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Original article

Treatment of Distal Tibial Fracture by Tibial Expert Nail

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Abstract

Background: The tibial expert nail is currently considered an efficient method for managing complex tibial fractures, including distal tibial metadiaphyseal fractures. Compared to conventional intramedullary nails, this advanced system offers benefits in addressing both proximal and distal tibial fracture (DTF). This study aimed to assess the clinical and radiological outcomes of using the tibial expert nail for treating DTFs. **Methods:** This work was performed on 20 cases with DTF managed by expert tibial nail fixation and (Type A) extra- articular metaphysical fractures based on the Arbeit gemeinschaft fur Osteosynthesefragen classification of DTF. **Results:** Pain was significantly different postoperative, after 1 month, after 3 months, after 6months and after 1 year (P value =0.012). Postoperative return to activity was significantly different at postoperative, after 1 month, after 3 months, after 6months and after 1 year (P value =0.004). **Conclusions:** Expert tibial nail fixation for DTFs resulted in marked improvements in pain, range of movement, and return to activity over 1 year follow-up period, with most patients experiencing favorable outcomes, with 70% achieving good to excellent satisfaction scores.

Keywords: Distal Tibial Fracture, Tibial Expert Nail, Tibial Diaphysis, Orthopaedic Surgeons

Introduction

The tibial shaft is the most commonly fractured long bone, accounting for around 40% of all diaphyseal fractures

Distal tibial fractures (DTF) [1] occur at the transition between the shaft and the metaphysis and may be classified as intra-articular or extra-articular [2]. Although they represent fewer than ten percent of lower limb fractures, they are more frequently observed in males than females. While they can affect individuals of any age, such fractures are relatively rare in both pediatric and elderly populations. These injuries typically result from high-energy trauma, most commonly due to road traffic accidents or falls from height [3]. Due to their closeness to the ankle joint, DTFs are accompanied by a greater risk of complications compared to mid-shaft fractures[4]. As a result, the treatment of these fractures—whether or not the joint surface is involved—remains a complex and challenging task.[5].

The primary objective of orthopedic surgeons in managing DTFs is restoring the tibial normal anatomy, achieving stable fixation between the epimetaphyseal region and the diaphysis, and prevent complications [6]. However, no single fixation technique is universally applicable to all DTFs or appropriate for every patient. Selecting the treatment is largely based upon factors such as the fracture configuration, soft tissue condition, the patient's overall health, and the surgeon's experience. Achieving a successful outcome relies on accurate fracture reduction, proper alignment of the joint surfaces, stabilization of the posterior column, and preservation of the soft tissues while maintaining correct limb alignment [7].

Traditionally, DTFs are managed using open reduction and internal fixation with plating. However, this method has been linked to an elevated incidence of soft tissue complications, prompting the development of less invasive techniques. In comparison to minimally invasive plate osteosynthesis, intramedullary nailing (IMN) offers the advantage of reduced soft tissue disruption, making it a compelling alternative for managing these fractures[8, 9].

Due to its subcutaneous location and limited soft tissue protection, the tibia is particularly susceptible to local soft tissue complications and delayed fracture healing. As a result, open reduction and plating are more usually accompanied by soft tissue damage and complications in bone healing. The primary goal in treating DTFs is to achieve stable fixation while minimizing trauma to the surrounding soft tissues. Minimally invasive, percutaneous IMN has been well established as an effective method for stabilizing tibial shaft fractures. Therefore, this technique also fulfills the criteria to be considered the preferred option for managing DTFs[10].

The Expert Tibial Nail is a modern intramedullary device featuring multidirectional locking capabilities. This system offers several locking configurations in multiple planes at both the proximal and distal ends, enhancing its versatility. It includes an angular stable locking mechanism that significantly improves both axial and lateral stability of fracture fragments [11]. This nail has proven to be an effective solution for managing complex tibial fractures, particularly distal tibial metadiaphyseal injuries [12]. Compared to conventional tibial intramedullary nails, it provides superior performance in treating both proximal and distal fractures. The advanced design includes four distal locking options: one oblique lock positioned at the very distal end for optimal bone engagement and reduced soft tissue damage, two mediolateral locking options, and one anteroposterior lock, all of which contribute to improved fixation of the distal fragment [13].The usage of multidirectional interlocking screws helps maintain proper alignment and stability, even when the proximal or distal tibial segment is short [14].

This work aims to assess outcomes of the tibial expert nail fixation for management of the DTFs clinically and radiologically.

