

Expert Tibial Intramedullary Nailing For proximal and distal tibial fractures

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Abstract

Fractures of the proximal or distal thirds of the tibia are one of the most challenging injuries in orthopedic. Several methods have been described in the choice of technique depends on multiple factors including fracture configuration, bone quality, soft-tissue injury and available equipment. Intramedullary nailing may be effective in managing these fractures even with simple articular extension, but care needs to be taken with reduction and adequate screws locking to prevent malalignment and chronic knee pain may also be an issue. This study included 20 patients with distal and proximal tibial fractures treated with intramedullary nail with multidirectional proximal and distal locking screws (Expert tibial nail). The period of follow up was up to 6 months using certain scoring systems. The symptomatic and functional evaluation results were graded according to the criteria by Johner and Wruh's Criteria According to Johner and Wruh's criteria, 45.0% of patients showed good criteria, 30.0% were excellent, 15.0% were fair and only 10.0% were poor. Two cases developed delayed union (10%), two cases developed Sudeck's atrophy (10%), one case developed malunion (5%), one case developed nonunion (5%) and anterior knee pain was found in four cases (20%). So anterior knee pain represented the most common complication in this study. Treatment of proximal and distal thirds tibial fractures using expert tibial intramedullary nail (with multidirectional locking screws) is a safe and accepted method alternative to conventional nail and plating technique. This design of the implant helps in achieving stable fixation and improved locking in most extraarticular tibial fractures.

1. Introduction

The tibia is currently the most commonly fractured long bone in the body with an annual incidence of two tibial shaft fractures per 1000 individuals. The average age of patients with tibial shaft fractures is approximately 37 years, and teenage males are reported to have the highest incidence (1).

there are many ways that a person can suffer a tibia fracture. These include traumatic injuries, such as motor vehicle accidents or falls, sports that involve repeated impact to the shin, such as long-distance running, injuries from contact sports such as football (2).

Numerous treatment options exist for treating tibial fractures and good results have been reported with both conservative and surgical methods. To reduce the complications associated with conservative treatment, tendency towards operative management of tibial fractures become more popular. Various operative methods like open reduction and plating, intramedullary nailing and external fixation have their own indications, advantages and disadvantages (3).

Interlocking nail has widened the range of indications for medullary osteosynthesis of tibial shaft fractures to include almost every type of fracture. Intramedullary nailing offers an attractive treatment, stable fixation with early restoration of function without use of plaster and avoid the complications associated with plating as ulceration of skin overlying plate, deep infection leading to osteomyelitis and refracture and delayed union. However

there are some problems in treatment of fracture tibia with conventional intramedullary interlocking nailing like difficulty in manipulating fractures of proximal and distal 1/3rd tibia and comminuted metaphyseal fractures (4,5).

These shortcomings of conventional intramedullary interlocking nail in managing proximal and distal third fractures have been overcome by the introduction of Expert Tibial Interlocking Nail due to modifications in operative techniques, its design and advancement in locking screws. Thus expert tibial nail design allows better control in metaphyseal tibial segments through multiple interlocking holes in close proximity to either end of the nail. Multidirectional interlocking screws ensure that alignment can be well maintained and stability preserved despite a short proximal or distal fragment (6).

The Expert Tibial Nail System (ETNS In addition to the standard static and dynamic locking options, the ETNS features multi directional locking options in the distal and proximal part of the nail, 5 proximal locking options (three unique oblique and two medio-lateral locking options) and 4 distal locking options (Two medio-lateral, one antero-posterior and one additional oblique locking option, placed very distally) .. End cap block the most proximal screw creating an angular stable construct (7,8).

The use of multidirectional interlocking screws ensures that alignment can be maintained and that stability can be preserved

despite a short proximal or distal tibial segment (9).

Postoperative complications of intramedullary ETN fixation of tibia fractures include delayed union, primary and secondary malalignment, implant-related complications, and secondary surgery but with lower rates in comparison to conventional intramedullary interlocking nail (10).

The aim of this study was to evaluate the outcome of Expert Tibial Nail System (ETNS) in fixation of proximal and distal extra articular tibial fractures

2. Patient and Method

This study included 20 patients (14 males and 6 females) with distal and proximal tibial fractures (4 proximal and 16 distal) treated between January 2019 and January 2020 at Banha University Hospital with intramedullary nail with multidirectional proximal and distal locking screws (Expert tibial nail). Their ages ranged from 20 years to 59 years with an average of 35 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.

