Outcomes of Distal Third Tibial Shaft Fractures Treated by Modified Interlocking Intramedullary Tibial Nail

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Abstract

Introduction:
Distal third tibial shaft fractures are challenging to manage due to poor soft tissue coverage and high risk of malalignment and delayed healing. Modified interlocking intramedullary nailing offers improved stability and early mobilization compared to conventional methods.

Objective:
This study aimed to evaluate the clinical, radiological, functional, and structural outcomes of distal third tibial shaft fractures treated with the modified interlocking intramedullary tibial nail.

Methods:
This prospective observational study was conducted in the Department of Orthopaedic Surgery at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh from July 2016 to June 2018. A total of 30 patients aged between 18 and 65 years of both sexes, presenting with distal third tibial shaft fractures (AO classification types 42A1–3 and 42B1–3) were included. Data was analyzed using the Statistical Package for Social Sciences (SPSS), version 22.

Results:
In this study of 30 patients with distal third tibial shaft fractures treated using a modified interlocking intramedullary tibial nail, the majority achieved radiological union within 16–18 weeks and full weight bearing by 14–16 weeks. Most patients experienced no pain, deformity, or significant motion loss, with 90% showing excellent-to-good functional recovery per the Karlstrum–Olerud score. Overall, the procedure provided stable fixation, rapid healing, and satisfactory functional and structural outcomes with minimal complications.

Conclusion:
Treatment of distal third tibial shaft fractures with the modified interlocking intramedullary tibial nail yields excellent clinical, radiological, functional, and structural outcomes with minimal complications.

Keywords: Tibial shaft, Fractures, Modified interlocking intramedullary tibial nail

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Introduction

Distal-third tibial shaft fractures occupy a biomechanically and clinically challenging zone where diaphyseal mechanics meet the metaphyseal taper toward the ankle. These injuries are common after high-energy trauma and are associated with a higher rate of soft-tissue compromise, mal-alignment, and wound problems compared with mid-shaft tibial fractures, which makes implant choice and technique critical to outcome.[1,2] Historically, both plate fixation (including minimally invasive percutaneous plate osteosynthesis—MIPPO) and intramedullary nailing (IMN) have been used; each method has distinct advantages and trade-offs. Plates permit precise reduction and avoidance of knee irritation but are associated with more wound and soft-tissue complications, whereas IMN preserves biology and allows earlier rehabilitation but has been linked to malunion and distal fixation problems in far-distal fractures.[3–5] Standard interlocking intramedullary

nails can be less secure when the distal fragment is short and the metaphyseal flare limits purchase for distal interlocking screws; this technical limitation can increase rotational instability and the risk of valgus/varus malalignment or nonunion in fractures within the distal fourth of the tibia.[1,2] To address these concerns, several strategies have been described: use of multiple biplanar distal locking screws, blocking (Poller) screws to control alignment, modified distal nail designs with more distal and multiplanar locking options, and angle-stable distal locking constructs that increase mechanical stability in the short distal fragment.[6,8] Biomechanical and clinical reports suggest angle-stable or modified distal locking configurations improve construct rigidity and reduce screw cut-out compared with conventional single-plane distal locking in osteopenic or metaphyseal bone.[6,9] High-quality comparative data have been produced in the past decade. Randomized and prospective studies comparing IMN with locking plate fixation for extra-articular distal tibial fractures report similar long-term functional outcomes, with differences largely appearing in early rehabilitation, wound complications, and secondary procedure rates.[1,3,10] Systematic reviews and meta-analyses of randomized trials and observational series have generally shown that intramedullary nailing is associated with fewer wound problems and faster early recovery, while plates may reduce malalignment in some series findings which underline the importance of careful patient and fracture selection rather than a one-size-fits-all approach.[4,8] Several clinical series and comparative studies report good union rates, acceptable alignment, and low infection rates when modified distal locking strategies (e.g., multiplanar distal screws, angle-stable designs, adjunctive Poller screws) are employed, although malalignment and the need for secondary procedures remain reported complications in select cohorts.[5,6,9]

Methods

This prospective observational study was conducted in the Department of Orthopaedic Surgery at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), Dhaka, Bangladesh from July 2016 to June 2018. A total of 30 patients aged between 18 and 65 years of both sexes, presenting with distal third tibial shaft fractures (AO classification types 42A1–3 and 42B1–3) were included. Only closed fractures with a fracture duration of 7–14 days were considered eligible. Patients with a history of previous surgery involving the tibial shaft, fractures with intra-articular extension, open fractures, active infections of the tibia or elsewhere in the body, or pathological fractures were excluded from the study. After appropriate resuscitation and necessary preoperative investigations, all patients underwent closed reduction and internal fixation using a modified interlocking intramedullary tibial nail. Postoperative follow-up was carried out for a minimum period of six months, during which clinical and radiological evaluations were performed to assess fracture union, alignment, and functional outcomes. Figure -1 showed the per operative and post-operative images.

