Management of Distal Tibial Fractures by Expert Titanium Nail

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ABSTRACT

Background: Expert intramedullary nailing is minimally invasive, symmetric, and dynamic fracture fixation procedure that follows the principles of biological fracture fixation. It has also been widely utilized with favorable outcomes for distal tibia shaft fractures. The aim of this study was to assess the clinical and radiological fracture healing and functional outcome of distal tibial fractures fixed by Expert tibial nail.

Patients and methods: This prospective clinical study was conducted on 40 patients with distal tibial fractures and fixation with Expert titanium nail was done and follows up of patients involved in this study for up to one year.

Result: All the patients except one in our study achieved union. The mean time tounion was 15.08±3.84 weeks. The functional assessment was done using AOFASscore and found to be excellent to good in about 97.5% and poor in 2.5% of the cases **Conclusion:** We concluded that treatment of distal tibial fractures using expert intramedullary nail with multidirectional distal locking screws is a safe and acceptedmethod alternative to conventional nail and plating techniques.

Keywords: Distal Tibial Fractures, Titanium Nail, plate.

INTRODUCTION

The tibia is the most common broken long bone in the body. According to published data, the incidence is around 17 per 100,000 person-years, though more recent data suggests that the incidence is decreasing.[(1)] Injuries frequently necessitate hospitalization and surgery, resulting in extended periods of time (months) away from work and social activities, even when conservative treatment is used. Tibial diaphysis fractures are the most prevalent type of tibia fracture, and commonly haveassociated fibular fractures in majority of cases. [(2)]

Fractures of the distal tibia account for more than 37% of all tibial injuries. [(3)] Distal tibia fractures affect people of all ages. Because of its unique anatomical characteristics of subcutaneous placement with inadequate blood supply and proximity to the ankle joint, treating distal tibial fractures in skeletally mature patients without articular extension is difficult.[(4)]

In up to 40% of patients, non-operative treatment is linked to joint stiffness, as well as shortening and rotational malunion in over 30% of cases. [(5)]

Open reduction internal fixation has traditionally been used to treat distal tibia fractures. Alternative fixation procedures such as minimally invasive percutaneous plate osteosynthesis (MIPPO) and intramedullary nailing (IMN) have become frequent fixation methods to address this damage pattern due to the high rate of problems with ORIF. [(6)]

Expert intramedullary nailing is minimally invasive, symmetric, and dynamic fracture fixation procedure that follows the principles of biological fracture fixation. It has alsobeen widely utilized with favorable outcomes for distal tibia shaft fractures. Each of these methods has its own set of benefits and drawbacks. [(7)] Intramedullary nailing provides the biomechanical principle of inter-fragmentary compression, support and adaptation to the basic principles of osteosynthesis. Interlocking nail has widened the range of indications for medullary osteosynthesis of tibial shaft fractures to include almost every type of fracture. [(8)]

In addition to the standard static and dynamic locking options, the Expert Tibial Nail features multi-directional locking options in the distal and proximal part of the nail. End cap block the most proximal screw creating an angular stable construct. Expert Tibial Nail is having an option for compression at the fracture site (up to 7 mm) by inserting one distal locking screw and one proximal dynamic locking screw with a compression screw. [(9)]

The aim of this study was to assess the clinical and radiological fracture healing and functional outcome of distal tibial fractures fixed by Expert tibial nail.

Patients and methods

This is a prospective clinical study was conducted in Beni-Suef University hospital andAl-agouza police hospital including 40 patients, and follow up of patients involved in this study for up to one year, from November 2019 to October 2020.

All patients were evaluated and examined preoperative and postoperative. Evaluation was done two-week post-operative, six weeks, 3-months and six months Then one year follow up.

Inclusion criteria: Skeletally mature patients with Extra-articular Diaphyseo-metaphyseal fractures of distal tibia, (simple, wedge or complex), closed or open type I, II fractures and both males & females.

Exclusion criteria: young patients (Skeletally immature patients -with open physis-), all intra-articular fractures, Grade III open fractures, Pathological fractures and Patients associated with general condition that affects bone mineralization (renal, malnutrition, parathyroid hormone disturbance).

Surgical technique: Spinal or general anesthesia was used, supine Positioning and the limb was hanging with a support under the knee. Primary fibular fixation by screwed plate was performed in 9 cases (22.5%). Standard Incision, The entry point is lined with the axis of the intramedullary canal and the lateral tubercle of the intercondylar eminence in the A.P. view. The entry point is at the ventral margin of the tibial plateau in lateral view. Creation of nail entry site (A solid awl is used to create the nailentrance site, and an image intensifier is used to verify that it is correct) Fig1.

