

2024

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### How to Cite This Article

Katamesh, Ali Adel; Hegazy, Mohamed Osama; and Hassen, Ahmed Shaban (2024) "Ilizarov external fixation versus plate osteosynthesis in the management of complex extra-articular distal tibial fractures," *Trends in advanced sciences and technology*. Vol. 1, Article 16.

DOI: 10.62537/2974-444X.1017

Available at: <https://tast.researchcommons.org/journal/vol1/iss1/16>

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## ORIGINAL STUDY

# Ilizarov External Fixation Versus Plate Osteosynthesis in the Management of Complex Extra-articular Distal Tibial Fractures

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## Abstract

**Background:** This study aimed to compare Ilizarov external fixation (IE) versus plate osteosynthesis (PO) as a definitive treatment of complex extra-articular distal tibial fractures.

**Methods:** A comparative prospective randomized control study was carried out on series of thirty cases met the inclusion criteria, classified into two equal groups. The first one was managed using plate osteosynthesis. The second one was managed using IE. For group A, nonweight bearing ambulation was allowed two days after the surgery while partial weight-bearing was allowed depending on the clinical and radiological criteria of the progress in the union. Regarding the second group, weight bearing was initiated as tolerated one day after the surgery. The patients carry out their physiotherapy as well as the pin-site care.

**Results:** According to Ovadia and Beals' scoring system objective score in group A (excellent 3, good 8, fair 2, poor 2) while in group B (excellent 8, good 4, fair 2, poor 1) *P* value was 0.268083 which is insignificant.

Regarding subjective score in group A (excellent 4, good 8, fair 1, poor 2). In group B (excellent 8, good 4, fair 2, poor 1) *P* value was 0.34303 which is insignificant. The average time for union was 16.69 weeks (range, 14–28 weeks) in the first group and 18.33 weeks (ranging from 16 to 26 weeks) in the second group. The results can be considered the same in both groups and many cases showed satisfaction with the outcome.

**Conclusions:** IE and PO are efficient in treating and fixing closed extra-articular fractures with no significance except for superficial infection as all patients in group B had pin tract infections while in group A two patients had superficial infections which were treated successfully with oral antibiotics. Proper handling to soft tissues is pivotal for better healing of the fractures and to prevent complications as well.

**Keywords:** Distal tibia, Extra-articular, Fractures, Ilizarov, Plate osteosynthesis

## 1. Introduction

Distal tibial fractures represent 37.8% of all tibial injuries (Mahmood and Kumar, 2014). Rotational and axial forces are the main causes of these fractures. As these fractures usually follow a high-energy trauma, approximately half of the cases might have other lower limb injuries, usually tibial or calcaneal fractures on the same side. Also, 6% of cases might be with multiple system injuries (Joveniaux

et al., 2010). Distal tibial fracture treatment in skeletally mature cases with no extension is a challenge for Orthopedicians because of the poor soft tissue coverage, complex fracture anatomy, and proximity to the ankle joint. Possible complications include malunion, nonunion, infection, and post-traumatic arthritis (Newman et al., 2011). Surgical treatment includes various methods. Open reduction and internal fixation (ORIF) provide stability, yet it has an elevated rate of soft tissue and neurovascular complications.

Received 4 February 2024; revised 12 May 2024; accepted 7 July 2024.  
Available online 4 October 2024

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<https://doi.org/10.62537/2974-444X.1017>

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Minimally invasive percutaneous plate osteosynthesis (MIPPO) exhibited increased rate of healing with minimal soft-tissue complication (Oh et al., 2003). External fixation has a role in patients having severe comminution and bad soft tissue. It has good functional results with minimal soft tissue complications (Marcus et al., 2013). Closed intramedullary nailing (IMN) is a minimally invasive technique that has a role in extra-articular fractures. It preserves soft tissue integrity and extra osseous blood supply (Bacon et al., 2008).

This work aimed to compare Ilizarov external fixation (IE) versus plate osteosynthesis (PO) as a definitive treatment of complex extra-articular distal tibial fractures.

## 2. Patients and methods

A comparative prospective randomized control study was carried out in Badr hospital, Elhelmyah Military Hospital for Burns and Orthopedics, and Elhhal Hospital from August 2021 to August 2022. A series of 30 patients were enrolled, divided into two groups. Group (A) included fifteen cases that were treated with plate osteosynthesis. Group (B) included fifteen cases that were treated with Ilizarov external fixation. All cases had clear explanation concerning the study and informed consent was obtained from each patient. The age ranged from 19 to 72 with mean of  $42.06 \pm 19.07$  in group A, whereas in group B ranged it was between 18 and 71 with mean of  $41.8 \pm 17.352$ .

