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ORIGINAL RESEARCH

Functional and Radiological Outcomes of Suprapatellar Intramedullary Nailing in Proximal Third Tibial Fractures: A Prospective Observational Study

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ABSTRACT

Background: Tibial shaft fractures are one of the most common long bone injuries in adults, comprising approximately 37% of all such fractures. Extra-articular proximal tibial fractures represent 5–11% of these cases. Traditionally managed with casting and functional bracing, challenges such as patient discomfort and long-term joint stiffness have led to a shift towards intramedullary nailing (IMN). The suprapatellar approach for IMN offers potential benefits, including reduced anterior knee pain, improved fracture alignment, and enhanced functional outcomes compared to infrapatellar techniques. **Materials and Methods:** This prospective observational study was conducted at Pt. J.N.M. Medical College and Dr. B.R. Ambedkar Hospital, Raipur, from January 2023 to May 2024. A total of 25 patients with proximal third tibial fractures, aged 18–60 years, were included. Patients with compound fractures (Grade 3), intra-articular fractures, prior surgeries or trauma to the same limb, or pathological fractures were excluded. Suprapatellar IMN was performed using the expert tibia nail system. Functional outcomes were assessed using the Modified Lysholm score, anterior knee pain using the Visual Analog Scale (VAS), and radiological alignment through standard imaging. Follow-ups were conducted at 2 weeks, 6 weeks, 3 months, and 6 months. **Results:** The mean age of the participants was 37.6 years, with the highest incidence in the 31–40 age group (32%). Males constituted 76% of the cases. Road traffic accidents accounted for 88% of the injuries. Proximal third tibial fractures were the most common (72%), with segmental fractures comprising 28%. Functional outcomes showed 68% of patients achieving excellent results, 24% good, and 8% fair, with a mean Modified Lysholm score of 90.92. Radiological alignment was achieved in 92% of cases, with malalignment observed in 8%. Postoperative pain was minimal, with a mean VAS score of 0.32. Complications occurred in 16% of cases, including two infections (8%) and two cases of mal-reduction (8%). **Conclusion:** The suprapatellar approach for intramedullary nailing demonstrates excellent functional outcomes, minimal postoperative pain, and reliable fracture alignment in the treatment of proximal third tibial fractures. These findings suggest that this approach is a viable and effective option for managing such fractures. Further studies with larger sample sizes are warranted to validate these results and explore long-term outcomes.

Keywords: Proximal tibial fractures, suprapatellar approach, intramedullary nailing, functional outcomes, Modified Lysholm score, radiological alignment.

INTRODUCTION

Tibial shaft fractures are among the most prevalent adult long bone injuries, accounting for approximately 37% of such fractures (1). Of these, extra-articular proximal tibial fractures represent 5–11% (2). Historically, closed, stable, and isolated tibial fractures have been effectively managed using casting and functional bracing, leading to favorable outcomes. Sarmiento et al. reported a union rate within 16–18 weeks, a low non-union rate of 0.7%, and no post-treatment infections (3). Despite these positive outcomes, challenges associated with long-leg casting include patient discomfort and long-term reductions in joint range of motion (4).

The development of intramedullary nailing (IMN) with locking screws has provided an alternative treatment option for metaphyseal tibial fractures. However, infrapatellar nailing—the traditional

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technique—requires knee flexion or hyperflexion during nail insertion, employing either a patellar tendon-splitting or tendon-sparing approach. This method has been associated with technical difficulties, such as malalignment due to proximal fragment displacement caused by quadriceps muscle tension during knee flexion. Additionally, anterior knee pain is a commonly reported complication, with varying incidence rates in the literature (5,6).

To address these limitations, the suprapatellar approach for tibial IMN has gained traction. This technique offers several advantages, including better nail entry points for fracture reduction, reduced operative times, decreased radiation exposure, and potentially higher patient satisfaction during the early postoperative period (7). This study focuses on evaluating the functional outcomes of intramedullary interlock nailing using the suprapatellar approach for managing proximal third tibial fractures.

Images showing Intra operative images of the suprapatellar nailing (a) Position of the lower limb at 15 °–20 ° of flexion. (b) AP view in image intensifier showing entry point just medial to lateral tibial spine. (c) Lateral view in image intensifier showing entry point at the junction of articular surface and tibial slope. (d) Incision for suprapatellar nailing

MATERIALS AND METHODS

This prospective observational study was conducted in the Department of Orthopaedic Surgery at Pt J.N.M. Medical College and associated Dr. B.R. Ambedkar Hospital, Raipur, Chhattisgarh, between January 2023 and May 2024. A total of 27 patients meeting the inclusion criteria were initially enrolled; however, 2 patients were lost to follow-up, resulting in a final sample size of 25. The patients were assessed at 2 weeks, 6 weeks, 3 months, and 6 months postoperatively for functional and radiological outcomes.