The fracture was reduced to allow for the insertion of a guide wire, reaming, and nail insertion. The restoration of length, angulation, and rotation were all essential. Even after the guidewire has been inserted, further alignment correction may be required to avoid deformity. Mild traction and rotational adjustment are sometimes all that was required. Percutaneous reduction devices (pointed reduction forceps or ball-spike pusher) were also used to reduce the fracture without opening it. Other fractures necessitated the use of a blocking (pollar) screw. We start with less invasive

reduction techniques and advance to more invasive techniques if they do not really succeed (Fig.2).

Standard reaming and Nail insertion steps (After confirming nail length and diameter). Interlocking screws were inserted screws on the Expert nail are multidirectional and interlocking. Some nail systems use anteromedial to posterolateral and anterolateral to posteromedial oblique proximal locking screws.

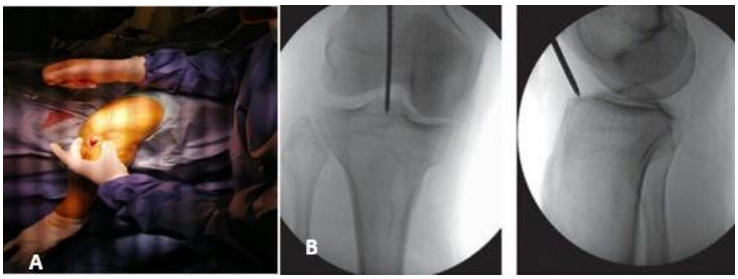
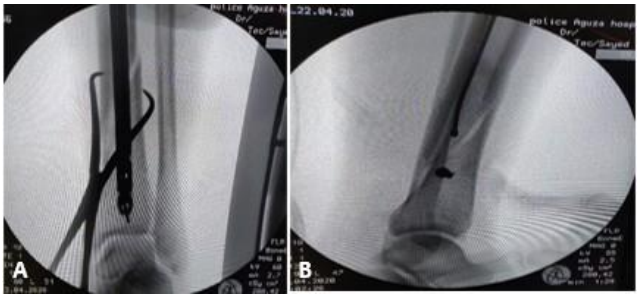


Figure 1: (A) photo showing patient positioning and the incision. (B) AP and lateral views of the proximal tibia demonstrate the ideal starting point for a tibial nail.

Figure 2: (A) Reduction of spiral fracture by reduction clamp. (B) Reduction by polar screw.



Postoperative course: Stitches were removed 2 weeks postoperatively and oral antibiotics were discontinued. Weight bearing was restricted to the uninjured side with crutches held on the other side for 6 weeks. No immobilization was imposed. Radiologic assessment was based on plain AP and lateral views taken postoperatively and at intervals of ½ months, 3 months then every 2 months until complete union (Fig.3). Assessment included: primary reduction error, union, secondary displacement, non-union (at 6 months), malunion and malalignment. All complications were recorded.

Functional score: American Orthopedic Foot and Ankle Society (AOFAS) scoring system was calculated at 3 and 6 months. The maximum score is 100 points. A value greater than 90 points considered an excellent result, 75-89 considered good, 50-74 considered fair and less than 50 considered poor [(10)].

Figure3: X ray pictures of fracture distal tibia fixed with expert titanium nail preoperative (A), postoperative(B) and 12 months postoperative (C).

Statistical analysis

The collected data, tabulated, and statistically analyzed using SPSS program (Statistical Package for Social Sciences) software version 26.0, Microsoft Excel 2016 and MedCalC program software version 19.1. Descriptive statistics were done for numerical parametric data as mean±SD (standard deviation) and minimum & maximum of the range and for numerical non parametric data as median and 1st& 3rdinter-quartile range, while they were done for categorical data as number and percentage. Inferential analyses were done for quantitative variables using independent t-testand Kruskal-Wallis's test. Inferential analyses were done for qualitative data using Chi square test The level of significance was taken at P value
<0.05 is significant, otherwise is non-significant.

RESULTS

Mean follow-up (40 patients) was 12 ± 5 months. The main demographic data and fracture characteristics found in the study are presented in the **table 1**.
The decision of fibular fixation and distal locking screw orientation were decided by surgeon's preference. In our study, fibular fractures were present in 15 patients where 9 of them were fixed, in all cases fibula was fixed first followed by tibia nailing. The men number of the inserted locking bolts in distal fragment was 2.93±0.86.

