

Functional Outcome and Complications of Distal Third Extra-Articular Tibial Fractures Managed with Expert Tibial Nail System

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Abstract

Background: Distal third extra-articular tibial fractures are difficult to manage due to limited soft-tissue coverage and proximity to the ankle joint. The Expert Tibial Nail (ETN) system provides multiplanar distal locking and stable fixation with minimal soft-tissue disruption.

Methods: This quasi-experimental prospective study was conducted in the Department of Orthopaedic Surgery, Dhaka Medical College Hospital, from June 2024 to May 2025. Thirty patients aged 18–60 years with closed distal third extra-articular tibial fractures (AO types 43-A1, A2, A3) underwent closed reduction and internal fixation with the ETN system. Functional and radiological outcomes were assessed using the Olerud and Molander Ankle Score (OMAS) and Radiographic Union Scale for Tibial fractures (RUST).

Results: Radiological union occurred in 97% of cases, with a mean union time of 4.9 ± 1.45 months. The mean RUST score was 10.2 ± 1.61 , and the mean OMAS was 84.5 ± 16.5 , indicating good to excellent recovery in 97% of patients. Complications occurred in 30%, mainly superficial infection, anterior knee pain, malunion, and delayed union, and nonunion. Younger age was significantly associated with better functional outcomes ($p = 0.001$), while fracture type and gender were not significant.

Conclusion: Closed reduction and internal fixation using the Expert Tibial Nail system is a safe, effective, and biologically sound technique for distal third extra-articular tibial fractures, ensuring high union rates, minimal complications, and excellent functional results, particularly in younger patients.

Keywords: Distal tibial fracture; Extra-articular fracture; Expert Tibial Nail; Intramedullary nailing; Functional outcome; Radiological union; Complications

1. INTRODUCTION

The tibia, one of the principal weight-bearing bones of the lower limb, plays a crucial role in locomotion and stability. Because of its subcutaneous anteromedial surface and limited soft-tissue envelope, it is especially vulnerable to

traumatic injuries (Filardi, 2018; Chowdhury et al., 2021).

Distal tibial fractures represent a distinct subset of tibial injuries, often involving the metaphyseal region within 4 cm of the tibial plafond as described by Müller (Ravishankar et al., 2018).

These fractures may be non-articular or extend minimally into the plafond without displacement.

Epidemiological studies show that distal tibial fractures account for 1 % of all lower extremity fractures and approximately 3–10 % of all tibial fractures, with an incidence ranging between 3–28 cases per 10,000 population annually. They are more frequent in males aged 30–50 years and are often associated with concomitant fibular fractures in up to 85 % of cases (Kujur et al., 2023; Khalil et al., 2022; Sitnik et al., 2017).

The mechanism of injury may vary from low-energy torsional forces in elderly individuals to high-energy axial or rotational trauma in younger populations, typically resulting from road-traffic accidents, falls from height, or sports-related impacts (Kumar & Sahu, 2020; Bisaccia et al., 2018). High-energy injuries are commonly open fractures accompanied by soft-tissue compromise, thereby increasing the risk of infection, malunion, non-union, and delayed recovery (Rushdi et al., 2020).

Anatomically, the distal tibia poses unique challenges for fracture management. The limited soft-tissue coverage, subcutaneous bone surface, and proximity to the ankle joint make surgical exposure difficult and raise the risk of postoperative complications (Liu et al., 2024; Hadhoud et al., 2022; Bhupesh et al., 2020). The choice of treatment is therefore influenced by several factors, including the pattern of fracture, soft-tissue condition, available resources, and surgeon expertise (Filardi, 2018; Ravishankar et al., 2018).

Various treatment modalities—ranging from conservative casting to operative fixation with plates, external fixators, or intramedullary nails—have been described, each with distinct advantages and drawbacks (Abhinandan & Naganur, 2019; Mioc et al., 2018). While open reduction and internal fixation (ORIF) using plates provides anatomical reduction, it may compromise periosteal blood supply and increase the risk of soft-tissue complications. Minimally invasive percutaneous plate osteosynthesis (MIPPO) reduces tissue trauma but may still cause hardware prominence and skin necrosis, especially in patients with poor soft-tissue envelopes (Kuhn et al., 2014; Badami et al., 2017).