Patients and Methods:

Single center study was performed on 20 cases aged more than 18 y , both genders, with DTF treated by expert tibial nail fixation in Benha University Hospitals from 2022 to 2024 and (Type A) extra- articular metaphysical fractures according to the Arbeit gemeinschaft fur Osteosynthesefragen (AO) classification of fractures of distal tibia [15]. The study was carried out following approval from the Ethical Committee (MS 24-2-2019), Benha University, Egypt. An informed written consent was taken from all participants.

Exclusion criteria included cases with (Type B) partial articular fractures, (Type C) complete articular fracture, open fractures (Gustilo II & III), pathological fracture, the presence of any medical or surgical contraindications.

All cases underwent personal history taking and demographic data collection, complete clinical assessment [General & local examination.], routine lab investigations [CBC, hepatic & renal function tests], radiological investigations: [Plain X-ray (AP & Lateral views) of the tibia revealing the knee and the ankle joints].

Careful assessment of the skin and soft tissue surrounding the fracture for any abrasion, bruises, confusions, or lacerations that might cause delayed opening procedure or interfere internal fixation usage.

Surgical technique steps:

General or spinal anesthesia were used. A prophylactic antibiotic was given to protect against wound infection postoperatively. The patients received IV antibiotics 30 minutes to one hour before the operation. The patient was put in supine position on the radiolucent table with flexion of the knee of the injured leg at ≥ 90°. Positioning of the C arm was crucial to enable good visualization of the tibia along with the articular surface proximal as well as distal in both AP & lateral views. Closed reduction was manually done by axial traction under the C arm control. Incision was made in line with the central axis of the intra - medullary canal according to the anatomy of the tibia, the incision was done trans patellar, medially, or even laterally to the parapatellar. The incision started proximally at the distal 1/3 of the patella across the patellar ligament till reaching the tibial tuberosity. Free access of nails to the insertion point was guaranteed. The entry point was determined, and the awl was inserted. The entry point defined the optimal position of the expert tibial nail in the intramedullary canal. Such step was essential to prevent fragment displacement. The guide wire was positioned centrally in both AP and lateral views, followed by fracture reduction. The intramedullary canal was then reamed to accommodate the appropriate nail diameter, and the nail length was determined under fluoroscopic guidance using a C-arm. The nail was inserted into the intramedullary canal in hyper flexed knee. Twisting motion was done to advance the nail. The final nail position was checked in AP and Lat views. Then the distal and proximal locking screws were inserted. In some cases, four distal locking screws were required to secure the distal fragment, but often three screws placed in the most distal locking holes provided adequate stabilization. An end cap was applied to avoid soft tissue and bone from growing into the nail. Throughout the procedure, reduction was continuously evaluated using both direct visualization and fluoroscopic imaging. Attention was given to maintaining proper angulation, tibial and fibular length, rotation, and ensuring the ankle mortise remained intact.

Postoperative care:

In the 1st 24 h following surgery, the patient's overall condition and the operated lower limb were closely monitored. Postoperative plain X-rays (anteroposterior and lateral views) were obtained to evaluate the quality of fracture reduction. Intravenous antibiotics were administered for up to five days, based on the wound's condition. Wound care and dressing changes were performed 48 h following the surgery. Patients were discharged with instructions to begin knee exercises and were allowed to start touch weight-bearing as tolerated.

Clinical & Radiological follow up:

All cases underwent monthly clinical evaluations and radiographic examinations until the fracture healed. Successful union was confirmed when the fracture gap disappeared on X-rays and there was no pain or tenderness at the fracture site. The patients started non-weight bearing movement with crutches for 6 weeks. The patients started partial weight-bearing walking on the 6th to 8th weeks following surgery.

By three months post-surgery, patients may progress to full weight-bearing based on radiographic signs of healing. In cases of severely comminuted fractures or delayed healing, an extended period of partial weight-bearing is recommended

Statistical analysis

Statistical analysis was done by SPSS v26 (IBM Inc., Chicago, IL, USA).

Shapiro-Wilks test and histograms were **utilized for the** evaluat**ion of** normality of the data distribution. Quantitative parametric data were presented as mean and SD and compar**ison were done** by paired T-test. Quantitative data that were non-parametric were expressed as median and IQR and analyzed using the Wilcoxon test. Qualitative variables were documented as frequencies and percentages (%) and compared using the Chi-square test. Statistical significance was considered as a two-tailed P value < 0.05.

Results:

Demographic data, comorbidities, mode of trauma and fibular fracture of the studied patient were enumerated in **table 1**.

