

Original Research Article

Outcome of closed tibial diaphyseal fracture managed by intramedullary interlocking nail through suprapatellar approach

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ABSTRACT

Background: Tibial fractures are among the most common long-bone injuries, and their subcutaneous location makes management challenging. Intramedullary fixation is the preferred treatment for diaphyseal tibial fractures, though the optimal approach remains debated. The suprapatellar approach is increasingly favored by surgeons.

Methods: A prospective observational study was conducted at the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka, from September 2021 to March. Thirty-three patients with closed diaphyseal tibial fractures meeting the selection criteria were treated with intramedullary interlocking nails using a suprapatellar approach and followed up for 12 months.

Results: The mean age was 38.3 ± 11.6 years, with 70% male patients. The mean duration from injury to surgery was 13.4 ± 3.3 days. Anterior knee pain occurred in only 5 patients (15.2%). The mean VAS score was 0.5 ± 1.1 (range 0–4). Union time averaged 17.9 ± 3.5 weeks; delayed union occurred in 2 cases (6.1%) and nonunion in 1 case (3%). The mean arc of knee motion was 130.3 ± 8.6 degrees. Functional outcome assessed via Lysholm knee score averaged 93.8 ± 8.9 . Outcomes were excellent in 72.7%, good in 18.2%, and fair in 9.1% of patients.

Conclusions: Intramedullary nailing using the suprapatellar approach for tibial diaphyseal fractures demonstrates favorable outcomes, including high Lysholm scores, low complication rates, reliable union, improved knee motion, and reduced anterior knee pain.

Keywords: Tibial fracture, Suprapatellar approach, Intramedullary nailing, Functional outcome, Lysholm knee score

INTRODUCTION

Tibial fractures are one of the commonest long-bone injuries with challenging management due to their subcutaneous placement.¹ An intramedullary fixation device is the preferred treatment for diaphyseal tibial fractures. This enables the use of a minimally invasive procedure, with a high possibility for closed reduction and

early mobilisation.² But the approach of intramedullary nailing is still controversial.

Tibial shaft fractures have an incidence of 16.9/100,000 population per year. The risk is somewhat higher in males than in females. The most common type of tibial shaft fracture is AO type 42-A1, representing 34% of all tibial shaft fractures. Motor vehicle accident is the major cause.

Transverse fracture usually occurs in young adults following high-velocity trauma.³

Tibial shaft fractures typically manifest in young and physically active individuals, frequently resulting from high-impact incidents such as motor vehicle collisions, sports-related incidents, or falls from significant heights. Direct trauma, such as road traffic accidents, frequently leads to simultaneous and severe injury to soft tissues, sometimes resulting in open fractures with a high occurrence rate.⁴ Due to the absence of sufficient soft tissue coverage and the challenging blood supply, fractures of the tibial shaft are prone to infection and non-union. Tibial shaft fractures are very consequential injuries that can lead to permanent disability.⁵

There are various treatment methods available, ranging from non-surgical to surgical treatment, which may also include additional strategies. Long-term cast application is highly uncomfortable for the patient.⁵ Surgical intervention is the most well-established choice. Surgeons have a wide array of implant options available to them, including external fixation and intramedullary nailing. Although numerous studies have been published on this subject, the preferred approach remains a source of debate.⁶ Several different implants are available to the orthopedic surgeon. Intramedullary nailing provides significant biomechanical stability, and unreamed intramedullary nails can be used even in higher degrees of soft tissue injury up to Gustilo grade IIIb, if wound closure or flap plastic can be performed within 48 h after stabilization. The use of external fixation has declined, although it is a biological osteosynthetic easy to apply.⁵ However, there is a growing inclination towards utilizing intramedullary nailing.⁶

The primary benefits of intramedullary nailing are biomechanical stability and the possibility to use a minimally invasive method while maintaining a distance from the fracture. The available evidence strongly supports the use of intramedullary nailing as the preferred implant for diaphyseal tibial fractures.⁷ There is compelling evidence that intramedullary nails provide an advantage over external fixation even in open fractures when wound closure is promptly accomplished.²

