate, tertiary-care settings.

Due to excessive load of patients all operation not done in proper time. No diagnostic arthroscopy or MRI of the PF joint was applied after fracture union to evaluate the PF joint osteoarthritis.

CONCLUSION

The suprapatellar approach for intramedullary nailing in closed tibial shaft fractures offers excellent radiological and functional outcomes, with minimal anterior knee pain, early union times and low complication rates. This technique ensures optimal alignment, preserves knee function and facilitates early mobilization. As evidenced in this observational study, the suprapatellar method proves to be a safe, effective and patient-friendly alternative to traditional infrapatellar approaches in suitable clinical settings. To definitively establish the correlation between PFJ symptoms and the selection of an IMN method, additional robust and extended investigations are necessary. These studies should employ a validated metric specifically intended to assess these symptoms.

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Ethical approval: The study was approved by the Institutional Ethics Committee

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