

Case Series

OUTCOME OF SUPRAPATELLAR APPROACH FOR INTRAMEDULLARY INTERLOCKING NAILING IN TIBIAL SHAFT FRACTURES – A PROSPECTIVE CASE SERIES

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ABSTRACT

Background: Intramedullary interlocking nailing (IMIL) is the gold standard treatment for tibial shaft fractures. However, anterior knee pain remains a common complication of the traditional infrapatellar approach. The suprapatellar technique, performed in a semi-extended position, may improve fracture alignment and reduce postoperative knee pain. Prospective data evaluating early functional outcomes with this approach remain limited. The aim is to evaluate early functional outcomes following suprapatellar intramedullary interlocking nailing in patients with tibial shaft fractures.

Materials and Methods: This prospective case series included 25 consecutive patients with tibial shaft fractures who underwent suprapatellar IMIL nailing between October 2022 and November 2024 at a tertiary care center. Patients were assessed at 2, 4, and 12 weeks postoperatively. Outcomes included anterior knee pain measured using the Numerical Pain Rating Scale (NPRS), quadriceps strength assessed with a handheld dynamometer and expressed as percentage of the contralateral limb, functional outcome evaluated using the Tegner–Lysholm Knee Score, and quality of life measured by the Short Form-12 (SF-12). Data were analyzed using descriptive statistics.

Results: Mean anterior knee pain scores progressively decreased from 6.68 ± 1.21 at 2 weeks to 4.56 ± 1.33 at 4 weeks and 2.40 ± 1.19 at 12 weeks. Quadriceps strength recovery improved from 12.16% at 2 weeks to 32.69% at 4 weeks and 56.53% at 12 weeks. The mean Lysholm score at 12 weeks was 81.88 ± 8.85 , with 16% achieving excellent, 32% good, 48% fair, and 4% poor outcomes. The mean SF-12 score was 50.56 ± 3.40 .

Conclusion: Suprapatellar IMIL nailing demonstrated progressive pain reduction, significant improvement in quadriceps strength, and satisfactory early functional outcomes at 12 weeks follow-up, supporting its effectiveness in the management of tibial shaft fractures.

Keywords: Suprapatellar nail, Tibial shaft fracture, Anterior knee pain, Lysholm score, Case series.

INTRODUCTION

Tibial shaft fractures are among the most frequently encountered long bone fractures worldwide, accounting for a significant proportion of orthopaedic trauma admissions. The reported annual incidence is approximately 16.9 per 100,000 population, with a higher prevalence in young adult males due to high-

energy mechanisms such as road traffic accidents, sports injuries, and falls from height.^[1,2] Elderly patients commonly sustain these fractures following low-energy trauma associated with osteoporosis.^[3] Owing to the subcutaneous location of the tibia and limited soft tissue envelope, these fractures are often associated with complications such as malalignment, delayed union, and functional impairment^[7]. Early

stabilization and restoration of limb alignment are therefore crucial to optimize outcomes and facilitate early mobilization.^[4]

Intramedullary interlocking nailing (IMIL) has become the gold standard treatment for displaced tibial shaft fractures. The technique provides stable fixation, preserves fracture biology, allows early weight bearing, and demonstrates high union rates.^[3] Traditionally, tibial nailing is performed using the infrapatellar approach, either via a patellar tendon-splitting or paratendinous technique with the knee in flexion or hyperflexion.^[6] Although widely practiced, the infrapatellar approach has been consistently associated with postoperative anterior knee pain, with reported incidence rates ranging from 30% to 47%.^[5] The etiology of anterior knee pain is multifactorial and may include patellar tendon irritation, injury to the infrapatellar branch of the saphenous nerve, fat pad scarring, and increased patellofemoral contact pressures.^[13,14]

In recent years, the suprapatellar approach has emerged as an alternative technique for tibial nailing.^[10] Performed in a semi-extended knee position, the nail is introduced through the quadriceps tendon and the patellofemoral joint using a protective sleeve system.^[11] The semi-extended position neutralizes the deforming forces of the quadriceps muscle and facilitates improved fracture alignment, particularly in proximal third fractures.^[6,9] Several comparative studies and meta-analyses have reported reduced anterior knee pain, decreased malalignment, and improved early functional outcomes with the suprapatellar technique compared to the infrapatellar approach.^[17-19]

Despite increasing adoption of the suprapatellar approach, concerns remain regarding potential intra-articular cartilage injury and long-term functional outcomes.^[20] Furthermore, prospective data evaluating early pain relief, quadriceps strength recovery, and functional outcomes in Indian patient populations remain limited.

The present study was therefore undertaken as a prospective case series to evaluate early functional outcomes following suprapatellar intramedullary interlocking nailing in tibial shaft fractures, with particular emphasis on anterior knee pain, quadriceps strength recovery, knee function, and quality of life at short-term follow-up.