More recently, the focus of orthopedic trauma surgeons has been comparing the different techniques of insertion for tibial nails, specifically suprapatellar versus infrapatellar.⁸ The preferred therapy for extra-articular tibial fractures, regardless of their location (epiphysis, metaphysis, or diaphysis), is the use of intramedullary nails for fixation and osteosynthesis.⁹ These nails are placed through an infrapatellar portal while the knee is in maximal flexion.¹⁰ This strategy has two issues. Firstly, achieving the maximum bending of the knee is necessary for the fixation of proximal fractures. This fixation is influenced by the patellar tendon, which exhibits an antecurvatum deformity. Secondly, soft tissue injuries

arising from these fractures sometimes impair the location where the nail is inserted.⁶

To tackle these problems, an alternative suprapatellar (SP) approach has been created. This approach aims to assist in reducing the problem, ease precise insertion, and minimize exposure to fluoroscopy. It is conducted in the semi-extended position.¹ While this method may decrease anterior knee pain, there are concerns about the possibility of an elevated risk of harm to the patellofemoral joint (PFJ).¹¹ The question of whether this leads to long-lasting anterior. Knee discomfort and eventual patellofemoral joint arthrosis are still topics of debate.¹⁰

Considering the above-mentioned fact, the present study was undertaken to evaluate the outcome of closed tibial diaphyseal fractures managed by intramedullary interlocking nail through a suprapatellar approach.

Objective

The objective of this study was to see the outcome of closed tibial diaphyseal fractures managed by intramedullary interlocking nail through the suprapatellar approach.

METHODS

This prospective observational study was conducted at the National Institute of Traumatology and Orthopedic Rehabilitation (NITOR), Dhaka, Bangladesh, from September 2021 to March 2024. A total of 33 patients with closed diaphyseal tibial fractures were included in the final analysis. The initial sample consisted of 36 cases; however, 2 patients were lost to follow-up, and 1 patient died due to myocardial infarction, leaving 33 cases available for outcome evaluation. The study population comprised adult patients meeting the predefined selection criteria.

Sample selection

Inclusion criteria

Patients with closed diaphyseal tibial fractures, age ≥ 18 years, and injury duration within 21 days were included.

Exclusion criteria

Patients with multiple fractures or polytrauma, unstable medical illness significantly increases the risk, and pathological fractures were excluded.

Data collection and study procedure

Detailed history regarding injury mechanism and duration was recorded. Initial management followed ATLS protocol. Standard radiographs of the affected leg were obtained in AP and lateral views. Preoperative evaluation included necessary investigations and pre-anaesthetic

check-up. Informed consent was taken. All patients received preoperative cefuroxime. Suprapatellar intramedullary nailing was performed under sterile conditions. Postoperatively, isometric quadriceps exercises began within 24 hours. Crutch-assisted ambulation without weight-bearing was initiated as tolerated. Patients were discharged on postoperative day 3 or 4 with instructions on limb mobilization and follow-up. Scheduled follow-ups occurred at 2 weeks, 6 weeks, 3 months, 6 months, and 12 months. Functional outcome was assessed using the modified Lysholm knee scoring system, and radiological union was monitored with periodic X-rays.

Statistical analysis

Data were analyzed using Microsoft Office 365. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as mean±standard deviation and range. Comparisons of continuous variables were made using the t-test. A p value <0.05 was considered statistically significant at a 95% confidence interval.

RESULTS

The present study was carried out between September 2021 to March 2024 at NITOR, Dhaka. All the patients, after proper resuscitation and investigation, were treated by closed reduction and internal fixation by interlocking intramedullary nail through a suprapatellar approach and follow-up. After 12 months of follow-up for each patient, the following findings were compiled. All the relevant findings obtained from data analysis are presented in tables and figures.

Table 1 shows that among the patients, 33.3% (n=11) were from the 21-30 years age group. The mean age of the patients was 38.3±11.6 years, where the minimum age was 21 years and the maximum age was 60 years.

Table 1: Distribution of patients by age (n=33).