Intramedullary nailing (IMN) has gained popularity as a biological fixation method that preserves fracture hematoma and minimizes periosteal stripping. However, standard IMN

systems can encounter technical difficulties in distal fractures due to the metaphyseal flare and wide medullary canal, resulting in malalignment or instability. The use of Poller (blocking) screws can improve stability but introduces risks such as bone splitting and screw breakage (Liu et al., 2024).

To overcome these limitations, the Expert Tibial Nail (ETN) System, introduced in 2005, incorporates multiple multiplanar and angular-stable locking options that enhance fixation in distal fragments and allow for better control of axial alignment (Tijoriwala et al., 2019; Elsherbiny et al., 2021; Kachchap et al., 2017). Its design facilitates stable fixation even in short distal segments and helps preserve vascular integrity by minimizing surgical trauma.

Despite these advancements, the ideal fixation method for distal third extra-articular tibial fractures remain a subject of debate (Raj et al., 2019). Current literature lacks sufficient evidence comparing the functional outcomes and complication profiles of patients treated with the Expert Tibial Nail System.

Therefore, the present study aims to evaluate the functional outcomes and complications associated with distal third extra-articular tibial fractures managed using the Expert Tibial Nail System, thereby contributing to evidence-based refinement of treatment strategies for these challenging injuries.

2. OBJECTIVES

The main objective was to evaluate the functional outcomes and complications of distal third extra-articular tibial fractures managed with the Expert Tibial Nail System.

3. METHODOLOGY & MATERIALS

This quasi-experimental study was conducted in the Department of Orthopaedic Surgery at Dhaka Medical College and Hospital (DMCH), Dhaka, Bangladesh, over 12 months from June 2024 to May 2025. A total of 31 patients with distal third extra-articular tibial fractures were initially enrolled using purposive (non-randomized) sampling based on availability and fulfillment of the inclusion criteria. One patient was lost to follow-up, leaving thirty cases for final analysis. Patients aged between 18 and 60 years with closed distal third extra-articular tibial fractures (AO type 43-A1, A2, A3) presenting within 14 days of injury were included in the study, while those with open or pathological fractures, unstable medical illness, or additional fractures in

the ipsilateral limb other than the fibula were excluded.

All patients underwent closed reduction and internal fixation using the Expert Tibial Nail (ETN) System under either spinal or general anesthesia, depending on individual clinical suitability. The surgery was performed in the supine position on a radiolucent table under C-arm guidance, following strict aseptic precautions. Postoperatively, passive knee and ankle mobilization were encouraged after 48 hours as tolerated, gradually progressing to active-assisted exercises.

Patients were discharged on the third or fourth postoperative day with a two-week course of antibiotics and advised to attend regular follow-ups at the 2nd and 6th weeks and at the 3rd, 6th, and 9th months. During each follow-up, clinical

and radiological evaluations were performed to assess fracture union and functional recovery.

Data were collected using a structured questionnaire that included demographic details, fracture characteristics, operative findings, and postoperative outcomes. Radiological union was assessed using the Radiographic Union Scale for Tibial Fractures (RUST) score, and functional outcomes were evaluated using the Olerud and Molander Ankle Score (OMAS). Data were analyzed with SPSS version 26, where categorical variables were expressed as percentages, continuous variables as mean \pm standard deviation, and $p < 0.05$ was considered statistically significant. Ethical approval was obtained from the Institutional Review Board (IRB) of DMCH, and informed written consent was obtained from each participant, ensuring confidentiality throughout the study.

4. RESULT

Table 1. Baseline Characteristics of the Study Population (N = 30)

Variable	Category	Frequency	Percentage (%)
Age (years)	21–30	8	26.7
	31–40	5	16.7
	41–50	7	23.3
	51–60	10	33.3
Mean \pm SD (years)	42.73 \pm 12.25		
Range (years)	21–60		
Gender	Male	21	70
	Female	9	30
Side of injury	Right	12	40
	Left	18	60

Table 1 shows the baseline characteristics of the study population. The mean age was 42.7 years (range 21–60), with a male predominance (70%). Left-sided fractures were slightly more frequent (60%).

