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Expert Nail in Management of Distal Tibial Fractures

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Abstract

Background: Fractures of the distal tibia are one of the most challenging injuries in orthopedic. Several methods have been described for the treatment of these fractures, including casting, external fixation, intramedullary nail and plate fixation. The choice of technique depends on multiple factors including fracture configuration, proximity to the plafond, bone quality, soft-tissue injury and available equipment. Non-operative management may be appropriate in some patients, particularly those with contraindications to anaesthesia. External fixation offers benefits in terms of soft-tissue management and in the management of severely comminuted fractures, but questions remain over the risks of infection and non-union. Intramedullary nailing may be effective in managing these fractures even with simple articular extension, but care needs to be taken with reduction and adequate distal locking to prevent malalignment and chronic knee pain may also be an issue. The aim of this work was to evaluate the results of locked intramedullary nailing in distal tibial shaft fractures clinically and radiologically. Methods: In this study 21 patients with closed distal tibial fractures treated in the period between October 2017 and October 2018 at Tanta University Hospital with intramedullary nail with multidirecrional distal locking screws (Expert tibial nail).The period of follow up ranged from 3 to 6 months with an average of 4.5 months. Results: The mean age of the patients was 36.38 years (range 20-59). The most commonly affected age group was20-30(38.1%). Males were more affected than females (76.2%). The most common mechanism of injury was motor vehicle accident (61.9%). According to Tenny & Wiss scoring systems for distal tibial fractures the clinical results were graded as excellent in six patients (28.6%), good in nine patients (38.1%), fair in four patients (19%) & poor in two patients (9.5%).The excellent and good results were considered as satisfactory results while the unsatisfactory included the fair and the poor results. Thus, satisfactory results were found in 15 patients (71.43%), and the unsatisfactory results were found in six patients (28.57%).There were some factors which affected the time of bone union: Younger age and patients not associated with medical conditions had rapid rates of union. This study encountered the following complications: nonunion in one patient (4.76%), delayed union in three patients (14.28%), sudeck's atrophy in three patients (14.28%), malunion in one patient (4.76%) and anterior knee pain in four patients (19.04%). Anteroir knee pain presented the most common complication. Youner and non-diabetic patients had rapid rates of bone union. Conclusion: Treatment of distal tibial fractures using intramedullary nail with multidirectional distal locking screws (Expert nail) is a safe and accepted method alternative to conventional nail and plating technique. It also provides greater preservation of the soft tissue and reduces varus/valgus or rotational deformity and lesser complications as metalwork irritation, infection and wound breakdown with the advantages of early weight bearing and good functional recovery.

Key words: Expert Nail, Distal Tibial Fractures.

1. Introduction

Fractures of the distal tibia involve the diaphyseo-metaphyseal area of the bone. It is one of the most challenging injuries in orthopedic and accounts for less than 10% of all fractures of the lower extremity. [1]

The optimal treatment of unstable distal tibial fracture remains controversial, despite the variety of treatment options which have been suggested for these injuries, including nonoperative treatment, plate fixation, intramedullary nailing, and external fixation. However, each of these treatment options has certain defects. The objectives in the treatment in these fractures are rapid and ideal healing, minimization of loss of function and prevention of any deformity. [2]

The aim of this work was to evaluate the results of locked intramedullary nailing in distal tibial shaft fractures clinically and radiologically.

2. Patients and Methods

A-Patients:

This study included 21 patients (16 males and 5 females) with distal tibial fractures treated between October 2019 and October 2020 (including follow up period) at Elmahalla general hospital and Benha university hospitals with intramedullary nail with multidirectional distal locking screws (Expert tibial nail). Their ages ranged from 20 years to 59 years with an average of 36.38 years. The period of follow up was up to six months.

On admission, all patients were subjected to history taking, clinical examination, radiological and laboratory investigations. Full counseling of participants in this research and informed consent was obtained with full Privacy of participants and confidentiality of the data.

Personal history

Name, Age, Sex, Residency and occupation.

Present history:

- Date of trauma.
- Mode of trauma.
- Date of admission.
- Present medical history.

Clinical examination

General examination

Blood pressure, Pulse, Temperature, Respiration and other body systems.

Examination of the spine, knee, pelvis and calcaneus is very important for associated injury.

Local examination:

Inspection: deformity, skin condition and presence of wound or associated injuries.

Palpation: skin temperature, dorsalis pedis and posterior tibial pulse.