Age group (in years)	Number of patients	Percentage (%)
21-30	11	33.33
31-40	8	24.24
41-50	7	21.21
51-60	7	21.21
Total	33	100.00
Mean	38.3±11.6	
Range	21-60	

Out of 33 cases, 23 (69.7%) patients were male, and 10 (30.3%) patients were female. The male: female ratio is 2.3: 1 (Figure 1).

Table 3 shows that 54.5% (n=18) of patients had AO type 42A fracture, 8 (24.2%) 42B type and the remaining 7 (21.2%) had 42C type fracture.

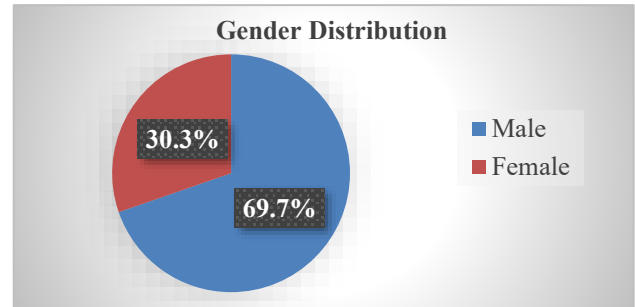


Figure 1: Gender distribution of the patients (n=33).

Table 2: Distribution of patients by duration following injury to operation (n=33).

Duration following injury to operation (in days)	Number of patients	Percentage (%)
8-13	19	57.6
14-20	14	42.4
Total	33	100.0
Mean	13.4±3.3	
Range	8-20	

Table 3: Distribution of patients by type of fracture (n=33).

Type of fracture (AO)	Number of patients	Percentage (%)
42A	18	54.5
42B	8	24.2
42C	7	21.2
Total	33	100.0

At the last follow-up, 28 (84.8%) patients had no anterior knee pain. Only 5 (15.2%) patients had anterior knee pain. The mean VAS score was 0.5±1.1, ranging from 0 to 4 (Table 4).

Table 4: Anterior knee pain (according to VAS) (n=33).

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

Table 5 shows the duration of radiological union. Most of the fractures (54.5%, n=18) were united within 14 to 17 weeks. The mean duration of radiological union was 17.9±3.5 weeks.

Twenty-nine (87.9%) patients did not suffer from any complications. Two (6.1%) had delayed union, 1 (3%) had superficial surgical site infection, and 1 (3%) was diagnosed as non-union (Table 6).

Table 5: Duration of radiological union in weeks (n=33).

Radiological union (in weeks)	Number of patients	Percentage (%)
14-17	18	54.5
18-21	13	39.4
22-25	0	0.0
26-30	2	6.1
Total	33	100.0
Mean	17.9±3.5	
Range	14-30	

Table 6: Rate of complications (n=33).

Complications	Number of patients	Percentage (%)
No complication	29	87.9
Delayed union	2	6.1
Nonunion	1	3.0
Superficial surgical site infection	1	3.0

Table 7 shows the arc of motion at the knee joint. The mean arc of motion was 130.3±8.6 degrees, ranging from 110 to 140 degrees.

Table 7: ROM of knee at last follow-up (arc of flexion-extension) (n=33).

ROM of knee (arc of flexion-extension) (in degree)	Number of patients	Percentage (%)
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	

*ROM=Range of motion

After 6th months' follow-up, the mean Lysholm knee score was 83.1±10.8. It has increased significantly to 93.8±8.9 at the 12th month's follow-up ($p<0.05$) (Table 8).

Table 8: Lysholm knee score at different follow-up (n=33).

Lysholm score	Mean±SD	P value
6 months	83.1±10.8	0.000
12 months	93.8±8.9	

The final functional outcome according to the Lysholm knee score of the study gave excellent results in 72.7% (n=24), 18.2% (n=6) showed good, and 9.1% (n=3) showed fair results (Figure 2).

