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Original Article

Comparative study between Treatment of Distal Tibia Fracture using Intramedullary Expert Nail versus Ilizarov

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ABSTRACT

Background: Distal fracture of the tibia is a fracture of diaphyseal-metaphyseal area of distal tibia. It may extend to the articular surface.

Aim of the work: This study aimed to compare the result of using expert nail and Ilizarov in treatment of distal tibia fracture.

Patients and methods: This was a prospective comparative study conducted on 20 patients attending at Emergency Room of Al-Hussein university hospital, Ahmed Maher Teaching hospital. patients were divided into two groups according to the type of surgical intervention: **Group [A]:**10 patients operated by expert nail and **Group [B]:** 10 patients operated by Ilizarov.

Results: There was no statistical significant difference between the two studied groups regarding Trauma and Fracture types, major complication, malunion and radiological outcome p>0.05, but regarding minor complication, there was a significant difference [p= 0.01]. The Total score in Ilizarov group ranged from 38 to 92 with mean ± SD = 73.8 ± 16.84 while in IM nail group the Total score ranged from 8 to 74 with mean ± SD = 43.1 ± 26.81 with statistical significant difference [p= 0.008] between the two groups.

Conclusion: Adult distal tibia fracture can be effectively fixed with expert nail which have less invasive technique, less complications, better biochemical and biological advantage, more satisfaction, allow early mobilization and weight bearing as load sharing device and superior functional outcome in comparison with ilizarov in management of distal tibia fracture.

Keywords: Distal Tibia; Fracture; Intramedullary Expert Nail; Ilizarov.

INTRODUCTION

Distal tibial fracture is a fracture of diaphyseal-metaphyseal area of distal tibia and may extend to its articular surface. It accounting for less than10% of lower extremity fracture [1]. The definite management of distal tibial fracture remains debatable although there are multiple choices like non-operative management, plate fixation, intramedullary nail and external fixation. Goals of any operative treatment is to achieve good healing, normal alignment, improve function or affection of soft tissue around and to prevent any deformity or infection that can happen [2, 3].

Intramedullary nailing [IMN] is a minimally invasive and biological fixation option. It represents the gold standard for treatment of tibial shaft fractures. The last decades showed that, IMN has gained popularity for the treatment of extra articular fractures. Its indications are diverse and include distal fractures of the tibia with or without partial articular extension as well [4, 5]. Expert tibial nail [ETN] designed as modification that has biomechanical stability as compared with traditional nails [6]. It has five locking options in four planes in the proximal part and four locking options in three planes in distal part.

Irrespective of the status of the soft tissues, the use of ETN is associated with minimal soft-tissue exposure and less invasive. This circular ring fixator permits adjustment if needed. In addition, the compression/distraction both can be performed if there is non-union or delayed bone healing after surgery. Furthermore, it permits immediate postoperative weight bearing when used with Ilizarov external fixator application [7].

This study was designed to compare the result of using expert nail and Ilizarov in treatment of distal tibia fractures.

PATIENT AND METHODS

This was a prospective comparative study conducted on 20 patients attending at Emergency Room of Al-Hussein university hospital, Ahmed Maher Teaching hospital.

Inclusion criteria: Age: adult age 20-45years, closed or open fracture Gustillo type1 and AO classification type A.

Exclusion criteria: Open fracture Gustillo type2, 3, Pathological fracture, neurovascular injury and Pilon fracture.

Sample size: The estimated sample is 20 patients, Grouping: A total of 20 distal tibia fracture patients were divided into two groups according to the type of surgical intervention: **Group [A]:**10 patients operated by expert nail and **Group [B]:** 10 patients operated by Ilizarov.