Group A includes eight (53.3%) males and seven (46.7%) females while group B includes 11 (73.3%) males and four (26.7%) females. Both groups include nine (60%) patients with Rt side fractures and six (40%) patients with Lt side fractures. In group A seven (46.7%) patients presented with high-energy traumas and eight (53.3%) with low-energy traumas, whereas in group B males 10 (66.7%) patients presented with high-energy trauma and five (33.3%) with low energy trauma. All patients in both groups were presented with associated fibular fractures (Table 1).

All cases were prepared before operations (for instance cases with poly-traumas were checked for stable vital signs). Any abrasions, bruises, contusions,

lacerations, and neurovascular injuries were examined, and a radiological investigation was done as well. The inclusion criteria were adult (aged >18 y) male and female patients with distal complex closed extra-articular fractures type A3. We explained in detail the condition of each patient to him/her pre-operatively, also, operation details and instructions following surgery were informed.

A consent was taken from each patient to be enrolled in this study and to be treated with PO or IE randomly.

### 2.1. Surgical technique

Surgeries in group A were delayed till good soft tissue condition with average 10 days before operation while in group B surgeries were done as soon as possible with average two days after injury. All surgeries were done under spinal anesthesia. PO surgeries were performed through minimally invasive techniques to keep the soft-tissues and vasculature in the metaphyseal fracture site. Skin incision was carried out on the medial side of the distal tibia straightly, or with slight curving. The incision's length varies from 3 to 5 cm. Plate contouring was done by making concave arc at the distal 8–12 cm of the plate to fit the distal tibia. A cloverleaf plate and distal tibial locked plate were used. In IE, Ilizarov frames of stainless-steel material that is composed of two rings only were used for all cases, in some cases fracture was supported with a calcaneal ring or calcaneal shank connected to the distal ring.

#### 2.1.1. Postoperative instructions

For the PO group, nonweight bearing ambulation was allowed on the second day after surgery, discharged from, nonweight bearing ambulation was allowed on the second day after surgery, discharged from hospital in a below knee back slab, which was removed after two weeks for active motion of the ankle joint to achieve complete range of motion. Physiotherapy was carried out postoperatively by patients themselves due to their low socioeconomic status in the form of active ROM for the knee as well as the ankle joints. Physiotherapy was carried out immediately in the IE group, and in a gradual

Table 1. Demographic data of the studied cases.

Operative technique	Plate Osteosynthesis (n = 15) [n (%)]	Ilizarov external fixation (n = 15) [n (%)]
Sex (M/F)	8/7	11/4
Mean age in years	42.06	41.8
Side (RT/LT)	9/6	9/6
Fracture type: number of patients	A2: 9 (60) A3: 6 (40)	A2: 8 (53.3) A3: 7 (46.7)

manner following removing the suture in the PO group.

Weight bearing was allowed partially based on the clinical and radiological progress in the union criteria. For the IE group, weight-bearing began as can be tolerated from the 1st day postoperatively. The patients themselves did continuous pin-site care and checked regularly at every visit.

Follow-up of each patient was done once/3 weeks till union of the fractures and once/3 months later. The fractures were united when we observed a bridging callus at the site of the fracture in greater than or equal to 3 cortices in the anteroposterior and lateral views. Trabeculations that extend through the fracture's region were considered as well (Figs 1, 2).

## 2.2. Statistical analysis

Statistical analysis was done by SPSS v26 (IBM Inc., Chicago, IL, USA). Quantitative variables were presented as mean and standard deviation (SD) and compared between the two groups utilizing unpaired Student's *t*-test. Qualitative variables were presented as frequency and percentage (%) and analyzed using the  $\chi^2$  or Fisher's exact test when appropriate. A two-tailed *P* value less than 0.05 was considered statistically significant.

## 3. Results

Operative time ranged from 90 to 120 min with mean of  $104.7 \pm 10.24$  in group A and from 90 to 120 with a mean of  $107.3 \pm 9.98$  in group B. there were no major complications during surgery. Time for union ranged from 12 to 22 weeks with a mean of  $16.538 \pm 2.7905$  in group A. whereas in group B was from 16 to 36 weeks with a mean of  $19.733 \pm 4.891$ . In group A two patients developed superficial infections and 1 case developed deep infection treated with implant removal and fixation with ilizarov. Pin tract infection was reported in all cases of group B. All cases were controlled using 1st generation cephalosporins orally or parentally with no deep infection.