Inclusion Criteria was (Extraarticular metaphyseal fractures of proximal and distal tibia (simple, wedge or complex), Skeletally mature patient, Primary intervention, Co-operative medically healthy patient and Open fractures,

Exclusion Criteria was (Intra-articular fractures, open fractures grade III with contamination and, Patient with active infection)

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 antiedematous, analgesics and antibiotics in cases of severe soft tissue damage for prevention of infection.

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.

Spinal or general anesthesia were used in all patients. 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 visualization of the tibia including the articular surface proximally and distally was possible in AP and lateral views. 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. The entry point was determined. It was guided 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. After determination of the entry point the awel was inserted into this point under control of the image intensifier in A.P and lateral view (Figure 2). The guide wire was inserted in central position 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 percutaneous 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). 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. 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). After confirmation of the nail position, the guide wire was removed and the distal locking screws were inserted in distal tibial fractures four screws were, two medial to lateral screws and two antero-posterior screws. In some cases three screws were sufficient to stabilize the distal fragment. In proximal tibial fractures two screws distally are usually sufficient to stabilize distal fragment (Figure

5). After insertion of distal locking screws and confirmation of reduction of distal fragment, two proximal locking screws (one anteromedial to posterolateral and the other anterolateral to posteromedial) were inserted if the fracture was distal. In proximal tibial fractures five screws were inserted (three unique oblique and two mediolateral locking screws). In some cases four proximal screws were sufficient to stabilize the proximal fragment. (Figure 6). The end cap was inserted to prevent ingrowth of soft tissue and bone into the nail. 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. Most tibial fractures are accompanied by fibular fractures. The fibular incision was placed slightly posterior to the mid coronal plan. Fibula fixation was done using plate and screws or K-wire fixation in high fractures.

Postoperative assessment of general condition and lower limb for the first 24 hours. Plain X-ray was done (A.P. and lateral views) after the operation for the assessment of fracture reduction. Immediate postoperative elevation of the limb for at least 2 or 3 days, active and passive range of motion of knee were started. IV antibiotic coverage continued for 5 days postoperatively, depending on the condition of the wound. Wound care and dressing 48 hours after surgery.

The patients were discharged with instructions to start knee exercise with

possibility for touch weight bearing for 6 weeks. In cases with fixed fibular fractures a below knee non-weight bearing cast was done for 6 weeks before beginning range of motion activities.

Stitches were removed 10 to 14 days post-operative. Follow up visits were at two, six and 12 weeks postoperative in comminuted unstable cases follow up visits were every (2weeks). Clinical follow up assessed for pain, tenderness and mobility of fracture site

Radiographic follow up of the patients assessed for maintenance of reduction, limb alignment, re-establishment of bone continuity, loosening of metal and callus formation. Radiographic union was defined as the presence of bridging callus in three of the four cortices as seen on anterior- posterior and lateral radiographs.

Weight-bearing was forbidden until 6 weeks after surgery, the patients were allowed to non-weight bearing ambulation with crutches. Partial weight-bearing walking was allowed 6 to 8 weeks postoperatively when evidence of callus bridging was seen on plain radiographs.

By 3 months the patient can be advanced to full weight – bearing depending on radiological evidence of healing. For severely comminuted fractures and fractures showing delayed healing, a longer period of partial weight bearing is suggested.

All the patients were assessed at the time of final follow up using certain scoring systems. The symptomatic and functional evaluation results were graded according to the criteria by Johner and Wruh's Criteria. Clinical results were graded as excellent, good, fair, or poor.



Figure (1): Transpatellar incision.



Figure (2): Insertion of the nail.

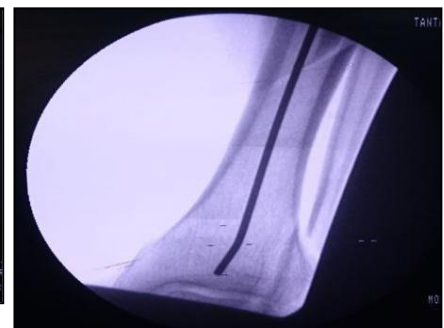


Figure (3): Insertion of the guide wire.