Methods

All patients were subjected to the following:

Pre-operative evaluation: Clinical examination: Full detailed history, Comorbidities, general examination for chest, head abdomen and other injuries, local examination of the Limb, vascular condition of the affected limb, motor and sensory function and soft- tissue envelope of the limb. **Radiological examination:** X-ray and anterior-posterior and lateral views of tibia showing knee and ankle joints. **C.T SCAN:** To exclude intraarticular involvement and proper preoperative planning when it is indicated and **Laboratory investigations:** Routine preoperative investigations in the form of complete blood count [CBC], Prothrombin time [PT], prothrombin concentration [PC], international normalized ratio [INR] and liver function tests and kidney function tests.

Operative procedures

Anesthesia: General or spinal anesthesia was used. Prophylactic antibiotics are given 60 minutes before surgical incision. A shut-off drape was placed mid-way up the thigh to guard against any proximal pooling of the antiseptic solution.

Surgical technique

Intramedullary nailing:

The entry point for a fracture was set in the line with the medullary canal and distal to the angle between tibial plateau and anterior tibial metaphysis. To reach to the correct entry point, the tibial crest was identified and a guide wire was placed along it. A longitudinal skin incision was made over the planned entry point. It was extended 3-5 cm in proximal direction from the tibial plateau level. A soft tissue protector was used over the guide wire and a cannulated starting point reamer was used to open the canal. A ball tip guide wire was placed in the canal with a T-hand and pushed manually past the fracture site to the distal physeal scar. Ream the reamer up 0.5-1.0 mm with each reamer, pushing down through the starting hole into the bone before starting the reamer.

Ilizarov:

The patient was placed on a radiolucent table and evaluated for normal limb attitude using a sandbag positioned under the ipsilateral hip. The general anesthetic was supplemented with a nerve block [popliteal or epidural nerve block] to improve postoperative pain relief. Biplane fluoroscopy was used during reduction, pin insertion, and assembly of the frame. Fractures were reduced using traction and manual external pressure. If it is not acceptable, percutaneous elevators were inserted, the forceps were reduced, or wires with olives were used. The proximal ring was set at the level of the fibular head, and additional stability was achieved by extra wires parallel to the articular surface with posts fixed on the distal ring. Olive wires were fixed to the ring on the lateral or medial side. All wires were assembled and a minimum of 120 kg tension was applied. Additional rings in the tibia were used to achieve further stability and permit for unrestricted weight-bearing.

Post-operative management:

Medications: Intravenous [IV] antibiotics [third-generation cephalo-sporin [Ceftriaxone] was given for all subjects. It started in the day of surgery till the end of the first postoperative week. Anti-inflammatory, prophylactic anticoagulant and anti- edematous medications were continued until pain and edema subsided.

Immobilization: Patients began immediate knee range of motion exercises.

Weight bearing: Partial weight bearing was allowed from four to six weeks postoperatively after radiological evidence of callus formation, followed by return to activity after complete radiological union.

Post-operative follow-up: Postoperatively, patients should report any chest pain, excessive swelling, redness, or discharge immediately. Follow-up visits in the outpatient clinic are weekly for two weeks, followed by monthly visits for six months to evaluate fracture healing and any possible complications. The end point of follow-up visits is determined after evaluating complete radiological union, full weight bearing, and return to daily activities.

Outcome criteria

Clinical assessment: Assessment of wound condition, swelling, range of motion, frontal and sagittal plane deformity and leg length discrepancy.

Radiological assessment: Plain X-ray films were done postoperatively in anteroposterior and lateral views for assessment of progress of bone healing. Complete Radiographic union was defined if there was a continuity of both cortices in two radiographic planes.

Functional outcome Patients were evaluated according to Teeny and Wiss scoring system [8].

Statistical analysis: The collected data were coded and fed into statistical software package for analysis. The continuous normally distributed data were described by means and standard deviation. On the other side, quantitative variables were summarized by their frequencies and percentage. The SPSS Version 22.0 [IBM Corp, Armonk, NY] was used to carry out all tests. In order to compare between groups, Chi-square test and independent sample t-test [or equivalents] used to test associations between categorical variables and compare means for continuous data. P-value less than 0.05 was considered significant.