Positioning of the patient and incision	Checked with the image intensifier	After closure of the wound

Figure-1: Per operative and post-operative images

All data collected during the study were systematically recorded, compiled, and analyzed using the Statistical Package for Social Sciences (SPSS), version 22.

Results:

Table-I showed the distribution of patients according to age and sex. Most of the patients (33.33%) were in the 26–35 years age group, followed by 26.67% in the 46–55 years age group. The lowest proportion (10%) belonged to the 56–65 years age group. Regarding sex distribution, male:femle was 4:1.

Majority subtype of the fracture was AO Muller's B2 (36.67%) followed by AO Muller's A3 (26.65%) (Figure-2)

Table-I: Distribution of the patients according to age and sex (N=30)

Variables	no. (%)
Age group (years)	
18–25	5(16.67)
26–35	10(33.33)
36–45	4(13.33)
46–55	8(26.67)
56–65	3(10.00)
Sex	
Male	24(80.00)
Female	6(20.00)

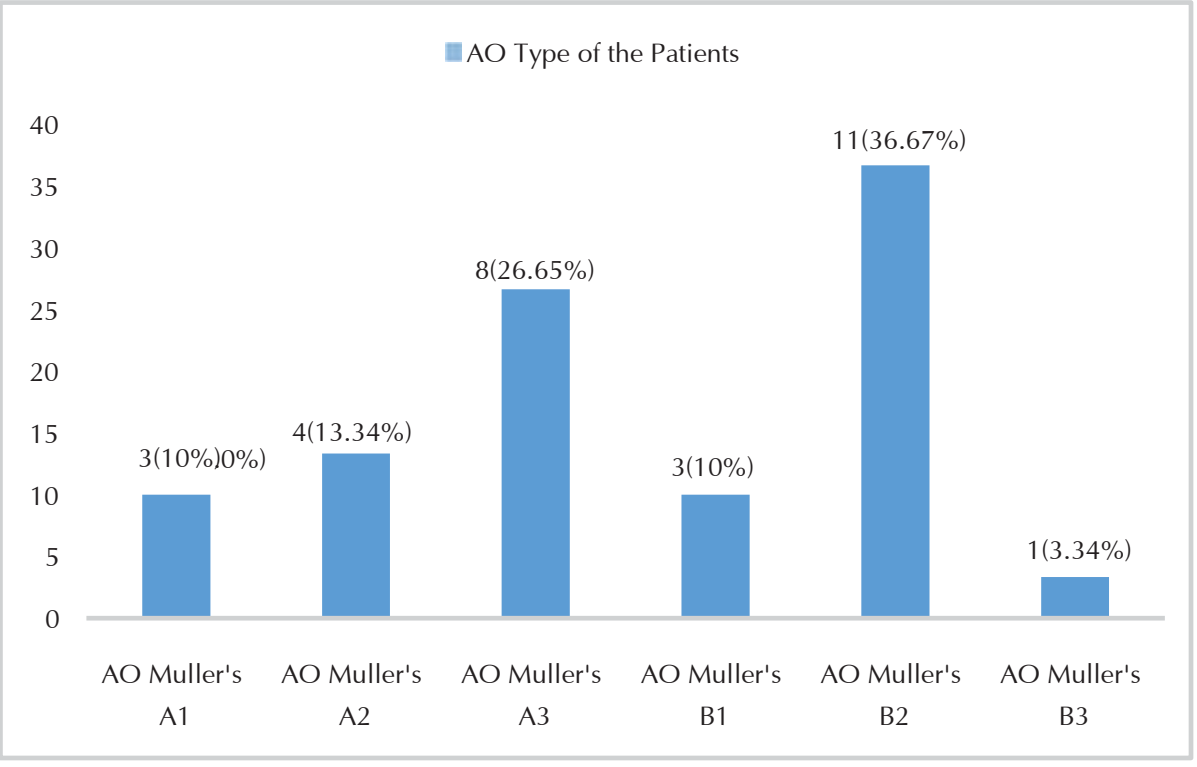

Figure-2: Distribution of fracture subtype (According to Мьller AO classification) (N=30)

Table-II presented the treatment timelines of patients with distal third tibial shaft fractures. The mean time interval between injury and surgery was 10.77 ± 3.13 days, ranging from 4 to 14 days. The average duration of hospital stay was 14.97 ± 4.21 days, with most patients (43.33%) staying between 16–20 days. Full weight bearing was achieved predominantly between 14–16 weeks (53.33% of patients), while radiological union occurred most frequently within 16–18 weeks (56.7%), indicating satisfactory and timely fracture healing following fixation with the modified interlocking intramedullary tibial nail.