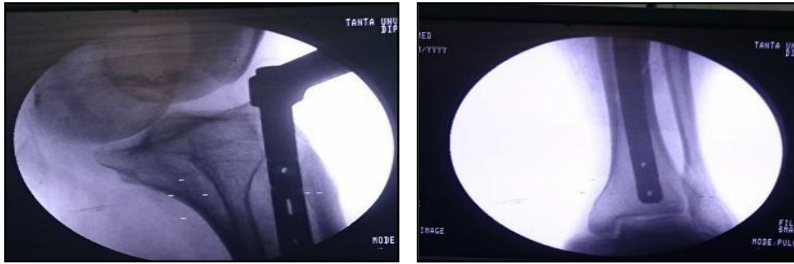


Figure (4): Intraoperative position of nail proximally and distally

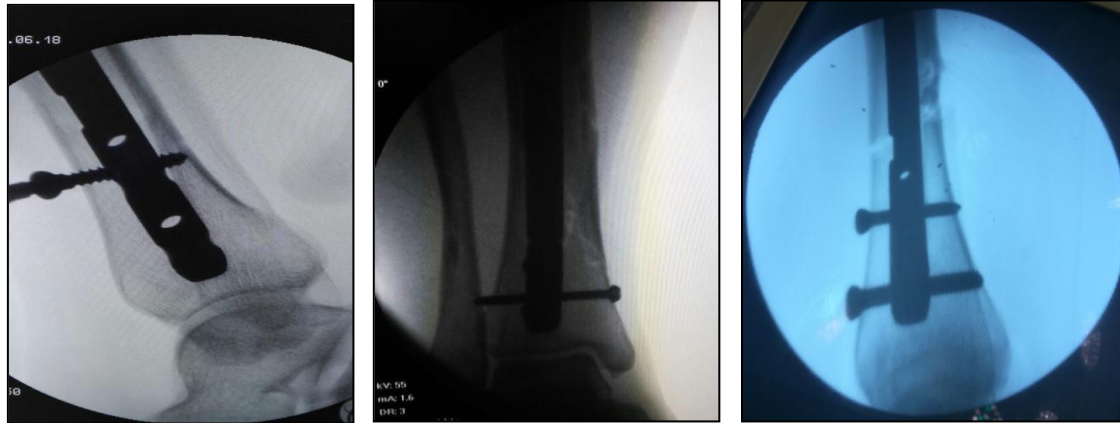


Figure (5): Distal locking screws.

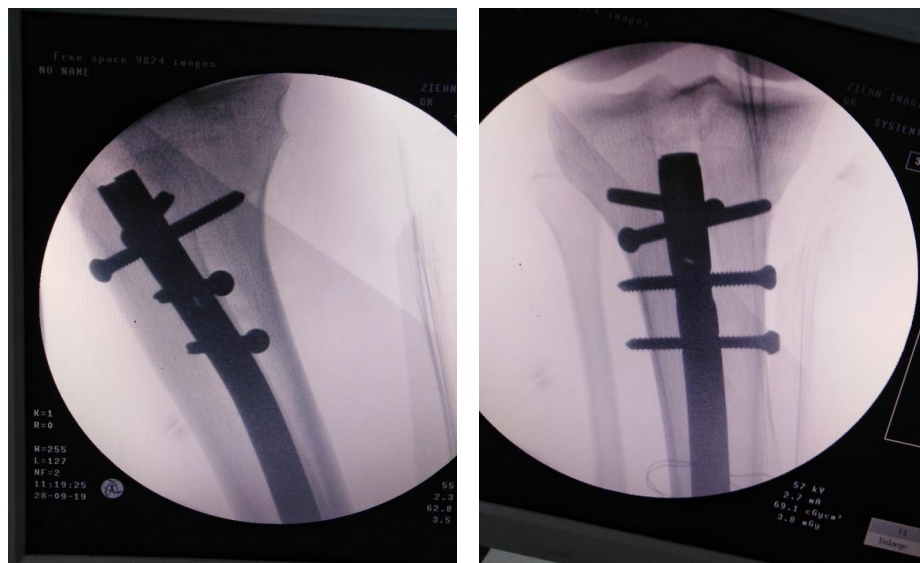


Figure (6): proximal locking screws.

3. Results

Mean age of the study population was 35 years with standard deviation of 14 years. As regard gender, 70.0% of study population were males with only 30% females. 20.0% were smokers and 15.0% had diabetes.