Inclusion criteria included patients aged 18–60 years with proximal third tibial fractures, segmental tibial fractures involving the proximal third, and fractures less than 3 weeks old. **Exclusion criteria** encompassed compound fractures classified as Grade 3 according to the Gustilo-Anderson classification, intra-articular proximal tibial fractures, prior surgeries or trauma to the same limb, pathological fractures, and patients unfit for surgery or unwilling to participate.

Preoperative evaluation included demographic and clinical assessments, systemic and local examinations, and radiological imaging (anteroposterior and lateral views of the leg). Fractures were classified using the Gustilo-Anderson and AO classifications. Standard investigations, including hemograms, renal and liver function tests, coagulation profiles, and anesthetic assessments, were performed prior to surgery.

The surgical procedure involved suprapatellar intramedullary nailing using the expert tibia nail system. Postoperatively, patients began quadriceps strengthening and range-of-motion exercises on the

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first day, progressing to partial and then full weight-bearing as union was confirmed clinically and radiologically. Functional outcomes were evaluated using the Modified Lysholm score, anterior knee pain by VAS score, and radiological alignment via standardized imaging. Complications were meticulously recorded to assess the safety and efficacy of the technique.

RESULTS

Age Incidence

The study included patients aged between 18 and 60 years, with a mean age of 37.60 years. The highest incidence was observed in the age group of 31–40 years (32%), followed by 21–30 years and 51–60 years (24% each), while the lowest incidence was in the 18–20 age group (12%) (Table 1).

Sex Incidence

Males were predominantly affected, accounting for 76% of cases, compared to 24% in females (Table 2). This highlights the higher likelihood of tibial fractures in males, possibly due to their greater exposure to high-risk activities.

Occupation

Patients engaged in occupations requiring high mobility, such as drivers and laborers, had the highest incidence of fractures (20% each), followed by housewives (20%), farmers (16%), and students (12%) (Table 3). Shopkeepers had the lowest incidence (4%).

Mode of Injury

Road traffic accidents were the leading cause of proximal third tibial fractures, responsible for 88% of cases, followed by physical assault (8%) and falls on hard surfaces (4%) (Table 4).

Fracture Type

Proximal third tibial fractures accounted for 72% of cases, while segmental fractures involving the proximal third made up the remaining 28% (Table 5).

Gustilo-Anderson Classification

Most fractures were closed (60%), followed by Grade 2 (24%) and Grade 1 (16%) injuries, indicating that the majority of cases were minimally contaminated (Table 6).

Side Affected

Fractures were more common on the right side (64%) compared to the left side (36%) (Table 7).

Trauma-Surgery Interval

Most patients underwent surgery within 1–6 days of trauma (80%), while 12% underwent surgery between 7–14 days, and 8% between 14–21 days (Table 8).

Complications

The overall complication rate was 16%. Two patients (8%) experienced infections, and two patients (8%) had mal-reduction. No cases of septic arthritis or other complications were observed (Table 9).

Functional Outcome

At six months follow-up, 68% of patients achieved excellent outcomes, 24% had good outcomes, and 8% reported fair outcomes. No poor outcomes were observed, as evaluated by the Modified Lysholm score (Table 10).

Radiological Outcome

Good alignment was achieved in 92% of cases, with only 8% showing malalignment—one in the coronal plane and one in both planes. No malalignment in the sagittal plane was observed (Table 11).

VAS Score

Postoperative pain, as measured by the Visual Analog Scale (VAS), showed favorable results. At six months, 16% of patients had a VAS score of 1, 8% had a score of 2, and 76% had a score of 3 or more, with a mean VAS score of 0.32, indicating minimal pain (Table 12).