Radiological examination

Plain X-ray (Antero-posterior and Lateral views) of the tibia showing the knee and the ankle joints.

Computed Tomography (CT) was done to exclude intraarticular fractures in some patients.

Laboratory investigations

- CBC
- Renal function test
- Liver function test
- Random blood sugar

Patients Selection

Inclusion Criteria:

All patients included in this study were

- Above 18 years of age.
- (Type A) extra- articular metaphysical fractures according to the AO classification of fractures of distal tibia.
- With recent fractures within 14 days after the onest of trauma.
- Open fractures grade 1.

Exclusion Criteria

- Patients below 18 years old.
- (Type B) prartial articular fractures.
- (Type C) complete articular fractures.
- Open fractures grade 2 and 3.
- Pathological fractures.
- Medical and surgical contraindications.

Demographic distribution of the patients:

1) Age, sex and side distribution:

The age of the patients in this work ranged from 20 to 59 with a mean of 36.38 years. The highest age incidence was between 20-30 years (38.1%).

There were 16 males (76.2%) and 5 females (23.8%) with male to female ratio (3:1).

In this study right side was affected in 12 patients (57.14%) While the left was affected in 9 patients (42.86%).

Mechanism of injury and associated fibular and other fractures:

The cause of fractures was motor vehicle accident (M.V.A) in 13 patients (61.9%), fall from height in five patients (23.8%) and direct trauma in three patients (14.3%).

Seventeen patients (80.95%) had associated fibular fractures and fixation was done in four cases.

Other than fibular fractures, three patients presented with other injuries. One patient had ipsilateral fracture femur treated by interlocking nail femur. The second patient had facture 1st lumbar spine treated conservatively by dorsolumbar support. The third patient had ipsilateral patellar fracture treated by screws.

3) Associated medical conditions and smoking:

Four patients were diabetic (19.05%) and 6 patients (28.57%) were smokers.

4) Time elapsed before surgery:

The time lag before surgery ranged from 1 to 14 days**.**

B-Methods:

Preoperative evaluation:

Initial management was usually directed toward general patient stabilization. Fracture splinting with above knee slab and screening radiography was done at first. Personal information, any associated medical problem as Diabetes Mellitus or habits as smoking, the type of fracture, time and mechanism of trauma were also documented.

The skin and soft tissue around the fracture were carefully examined for abrasion, bruises, contusion and laceration that may delay open procedures or interfere with the use of internal fixation. The anteroposterior and lateral views of tibia were done. CT evaluation was done in some patients for detection of intra-articular fractures.

The patient received anti edematous, analgesics and antibiotics in cases of severe soft tissue damage for prevention of infection.

Timing of the surgery

The timing of surgery was optimized to allow the soft tissues to stabilize and minimize the postoperative wound problems often associated with the surgical management of these complex fractures.

In the presence of severe soft-tissue swelling or skin blisters, the surgery was delayed for about a week until the swelling has subsided and the skin begins to wrinkle.

Operative technique

preoperative preparation

All patients were examined both clinically & laboratory to be sure that they were fit for operation. Preoperative antibiotics were used to prevent the risk of postoperative wound infection. IV antibiotics were given 30 min. to 1 h. before surgery.

operative steps

Anaesthesia

Spinal or general anaethesia were used in all patients.

Position of the patient

The patient was positioned supine on a radiolucent table with the ability to flex the knee by at least 90°. Position of the image intensifier was important such that visualisation of the tibia including the articular surface proximally and distally was possible in AP and lateral views.

The incision

Incision was made in line with the central axis of the intra - medullary canal, this incision was transpatellar Figure (1). The incision started proximally at the distal third of the patella along the patellar tendon down to the tibial tuberosity.

Fig. (1) Transpatellar incision.

Determination of the entry point:

The entry point was determined. It was giuded by the image intensifier. In the A.P. view the entry point was in line with the axis of the intramedullary canal and with the lateral tubercle of the intercondylar eminence. In lateral view the entry point was at the ventral edge of the tibial plateau.

Opening of the medullary canal:

After determination of the entry point the awel was inserted into this point under contol of the image intensifier in A.P and lateral view Figure (2).

Insertion of the guide wire:

The guide wire was inserted in central postion in AP and Lat. views and fracture was reduced by axial traction under the the image intensifier.In some cases the reduction was temporarily fixed by pecutanous reduction clamps. Then the intramedullary canal was reamed by flexible or rigid reamers over the guide wire to adjust the the diameter of the nail then the length of the nail was measured under the control the the image intensifier Figure (3).