Regarding Ovadia and Beals scoring system objective score in group A three patients get excellent, eight get good, two got fair and two get poor while in group B eight patient got excellent, four get good, two get fair while one were poor (Table 2).

Table 2. Results according to Ovadia and Beals scoring system objective score.

Results	Group A	Group B
Excellent	3	8
Good	8	4
Fair	2	2
Poor	2	1



Fig. 1. 50 years old man presented with A3 extra-articular fracture of the tibia as well as the fibula on the right side managed using PO. A) Represents AP and lateral radiographs of post-traumatic fractures of lower bones. B) Represents AP and lateral radiograph of fracture fixation postoperatively by plate osteosynthesis. C) AP, lateral radiograph at last follow-up after the 14th week showing good outcome for subjective and objective Ovadia and Beals scoring system.

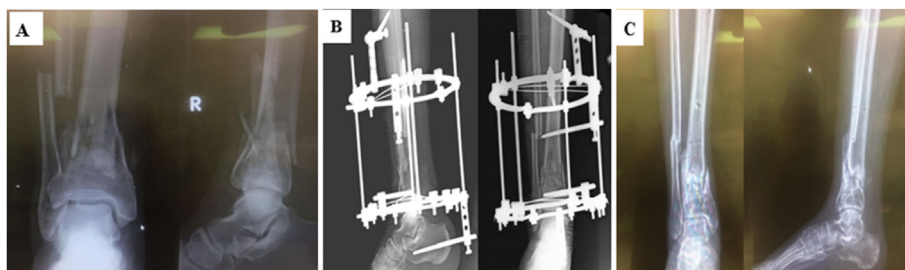


Fig. 2. 60 years old female patient presented with A3 extra-articular fracture of the right tibia and fibula treated with IE. A) AP & lateral radiographs of post traumatic fractures of lower leg bones. B) AP, and lateral radiograph of fracture fixation by ilizarov postoperatively. C) AP, lateral radiograph at last follow-up following 20 weeks and outcome was fair for subjective and objective Ovadia and Beals scoring system.

Table 3. Results according to Ovidia and Beals scoring system subjective score.

Results	Group A	Group B
Excellent	4	8
Good	8	4
Fair	1	2
Poor	2	1

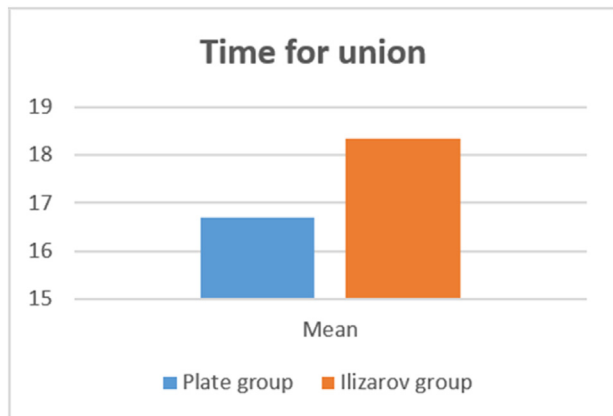


Fig. 3. Time of union among studied groups.

Regarding subjective score in group A four patient get excellent, eight get good, one get fair while two was poor. In group B eight cases get excellent, four get good, two get fair while one get poor (Table 3).

Regarding union, there is one (6.7%) cases of delayed union in group A while two (13.3%) cases of delayed union in group B with. No patients showed malunion in group A while there is one (6.7%) case of malunion in group B. No cases of nonunion in both group (Fig. 3).

There was no significant difference regarding the time of union and complication except for superficial infection as all patients in group B had pin tract infection while in group A 2 patients had superficial infection. Good handling to soft tissues is an important factor to rapid healing of the fracture and to avoid complications.

#### 4. Discussion

Distal tibial fractures are one of the problematic and challenging fractures because of poor soft tissue covering and poor vascularization. There are various surgical techniques for treatment including plate osteosynthesis, IE and nailing. Although PO and ilizarov eternal fixation have proved to be efficiently greatly accepted therapeutic options for distal tibial fractures, few comparative studies were conducted to optimize the therapeutic decision. A study by Janssen et al. (2007) compared using IMN

and PO in the management of extra-articular distal tibial fracture. Janssen documented that the time for radiological union averaged 147 days for IMN and 133 days for PO.