Table 1: Age Incidence

Age Group (Years)	Number of Cases	Percentage (%)
18–20	3	12%
21–30	6	24%
31–40	8	32%
41–50	2	8%
51–60	6	24%
Total	**25**	**100%**

Table 2: Sex Incidence

Sex	Number of Cases	Percentage (%)
Male	19	76%
Female	6	24%
Total	**25**	**100%**

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Table 3: Incidence of Occupation

Occupation	Number of Cases	Percentage (%)
Driver	5	20%
Labour	5	20%
Farmer	4	16%
Employee	2	8%
Student	3	12%
Housewife	5	20%
Shopkeeper	1	4%
Total	**25**	**100%**

Table 4: Mode of Injury

Mode of Injury	Number of Cases	Percentage (%)
Road Traffic Accident	22	88%
Fall on Hard Surface	1	4%
Physical Assault	2	8%
Total	**25**	**100%**

Table 5: Fracture Type

Fracture Type	Number of Cases	Percentage (%)
Proximal Third Tibia Fracture	18	72%
Segmental Tibia Including Proximal Third Fracture	7	28%
Total	**25**	**100%**

Table 6: Gustilo-Anderson Classification

Gustilo-Anderson Grade	Number of Cases	Percentage (%)
Closed	15	60%
Grade 1	4	16%
Grade 2	6	24%
Total	**25**	**100%**

Table 7: Side Affected

Side	Number of Cases	Percentage (%)
Left	9	36%
Right	16	64%
Total	**25**	**100%**

Table 8: Trauma-Surgery Interval

Interval (Days)	Number of Cases	Percentage (%)
1–6	20	80%
7–14	3	12%
14–21	2	8%
Total	**25**	**100%**

Table 9: Complications

Complications	Number of Cases	Percentage (%)
Infection	2	8%
Mal-reduction	2	8%
Septic Arthritis	0	0%
Other	0	0%
Total	**4**	**16%**

Table 10: Functional Outcome of Patients by Modified Lysholm Score

Outcome	Number of Cases	Percentage (%)
Excellent	17	68%
Good	6	24%
Fair	2	8%
Poor	0	0%

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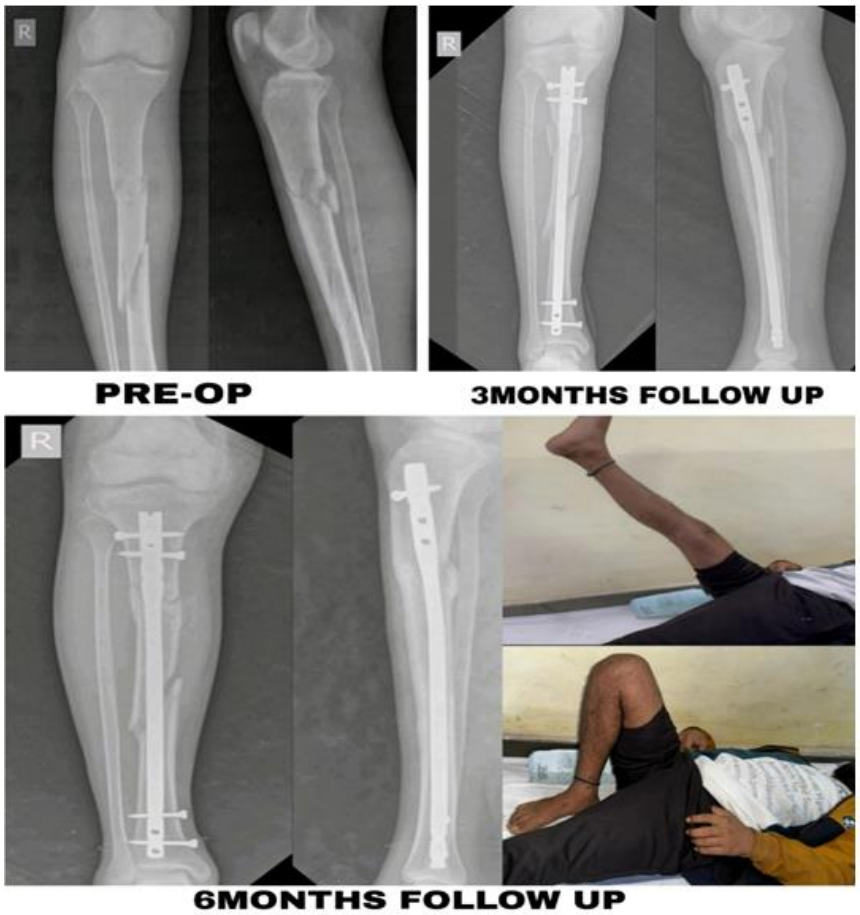
Total	**25**	**100%**

Table 11: Radiological Outcome

Radiological Outcome	Number of Cases	Percentage (%)
Aligned in Both Planes	23	92%
Mal-aligned in Coronal Plane Only	1	4%
Mal-aligned in Both Planes	1	4%
Mal-aligned in Sagittal Plane Only	0	0%
Total	**25**	**100%**