Preoperative pain, range of motion (ROM), and return to activity of the studied patient were enumerated in **table 2.**

Pain and postoperative return to activity were significantly different postoperative, after 1 month, after 3 months, after 6months and after 1 year (P value =0.012). **Table 3.**

Case 1: A man aged 50 y, involved in road traffic accident causing the right DTFs**.** He also had proximal fibular fracture. the operation was performed a day after the trauma. union of the fracture occurred after the 12^{th} week. **(Figures 1-3)**

Table 1: Demographic data, comorbidities, mode of trauma and fibular fracture of the studied patient

		(n=20)
Age (years)		41.6 ± 14.3
	20-30	6 (30.0%)
	>30-40	4 (20.0%)
	>40-50	4 (20.0%)
	>50-60	6 (30.0%)
Sex	**Male**	11 (55.0%)
	Female	9 (45.0%)
Weight (kg)		76.3 ± 14.79
Height (m)		1.68 ± 0.08
BMI (kg/m^2)		27.2 ± 5.49
Medical conditions	**Diabetic**	4 (20.0%)
	Not diabetic	16 (80.0%)
Smoking	**Smokers**	13 (65.0%)
	Nonsmokers	7 (35.0%)
Mode of trauma and fibular fracture		
Mode of trauma	**Motor vehicle accident (MVA)**	12 (60.0%)
	Falling from height (FFH)	5 (25.0%)
	Direct trauma	3 (15.0%)
Fibular fracture	**Present**	17 (85.0%)
	Absent	3 (15.0%)

Data is presented as frequency (%). BMI: Body mass index.

Table 2: Preoperative pain, range of motion, return to activity, time lag, time of union and follow up of pain of the studied patient

		(n=20)
Preoperative pain	**Continuous pain does not respond to medication**	4 (20%)
	Moderate pain that presents during rest and needs medication	6 (30.0%)
	Mild pain after activity that needs medication	7 (35.0%)
	Very mild pain that doesn't require medication	3 (15.0%)
	No pain	0 (0.0%)
Preoperative range of motion	**Full ankle range of motion**	17 (85.0%)
	> 50% of normal ankle range of motion	2 (10.0%)
	Less than 50% of normal ankle movement	1 (5.0%)
Preoperative return to activity	**Return to previous activity**	7 (35.0%)
	Didn't return to previous activity	13 (65.0%)
Time lag	**1-3 days**	8 (40.0%)
	>3-7 days	9 (45.0%)
	>7-10 days	1 (5.0%)
	>10-14 days	2 (10.0%)
Time of union	**<16 weeks**	13 (65.0%)
	>16 weeks	7 (35.0%)
Satisfactory score	**Excellent**	6 (30.0%)
	Good	8 (40.0%)
	Fair	4 (20.0%)
	Poor	2 (10.0%)

Data is presented as frequency (%).

Table 3: Follow up of pain and return to activity of the studied patient

	Postoperative	After 1 months	After 3 months	After 6months	After 1 year	P value
Continuous pain not respond to medication	2(10.0%)	1(5.0%)	0(0.0%)	0(0.0%)	0(0.0%)	**0.012***
Moderate pain that present during rest and needs medication.	3(15.0%)	2(10.0%)	1(5.0%)	1(5.0%)	0(0.0%)	
Mild pain after activity that needs medication.	5(25.0%)	4(20.0%)	2(10.0%)	1(5.0%)	2(10.0%)	
Very mild pain that does not require medication.	2(10.0%)	3(15.0%)	6(30.0%)	4(20.0%)	2(10.0%)	
No pain	8(40.0%)	10(50.0%)	11(55.0%)	14(70.0%)	16(80.0%)	
Return to previous activity.	7(35%)	11(55%)	16(80%)	17(85%)	18(90%)	**0.004***
Did not return to previous activity	13(65%)	9(45%)	4(20%)	3(15%)	2(10%)	

Data are presented as number (%).

(A) **(B)**

(c) **(D)**

(E)