In the current study, it averaged 117 days in PO and 128 days in IE. Another comparative study Lee et al. (2008) between locked and unlocked IMN reported that distal 3rd fractures of tibia managed using intramedullary nail had higher mal-union rate in comparison with the middle third fractures ( $P = 0.06$ ). In addition, four patients in this study showed nail migration in the unlocked group and two patients had broken distal locking screws in the locked group. In our study, there was 1 case of malunion in IE group. A study by Brown et al. (Court-Brown et al., 1997) concerning knee pain following intramedullary nail, revealed that functionally impaired cases due to experiencing knee pain were 91.8 while 33.7 percent of cases suffered pain even during rest. Another study by Keating et al. (Keating et al., 1997) regarding intramedullary nail in tibial fractures concluded that in 80% of cases needed to remove the nail, chronic knee pain following intramedullary nail was a disturbing complication irrespective of the surgical technique used, ranged between 5 and 86% and removing the nail could not eradicate pain.

Our study has no case with anterior knee pain.

A retrospective comparative study Vallier et al. (2008) between IMN and PO for one hundred eleven cases with extra-articular distal tibia fracture (76 were managed using an intramedullary nail and 37 were treated with Plate osteosynthesis). Osteomyelitis appeared in 5.3% managed by intramedullary nail and 2.7% after Plate osteosynthesis, 12% had delayed union or nonunion after intramedullary nail and 2.7 percent had a nonunion after PO ( $P = 0.10$ ). In our study 1 (6.7%) case in PO group had deep infection while no cases in the IE group had a deep infection. 2 (13.3%) cases had delayed union in IE group. 1 (6.7%) case had delayed union in group B. A comparative study by Bach et al. (Bach and Hansen, 1989) on comparing the usage of EF and plate in 59 cases having distal tibial open fracture types II and III. 19% of patients in the PO group were complicated by severe osteomyelitis, whereas 11.5% had failed fixation that necessitated an EF, whereas only 1 case of the EF group documented osteomyelitis. In our study 1 (6.7%) case in the PO group had a deep infection while no cases in the IE group had a deep infection.

A retrospective comparative study by Ristiniemi et al. (2011) between intramedullary nail and external fixators in the distal tibial fractures. The healing time was 21 weeks in the intramedullary

Table 4. Summary of the relevant studies in the literature compared with the current study.

Author/Year	Region	Journal	Type of fixation		Mean		Time of union in weeks		PO	IE	BIN	Outcome parameters 'scoring system'	Result of scoring system	Site of fracture
			PO	IE	PO	IE	PO	IE						
Janssen et al. (2007)	Netherlands	Int orthop	12	–	–	12	19	–	21	–	Knee society score	P0146 IMN 139	Extra articular distal tibia	
Lee et al. (2008)	Taiwan	Int orthop	–	82	–	–	–	17.25	–	–	Functional score of karlstrom and olend	IE 33.65	Middle and distal 1/3 tibia	
Court-Brown et al. (1997)	Scotland	J orthop trauma	–	16.9	–	–	–	–	–	–	Knee pain	NA	Tibial diaphysis	
Keating et al. (1997)	Scotland	J orthop trauma	–	11	–	–	–	–	–	–	Knee pain	NA	Tibial diaphysis	
Vallier et al. (2008)	USA	J orthop trauma	37	–	–	76	–	–	–	–	–	NA	Extra articular distal tibia	
Bach and Hansen (1989)	USA	CORR	29	30	–	–	–	–	–	–	–	NA	Tibial diaphysis	
Ristinieni et al. (2011)	Finland	J orthop trauma	34	33	–	–	21	23	–	–	Olerud-Molander ankle score	PO 75 IE 74	Extra articular distal tibia	
Current study	Egypt	–	15	15	–	–	17.5	19.7	–	–	Ovadia and Beals objective and subjective score	PO E3, G8, F2, P2 PO E4, G8, F1, P2 IE E8, G4, F2, P1 IE E8, G4, F2, P1	Extra articular distal tibia	

nail group and 23 weeks in the external fixator group. In our study the mean healing time was 16.69 weeks in the PO group and 18.33 weeks in the IE group.

We found that IE will provide provisions of immediate weight-bearing as tolerated after recovery, with no cases of non-union or deep infection but it has a high rate of pin tract infection which is treated with oral antibiotics. PO needs good soft tissue handling to minimize complications we reported one case of deep infection treated with secondary surgery to remove implants and fixed with ilizarov and one case of delayed union with a lower rate of superficial infection than ilizarov. Table 4 shows the summary of the relevant studies in the literature compared with the current study.