Table-II: Distribution of patients according to treatment timelines (N=30)

Timelines	no. (%)
Time interval (days)	
1–5	2(6.67)
6–10	13(43.33)
11–15	15(50.00)
Mean ± SD	10.77±3.13
Range	4–14
Duration of hospital stay (days)	
6–10	4(13.33)
11–15	12(40.00)
16–20	13(43.33)
21–25	1(3.33)
Mean ± SD	14.97±4.21
Range	7–25
Time at which full weight bearing is achieved (weeks)	
11–13	11(36.67)
14–16	16(53.33)
17–19	3(10.00)
Duration of radiological union (weeks)	
16–18	17(56.70)
19–20	7(23.30)
21–22	6(20.00)

The functional outcomes of patients following treatment with the modified interlocking intramedullary tibial nail. Most patients (93.3%) reported no pain on weight bearing, while only 6.7% experienced mild discomfort. Similarly, 93.3% of patients could walk as before the injury, and only a small fraction (6.7%) reported moderate difficulty. Regarding stair climbing, 90% of patients managed without any assistance, and 10% required some support. None of the patients experienced severe pain, inability to walk, or inability to climb stairs, indicating excellent postoperative functional recovery (Table-III).

Table-III: Distribution of patients according to functional outcome (N=30)

Functional outcome	no. (%)
Pain on weight bearing	
Severe	0(0.0)
Little	2(6.7)
No	28(93.3)
Difficulty in walking	
Same as before	28(93.3)
Moderate difficulty	2(6.7)
Severe	0(0.0)
Difficulty in stair climbing (climbing up)	
No	27(90.0)
Supported	3(10.0)
Unable	0(0.0)

Table-IV demonstrated the postoperative functional limitations and joint mobility outcomes among the study patients. Most participants (90%) reported no limitation at work, and only 10% had moderate restriction. Regarding sports activities, 86.7% resumed their previous level of participation, while a small number (3.3%) were unable to return fully. Most patients exhibited less than 10° loss of knee motion (80%) and minimal subtalar stiffness (<10° in 93.3%), indicating that fixation with the modified interlocking intramedullary tibial nail allowed good preservation of knee and ankle joint mobility with minimal residual functional impairment.

Table-IV: Distribution of patients according to functional limitations and range of motion (N=30)

Functional parameters	no. (%)
Limitations at work	
No	27(90.0)
Moderate	3(10.0)
Unable	0(0.0)
Difficulty in previous sports	
No	26(86.7)
Some sports	3(10.0)
Unable	1(3.3)
Loss of motion at the knee joint	
<10°	24(80.0)
10–20°	6(20.0)
>20°	0(0.0)
Loss of subtalar motion	
<10°	28(93.3)
10–20°	2(6.7)
>20°	0(0.0)

Table-V showed the structural outcomes of patients treated with the modified interlocking intramedullary tibial nail. The majority of patients (90%) exhibited normal skin condition, with only a few showing minor discoloration (6.7%) or ulceration (3.3%). Most patients (90%) had no deformity, while 10% showed minimal angular deviation (≤7°). Similarly, 90% demonstrated less than 1 cm of calf muscle atrophy, and 93.3% had limb shortening of less than 1 cm. No patient experienced marked deformity, significant muscle wasting, or major shortening, reflecting excellent structural restoration and satisfactory cosmetic outcome following surgical intervention.

Table-V: Distribution of patients according to structural outcome (N=30)

Structural outcome	no. (%)
Status of skin	
Normal	27 (90.0)
Various color	2 (6.7)
Ulcer/Fistula	1 (3.3)
Deformity	
No deformity	27 (90.0)
Little (up to 7°)	3 (10.0)
Remarkable (>7°)	0 (0.0)
Muscle atrophy (calf muscle)	
<1 cm	27 (90.0)
1–2 cm	3 (10.0)
>2 cm	0 (0.0)
Shortening	
<1 cm	28 (93.3)
1–2 cm	2 (6.7)
>2 cm	0 (0.0)

Table-VI presented the functional outcomes of patients according to the Karlstrum–Olerud scoring system. Most patients (70%) achieved an excellent outcome, while 20% had a good result. Only 3.3% of patients were classified as satisfactory, and 6.7% as poor, with no cases falling under the moderate category. Overall, these findings indicate that most patients treated with the modified interlocking intramedullary tibial nail attained favourable functional recovery and returned to near-normal activity levels within the follow-up period.