Aim

To comprehensively evaluate the early clinical and functional outcomes of suprapatellar intramedullary interlocking nailing in the management of tibial shaft fractures, with particular emphasis on postoperative anterior knee pain, recovery of quadriceps muscle strength, functional knee performance, and overall quality of life during short-term follow-up.

Objectives

Primary Objective

- To assess anterior knee pain following suprapatellar intramedullary interlocking nailing using the Numerical Pain Rating Scale at 2 weeks, 4 weeks, and 12 weeks postoperatively.

Secondary Objectives

- To evaluate quadriceps muscle strength recovery using a handheld dynamometer and compare it with the contralateral limb at 2, 4, and 12 weeks postoperatively.
- To assess functional outcome using the Tegner–Lysholm Knee Scoring Scale at 12 weeks follow-up.
- To evaluate overall quality of life using the SF-12 questionnaire at 12 weeks postoperatively.

MATERIALS AND METHODS

Study Design

This study was designed as a prospective case series, derived from the originally approved non-randomized controlled trial dissertation protocol. For the purpose of this publication, only patients undergoing the suprapatellar approach were included and analyzed. The study aimed to evaluate early functional outcomes following suprapatellar intramedullary interlocking nailing (IMIL) in tibial shaft fractures.

Study Setting: The study was conducted in the Department of Orthopaedics, Pondicherry Institute of Medical Sciences (PIMS), Puducherry, a 740-bedded tertiary care teaching hospital catering to both rural and semi-urban populations of Puducherry and neighbouring districts of Tamil Nadu. The institution provides comprehensive trauma care facilities including emergency services, operative trauma management, and physiotherapy rehabilitation services.

Study Period: The study was conducted over a period of two years, from October 2022 to November 2024. Patients were prospectively recruited during this period and followed up for a minimum duration of 12 weeks postoperatively.

Study Population

Inclusion Criteria

Patients were included in the study if they met the following criteria:

- Age greater than 16 years
- Radiologically confirmed tibial shaft fracture
- Undergoing primary intramedullary interlocking nailing via the suprapatellar approach
- Glasgow Coma Scale (GCS) score of 15/15 during follow-up
- Willingness to participate and provide informed consent

Exclusion Criteria

Patients were excluded if they had:

- Established non-union
- Underwent revision tibial nailing
- Associated neurovascular compromise affecting functional assessment
- Incomplete follow-up

Sample Size and Sampling Technique: All consecutive eligible patients undergoing suprapatellar IMIL nailing during the study period

were included. A total of 25 patients satisfied the inclusion criteria and completed 12-week follow-up. A consecutive sampling technique was employed to minimize selection bias.

Ethical Considerations: The study was conducted after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants. Patient confidentiality was maintained throughout the study.

Surgical Procedure: All surgeries were performed under spinal or general anaesthesia using the suprapatellar approach in the semi-extended knee position.

A longitudinal incision was made proximal to the patella. The quadriceps tendon was split longitudinally, and a protective cannula system was inserted through the patellofemoral joint into the tibial entry point. The semi-extended position helped neutralize quadriceps deforming forces and facilitated fracture reduction, particularly in proximal third fractures.

Standard intramedullary interlocking nailing was performed under fluoroscopic guidance. Proximal and distal locking screws were inserted as per fracture configuration. Postoperatively, patients were started on static quadriceps exercises and knee range-of-motion exercises as tolerated.

Outcome Measures

Patients were evaluated at 2 weeks, 4 weeks, and 12 weeks postoperatively.

1. Anterior Knee Pain

Anterior knee pain was assessed using the Numerical Pain Rating Scale (NPRS).

The scale ranges from 0 to 10

- 0 = No pain
- 1–3 = Mild pain
- 4–6 = Moderate pain
- 7–10 = Severe pain

Patients were asked to rate their pain at each follow-up visit. The average pain score was recorded.

Pain assessment was performed at:

- 2 weeks
- 4 weeks
- 12 weeks

2. Quadriceps Strength Assessment

Quadriceps strength was measured using a handheld dynamometer (HHD) in the physiotherapy department.

Measurement Technique

- The patient was seated at the edge of the bed with knees flexed to 60 degrees.
- The handheld dynamometer was placed approximately 5 cm proximal to the medial malleolus.
- The patient was instructed to perform maximal knee extension against resistance for five seconds.
- Three readings were taken and the average value was recorded.
- Strength of the affected limb was compared to the contralateral normal limb.

- Results were expressed as a percentage of strength recovery.

Quadriceps strength was assessed at:

- 2 weeks
- 4 weeks
- 12 weeks

3. Functional Outcome

Functional outcome was evaluated at 12 weeks using the Tegner–Lysholm Knee Scoring Scale.