Table 12: VAS Score

VAS Score	Number of Cases	Percentage (%)
1	4	16%
2	2	8%
3 or More	19	76%
Total	**25**	**100%**



Images showing pre-operative radiograph, post-operative radiograph at 3months and 6months follow up and clinical images in full knee extension & flexion

DISCUSSION

This prospective observational study, conducted at Pt. Jawaharlal Nehru Memorial Medical College and Dr. Bhimrao Ambedkar Memorial Hospital, Raipur, evaluated the functional and radiological outcomes of the suprapatellar approach for intramedullary interlocking nailing in proximal third tibial fractures. A total of 25 patients were included after meeting strict inclusion criteria. The primary outcome was assessed using the Modified Lysholm score for functional evaluation, while secondary outcomes included anterior knee pain measured by VAS score and radiological alignment.

The age range of patients was 18–60 years, with a mean age of 37.6 years. The highest proportion of patients (32%) was in the 31–40 years age group, consistent with studies by Umur et al. (1) and Kulkarni et al. (2), which reported similar age distributions. However, our mean age was slightly lower than that reported by Jayaraju et al. (3), who

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found a mean age of 43 years, indicating variability in the age demographics across studies.

Males were significantly more affected, accounting for 76% of cases, reflecting a male-to-female ratio of 3.2:1. This aligns with studies by Daley-Lindo et al. (4) and Kulkarni et al. (2), which reported ratios of 2.3:1 and 7.6:1, respectively. The male dominance is likely due to greater involvement in high-risk activities such as driving and labor work.

Road traffic accidents (RTAs) were the predominant cause of injury, responsible for 88% of cases, consistent with findings by Kulkarni et al. (2), who reported an identical percentage. Other modes of injury, including falls (4%) and physical assaults (8%), were less common. Studies like Zhonglian Zhu et al. (5) have reported a broader distribution of trauma causes, emphasizing the regional and population-based variability in injury mechanisms.

Upper third tibial fractures were the most common fracture type, accounting for 72% of cases, while segmental fractures involving the proximal third constituted 28%. This distribution aligns with observations by Beigang et al. (6) but contrasts with studies that included more complex fracture patterns, such as Daniel S. Chan et al. (7), who incorporated Grade 3 fractures, potentially affecting their results.

Radiological outcomes in our study demonstrated a high success rate, with 92% of cases achieving proper alignment. Malalignment was observed in 8% of patients, which included one case each of procurvatum deformity and combined procurvatum and varus deformities. These findings are similar to those reported by Kulkarni et al. (2), who documented malalignment in 9.3% of cases, but significantly lower than the 22.5% malalignment rate observed by Bhaskar et al. (8). The high alignment success in our study underscores the precision achievable with the suprapatellar approach.

Functional outcomes were favorable, with a mean Modified Lysholm score of 90.92. Excellent outcomes were achieved in 68% of cases, good outcomes in 24%, and fair outcomes in 8%. These results are comparable to Al-Azzawi et al. (9), who reported a mean score of 90, but higher than Sanders et al. (10), whose study included compound fractures and reported a mean score of 82.14. The exclusion of Grade 3 fractures in our study likely contributed to these superior functional outcomes.

Postoperative pain was minimal, with a mean VAS score of 0.32, similar to findings by Daniel S. Chan et al. (7), who reported a mean score of 0.36. Our results align with studies suggesting that the suprapatellar approach reduces anterior knee pain compared to infrapatellar techniques (11). However, studies like Zhonglian Zhu et al. (5) have reported slightly higher pain scores, highlighting variability across patient populations and surgical techniques.

Complications in our study were minimal, with an overall rate of 16%. Two cases of infection (8%) and two cases of mal-reduction (8%) were observed. These findings are consistent with Sanders et al. (10), who reported an infection rate of 5%, and slightly higher than those reported by Daniel S. Chan et al. (7), who documented no infections. The low complication rate in our study underscores the safety of the suprapatellar approach when performed with meticulous surgical technique.

CONCLUSION

In conclusion, our findings support the use of the suprapatellar approach for intramedullary interlocking nailing in proximal third tibial fractures. This technique offers excellent functional outcomes, reliable radiological alignment, and minimal postoperative pain. Future studies with larger sample sizes and extended follow-up durations are recommended to further validate these findings and explore the long-term benefits of this surgical approach.

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