Table (1): Showing the demographic characteristics of studied cases.

Parameters		Studied cases (n= 40)	
		N	%
Sex	Male	30	75.0%
	Female	10	25.0%
Age (years)	Mean± SD	37.50± 12.94	
	Range	18.0 – 67.0	
Affected side	Right	22	55.0%

	Left	18	45.0%
Occupation	Not working	13	32.5%
	Working	27	67.5%
Associated conditions	Smoking	16	40%
	DM	4	10%
Mode of trauma	FFH	2	5.0%
	FOG	6	15.0%
	RTA	32	80.0%
AO classification	43-A1	23	57.5%
	43-A2	11	27.5%
	43-A3	6	15.0%
Time befor eSurgery(days)	Mean± SD	2.13± 1.57	

SD= standard deviation, n: number, %: percentage, FFH= fall from height, FOG= fall of the ground, RTA= road traffic accident.

All the patients except one in our study achieved union. The mean time to union was 15.08±3.84 weeks (range 12.0–36.0 weeks). Dynamization was needed in one patient for delayed union 3 months postoperatively.

The functional assessment was done using AOFAS score and found to be excellent to good in about 97.5% and poor in 2.5% of the cases (Table 2)

Table (2): Showing operative and postoperative data of the studied cases.

parameter		Studied cases(n= 40)	
		N	%
Anesthesia type	General	3	7.5%
	Spinal	37	92.5%
Operative Time(minutes)	Mean± SD	77.13±12.90	
Distal locking screws	Mean± SD	2.93±0.86	
Fibula Fixation	Yes	9	22.5%
Secondary procedures	Yes	1	2.5%
Time to union (weeks)	Mean± SD	15.08±3.84	
	Range	12.0–36.0	
AOFAS score	Excellent	26	65.0%
	Good	13	32.5%
	Fair	0	0.0%

	Poor	1	2.5%

Complications	Knee pain	4	10.0%
	Superficial infection	5	12.5%
	Deep infection	0	0.0%
	Delayed union	1	2.5%
	Non-Union	1	2.5%

Complications: four (10%) patients reported knee pain postoperatively while kneeling activities. five (12.5%) patients reported superficial infection that treated by convenient antibiotics and dressing. None of patients experienced deep infection. One case had delayed union and non-union was observed in another one.

Table (3): Association between AOFAS Score results and different demographic and clinical parameters.

parameter		Excellent(n=26)		Good (n=13)		Poor(n=1)		Test value	P-value
		No.	%	No.	%	No.	%		
Sex	**Male**	18	69.2%	11	84.6%	1	100.0%	X^2=1.44	0.488
	Female	8	30.8%	2	15.4%	0	0.0%		
Age(years)	**Mean±SD**	33.69± 10.52		51.97± 8.09		38.0± 0.0		KW=4.20	0.074
Smoking	**Not smoker**	16	61.5%	8	61.5%	0	0.0%	X^2=1.538	0.463
	Smoker	10	38.5%	5	38.5%	1	100.0%		
DM	**No**	26	100.0%	9	69.2%	1	100.0%	X^2=9.231	**0.010**
	Yes	0	0.0%	4	30.8%	0	0.0%		
AO classification	**43-A1**	16	61.5%	7	53.8%	0	0.0%	X^2=7.46	0.114
	43-A2	8	30.8%	3	23.1%	0	0.0%		
	43-A3	2	7.7%	3	23.1%	1	100.0%		
Time before surgery(days)	**Mean±SD**	1.85± 1.38		2..54± 1.85		4.0± 0.0		KW=3.69	0.158
Operative time (minutes)	**Mean±SD**	74.42± 10.61		83.08± 15.75		70.0± 0.0		KW=3.65	0.162
Distal screws	**Mean±SD**	3.04± 0.87		2.77± 0.83		2.0± 0.0		KW=2.72	0.257

Fibula Fixation	**No**	23	88.5%	7	53.8%	1	100.0%	X^2=6.25	**0.044**

	Yes	3	11.5%	6	46.2%	0	0.0%		

p≤0.05isconsideredstatisticallysignificant,p≤0.01isconsideredhighstatisticallysignificant,SD=standard deviation, *X2: Chi-Square test and KW: Kruskal Wallis Test.