The scale includes eight parameters:

- Limp
- Support
- Pain
- Instability
- Locking
- Swelling
- Stair climbing
- Squatting

The total score ranges from 0 to 100 and is categorized as:

- <65 – Poor
- 65–83 – Fair
- 84–90 – Good
- 90 – Excellent

4. Quality of Life Assessment

Quality of life was assessed at 12 weeks using the Short Form-12 (SF-12) questionnaire.

The SF-12 consists of 12 questions assessing:

- Physical health component
- Mental health component

The questionnaire was administered verbally in a language understandable to the patient. Scores were calculated according to standard scoring guidelines.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using SPSS version 22.0.

Statistical Methods

- Continuous variables were expressed as mean \pm standard deviation (SD).
- Categorical variables were expressed as frequency and percentage.
- Pain scores and quadriceps strength recovery were analysed descriptively over time.
- A p-value < 0.05 was considered statistically significant where applicable.

RESULTS

Demographic Profile: A total of 25 patients with tibial shaft fractures who underwent suprapatellar intramedullary interlocking nailing were included in the final analysis. All patients completed the 12-week follow-up period.

The study population demonstrated a male predominance, reflecting the higher incidence of high-energy trauma in males. The age distribution showed that the majority of patients were young to middle-aged adults, consistent with the typical epidemiology of tibial shaft fractures.

No intraoperative complications related to the suprapatellar approach were observed. All patients

were compliant with postoperative rehabilitation and follow-up assessments.

1. Anterior Knee Pain: Anterior knee pain was assessed using the Numerical Pain Rating

Scale (0–10). A progressive reduction in pain was observed over successive follow-up visits.

Table 1: Mean Anterior Knee Pain Scores at Different Follow-up Periods (NPRS)

Follow-up Period	Mean ± SD
2 weeks	6.68 ± 1.21
4 weeks	4.56 ± 1.33
12 weeks	2.40 ± 1.19



Figure 1: Trend of Anterior Knee Pain

At 2 weeks postoperatively, patients reported moderate pain levels. By 4 weeks, there was a marked reduction in pain scores. At 12 weeks, the mean pain score had decreased to mild levels, demonstrating substantial clinical improvement.

The consistent decline in pain scores over time indicates effective early pain control and favourable short-term recovery following the suprapatellar approach.

2. Quadriceps Strength Recovery

Quadriceps strength was evaluated using a handheld dynamometer and expressed as a percentage of the contralateral normal limb.

Table 2: Quadriceps Strength Recovery at Different Follow-up Periods

Follow-up Period	Mean Percentage Recovery
2 weeks	12.16%
4 weeks	32.69%
12 weeks	56.53%

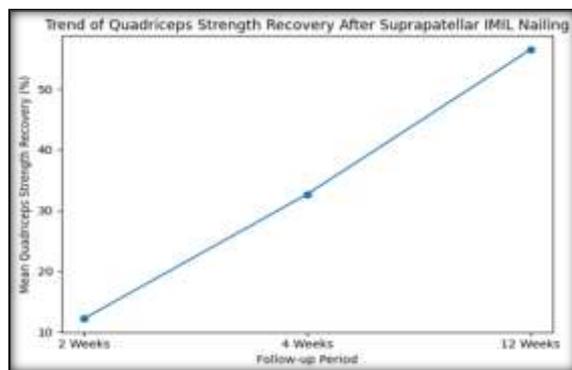


Figure 2: Trend of Quadriceps Strength Recovery

- Excellent (>90): 4 patients (16%)
- Good (84–90): 8 patients (32%)
- Fair (65–83): 12 patients (48%)
- Poor (<65): 1 patient (4%)

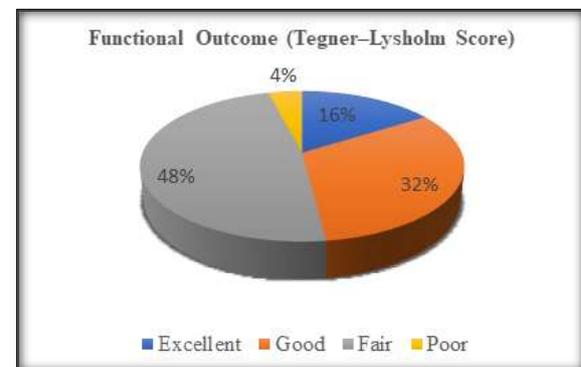


Figure 3: Distribution of Functional Outcomes

At 2 weeks, quadriceps strength recovery was limited, reflecting early postoperative muscle inhibition and pain-related weakness. However, by 4 weeks, strength improved significantly, reaching approximately one-third of the contralateral limb strength.

By 12 weeks, mean quadriceps recovery exceeded 50%, demonstrating steady and progressive improvement with rehabilitation.