Fig. (2) Insertion of the awel.

Fig. (3) Insertion of the guide wire.

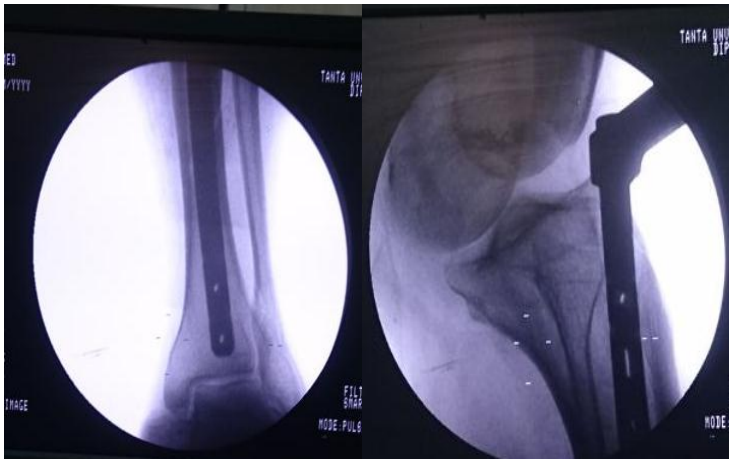

Fig. (4) Intaoperative position of nail proximally and distally.

Insertion of the nail:

The nail was inserted with the knee in at least 90° flexion using the insertion handle with slight rotational movements. The passage of the nail through the fracture site was closely monitored by the the image intensifier.

Confirmation of the proximal and distal nail position:

The correct proximal and distal positions of the nail were confirmed by the image intensifier in A.P. and lateral views. Consideration was given if primary compression or secondary dynamization was planned **(Figure 4)**.

Insertion of distal locking screws

After confirmation of the nail postion,the guide wire was removed and the distal locking screws were inserted. Four screws were, two medial to lateral screws and two antro-posterior screws. In some cases three screws were sufficient to stabilize the distal fragment.

Insertion of proximal locking screws:

After insertion of distal locking screws and confirmation of reduction of distal fragment, two proximal locking screws were inserted.

Insertion of the end cap:

The end cap was inserted to prevent ingrowth of soft tissue and bone into the nail.

Assessment of reduction:

Reduction was assessed repeatedly during the different steps of the operation using both visual and image intensifier control.Angulation, length of both tibia and fibula,and rotation need to be considered, as well as the integrity of the ankle mortise.The aim is to achieve less than 5 degrees of varus or valgus, less than 5 degrees of anterior or posterior angulation.

Fixation of the fibula:

Most distal tibial fractures are accompanied by fibular fractures

The fibular incision was placed slightly posterior to the mid coronal plan.

3. Results

Clinical (functional) results:

According to **Tenny** & **Wiss** scoring systems for distal tibial fractures the clinical results were graded as excellent in six patients (28.6%), good in nine patients (38.1%), fair in four patients (19%) & poor in two patients (9.5%).The excellent and good results were considered as satisfactory results while the unsatisfactory included the fair and the poor results. Thus, satisfactory results were found in 15 patients (71.43%), and the unsatisfactory results were found in six patients (28.57%) Table (1).

Table (1) Grades of final functional clinical score.

Grades		Number	Percentage
Satisfactory	**Excellent**	6	28.6%
	Good	9	42.9%
	Total	15	71.43%
Unsatisfactory	**fair**	4	19%
	poor	2	9.5%
	Total	6	28.57%
Total		21	100%

Age and the end results:

There was no significant correlation between the age of the patients at the time of surgery and the final end results. P.value = 0.191 (P<0.05 statistically significant)

The highest incidence of excellent results occurred at the age of 20-30 years while poor results occurs at the age of >30-40 years Table (2).

Associated Fibular fracture and the end results:

Comparing the functional end results and associated fibular fracture, no significant correlation was found. P.value = 0.341. 17 patients had associated fibular fracture. Fixation was done in four cases there was no fibular shortening in any case associated with fibular fracture Table (3).

Associated medical conditions and the results:

Associated medical condition was found to have no statistically significant effect in the results. P. value = 0.218 Table (4).

Smoking and the end results:

Smoking was found to have statistically insignificant effect in the results**.** P.value = 0.110 Table (5).

Time lag and the end results:

Time lag was found to have statistically insignificant effect in the results. P.value = 0.254 Table (6).