Table-VI: Distribution of patients according to Karlstrum–Olerud functional score (N=30)

Karlstrum–Olerud score	no. (%)
Excellent (33 points)	21(70.0)
Good (32–30 points)	6(20.0)
Satisfactory (29–27 points)	1(3.3)
Moderate (<25 points)	0(0.0)
Poor (21–23 points)	2(6.7)

Discussion:

In this prospective study conducted on 30 patients with distal third tibial shaft fractures treated by modified interlocking intramedullary nailing, the majority (33.33%) were within the 26–35 years age group, and males constituted 80% of the study population. This demographic distribution aligns with previous studies by Court-Brown and Caesar [11] and Goh et al,[8] who reported that such fractures predominantly affect young adult males due to high-energy trauma mechanisms such as road traffic accidents and occupational injuries. The mean time to surgery in the present study was 10.77 ± 3.13 days, which is comparable to Metcalf et al,[12] who observed an average interval of 9.8 days between injury and surgery. The mean hospital stay of 14.97 ± 4.21 days corresponds closely with findings from Kruppa et al,[13] where the mean stay was approximately 13–15 days, suggesting that early mobilization after stable fixation significantly reduces inpatient duration. In terms of bone healing, the majority (56.7%) achieved radiological union within 16–18 weeks, with a mean union time of approximately 17 weeks. This is consistent with studies by Lee et al,[14] and Obremskey et al[15] who reported union times ranging from 16 to 20 weeks following interlocking intramedullary nailing. Early weight-bearing was achieved between 14–16 weeks in 53.33% of patients. Functionally, 93.3% of patients reported no pain on weight-bearing, and 90% reported no difficulty in stair climbing or walking. Comparable outcomes were documented by Goh et al, [8] where 88% of patients regained near-normal gait within four months postoperatively. Evaluation of joint mobility showed that 80% of patients had knee motion loss of less than 10°, and 93.3% had subtalar motion loss under 10°, indicating minimal postoperative stiffness. Similar functional recovery was reported

by Cekiɜ et al,[16] who highlighted that rigid fixation with appropriate physiotherapy maintains good ankle and knee function. Regarding structural outcomes, 90% of the patients showed no deformity, and 93.3% exhibited less than 1 cm limb shortening, which is consistent with Robinson et al[17] reporting negligible malalignment rates and minimal limb-length discrepancy. Only one patient (3.3%) developed an ulcer/fistula at the surgical site. Based on the Karlstrum–Olerud scoring system, functional results were excellent in 70%, good in 20%, satisfactory in 3.3%, and poor in 6.7% of cases. These findings are in agreement with Metcalf et al,[12] and Goh et al[8] where the combined excellent-to-good outcome rate exceeded 80%,[2,3] The few poor outcomes in this study were mainly attributed to delayed union and prolonged immobilization rather than implant failure or infection.

Limitations:

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

Conclusion:

This study demonstrates that treatment of distal third tibial shaft fractures with the modified interlocking intramedullary tibial nails yield excellent functional and structural outcomes with minimal complications. Most patients achieved union within 16–18 weeks, resumed full weight bearing by 14–16 weeks, and regained near-normal mobility. According to the Karlstrum–Olerud score, 90% achieved excellent-to-good results. It is recommended that the modified interlocking intramedullary tibial nail be considered a preferred fixation method for distal third tibial shaft fractures, as it ensures stable fixation, early mobilization, and excellent functional recovery. Further studies with larger sample sizes and longer follow-up periods are advised to validate these outcomes and assess long-term complications or implant-related issues.