The most frequent mechanism of trauma was RTA (80.0%) followed by falling down and fall from height (10.0% for each) 95.0% of patients showed associated fibular fractures

and 15.0% showed associated other fractures. 45.0% of study population showed right side affection while 55.0% showed left side affection.

The most frequent time of fixation was 3 – 7 days (45.0%) followed by 1 – 3 days (30.0%) then 7 – 10 day (20.0%) while the least frequent was 10 – 14 days (5.0%)

According to Johner and Wruh's criteria 45.0% of patients showed good criteria, 30.0% were excellent, 15.0% were fair and only 10.0% were poor. 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 (75%), and the unsatisfactory results were found in 5 patients (25%) (fig. 2)

Mean time of union was 16 weeks with standard deviation of 6 weeks. There was no correlation between time of union and age ($r = 0.408$ & P value = 0.074)

Time of union was significantly higher in diabetics (20 week) compared to non-diabetics (16 week). P value was 0.04. There were no significant differences in time of union as regard gender, smoking status, side and site of fracture.

One case developed nonunion and further intervention had been done (bone graft and additional plate fixation). It represented 5% of

all cases. Two cases developed delayed union. Union started to appear after 20 weeks and completed at 24 weeks. It represented 10 % of all cases.

Four cases developed anterior knee pain. It was mainly due to the incision scar and infrapatellar pad scar. There was no need for continuous medical treatment. It represented 20 % of all cases. One case developed malunion due to malalignment after fixation. It represented 5% of all cases.

Two cases developed Sudeck's atrophy. One case was 35 years old smoker male. And the other was diabetic female patient 55 years old. They received treatment in the form of calcitonin and pain killer and they showed improvement after physiotherapy. It represented 10 % of all cases.