RESULTS

Both groups were comparable regarding the patient demographics **[table 1]**. In addition, there was no significant differences between the two groups regarding trauma and fracture characteristics **[table 2]**. Major complications showed that, there was no significant differences between the two groups [p= 0.399], or malunion [p=0.368]. However, minor complications showed a significant difference between the two groups [p= 0.01]. In Ilizarov group, there was significant increase of superficial wound infection than the IM nail group [50% vs 0.0% respectively] **[table 3]**. The Total score in Ilizarov group ranged from 38 to 92 with mean ± SD = 73.8 ± 16.84 while in IM nail group the Total score ranged from 8 to 74 with mean ± SD = 43.1 ± 26.81 with statistical significant difference [p= 0.008] between the two groups **[table 4]**.

Regarding Radiological outcome, there was no significant differences between the two groups [p= 0.785] **[table 5]**.

CASE PRESENTATION

Case One: A 42 years old male, presented with painful left tibia and inability to walk after twisted ankle. Antero-posterior and lateral X-ray of the left tibia showed spiral fracture of the distal third tibia**.** It was closed the patient was treated by Ilizarov**.** Patient was followed up regularly at the outpatient clinic both clinically and radiologically.

Case Two: A 33 years old male patient, presented with painful right tibia and inability to walk after fall down stairs. Antero-posterior and lateral X- ray of the right tibia-showing spiral fracture of distal third tibia. It was closed. The patient was treated by intramedullary expert nail Patient was followed up regularly at the outpatient clinic both clinically and radiologically.

Table [1]: Demographic data among the study population

		Ilizarov group [n = 10]	IM nail group [n = 10]	Test	p
Age [years]	**Mean±SD**	32.9 ± 6.45	32.5 ± 6.65	0.136	0.893
	Median [IQR]	33 [28.5 - 37.75]	32 [27.25 - 36.75]		
	Range [Min. – Max.]	20 [22 - 42]	20 [23 - 43]		
Age distribution [n,%]	**20-29**	3 [30.0%]	4 [40.0%]	**0.254**	**0.881**
	30-39	5 [50.0%]	4 [40.0%]		
	40-45	2 [20.0%]	2 [20.0%]		
Sex [n,%]	**Male**	7 [70.0%]	7 [70.0%]	**0.001**	**1.0**
	Female	3 [30.0%]	3 [30.0%]		

Table [2]: Fracture and trauma characteristics among the study population

		Ilizarov group [n = 10]	IM nail group [n = 10]	Test	p
Trauma type [n,%]	Low energy	6[60.0%]	8[80.0%]	0.952	0.329
	High energy	4 [40.0%]	2 [20.0%]		
Fracture Type [N,%]	Closed	3 [30.0%]	2 [20.0%]	0.267	0.606
	Open	7 [70.0%]	8[80.0%]		

Table [3]: Major complications incidence among the study population

		Ilizarov group [n = 10]	IM nail group [n = 10]	Test	p
Major Complications [n,%]	Compartment syndrome	0[0.0%]	1[10.0%]	5.143	0.399
	Deep infection	0[0.0%]	0[0.0%]		
	Hardware failure	0[0.0%]	0[0.0%]		
	Delayed union	1[10.0%]	1[10.0%]		
	Pheusdoarthrosis	0[0.0%]	0[0.0%]		
	None	9 [90.0%]	0[0.0%]		
Malunion [n,%]	Valgus > 5º	1[10.0%]	0[0.0%]	**2.000**	**3.68**
	Rotation > 10º	0[0.0%]	1[10.0%]		
	None	9 [90.0%]	9 [90.0%]		
Minor complications [n,%]	Superficial infection	5 [50.0%]	0[0.0%]	**6.67**	**0.01***
	None	5 [50.0%]	10 [100.0%]		