Table (2) Relation between age and the final end results.

Age group	Excellent		Good Fair	Poor	Total
20-30	4	4	0	0	8
>30-40	1	1	2	2	6
>40-50	0	3	1	0	4
>50-60	1	1	1	0	3
Total	6	9	4	2	21
P.value				0.191	

Table (3) Relation between the associated fibular fracture and the final end results.

Fibular	Excellent	Good	Fair	poor	Total
fracture					
Present	5	8	2	2	17
Absent	1	1	2	0	4
Total	6	9	4	2	21
P.value			0.341		

Table (4) Relation between the associated medical condition and the final end results.

Medical conditions	Excellent	Good	Fair	Poor	Total
Associated medical conditions (diabetic)	0	2	2	0	4
Not diabetic	6	7	2	2	17
Total	6	9	4	2	21
P.value			0.218		

Table (5) Relation between smoking and the final end results.

Smoking	Excellent	Good	Fair	Poor	Total
Nonsmokers	5	4	4	2	15
Smokers	1	5	0	0	6
Total	6	9	4	2	21
P.value			0.110		

Table (6) Relation between time lag and final end results.

Time lag	Excellent	Good	Fair	poor	Total
1-3 days	3	4	0	0	7
>3-7 days	1	4	4	1	10
>7-10 days	1	0	0	0	1
>10-14days	1	1	0	1	3
Total	6	9	4	2	21
P.value			0.254		

4. Discussion

Six patients (28.6%) had excellent results, nine patients (38.1%) had good results, four patients (19%) had fair results & two patients (9.5%) had poor results. The excellent and good results were considered as satisfactory results while the unsatisfactory included the fair and the poor results. Thus, satisfactory results were found in 15 patients (71.43%), and the unsatisfactory results were found in six patients (28.57%). In this study, the period of follow up ranged from 3 to 6 months with an average of 4.5 months.

Compared to the study was done by **Nadeem Ali et al;[3]** sixty patients with extra articular distal tibial fractures were divided into 2 groups, the first group included 30 patients treated by distal tibial locking plating group (MIPO) and the second group included 30 patients treated by closed intramedullary interlocking nailing. In the first group, 21 patients (70%) had satisfactory results, 8 patients (26.6%) had fair results and one patient had poor results while in the second group, 19 patients(63.3%) had satisfactory results, 9 patients (30%) had fair results and 2 patients had poor results.

Compared to the study was done by **Kartavya Chaudhari al ;[4]** thirty patients were treated by LCP by MIPO, 63% had excellent results, 26% had good, 7% had fair and 4% had poor results. Twenty six patients were treated by Expert tibial nail, 54% had excellent results, 27% had good, 11% had fair and 8% had poor results.

Age ranged from 20 years to 59 years with an average of 36.38 years. Age was found to have statistically insignificant effect in the end results of this study but had statistically significant effect in the time of union. The highest incidence of satisfactory results occurred at the age of 20-30 years old. These results were nearly the same with that reported by **Mohit Bihani et al;[5]** in his study of intramedullary fixation of distal tibial fractures around diametaphysis using Expert tibial nail, who found that age had significant effect in the end results.

This study included 17 patients with associated fibular fracture and fixation was done in four cases.

Comparing the functional end results and associated fibular fracture, no significant correlation was found.

The need for fibular fixation is unclear in extra-articular fractures of the distal tibial metaphysis, especially if the concomitant fibular fracture occurs above the level of the distal tibio-fibular syndesmosis. Although some authors recommend stabilizing all concomitant ipsilateral fibular fractures, they agreed that fixation should be performed if the fracture involves the distal tibiofibular syndesmosis or ankle. This practice reflects results from studies demonstrating that the stability of the syndesmosis has a direct correlation with good clinical outcomes in ankle fractures. Other authors have reported that associated fibular fixation aids to reduce distal tibial fractures. **[6]**

In general, associated fibular fixation seems to lessen the risk of distal tibial malalignment, but only a few clinical reports have specifically evaluated this clinical impression. **Egol et al;[7]** evaluated the role of fibular fixation in maintaining alignment of distal tibial fractures stabilized with a statically locked intramedullary nail. Of the 72 cases, there was loss of tibial alignment in 1 of 25 (4%) patients who had the fibula stabilized as compared to 6 of 47 (13%) who did not while **Whittle et al [8];** showed that the absence of fibular fixation did not increase the incidence of malunion in distal tibial fractures stabilized with intramedullary nailing. In their series, fibular stabilization was performed in 1 of 25 distal fourth tibial fractures.

