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Original Research Article

SHORT-TERM ANALYSIS OF THE FUNCTIONAL OUTCOME OF DISTAL TIBIA FRACTURES TREATED BY INTRAMEDULLARY NAILING IN A TERTIARY CARE CENTRE – A PROSPECTIVE STUDY

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Abstract

Background: Distal tibia fractures (<7% of tibial fractures) pose challenges owing to their subcutaneous location and limited blood supply. High-energy trauma, primarily road traffic accidents (RTA), is the leading cause of these injuries. This study evaluated the functional and radiological outcomes of distal tibia fractures treated with intramedullary interlocking nails. **Materials and Methods:** This prospective study included 20 adult patients with extra-articular distal tibia fractures (AO 43-A1, A2, and A3) within 7 cm of the ankle joint. The patients underwent intramedullary nailing via a patellar tendon-splitting approach, with proximal and distal locking screws placed under fluoroscopic guidance. Postoperative rehabilitation involves early mobilisation and gradual weight-bearing. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) and Olerud and Molander Ankle Scores (OMAS). **Result:** Most patients (40%) were aged 20–30 years, with a male predominance (80%). Right-sided fractures (55%) were more common, and RTA was the most common cause (85%). Closed fractures accounted for 75% of the cases. Fibula fractures were present in 55% of the patients, with 15% undergoing fixation. The most common AO classification was 43A1 (50%). Complications were minimal: malalignment and delayed union occurred in 5% of cases each, and infection occurred in 10%. No implant failures were recorded. Functional outcomes were excellent in 40% and good in 60% (AOFAS), whereas OMAS scores showed 50% excellent and 50% good results. **Conclusion:** Intramedullary nailing provides early stability, faster union, and minimal complications, making it the preferred treatment for distal tibia fractures. Fibular fixation may improve alignment in selected cases.

INTRODUCTION

The tibia is the primary weight-bearing bone of the leg and the most frequently fractured long bone, with an annual incidence of two fractures per 1,000 individuals. Tibial fractures can lead to prolonged morbidity if not treated appropriately. The subcutaneous anteromedial surface makes it more susceptible to open fractures than other long bones.[1] Distal tibia fractures account for < 7% of all tibial fractures and < 10% of all lower extremity fractures. The blood supply to the tibia is more vulnerable than that to bones surrounded by thick muscles.[2] High-energy tibial fractures may be associated with compartment syndrome or neural or vascular injuries. The knee and ankle joints do not permit adjustments for rotational deformities after a fracture, necessitating careful management during reduction. Delayed union, nonunion, and infection are common complications of tibial shaft fractures.

Distal tibia fractures are the second most common fractures after tibia diaphyseal fractures.[3] Stable fixation is needed for distal tibial metaphyseal fractures while minimising soft tissue damage through surgical dissection and implants. The optimal fixation method remains controversial. Treatment depends on fracture characteristics and associated soft tissue injury, making experience and clinical judgment crucial in the decision-making process. Treating distal tibia metaphyseal fractures is challenging, as they have not been differentiated from others, such as Pilon fractures.[4]

Distal tibial fractures involve fibular fractures in 80% of cases; with stable fixation, such as multidirectional intramedullary interlocking nailing, fibular fractures may not need fixing.[5] However, for better reduction and alignment of the bony axis, fibular fractures may be fixed before tibial fixation.[6] From diaphysis to distal metaphysis, the tibia transitions from triangular to rounded. Distal tibial metaphyseal fractures of AO type 43A1, 43A2, and 43A3 have a risk of nonunion due to precarious blood supply.[2] Injury mechanisms, treatment principles, and prognosis of metaphyseal fractures differ from those of proximal diaphyseal and distal intra-articular Pilon fractures and should be distinguished. Treatment selection depends on the fracture's proximity to the plafond, comminution, soft tissue injury, and displacement. Managing tibial fractures requires extensive experience and clinical judgment to choose the most appropriate treatment for each injury pattern.[4]

This study aimed to analyse the functional outcomes of distal tibia fractures treated with intramedullary nailing.

MATERIALS AND METHODS

This prospective study was conducted in 20 patients in the Department of Orthopaedics, Government Dharmapuri Medical College Hospital, for a period of 2 years and 4 months from June 2022 to September 2024. The study was initiated after obtaining ethical clearance from the Institutional Ethics Committee (Certificate No. 35/2022). Written informed consent was obtained preoperatively from all the patients.

Inclusion Criteria

Patients aged between 18 and 65 years with extra-articular fractures, with or without fibular fractures, involving the distal tibia within 7 cm from the ankle joint, including closed and grade 1 compound (43-A1, A2, A3) according to the AO classification system, and patients medically fit for surgery were included.

Exclusion Criteria

Patients aged <18 or > 65 years, with grade 2 or 3 compound fractures, intra-articular fractures (43-B1, B2, B3, C1, C2, C3), or distal tibial fractures extending beyond 7 cm from the ankle joint were excluded.