Conflict of interest: None declared

References:

1. Vallier HA, Cureton BA, Patterson BM. Randomized, prospective comparison of plate versus intramed ullary nail fixation for distal tibia shaft fractures. J Orthop Trauma. 2011 Dec;25(12):736-41. doi: 10.1097/BOT. 0b 013e 318213f709.
2. Vallier HA, Cureton BA, Patterson BM. Factors influencing functional outcomes after distal tibia shaft fractures. J Orthop Trauma. 2012 Mar;26(3):178-83. doi: 10.1097/BOT.0b013e 31823924df.
3. Costa ML, Achten J, Griffin J, Petrou S, Pallister I, Lamb SE,; FixDT Trial Investigators. Effect of Locking Plate Fixation vs Intramedullary Nail Fixation on 6-Month Disability Among Adults With Displaced Fracture of the Distal Tibia: The UK FixDT Randomized Clinical Trial. JAMA. 2017 Nov 14;318(18):1767-1776. doi: 10.1001/jama.2017.16429.
4. Mao Z, Wang G, Zhang L, Zhang L, Chen S, Du H, et al. Intramedullary nailing versus plating for distal tibia fractures without articular involvement: a meta-analysis. J Orthop Surg Res. 2015 Jun 16;10:95. doi: 10.1186/s13018-015-0217-5.
5. Daolagupu AK, Mudgal A, Agarwala V, Dutta KK. A comparative study of intramedullary interlocking nailing and minimally invasive plate osteosynthesis in extra articular distal tibial fractures. Indian J Orthop. 2017 May-Jun;51(3):292-298. doi: 10.4103/0019-5413.205674.
6. WɅhnert D, Stolarczyk Y, Hoffmeier KL, Raschke MJ, Hofmann GO, Mьckley T. Long-term stability of angle-stable versus conventional locked intramedullary nails in distal tibia fractures. BMC Musculoskelet Disord. 2013 Feb 20;14:66. doi: 10.1186/1471-2474-14-66.
7. Nork SE, Schwartz AK, Agel J, Holt SK, Schrick JL, Winquist RA. Intramedullary nailing of distal metaphyseal tibial fractures. J Bone Joint Surg Am. 2005 Jun;87(6):1213-21. doi: 10.2106/JBJS.C.01135.
8. Wang B, Zhao Y, Wang Q, Hu B, Sun L, Ren C, et al. Minimally invasive percutaneous plate osteosynthesis versus intramedullary nail fixation for distal tibial fractures: a systematic review and meta-analysis. J Orthop Surg Res. 2019 Dec 21;14(1):456. doi: 10.1186/s13018-019-1479-0.
9. Kuhn S, Appelmann P, Pairon P, Mehler D, Hartmann F, Rommens PM. A new angle stable nailing concept for the treatment of distal tibia fractures. Int Orthop. 2014 Jun;38(6):1255-60. doi: 10.1007/s00264-013-2267-9.

10. Seyhan M, Unay K, Sener N. Intramedullary nailing versus percutaneous locked plating of distal extra-articular tibial fractures: a retrospective study. Eur J Orthop Surg Traumatol. 2013 Jul;23(5):595-601. doi: 10.1007/s00590-012-1016-x.
11. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. Injury. 2006 Aug; 37(8):691-7. doi: 10.1016/j.injury. 2006. 04.
12. Metcalf KB, Brown CC, Barksdale EM 3rd, Wetzel RJ, Sontich JK, Ochenjele G. Clinical Outcomes After Intramedullary Nailing of Intraarticular Distal Tibial Fractures: A Retrospective Review. J Am Acad Orthop Surg Glob Res Rev. 2020 Jun 10;4(6):20.0008. doi: 10.5435/JAAOSGlobal-D-20-00088.
13. Kruppa CG, Hoffmann MF, Sietsema DL, Mulder MB, Jones CB. Outcomes After Intramedullary Nailing of Distal Tibial Fractures. J Orthop Trauma. 2015 Sep;29(9):e 309-15. doi: 10.1097/BOT.00000000000 00323.
14. Lee YS, Lo TY, Huang HL. Intramedullary fixation of tibial shaft fractures: a comparison of the unlocked and interlocked nail. Int Orthop. 2008 Feb;32(1):69-74. doi: 10.1007/s 00264-006-0271-z.
15. Obremskey WT, Medina M. Comparison of intramedullary nailing of distal third tibial shaft fractures: before and after traumatologists. Orthopedics. 2004 Nov; 27(11):1180-4. doi: 10.3928/0147-7447- 200 41101-15.
16. Cekiз E, Alıcı E, Yeşil M. Reliability of the radiographic union score for tibial fractures. Acta Orthop Traumatol Turc. 2014;48(5): 533-40. doi: 10.3944/AOTT.2014.14.0026.
17. Robinson CM, McLauchlan GJ, McLean IP, Court-Brown CM. Distal metaphyseal fractures of the tibia with minimal involvement of the ankle. Classification and treatment by locked intramedullary nailing. J Bone Joint Surg Br. 1995 Sep;77(5):781-7.