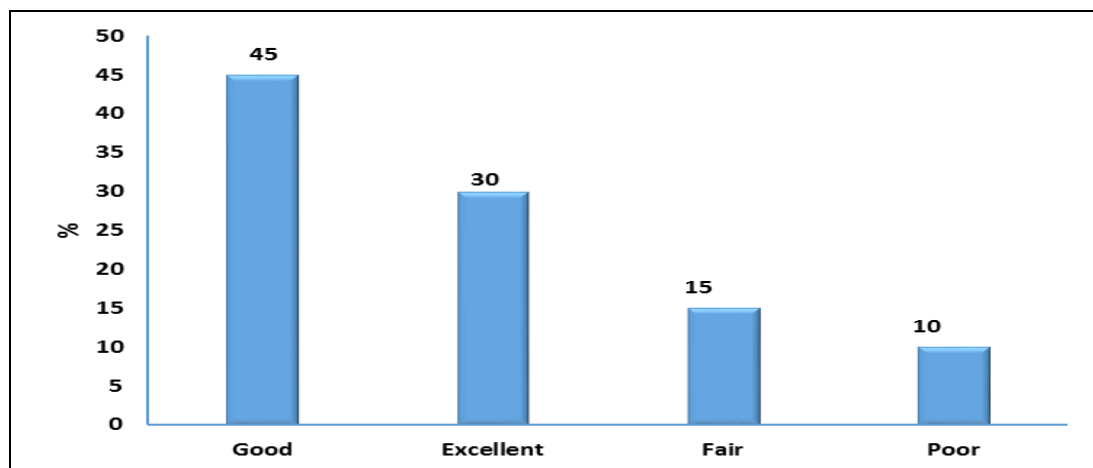


Fig (7) final functional results

Table (1) Time Of Union As Regard Patients Characheristics

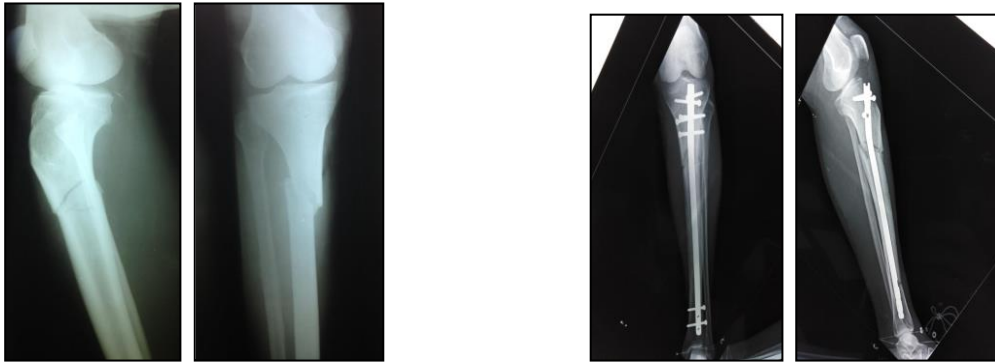
		Time of union (Wks)		P value
		Mean	SD	
Sex	Males	16	6	0.274
	Females	17	4	
Smoking	Non-smoker	15	3	0.29
	Smoker	21	11	
DM	Non-diabetic	16	6	0.04
	Diabetic	20	4	
Side	Right	17	7	0.882
	Left	16	4	
site of fracture	Distal tibia	15	3	0.148
	Proximal tibia	21	10	

Mann Whitney U test was used

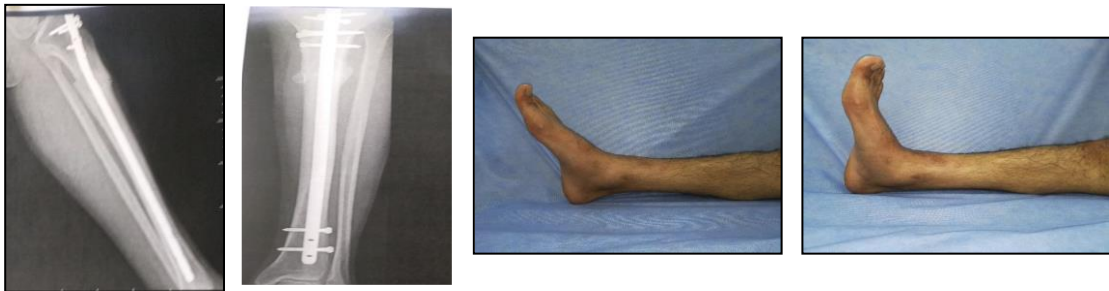
4. Case

Case 1 :

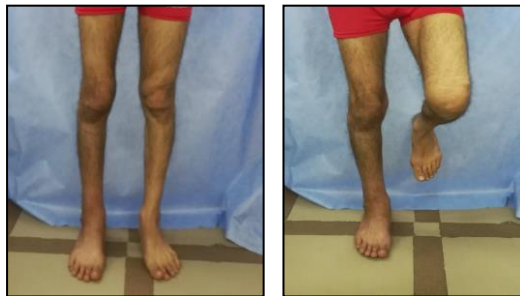
A 32 years old male patient, involved in motor vehicle accident caused left proximal tibial fracture. he was operated at the same day of trauma. The fracture united after 20 weeks. According to Johner and Wruh's criteria, he had excellent functional score.



Pre-operative X-rays for case No.1; AP and Lateral views. Post-operative X-rays for case No.1; AP and Lateral views.



Follow up X-rays for case No.1; AP and Lateral views after 6 months. Ankle range of motion in case No.1 after 3 months.



Full weight bearing in case No.1 after 3 months.

Case No. 2 :

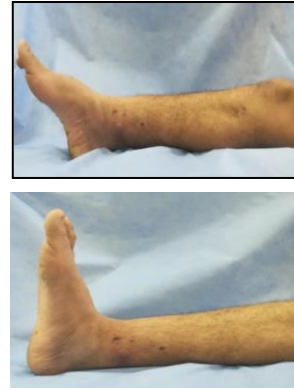
A 45 years old male patient, involved in motor vehicle accident caused right distal tibial fracture. He had distal fibular fracture which fixed by k wire. He was operated 5 days after trauma. The fracture united after 12 weeks According to Johner and Wruh's criteria , he had good functional score.



Pre-operative X-rays for case No.2; AP and Lateral views. Post-operative X-rays for case No.2; AP and Lateral views.



Follow up X-rays for case No.2; AP and Lateral views after 3 months.

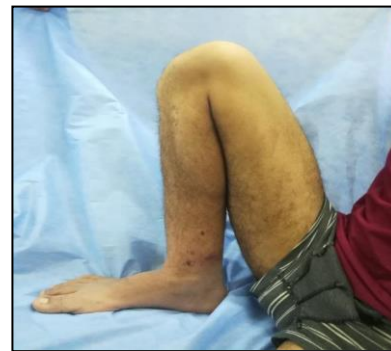


Ankle range of motion in case No.2 after 6 months



Knee

se



Full weight bearing in case No.2 after 6 months.