In **Whorton and Henley's [9]** retrospective review of 157 tibial fractures with ipsilateral fibular injuries, there were no statistical differences in final fracture alignment, time to union or number of secondary procedures needed to achieve union between the groups defined by fibula stabilization (all distal fibular fractures that involved the syndesmosis and ankle mortise were stabilized). They concluded that fibular fixation in the absence of syndesmotic and mortise-related injuries did not affect outcomes of tibial fractures.

Associated medical condition was found to have statistically insignificant effect in the results of our study. The highest incidence of complications was in the diabetic patients. Diabetic patients showed longer time to union than nondiabetic patients as three diabetic cases were presented by delayed union and also two diabetic patients was complicated with Sudeck's atrophy.

Smoking was found to have statistically insignificant effect in the end results of this study.

In this study, time lag was found to have statistically insignificant effect in the results.

The time of union ranged from 12 to 24 weeks with mean of 16.23 weeks. This matched with the study was done by **Mahajan et al;[10]** 46 patients with distal tibial metadiaphyseal fractures were treated by Expert nail tibia, The average time of union was 16.4 weeks (ranged from 12 to 28 weeks).it also matched with the study was done by **Ramachandra et al;[11]** as the average time of union was 16 weeks of 72 patients with distal tibial fractures treated by expert nail tibia. Similar results reported by **Kumar et al;[12]** as the average time of union was 16 weeks for nailing (Expert nail) group and for plating group it was 18 weeks.

However slower rates of union was reported by **Mohit Bihani et al;[5]** as the average time of union was 21.04 weeks.

In comparison with MIPPO, **Guo et al;[13]** reported no significant differences between nailing and MIPPO in terms of time to union, but nailing showed lesser operation and fluoroscopy use times, and better function and alignment. Other authors preferred MIPPO because of the difficulty in controlling the distal fracture fragment with nailing because of the metaphyseal flare, wound complications because of poorer soft-tissue coverage, and the proximity to the ankle joint, which may amplify the bending moment of the short distal

segment and may allow fracture propagation into the ankle joint.

In this study, three cases developed delayed union (14.28%), three cases developed Sudeck's atrophy (14.28%), one case developed malunion(4.76%), one case developed nonunion(4.76%) and anterior knee pain was found in four cases(19.04%). So anterior knee pain represented the most common complication in this study.

Mohit Bihani et al;[5] in their study, also reported that commonest complication was anterior knee pain (42%).

Markmiller et al;[14] in their study of fractures of the distal tibia treated with conventional intramedullary nail, reported that nearly half of his study population had a malalignment at the fracture site.

Compared to the study was done by **Nadeem Ali et al;[3]** malunion was the most common complication. Valgus malunion was the most type of malunion observed.

Compared to the study was done by **Kartavya Chaudhari et al;[4]** superficial skin infection (10%) and ankle movement restriction (10%) were the most common complications among patients treated by MIPO while anterior knee pain (38%) was the most common complication among patients treated by Expert tibial nail.

The mean operation time was 150 (90–240) minutes. It was long duration Compared to **Kumar et al;[12]** who reported that the average duration of surgery was 88 minutes.

The relatively low number of patients, short follow up period and the absence of control group are limitations to this study.

In general, this study emphasized the clinical success and low morbidity associated with the use of intramedullary nail tibia with multidirecrtional distal locking screws (expert nail). This was suited to the management of distal tibial fractures. Decreased incidence of soft tissue complications, early weight bearing and good functional recovery, all of these compare favorably with other reported treatments for patients with distal tibial fractures and substantiate the recommendations for expert nail should be the treatment of choice for such injuries

5. Conclusion

Treatment of distal tibial fractures using intramedullary nail with multidirectional distal locking screws (Expert nail) is a safe and accepted method alternative to conventional nail and plating technique**.** It provides additional biomechanical stability than the conventional nails and plate osteosynthesis. It has multiple proximal and distal locking options and hence is useful in all extraarticular tibia fractures. It has five locking options in proximally and four locking options distally in various planes. This design of the implant helps in achieving stable fixation and improved locking in most extraarticular tibial fractures. It also provides greater preservation of the soft tissue and reduces varus/valgus or rotational deformity and lesser complications as metalwork irritation, infection and wound breakdown with the advantages of early weight bearing and good functional recovery.

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