Figure 1:((A) and (B) Pre-operative X-rays; AP, (C), (D) and (E) lateral view

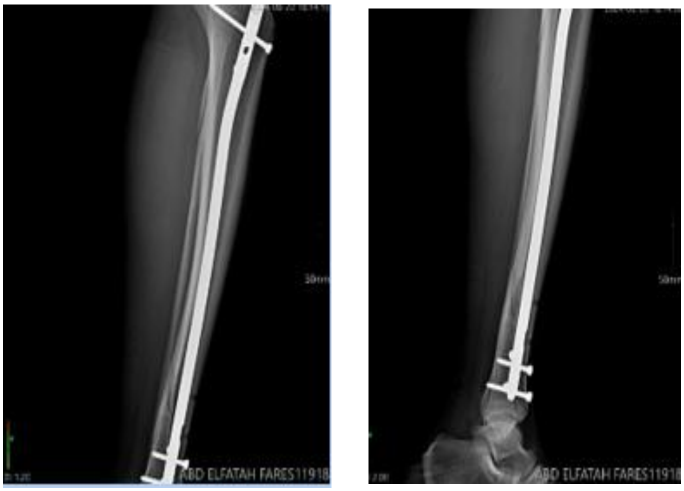

Figure 2: post-operative X-rays for the first case; anterior and lateral views

Figure 3: Follow up X-rays; AP and Lateral views after 2 months

Discussion

The tibia is the most frequently fractured long bone, with approximately two tibial shaft fractures occurring per 1,000 people each year. The average patient age is around 37 years, with the highest incidence reported among adolescent males [17].

In this study, regarding mode of trauma, there were 12 (60%) patients who had motor vehicle accident, 5 (25%) patients fell from height, and 3 (15%) patients had direct trauma. Fibular fracture was present in 17 (85%) patients.

In the same line, Khalil et al. [18] noted that the commonest mechanism of injury was road traffic accidents (61.9%).

Consistent with our findings, Mashhour et al. [17] reported that road traffic accidents were the leading cause of injury (80 %), followed by falls—both from standing height and from greater heights (10 %). Additionally, 95% of patients had associated fibular fractures, and 15% presented with other concurrent fractures

Our results showed that the time lag was one to three days in eight (40%) cases, >3-7 days in 9 (45%) cases, >7-10 days in 1 (5%) patient and >10-14 days in 2 (10%) patients.

This was consistent with Khalil et al. [18] who reported that the time lag prior to the operation ranged from 1 to 14 days.

According to our study, the time of union was less than 16 weeks in 13 (65%) cases and >16 weeks in 7 (35%) patients.

In the present findings, the pain was significantly different postoperative, after 1 month, after 3 months, after 6months and after 1 year. As the proportion of patients who reported no pain steadily increased over time, with 16 (80%) patients reporting no pain by the one-year follow-up while the number of patients reporting continuous pain decreased to zero at 3 months till one-year follow-up.

In the same line, Arora et al.[19] carried out a prospective clinical study on 25 cases distal tibia fractures managed with expert tibia nail. They revealed that the severity of pain significantly decreased over time, as the proportion of patients who reported no pain increased over time (96%) by the 24-weeks follow-up while none of cases reported severe pain.

In the same context, Khalil et al. [18] reported that anterior knee pain was detected in 4 cases (19.04%) and represented the commonest complication in their study.

In the current study, the postoperative ROM improved over time, with more patients achieving full ankle movement by one year. Initially, most patients had less than 50% ROM, but by 6 months, a significant number showed over 50% ROM, and after 1-year, full ROM was more common. Similarly, the return to activity also showed gradual improvement, with a higher proportion of patients resuming their previous activities from 1 month to 1 year, while more patients did not return to activity postoperatively.

In the same line, Arora et al. [19] carried out a prospective clinical study on 25 cases distal tibia fractures managed with expert tibia nail. They revealed that the range of movement at ankle and knee and the weight bearing improved over time till 24 weeks with 91-100% ROM in 22 (88%) and full weight bearing present in 24 (96%) patients at the final follow-up.

This was supported by Khalil et al. [18] who demonstrated that The use of **IMN** with multidirectional distal locking screws (Expert Nail) in treating DTFs offers superior soft tissue preservation, lowers the risk of varus, valgus, or rotational deformities, and results in fewer complications. Additionally, it facilitates early weight-bearing and supports effective functional recovery.

In the current study, satisfactory score was excellent in 6 (30%) cases, good in 8 (40%) cases, fair in 4 (20%) patients and poor in 2 (10%) patients.

In align with our results, Khalil et al. [18] revealed that the expert nail satisfactory outcomes were detected in 15 cases (71.43%), and the unsatisfactory outcomes were detected in 6 cases (28.57%).

This aligned with the higher rates reported in the outcomes of Zayda et al. [20] who documented that according to the Karlstrom–Olerud scoring system, there were 19 (73.08%) patients were graded as excellent, five (19.23%) patients good, one (3.85%) patient fair, and one (3.85%) patient poor.

Our study faced some limitations included that the sample size was relatively small in addition to being in a single center, not comparing the expert tibial nail fixation technique with other techniques used for DTFs and relatively short follow up.

Conclusions

Expert tibial nail fixation for DTFs resulted in marked improvements in pain, ROM, and return to activity over a one-year follow-up period, with most of patients experiencing favorable outcomes, with 70% achieving good to excellent satisfaction scores.

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