5. Discussion

The tibia is currently the most commonly fractured long bone in the body with an annual incidence of two tibial shaft fractures per 1000 individuals. The average age of patients with tibial shaft fractures is approximately 37 years, and teenage males are reported to have the highest incidence.

Numerous treatment options exist for treating tibial fractures and good results have been reported with both conservative and surgical methods. To reduce the complications associated with conservative treatment, tendency towards operative management of tibial fractures become more popular. Various operative methods like open reduction and plating, intramedullary nailing and external fixation have their own indications, advantages and disadvantages.

The objectives in the treatment in these fractures are rapid and ideal healing, minimization of loss of function and prevention of any deformity(11)

Any method of treatment must satisfy certain criteria. Treatment should be simple, inexpensive, available in every centre dealing with trauma, minimally invasive to protect the vascularity of distal tibia with solid fixation and should be effective(12).

This study included 20 patients (14 males and 6 females) with distal and proximal tibial

fractures(4 proximal and 16 distal) treated between January 2019 and January 2020 at Banha University Hospital with intramedullary nail with multidirectional proximal and distal locking screws (Expert tibial nail). Their ages ranged from 20 years to 59 years with an average of 35 years. The period of follow up was up to six months.

These patients were assessed according to Johner and Wruh's criteria. And Clinical results were graded as excellent, good, fair, or poor as follows:

45.0% of patients showed good criteria, 30.0% were excellent, 15.0% were fair and only 10.0% were poor.. 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 (75%), and the unsatisfactory results were found in 5 patients (25%). 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 done by Prashant B Kenganal et al ;The study involved 30 confirmed cases of metaphyseal and diaphyseal fractures of tibia . All cases were treated with intramedullary fixation with "Expert Tibial Interlocking Nail".Functional results were graded according to the criteria by Johner and Wruh's Criteria. 43.33 % of

patients achieved excellent results, 33.33 % of patients achieved good results, 16.67 % fair results were seen and in two patients, the functional results were poor (6.67%)(13).

Compared to the study done by N. D. Kachhap et al; The study involved 30 patients with 30 fractures of tibia . 26 patient were having fracture in distal 1/3rd tibia and 4 patient were having fracture of proximal 1/3rd tibia. On the basis of hospital for special surgery (HSS) knee score 13 (43%) patients had excellent results; 9 (30%) had good results, 05 (17%) had fair results and 3 (10%) had poor result(14).

Compared to the study was done by Nadeem Ali et al ;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(15).

Time of union was significantly higher in diabetics (20 week) compared to non-diabetics (16 week). The highest incidence of complications was in the diabetic patients. Two diabetic patients was complicated with Sudeck's atrophy.

There were no significant differences in time of union as regard gender, smoking status, side and site of fracture.

Mean time of union was 16 weeks with standard deviation of 6 weeks. This matched with the study was done by Neetin P. Mahajan et al; 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) (16).it also matched with the study was done by Ramachandra et al as the average time of union was 16 weeks of 72 patients with distal tibial fractures treated by expert nail tibia(17). Similar results reported by Kumar YC et al as the average time of union was 16 weeks for nailing (Expert nail) group and for plating group it was 18 weeks(18).

However slower rates of union was reported Prashant B Kenganal et al; as the average time of union was 21.04 weeks.

In comparison with MIPPO, Guo et al ;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(19).

Age ranged from 20 years to 59 years with an average of 35 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; in his study of intramedullary fixation of distal tibial fractures around diaphysis using Expert tibial nail, who found that age had significant effect in the end results.

In this study, two cases developed delayed union (10%), two cases developed Sudeck's atrophy (10%), one case developed malunion(5%), one case developed nonunion(5%) and anterior knee pain was found in four cases(20%). So anterior knee pain represented the most common complication in this study.

Mohit Bihani et al ;in their study, also reported that commonest complication was anterior knee pain (42%)(20).

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 multidirectional distal locking screws (expert nail). This was suited to the management of proximal and 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 proximal or distal tibial fractures and substantiate the recommendations for expert nail should be the treatment of choice for such injuries

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