Table (3) shows there were statistically significant association between AOFAS score and DM (p=0.010) and fibula fixation (p=0.044). Meanwhile, there was no statistically significant association between AOFAS score with age, sex, smoking, AO classification, time before surgery, operative time, as well as number of distal screws

DISCUSSION

Distal tibial extra-articular fractures are often a result of complex high-energy trauma, which commonly involves associated fibular fractures and soft tissue injury. The lower third of tibia is devoid of any muscle attachment and has sparse anterior soft tissue coverage, therefore prone to blister formation after injury and complications like infection, delayed-union, and non-union. [(11)]

Tibial fractures show the highest number of treatment alternatives. Each method has its own indications, advantages and disadvantages. Complex fractures of the distal tibia are difficult to treat. [(12)]

When distal tibial fractures are treated with internal fixation with plates, complications like skin necrosis, deep infections, delayed union and re-fractures may occur [(13)].

The conventional intramedullary tibia nail offers better option for treatment of metaphyseal fractures but problems with conventional nails are-difficult manipulation of fractures in metaphyseal regions with these nails, single plane locking screws in majority of nails, lower level of Herzog bend and the distal locking screw holes are not present at nail tip [(14)] . Ricci WM et al used poller screws to prevent nail translation in distal segment [(15)].

These difficulties are overcome by use of ETN as it has multiplanar interlocking options and locking holes in close proximity to nail tip provides angular stability despite short distal segment, also has provision for compression, and it has optimum Herzog's bend. [(16)] This study aimed to evaluate the effectiveness of using an Expert titanium nail in the treatment of such fractures.

We evaluated and compared our results with multiple similar studies. Mean age in our study was 37.50± 12.94 years . Gregory and Sanders [(17)] in their series has mean age of 30 years and in series by Duwelius et al [(18)] the mean age was 40.5 years.

Our results were similar to the results of Wang et al. as it was study done at Yantaishan Hospital (Yantai, China), all adults with distal tibial fractures and soft tissue damage who presented to their clinic were treated with Expert Nail and the mean ± standard deviation age of the 11 patients (10 males) was 52.2 ±13.5 (range 28 to 66) years, the mean operative time was 83 (range 65 to 105) minutes and the mean follow-up period was 16.3 (range 14 to 18) months. [(16)]

According to clinical history our results showed that 16 (40%) patients were smokers. Regarding comorbidities, 4 (10%) patients had hypertension and 4 (10%) patients had

DM.

The results of the study of Vallier et al. was similar to ours as they showed that Mechanism of injury Motor vehicle (collision) 44 patients and Motorcycle (collision) 25 so Road traffic accident (RTA (83%) and fall from height 27patients (14%) Industrial causes 5 patients 2 %. [(20)]

According to post-operative data and the distribution of studied cases as per post-operative complications our results showed that Eight (20%) patients reported knee pain postoperatively, five (12.5%) patients reported superficial infection that treated by convenient antibiotics. None of patients experienced deep infection. One case had delayed union and non-union was observed in another one.

The study of Bihani et al. showed similar results as the found that the most common complication in our study was the anterior knee pain (42%) and the higher incidence of anterior knee pain may be because of the trans-patellar tendon approach used to make entry portal for nailing. [(21)]

According to distribution of studied cases as per full union, our results showed that the time to full union ranged from 12 weeks to 36 weeks with mean time (±SD) was 15.08± 3.84 weeks. The study of Badami et al. showed that the average time of fracture healing was 16 wks. Delayed union was seen in 11%. [(22)] Also, the study of Bihani et al. showed that Average time of radiological union was 21.04 ± 9.44 weeks. Delayed union reported in (3 of 26 cases). 25 of 26 cases achieved union without secondary procedure, one case required secondary procedure [(21)].

Limitations of our study include Firstly; the sample size was relatively small which may limit the generalizability of our findings. Additionally the relatively low number of patients, short follows up period and the absence of control group. Future prospective studies with larger cohorts and longer follow-up periods are warranted to validate our findings. Also the decision of fibular fixation and distal locking screw orientation were decided by surgeon's preference.

Despite these limitations, our study provides valuable evidence for the use of the Expert titanium nail in the management of distal tibial fractures. The results support its application as a reliable and effective treatment option in appropriate cases. Surgeons should consider this technique as an alternative to other fixation methods and weigh the potential benefits against the associated risks on a case-by-case basis.

CONCLUSION

In conclusion, our study contributes to the growing body of literature on the management of distal tibial fractures using an Expert titanium nail. We have shown positive outcomes regarding fracture stabilization and patient recovery. Further research is needed to explore long-term outcomes, comparative effectiveness, and the influence of patient characteristics on treatment success. The findings of such studies will help refine surgical techniques and optimize patient care in the future.

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