Table 2. Clinical and Operative Characteristics of the Study Population (N = 30)

Variable	Category	Frequency	Percentage (%)
AO fracture type	43A1	17	57
	43A2	10	33
	43A3	3	10
Cause of injury	Road traffic accident	23	76
	Accidental fall	5	17
	Fall from height	2	7
Injury–operation interval (days)	6–8	12	40
	9–11	13	43
	12–14	5	17
Mean \pm SD (days)	9 \pm 2.38		
Hospital stay (days)	9–12	15	50
	13–16	12	40
	17–20	3	10
Mean \pm SD (days)	12.6 \pm 2.84		

Table 2 shows the clinical and operative Characteristics of the study population. Most fractures were type 43A1 (57%) caused by road

traffic accidents (76%). Mean injury-to-operation time was 9 days, and average hospital stay was 12.6 days.

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Table 3. Radiological and Functional Outcomes (N = 30)

Parameter	Category	Frequency	Percentage (%)	Mean ± SD
Radiological union	Union	29	97	4.9 ± 1.45 months
	Nonunion	1	3	
RUST score	10–12	21	70	10.2 ± 1.61
	7–9	8	27	
	4–6	1	3	
Olerud & Molander score	91–100 (Excellent)	7	23	84.5 ± 16.52
	61–90 (Good)	22	74	
	0–30 (Poor)	1	3	

Table 3 shows the radiological and functional outcomes. Radiological union occurred in 97% with a mean of 4.9 months.

Most patients (70%) had RUST scores ≥ 10 , and 97% achieved good to excellent functional scores.

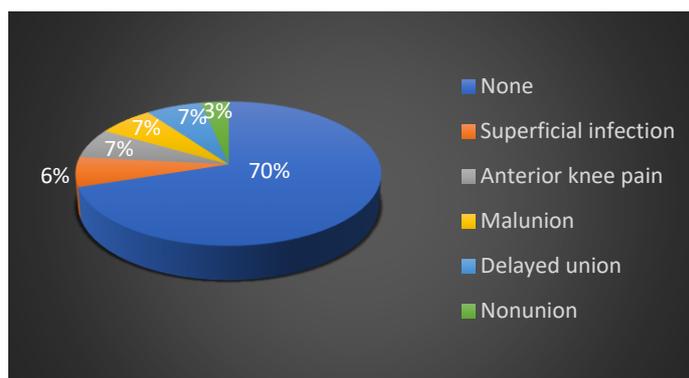


Figure 1. Postoperative Complications (N = 30)

Figure 1 shows the complications were observed in 30% of cases, primarily mild infections, anterior knee pain, and delayed nonunion.

Table 4. Association between Selected Variables and Functional Outcome (N = 30)

Variable	Category	Excellent	Good	Poor	p-value
Age (years)	21–30	7	1	0	0.001*
	31–40	0	5	0	
	41–50	0	7	0	
	51–60	0	9	1	
Fracture type	43A1	5	11	1	0.758*
	43A2	2	8	0	
	43A3	0	3	0	
Gender	Male	5	15	1	0.791*
	Female	2	7	0	
RUST score	10–12	7	14	0	0.007*
	7–9	0	8	0	
	4–6	0	0	1	

Table 4 shows the selected variables and functional outcome. Younger patients and those with higher RUST scores showed significantly better functional outcomes ($p < 0.05$). Fracture type and gender had no significant association.

5. DISCUSSION

This prospective study evaluated the functional outcome and complications of distal third extra-

articular tibial fractures treated with closed reduction and internal fixation using the Expert Tibial Nail (ETN) system at Dhaka Medical College Hospital between June 2024 and May 2025. A total of thirty patients were analyzed to determine union rate, functional recovery, and factors influencing outcomes. The mean age of the study population was 42.7 years, comparable to Attal et al. (2012), who reported a mean age of

44 years, and Bleeker et al. (2020), whose meta-analysis found a mean weighted age of 39 years. The predominance of patients in the fifth and sixth decades of life suggests that middle-aged adults, who are often active in daily and occupational activities, are at higher risk of such injuries. Male predominance (70%) observed in this study is consistent with other series by Arora et al. (2023) and Bleeker et al. (2020), both citing increased outdoor and vehicular exposure among males as a likely cause.