A study by Fadel et al. (2015) evaluate the outcome of IE versus dynamic compression plate (PO) in the management of extra-articular distal tibial fractures. Reported that the rate of healing in the IE group (average 130) was higher than the PO (average 196.5); plus, there were no cases of delayed union or nonunion in the IE group (P value 0.003). In our study, there was no statically difference regarding time of healing in both groups.

#### 4.1. Conclusions

We found that IE and PO are efficient in treating and fixing closed extra-articular fractures with no statistically significant difference except for superficial infection as all patients in group B had pin tract infection while in group A 2 patients had superficial infection.

#### Funding

None to declare.

#### Author contribution

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by AAK, MOH and ASH. The first draft of the manuscript was written by AAK and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

#### Ethics approval and consent to participate

The study was done at Badr Hospital, Elhelmyah Military Hospital for Burns and Orthopedics, and Elhwal Hospital from August 2021 to August 2022 and the Helwan University Research Ethical Committee approved the protocol of this study. All

patients provided written permission after being fully briefed.

### Consent for publication

Informed written consent was taken from each patient for publishing their photos.

### Availability of data and material

The datasets used and/or analyzed during the current study are available as MS Excel files (.xlsx) from the corresponding author upon reasonable request.

### Conflicts of interest

There are no conflicts of interest.

### References

- Bach, A. W., & Hansen, S. T. Jr (1989). Plates versus external fixation in severe open tibial shaft fractures. A randomized trial. *Clinical Orthopaedics and Related Research*, 241, 89–94.
- Bacon, S., Smith, W. R., Morgan, S. J., Hasenboehler, E., Philips, G., Williams, A., et al. (2008). A retrospective analysis of comminuted intra-articular fractures of the tibial plafond: Open reduction and internal fixation versus external Ilizarov fixation. *Injury*, 39, 196–202.
- Court-Brown, C. M., Gustilo, T., & Shaw, A. D. (1997). Knee pain after intramedullary tibial nailing: its incidence, etiology, and outcome. *Journal of Orthopaedics and Trauma*, 11, 103–105.
- Fadel, M., Ahmed, M. A., Al-Dars, A. M., Maabed, M. A., & Shawki, H. (2015). Ilizarov external fixation versus plate osteosynthesis in the management of extra-articular fractures of the distal tibia. *International Orthopaedics*, 39, 513–519.
- Janssen, K. W., Biert, J., & van Kampen, A. (2007). Treatment of distal tibial fractures: plate versus nail: a retrospective outcome analysis of matched pairs of patients. *International Orthopaedics*, 31, 709–714.
- Joveniaux, P., Ohl, X., Harisboure, A., Berrichi, A., Labatut, L., Simon, P., & e, al (2010). Distal tibia fractures: management and complications of 101 cases. *International Orthopaedics*, 34, 583–588.
- Keating, J. F., Orfaly, R., & O'Brien, P. J. (1997). Knee pain after tibial nailing. *Journal of Orthopaedics and Trauma*, 11, 10–13.
- Lee, Y. S., Lo, T. Y., & Huang, H. L. (2008). Intramedullary fixation of tibial shaft fractures: a comparison of the unlocked and interlocked nail. *International Orthopaedics*, 32, 69–74.
- Mahmood, A., & Kumar, G. (2014). Review of the treatment of distal tibia metaphyseal fractures; plating versus intramedullary nailing: a systematic review of recent evidence. *Foot and Ankle Surgery*, 20, 151.
- Marcus, M. S., Yoon, R. S., Langford, J., Kubiak, E. N., Morris, A. J., et al. (2013). Is there a role for intramedullary nails in the treatment of simple pilon fractures? Rationale and preliminary results. *Injury*, 44, 1107–1111.
- Newman, S. D., Mauffrey, C. P., & Krikler, S. (2011). Distal metadiaphyseal tibial fractures. *Injury*, 42, 975–984.
- Oh, C. W., Kyung, H. S., Park, I. H., Kim, P. T., & Ihn, J. C. (2003). Distal tibia metaphyseal fractures treated by percutaneous plate osteosynthesis. *Clinical Orthopaedics and Related Research*, 408, 286–291.
- Ristiniemi, J., Luukinen, P., & Ohtonen, P. (2011). Surgical treatment of extra-articular or simple intra-articular distal tibial fractures: external fixation versus intramedullary nailing. *Journal of Orthopaedics and Trauma*, 25, 101–105.
- Vallier, H. A., Le, T. T., & Bedi, A. (2008). Radiographic and clinical comparisons of distal tibia shaft fractures (4 to 11 cm proximal to the plafond): plating versus intramedullary nailing. *Journal of Orthopaedics and Trauma*, 22, 307–311.