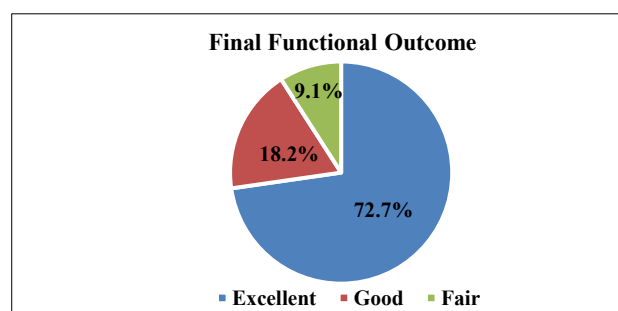


Figure 2: Final functional outcomes (n=33).

DISCUSSION

Closed tibial diaphyseal fractures can be effectively treated with intramedullary interlocking (IMIL) nails, which provide stable fixation and promote fracture healing. Using a suprapatellar approach for IMIL nail insertion in tibial fractures offers certain advantages. It offers precise nail insertion, facilitates improved C-arm positioning, thus reducing radiation exposure, improves reduction for more proximal fractures and reduces anterior knee pain, especially while kneeling. This prospective study was designed to evaluate the outcome of insertion of IMIL nail through the suprapatellar approach while treating closed tibial diaphyseal fractures. The following results from 33 fractures were evaluated.

Out of the patients, 33.3% (n=11) were between the age range of 21-30 years. A mean age of 38.3±11.6 years was observed among the patients, with a minimum age of 21 years and a maximum age of 60 years. The data suggests that most instances were associated with young and active adults aged 21-40, accounting for 57.7% of the total. Previous research undertaken by Badami et al, Perumal et al, and Acharya et al similarly demonstrated that the average age of the working population is approximately 35 years, suggesting a comparable demographic trend.¹²⁻¹⁴

Among the 33 instances, 23 (69.7%) were male patients and 10 (30.3%) were female patients. The ratio of males to females is 2.3:1. The male predominance in this series can be easily attributed to the continued prevalence of travel, bike riding, and sporting activities among the male population in our country. A study conducted in India by Perumal et al. revealed that 86.8% of the participants were male, while a study conducted in Nepal by Acharya et al indicated that 71% of the participants were male.^{13,14}

Approximately 57.6% (n=19) of the cases were completed during the second week. The average time from accident to surgery was 13.4±3.3 days, with a minimum duration of 8 days and a maximum duration of 20 days. In the study conducted by Badami et al, all cases were operated upon

within a 48-hour timeframe after the occurrence of the injury.¹² The current investigation has demonstrated a significant operational delay. The reason for this delay can be attributed to the high number of patents in the research location, NITOR, which has limited staff and operational resources compared to other studies.

Among the patients, 54.5% (n=18) exhibited an AO type 42A fracture, while 24.2% (8 patients) had a 42B type fracture. The remaining 21.2% (7 patients) had a 42C type fracture. Larsen et al conducted an epidemiological analysis which revealed that 64.3% of tibial diaphyseal fractures were classified as type 42A, 24.2% as type 42B, and the remaining 21.2% as type 42C.³ These findings are similar to the current investigation.

According to Packer et al, prior research has indicated that anterior knee pain continues to be the most prevalent consequence observed after the infrapatellar approach to IMIL nailing of the tibia.¹ The current investigation revealed that a mere 5 patients, accounting for 15.2% of the total, experienced anterior knee pain. The average VAS score was 0.5 ± 1.1 , with a range of 0 to 4. The study conducted by Serbest et al reported a mean visual analogue scale (VAS) score of 1 ± 1.3 for anterior knee discomfort following a 12-month follow-up period, which aligns with the findings of the current investigation.¹⁵ By avoiding the kneeling area, the suprapatellar incision can minimize irritation for individuals who need to kneel for recreational or vocational reasons. This decision holds significant importance, particularly for Muslims, as they are required to engage in prayer while in a kneeling position. Although the SP method minimizes harm to the patella tendon, there are apprehensions regarding potential damage to the patellofemoral joint (PFJ) during insertion. There is evidence of PFJ injury in SP, as well as greater rates of intraarticular damage linked with the use of the IP method, as demonstrated by cadaveric investigations.¹⁶ The presence of chondromalacia was indicated by post-operative MRI findings, as described in a study conducted by Chan et al.¹⁷ However, it should be noted that PFJ chondral damage does not always result in negative clinical results.¹

Most fractures (53.1%, n=17) were fully healed within a timeframe of 14 to 17 weeks. A mean length of 17.9 ± 3.5 weeks was observed for radiological union. The study conducted by Serbest et al reported a mean union time of 17.6 ± 2.8 weeks.¹⁵ The duration of the union in this study closely resembles that of the study.