Methods: A detailed history and comprehensive clinical examination, including a comorbidity assessment, were performed for each patient. Preoperative investigations included plain radiographs of both the tibia and fibula from the knee to the ankle joint in the anteroposterior and lateral views. Preoperative surgical profile blood investigations and pre-anaesthetic evaluation were conducted to ensure medical fitness for the procedure.

Surgical Procedure: Patients were positioned supine, with legs hanging, on the side, or with the knee flexed at 90° over a bolster. A vertical skin incision was made using the patellar tendon-splitting approach from the inferior pole of the patella to the tibial tuberosity. Bone entry was made using an awl that was aligned with the medullary canal.

A ball-tipped guide wire was inserted under fluoroscopic guidance to ensure central placement in the distal fragment. After reduction, serial reaming of the medullary canal was performed with flexible reamers, increasing the size by 1 mm. The guide wire was exchanged for a smooth guide wire via a flexible Teflon tube for nail insertion. The tibial nails used were either conventional AO Simplified Universal Nails (SUN, Switzerland) with two proximal and two distal interlocks or Zerolock Nails (AO Synthes, Switzerland) with additional anteroposterior and oblique interlocks.

Nail insertion was guided by fluoroscopic measurements, considering the nail length and diameter relative to the last reamer. Distal locking screws were placed using a freehand technique, whereas proximal locking was performed using a jig. Before final locking, fracture reduction was confirmed to prevent any further distraction. Surgeries were performed on a standard radiolucent table under fluoroscopic guidance and manual traction, and only closed reductions were performed.

Postoperative protocol: Intravenous third-generation cephalosporins were administered preoperatively and continued for five days postoperatively, followed by oral antibiotics until suture removal. Postoperative radiographs were used to assess fracture reduction, screw orientation, and alignment. Limb elevation and crepe bandage were maintained for 2-3 days to reduce swelling. Patients began ankle and knee mobilisation exercises on the first postoperative day. The sutures were removed between the 12th and 14th days. Weight-bearing was restricted until early callus formation (4-6 weeks), after which partial and full weight-bearing was gradually introduced based on radiological union.

Follow-up and functional assessment: Patients were followed up at two, and four weeks for one month and once every four weeks for three months, with a final follow-up at six months. At each visit, radiological assessments were performed to evaluate fracture union, alignment, and clinical parameters, including knee and ankle range of motion, healing time, return to work, knee pain, limb length discrepancy, and deformity. Functional outcomes were assessed using the American Orthopaedic Foot and Ankle Society (AOFAS) and Olerud and Molander Ankle Scores (OMAS).

The AOFAS score includes nine questions in three categories: pain, function, and alignment. The total score was 100 and rated as excellent (95-100), good (75-94), fair (51-74), or poor (0-50). The OMAS assesses nine aspects: pain, stiffness, swelling, stair climbing, running, jumping, squatting, support, and work. Scores range from 0 (totally impaired) to 100 (completely normal), with ratings similar to those of the AOFAS.

Fracture union was confirmed radiologically by bridging calluses in at least three cortices in both anteroposterior and lateral views. Malalignment was assessed using the following criteria: varus/valgus angulation of <5°, anterior/posterior angulation of

<10°, rotational deformity of <10°, and limb shortening of ≤ 1 cm. All data are presented as frequencies and percentages.

RESULTS

For age distribution, the highest proportion of patients was in the 20–30 age group 8 (40%), followed by the 41–50 group 7 (35%). Patients aged 51–60 and 61–70 years were 2 (10%), while the lowest proportion was in the 31–40 group with 1 (5%). Regarding sex distribution, males were predominantly 16 (80%), while females were 4 (20%) [Table 1].

Table 1: Demographic characteristics of patients.

		N (%)
Age (in years)	20-30	8(40%)
	31-40	1(5%)
	41-50	7(35%)
	51-60	2(10%)
	61-70	2(10%)
Sex	Male	16(80%)
	Female	4(20%)

Regarding the fracture side, the right was more commonly involved in 11 (55%) patients, while the left was involved in 9 (45%) patients. For the mode of injury, the predominant mode was Road Traffic Accidents (RTA) 17 (85%), whereas falls were reported in 3 (15%) patients.

Regarding the type of injury, closed fractures were more frequent in 15 (75%), while open fractures were less frequent in 5 (25%) patients. In terms of fibula fractures, 9 (45%) patients had no associated fibula fractures. Among those with fibula fractures, 8 (40%) were not fixed, whereas 3 (15%) underwent fixation [Table 2].

Table 2: Clinical characteristics of patients

			N (%)
Side involved	Right		11(55%)
	Left		9(45%)
Mode of injury	RTA		17(85%)
	Fall		3(15%)
Type of injury	Closed fracture		15(75%)
	Open fracture		5(25%)
Fibula fracture	Present	Fixed	3(15%)
		Non-fixed	8(40%)
	Absent		9(45%)

Regarding screw orientation, the majority of patients underwent biplanar screw orientation 17 (85%), while tri-planar screw orientation was used in 3 (15%) patients. Based on the AO OTA classification, type 43A1 was the most common in 10 (50%) patients, followed by type 43A2 in 6 (30%) and type 43A3 in 4 (20%) patients. Regarding complications, infection was observed in 2 (10%) patients, while malalignment and delayed union were each reported in one (5%) of patient, and no cases of implant failure were recorded [Table 3].