Table [4]: Functional outcome Total score among the study population

	Ilizarov group [n = 10]	IM nail group [n = 10]	Test	p
Mean ± SD.	73.8 ± 16.84	43.1 ± 26.81	**3.067**	**0.008***
Median [IQR]	75 [66 - 88]	41 [21.5 - 70]		
Range [Min-Max]	54 [38 - 92]	66 [8 - 74]		

Table [5]: Radiological follow up among the study population

	Ilizarov group [n = 10]	IM nail group [n = 10]	Test of Sig.	p
Union	**8 [80%]**	**7 [70%]**	**1.067**	**0.785**
Malunion	**1 [10%]**	**1 [10%]**		
Delayed union	**0 [0%]**	**1 [10%]**		
Non-union	**1 [10%]**	**1 [10%]**		

Figure [1a]: Pre-operative X-rays showing spiral fracture.

Figure [1b]: Skin condition

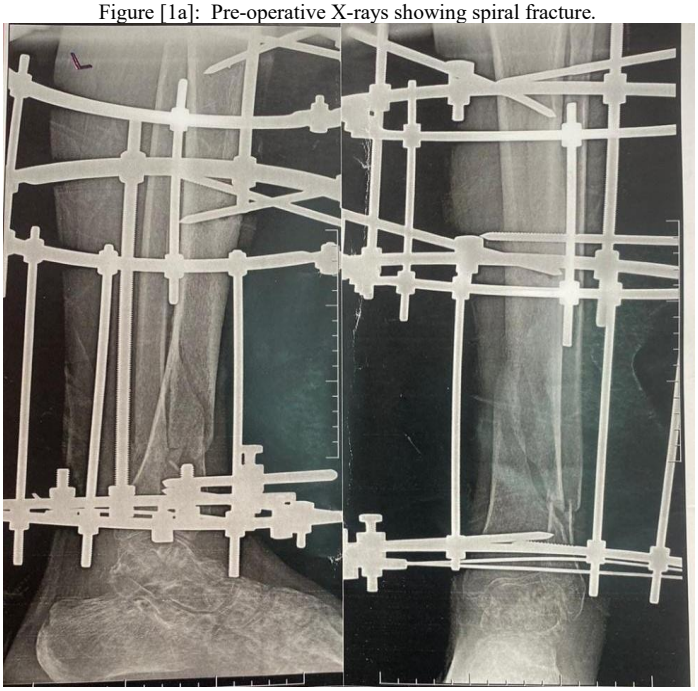

Figure [1c]: Immediate post-operative x-ray.

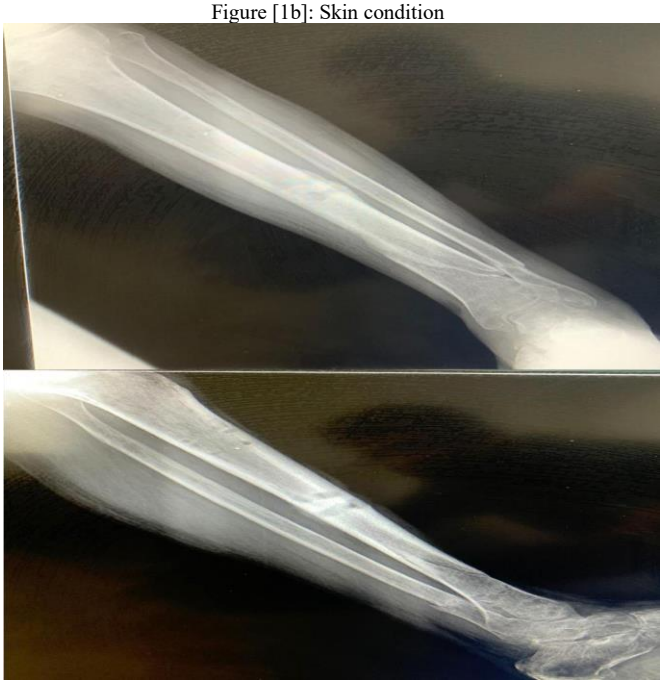

Figure [1d]: Complete fracture union.