This pattern suggests gradual restoration of extensor mechanism function following suprapatellar IMIL nailing.

3. Functional Outcome (Tegner–Lysholm Score)

Functional outcome at 12 weeks was assessed using the Tegner–Lysholm Knee Scoring Scale.

- Mean Lysholm score: 81.88 ± 8.85

Distribution of Functional Outcomes

The majority of patients (80%) achieved fair to good functional outcomes at 3 months postoperatively. A smaller proportion achieved excellent outcomes, while only one patient demonstrated poor functional recovery.

These findings indicate satisfactory early knee function following suprapatellar intramedullary nailing.

4. Quality of Life (SF-12 score)

Quality of life was evaluated at 12 weeks using the SF-12 questionnaire.

- Mean SF-12 score: 50.56 ± 3.40

The overall SF-12 scores indicate satisfactory physical and mental health status at short-term follow-up. Most patients reported improvement in daily activities, mobility, and overall well-being compared to the immediate postoperative period.

DISCUSSION

The present prospective case series evaluated early functional outcomes following suprapatellar intramedullary interlocking nailing in tibial shaft fractures. The results demonstrate progressive reduction in anterior knee pain, steady improvement in quadriceps strength, and satisfactory functional and quality-of-life outcomes at 12 weeks follow-up. Anterior knee pain remains one of the most commonly reported complications following tibial intramedullary nailing, particularly with the infrapatellar approach.^[5] In the present study, the mean pain score decreased from 6.68 at 2 weeks to 2.40 at 12 weeks, indicating substantial early pain reduction. This trend is consistent with previous literature suggesting that the suprapatellar approach may reduce extensor mechanism irritation and anterior knee discomfort.^[15,21] Avoidance of patellar tendon splitting and reduced manipulation of the infrapatellar nerve may contribute to lower postoperative pain levels.^[5,14]

Quadriceps strength recovery is an important determinant of functional outcome following tibial nailing. Persistent anterior knee pain has been shown to negatively affect quadriceps function in long-term studies ^[13,14]. In this study, quadriceps strength improved progressively from 12.16% recovery at 2 weeks to 56.53% at 12 weeks. Although early postoperative weakness is expected due to pain inhibition and surgical trauma, gradual recovery observed in our cohort suggests that the semi-extended suprapatellar technique does not adversely affect quadriceps function. Similar findings have been reported in randomized and comparative studies demonstrating no significant long-term quadriceps deficit with the suprapatellar approach.^[16,17]

Functional outcome assessment using the Tegner–Lysholm score revealed a mean score of 81.88, with 80% of patients achieving fair to good outcomes at 3 months. These findings align with previously published meta-analyses and systematic reviews indicating favourable early knee function following suprapatellar tibial nailing. Improved alignment control in the semi-extended position, particularly in proximal third fractures, may contribute to better functional recovery.^[6,9]

Quality-of-life assessment using the SF-12 questionnaire demonstrated satisfactory physical and mental health status at short-term follow-up. Early mobilization and stable fixation, as emphasized in prior trauma outcome studies, likely contributed to improved patient-reported outcomes.^[12]

The main strength of this study lies in its prospective design and uniform surgical technique. However,

limitations include the absence of a comparative infrapatellar group, relatively small sample size, and short-term follow-up duration. Previous literature reviews have emphasized the need for larger randomized trials to determine long-term safety and superiority of the suprapatellar approach.^[20]

Overall, the findings of this study support the suprapatellar approach as a safe and effective technique for tibial shaft fracture fixation with favourable early functional recovery.

CONCLUSION

This prospective case series demonstrates that suprapatellar intramedullary interlocking nailing for tibial shaft fractures provides favourable early functional outcomes. Patients showed progressive reduction in anterior knee pain, steady improvement in quadriceps strength, and satisfactory functional knee scores at 12 weeks follow-up. The majority achieved fair to good outcomes based on the Tegner–Lysholm scoring system, along with acceptable quality-of-life scores on the SF-12 assessment. The semi-extended suprapatellar technique appears to facilitate stable fixation while minimizing extensor mechanism irritation. Within the limitations of short-term follow-up, the suprapatellar approach can be considered a safe and effective method for managing tibial shaft fractures with encouraging early clinical recovery.

Limitations

The present study has certain limitations. The sample size was relatively small, and the absence of a comparative infrapatellar group limits direct evaluation of superiority. Additionally, follow-up was restricted to 12 weeks, preventing assessment of long-term anterior knee pain, cartilage effects, and functional outcomes. Radiological parameters such as malalignment and union time were not analysed in detail.

Future Directions

Future studies with larger sample sizes, longer follow-up durations, and randomized comparative designs are required to establish long-term safety and functional advantages of the suprapatellar approach. Incorporation of advanced imaging and objective functional performance measures would further strengthen future research in this domain.

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