Table 3: Surgical and postoperative characteristics of patients

		N (%)
Screw orientation	Biplanar	17(85%)
	Tri-planar	3(15%)
AO OTA type	43A1	10(50%)
	43A2	6(30%)
	43A3	4(20%)
Complication	Malalignment	1(5%)
	Delayed Union	1(5%)
	Infection	2(10%)
	Implant failure	0

Based on the AOFAS score, 8 (40%) of patients had excellent outcomes, whereas 12 (60%) reported good outcomes. Similarly, in OMAS, 10 (50%) patients reported excellent outcomes, whereas 10 (50%) had good outcomes [Table 4].

Table 4: Functional outcomes of patients

		N (%)
AOFAS score	Excellent	8(40%)
	Good	12(60%)
OMAS score	Excellent	10(50%)

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	Good	10(50%)

DISCUSSION

In our study, the mean age of the patients was 29.5 years, which is similar to the findings of Gregory and Sanders (30 years) but lower than that reported by Duwelius et al. (40.5 years).[7,8] High-energy trauma, particularly RTA, was the predominant cause of fractures in 85% of cases, which aligns with the findings of Gregory and Sanders (85.1%) and is higher than that reported by Krettak et al. (71%).[7,9] Malalignment was observed in 5% of patients in our study, which is lower than the rates reported by Markmiller et al. (50%) but aligns with that of Rene Attal et al. (5.4%).[10,11]

In our study, fibular fractures were present in 55% of cases, of which 27.2% underwent fixation, and none of these patients developed malunion, achieving union within an acceptable alignment. Studies have shown that fibular fixation reduces tibial malalignment. Tyllianakis et al. and Mosheiff et al. reported a lower malalignment when the fibula was fixed.[12,13] Dogra et al. reported a malunion rate of 20% (significantly higher) when fibular fixation was not performed.[14] Schmidt et al. highlighted that fibular fixation before tibial nailing aids in alignment restoration in comminuted fractures.[15] Pynsent et al. suggested that tibial fractures at any location with > 5° of deformity will result in radiographic changes in the ankle.[16] Van der Schoot et al. revealed that more arthritis was found in the ankle joint adjacent to the fracture than compared to the ankle in the uninjured limb.[17]

In our study, the mean time for a radiological union was 18.5 weeks (range: 12–24 weeks), which is consistent with the union times reported by Xue et al., which varied from 17 to 22.6 weeks.[18] Dynamisation was performed in 5% of patients for delayed union, leading to eventual fracture healing, and no cases required bone grafting. Regarding implant-related complications, screw breakage was not observed in our study (0%), whereas Rene Attal et al. reported a 3.2% screw breakage rate, and Markmiller et al. reported a 14% incidence.[10,11]

In our study, the overall complication rate of malalignment was 5%, which is lower than that reported by Gregory and Sanders (9%) and Duwelius et al. (9%).[7,8] Delayed union was observed in 5% of cases, comparable to Gregory and Sanders (5%) but lower than that reported by Duwelius et al. (10%).[7,8] Infection occurred in 10% of cases, which was higher than the rate observed by Krettek et al. (1.65%) and Gregory and Sanders (5%).[7,9] However, there were no cases of implant failure in our study, whereas Gregory and Sanders reported an implant failure rate of 15%, and Krettek et al. reported 9.7%.[7,9]

In our study, anterior knee pain following IMN was a commonly reported postoperative complaint, and anterior knee pain was observed in 10% of patients, all of whom underwent surgery using the patellar tendon-splitting approach. Weil et al. reported that using a parapatellar approach with meticulous dissection of the retropatellar fat pad resulted in a relatively low incidence of knee pain (19%) compared to 50%, as reported by Robinson et al. using a patellar tendon-splitting approach.[19,20]

Limitations

We did not compare the intramedullary nailing outcomes with those of other surgical options for these fractures. Additionally, the small sample size limits generalisability and is insufficient for significant correlations, the short study duration, multiple surgeons performing surgeries, and the fracture fixation decision based on the fracture pattern and surgeon's discretion.

CONCLUSION

Our study concluded that for distal tibial metaphyseal fractures without articular involvement, intramedullary nailing provides stability, promoting earlier fracture union and return to work. The Expert Tibia Nail enhances stability with multiple locking options, yielding excellent results in patients. The technique is simple, short, and associated with minimal complications. As nails are load-sharing devices, early weight-bearing is possible compared with plating. Maintaining the alignment of the short distal segment during fixation is essential for a good outcome. Recognising the stability of the distal fragment is crucial for fixation and preventing reduction loss. Postoperative AOFAS and OMAS scores were good to excellent in all patients. Fibular fixation can be combined with nailing when necessary. Early union rates, fewer complications, early weight-bearing, and a reduced failure rate make intramedullary nailing preferable for treating distal tibial fractures.

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