Figure [1]: Shows case one

Figure [2a]: Pre-operative X-rays.

Figure [2b]: Skin condition

Figure [2c]: Immediate post-operative x-ray.

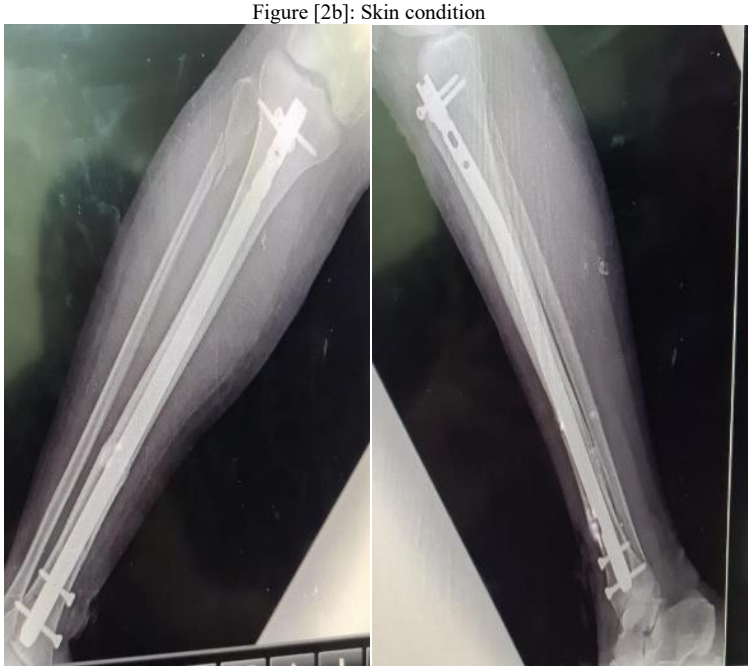

Figure [2d]:Complete fracture union

Figure [2]: Shows case two

DISCUSSION

Regarding demographic data among the study population, our results showed that age in Ilizarov group ranged from 22 to 42 with mean ± SD =32.9 ± 6.45 while in IM nail group the age ranged from 23 to 43 with mean ± SD = 32.5 ± 6.65 with no statistical significant difference [p= 0.893] between the two groups. Regarding age distribution, there was no statistically significant difference between the two studied groups [p= 0.881]. Regarding Sex, in both groups there were 70% males, there was no statistically significant difference between the two studied groups [p= 1]. Our results supported by **Ristiniemi *et al.*** [8] who aimed to compare IMN with external fixators [EF] in the treatment of tibial shaft fractures situated within 5 cm of the ankle, they reported that in IMN group the mean age was 47 ± 15years, among 34 patients there were 25 males. In external fixation group, the mean age was 48 ±12 years, among 33 patients there were 18 [54.5%] males, there was no significant difference between studied groups as regards age and sex.

Regarding trauma type, our current study showed that, in Ilizarov group among 10 patients there were 6[60%] low energy, 4[40%] high energy, in IM nail group there were 8[80%] low energy and 2[20%] high energy, there was no statistical significant difference between the two studied groups [p= 0.329]. Our results disagree with **Vaienti *et al.*** [9] who reported that in IMN group among 102 patients, there were 44[39.5%] patients' low energy fall and 5 [4.9%] high. As well, our results disagree with **Haonga *et al.*** [10] who reported that by using Ilizarov in 19 patients [61%], the high energy trauma was the mechanism. This include a fall from height, motor car accident or direct hit by a heavy object.

Our current study showed that regarding fracture type, in Ilizarov group among 10 patients there were [30%] closed fracture, 70% open fracture, in IM nail group there 20% closed fracture, 80 % open fracture, there was no statistical significant difference between the two studied groups [p= 0.606]. Our results agreed with **Ristiniemi *et al.*** [8] who reported that there was no statistical significant difference between the

IMN group and external fixation group regarding fracture type. On the other hand, our results disagree with **Vaienti *et al.*** [9] who reported that among them 9 patients, there were 5 [55.5%] closed fracture cases and 4 [44.44%] open fracture cases.