Twenty-nine (87.9%) patients did not suffer from any complications. Two (6.1%) had delayed union, 1 (3%) had superficial surgical site infection, and 1 (3%) was diagnosed as nonunion. However, both instances of delayed union achieved union after secondary dynamization. The case with nonunion was managed by exchange nailing with autogenous cancellous bone grafting. This patient is currently under follow-up. The case with surgical site infection was managed by appropriate antibiotics according to culture and sensitivity report, regular dressing and wound care. In the study of

Islam et al, they found 6.7% cases of nonunion and 6.7% cases of delayed union, which is similar to the present study.¹⁸

The average arc of motion ranged from 110 to 140 degrees, with a mean value of 130.3 ± 8.6 degrees. Out of the 33 individuals, only 9 (27.3%) exhibited knee range of motion that was somewhat lower than the usual range. The study conducted by Serbest et al reported a mean knee range of motion (ROM) of 133.1 ± 8.7 degrees after a 12-month period, which aligns with the findings of the current study.¹⁵

Following a follow-up period of six months, the average Lysholm knee score was recorded as 83.1 ± 10.8 . The value has increased significantly to 93.8 ± 8.9 at the 12-month follow-up ($p < 0.05$). The prompt emphasizes the importance of early weight bearing and appropriate postoperative physiotherapy to facilitate a prompt restoration of normal function after tibial diaphyseal fractures. The study conducted by Sanders, et al. reported a mean Lysholm knee score of 82.14 after a one-year follow-up period, which is lower than the score seen in the current study.¹⁰ However, the research conducted by Serbest et al yielded a mean Lysholm score of 95.7 ± 4 , which is consistent with the findings of the current study.¹⁵

The study's final functional outcome, as determined by the Lysholm knee score, yielded excellent outcomes in 72.7% (n=24), good in 18.2% (n=6), and fair in 9.1% (n=3). Although not united, one case (3%) achieved a fair outcome based on the Lysholm knee score at the last follow-up. The reason for this is that the patient has already undergone exchange nailing and ACBG treatment and has been permitted to bear weight after a period of 6 weeks. No instances of poor outcome were observed in the current investigation. The study conducted by Serbest et al revealed that 85.7% of the results were excellent, while 14.2% were good.¹⁵ The findings align with the current investigation.

The primary concern associated with employing an SP approach is the possibility of causing harm to the PF joint surface. When the patellar and femoral trochlear surfaces are adequately shielded by a cannula (or a 5cc syringe, which has been used in the present study), it is possible to prevent iatrogenic injury caused by friction. However, it is important to note that there remains a potential for exposure to compressive pressure. Gelbke et al conducted a study on fresh frozen cadavers using standard infrapatellar and SP techniques.¹⁹ The study found no substantial danger to the structural integrity and vitality of the PF joint cartilage.

Limitations

This study had a few limitations. Due to a high patient load, some surgeries were delayed beyond the ideal time. Additionally, no post-union MRI or diagnostic arthroscopy was performed to evaluate patellofemoral joint osteoarthritis.

CONCLUSION

The findings of this study indicate that the use of intramedullary nailing for tibial diaphyseal fractures via the suprapatellar approach results in favorable clinical outcomes. These include higher Lysholm knee scores, a lower incidence of complications, successful fracture union, and improved knee range of motion. Additionally, the occurrence of anterior knee pain is notably reduced when the suprapatellar approach is employed for nail insertion.

Recommendations

Suprapatellar intramedullary nailing can be considered a safe and effective alternative to the infrapatellar approach for tibial fractures. Further large-scale and long-term studies are recommended, using validated tools to assess patellofemoral joint symptoms and better establish the relationship between surgical approach and joint outcomes.

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

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