Left-sided injuries were more common (60%) in our cohort, whereas other authors such as Kachhap et al. (2017) and Khalil et al. (2022) reported near-equal or right-side predominance. These variations likely reflect differences in injury mechanisms and regional traffic patterns. The most common fracture pattern was AO 43A1 (57%), indicating a predominance of simple extra-articular fractures, aligning with findings by Raj et al. (2019) and differing from Mioc et al. (2018), who reported a higher frequency of comminuted (43A3) fractures. Road traffic accidents (RTA) were the leading cause of injury (76%), a finding corroborated by Badami et al. (2017) and Mohammed et al. (2008). High-energy trauma continues to dominate fracture etiology in developing countries, reflecting poor road safety measures and increased vehicular activity. The mean interval between injury and surgery in this series was 9 ± 2.38 days, similar to Attal et al. (2012), who reported 11 days. This interval may be attributed to patient optimization and soft-tissue recovery before definitive fixation, a standard approach in high-energy lower limb injuries. The mean hospital stay was 12.6 days, longer than the averages reported by Bisaccia et al. (2018) and Arora et al. (2023), likely due to public-sector workload, extended preoperative evaluation, and postoperative observation; however, all patients completed definitive management during the same hospital admission without requiring readmission.

Radiological union was achieved in 97% of cases, with a mean union time of 4.9 months, consistent with findings from Bleeker et al. (2020) and slightly faster than reported by Bisaccia et al. (2018) and Raj et al. (2019), who documented union times of 5–5.5 months. The low rate of nonunion (3%) and absence of deep infection reflect stable fixation and preservation of biological integrity with the ETN system. The mean RUST score of 10.2 further supports satisfactory radiological healing. Functionally,

the majority of patients reported no or minimal pain (97%) and minimal stiffness (7%) at final follow-up, similar to results by Arora et al. (2023), who demonstrated progressive improvement in joint mobility and pain reduction over 24 weeks. The mean Olerud and Molander Ankle Score (OMAS) of 84.5 ± 16.52 in this study indicates good to excellent recovery in 97% of patients, aligning closely with Li et al. (2012) and Mioc et al. (2018), though the present series showed slightly superior outcomes. Postoperative complications were in 30% of cases, primarily superficial infections, anterior knee pain, malunion, delayed union, and a single case of nonunion, each constituting 3–6.7% of patients. These rates are comparable or slightly lower than those reported by Raj et al. (2019) and Mohammed et al. (2008). The low incidence of complications may be attributed to adherence to meticulous aseptic techniques, early mobilization, and prompt management of wound-related issues.

Statistical analysis revealed a significant association between age and functional outcome ($p = 0.001$), with younger patients demonstrating better recovery, as supported by Elsherbiny et al. (2021) and Khalil et al. (2022). The RUST score was also significantly correlated with improved functional results ($p = 0.007$), confirming that adequate radiological healing is a key determinant of postoperative function. However, fracture type and gender showed no significant influence on outcome, suggesting that the ETN system provides consistent stability and recovery potential across different patterns and demographics. Overall, the Expert Tibial Nail system proved effective in achieving high union rates, maintaining alignment, and ensuring early functional restoration with minimal complications. The findings of this study reinforce the role of intramedullary nailing as a reliable method for managing distal third extra-articular tibial fractures, offering both mechanical stability and biological preservation.

6. LIMITATIONS OF THE STUDY

This study was limited by its small sample size, absence of a control group, and short follow-up period, which may not capture long-term outcomes or late complications. Limited research infrastructure and access to academic resources also restricted broader analysis. Future multicenter studies with longer follow-up are recommended to validate these findings and

compare the ETN system with alternative fixation methods.

7. CONCLUSION

Closed reduction and internal fixation with the Expert Tibial Nail system is an effective and reliable method for managing distal third extra-articular tibial fractures. It provides high union rates, minimal complications, and good to excellent functional outcomes, particularly among younger patients. The technique offers stable fixation and promotes early rehabilitation, supporting its continued use in distal tibial fracture management.

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