Regarding major complications incidence among the study population, our current study showed that, in IM nail group there were 10% had Compartment syndrome that needed for surgical interference by doing fasciotomy to relive it and 10% had Delayed union that dealt with it by iliac bone graft. In Ilizarov group 10% had delayed union, no patients had deep infection, there was no statistical significant difference between the two studied groups [p= 0.399]. Our results agreed with **Peng *et al.*** [10] who reported that by using IMN among 21 patients, three cases developed delayed union.

Also, our results in line with **Haonga *et al.*** [11] who reported that there were there was no statistical significant difference between the two studied groups regarding deep infection [**p**= 0.840]. As well, our results in contrast with **El Ibrahimi *et al.*** [12] who aimed to evaluate the functional results and the practicability of using interlocking nails to treat distal tibial fractures, 150 patients with a closed tibial fracture were treated, complications included two deep infections at the distal screw, no major complications occurred.

Regarding malunion, our findings revealed that 9 [90%] reported no malunion in both groups, in Ilizarov group there were 1 [10%] Valgus > 5º, no Rotation > 10º, in IMN group, there were 10% Rotation > 10º and no Valgus> 5º, there was no statistical significant difference between the two studied groups [p= 0.368]. Regarding Minor complication, our findings revealed that in Ilizarov group there were 50% had superficial infection, in IM nail group, there was no minor complications, there was a significant difference between the two studied groups regarding minor complications [p= 0.01]. Our results supported by **Haonga et al.** [10] who reported that there was no statistical significant difference between the two studied groups [IMN & external fixation] groups [**p**= 0.632] regarding superficial infection.

Regarding functional outcome among the study population, our results showed that there was no significant difference between the two groups regarding functional outcome among the study population. In Ilizarov group, there were 70 % had pain, 20% limited walk and no unable to walk, 30% not need support, 20% unable to run, 20% had no swelling. In IMN group, there was no patients had pain, 0% limited walk and 20% unable to walk, 0 % not need support, 30% unable to run, 10% had no swelling Regarding Functional outcome total score among the study population. The Total score in Ilizarov group ranged from 38 to 92 with mean ± SD = 73.8 ± 16.84 while in IM nail group the Total score ranged from 8 to 74 with mean ± SD = 43.1 ± 26.81 with statistical significant difference [p= 0.008] between the two groups. Our results supported by **Haonga *et al.*** [11] who reported that the mean short musculoskeletal function assessment score was 34.55 ± 31.88 [range 0.8– 96], among 185 subjects with 190 distal tibial fractures. Five patients [10%] had mild anterior knee pain. However, no restriction of the knee motion and function was recorded. Forty-five patients were capable to walk an unlimited distance, Forty-two subjects were able to participate in the recreational activities [e.g., soccer, running, aerobics and rowing].

Regarding radiological outcome among the study population, our results showed that, in Ilizarov group among 10 patients there were 80 % union, 10% malunion, no delayed union and 10% Non-union. In IM nail group there were 70% union, 10% malunion, 10% delayed union and 10% Non- union, there was no statistical significant difference between the two studied groups [p= 0.785]. Our results are in contrast with **Vaienti et al.** [9] who reported that in IMN group there were no delayed union and there was no nonunion.

Conclusion: Adult distal tibia fracture can be effectively fixed with expert nail which have less invasive technique, less complications, better biochemical and biological advantage, more satisfaction, allow early mobilization and weight bearing as load sharing device and superior functional outcome in comparison with Ilizarov in management of distal tibia fracture. However, the results must be treated caution due to the small sample size and short duration of follow-up; the main two limiting steps of the current work; which prevent globalization of results.

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