Indian Journal of Orthopaedics Surgery 2022;8(2):171–175

Content available at: https://www.ipinnovative.com/open-access-journals

Indian Journal of Orthopaedics Surgery

Journal homepage: https://www.ijos.co.in/

Case Series

Outcome of hybrid external fixator in the treatment of open distal tibia fractures

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ARTICLE INFO

Article history:
Received 31-05-2022
Accepted 02-06-2022
Available online 15-06-2022

Keywords:
Hybrid external fixators
Distal tibia fractures

ABSTRACT

Introduction: Distal tibia fractures are very common in day-to-day practise. Because one-third of the tibia is subcutaneous throughout most of its length and its location, it is more prone to open fractures.Distal tibia fractures (mostly due to RTA, sports injuries) include extra-articular fracture of the metaphysis and intra-articular pilon fractures. Treatment depends on the closeness to the tibial plafond, displacement of the fracture, comminution, and injury to the soft tissue envelope.The goal of treatment is to obtain a healed, well-aligned fracture; pain-free weight-bearing; and functional range of motion of the knee and ankle.

Materials and Methods: 17 patients of the 18–60-year age group with open distal tibia fractures (without vascular injury) of less than 3 weeks old of trauma were included in the prospective study of 1 year period (1^{st} June 2019 to 31^{st} May 2020). All cases were treated with the Hybrid external fixator (HEF).

Results: The mean duration of surgery was 67.6 minutes. All fractures united with a mean time of 16.5 weeks. The mean AOFAS score at 6 months was 84.59. A good-excellent functional outcome was seen in 88.25% of the cases. There was 1 case of valgus deformity and 4 cases of pin-tract infections.

Conclusion: HEF is effective in the treatment of open distal tibia fractures as it provides stable fracture fixation, early joint motion, and weight-bearing with minimal complications without jeopardizing the status of soft tissue condition.

1. Introduction

Distal tibia fractures are very common in day-to-day practise. Because of its location, the tibia is exposed to frequent injuries. It is the most commonly fractured long bone. Because one-third of the tibia is subcutaneous throughout most of its length, open fractures are more common in the tibia than in any other major long bone.[1] Distal tibia fractures include extra-articular fractures of the metaphysis and intra-articular pilon fractures. High-velocity trauma, including road traffic accidents (RTA) and sports injuries, accounts for approximately 37.8% of all tibial injuries.[2] The challenges of treating these fractures are extremely damaged soft tissue as well as comminuted metaphyseal and articular comminution.[3]

Treatment depends on the closeness to the tibial plafond, displacement of the fracture, comminution, and injury to the soft tissue envelope.[4] There is a broad consensus that the status of the soft tissue is the first priority because it is the basis of fracture healing.[5] The goal of treatment is to obtain a healed, well-aligned fracture; pain-free weight-bearing; and functional range of motion of the knee and ankle.[6]

Surgical intervention for open fractures is commonly managed as a one-stage or multi-stage procedure with external and internal fixation.[7] The role of modern external fixators with circular frames and tension transfixion wires that do not span the ankle joint have gained popularity because these devices minimize soft tissue problems and

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https://doi.org/10.18231/j.ijos.2022.030

allow for early joint motion while providing stability for fracture union.[8] In the case of circular ring fixators, pin site care and effective management of superficial infections are important to avoid deep infection.[9] While plate osteosynthesis has a high risk of soft tissue complications and ankle spanning external fixators cause stiffness in the ankle joint, hybrid external fixators have the ability to provide fixation at a single staged procedure.[10–12] Keeping this view in mind, a study was conducted to evaluate the role of the functional and radiological outcome of the hybrid external fixator in the treatment of open distal tibia fractures.

2. Materials and Methods

This hospital-based prospective study was cleared by the Institutional Ethics Committee of the institute and informed consent was taken from all patients who met the inclusion criteria of the study. In a period of 1 year (1^{st} June 2019 to 31^{st} May 2020), 17 patients (18-60 year age group) with the open distal tibia (less than 3 weeks old of trauma; without any vascular injury) were included in the study. Patients having pathological fractures, close fractures, old fractures (more than 3 weeks old), associated multisystem injuries, and cases contraindicated for surgery were excluded from the study. All cases were treated with the hybrid external fixator (HEF).

The wound was exposed (and bleeders, if any, were ligated), and thoroughly washed with a copious amount of fluid. More than 9 litres of fluid were used in type III open fractures.[13] Contaminants and necrotic tissues were removed in the emergency room as much as possible. Stay sutures were applied in type II and type III-A open fractures. The fractured limb was splinted with the help of a long leg POP slab. For type-I open fractures and clean type II, third-generation cephalosporin was used. One aminoglycoside and metronidazole were used for contaminated type-II and all type-III fractures.[14] All contaminated cases were debrided and operated as emergency cases within 24-48 hours. Clean type-I and II cases were treated as elective cases. Involved side knee and ankle with tibia and fibula at full length-anteroposterior and lateral view X-rays were taken in all patients; and a CT scan was done, if required. After spinal anaesthesia, the patient was placed on a radiolucent fracture table in a supine position. Bony ends were curetted. All necrotic tissues and contaminants were removed. Wounds were washed with normal saline (NS). The distal full ring was applied (1^{st} wire applied parallel to joint line anterolateral to posteromedial, followed by 2^{nd} wire posterolateral to anteromedial applied anterior to fibula maintaining at least 45° to the first wire and lastly drop wire was used to achieve stability of fracture reduction). The fracture was reduced under direct vision in large open fractures under intra-operative fluoroscopic guidance in the case of a small wound. Ankle spanning was not done as the reduction was stable. After reduction, three 4.5mm half pins were passed in the diaphysis through the normal soft tissue at various angles. Pins were then connected to a tubular connecting bar, and the same bar was fastened to the ring with a universal clamp or AO clamp. Another connecting bar was used to connect the previous bar and ring in an oblique fashion on the lateral side. Wounds that were amenable to closure were closed. Open wounds were later managed by plastic surgeons. The fibula was not fixed regularly as fibula fixation is not necessary in a case of external fixation.[15] Intravenous antibiotics were continued throughout the hospital stay. The post-operative dressing was done on third day. After that, regular dressing was done on the large and contaminated wounds. Pin track was cleaned with NS swab daily and covered with betadine pellet for 1 week. After that, pin tracks were cleaned with NS swab twice daily. The rings and rods were cleaned with spirit swabs daily. The post-operative equinus deformity was prevented by a sling fastened to the external fixator, which kept the limb in a plantigrade position. Static quadriceps, active knee bending, and ankle movements were started as early as possible depending on the pain threshold of patients. Assisted weight-bearing was started early depending on fracture configuration. Patients were discharged between 7-14 days after the operation, depending on the soft tissue condition. All cases were followed up at an interval of 1 month, 3 months, and 6 months. At every visit, patients were assessed clinically regarding ankle range of motion, walking ability, fracture union, deformity, and shortening. American Orthopaedic Foot and Ankle Society (AOFAS) score[16] was used for evaluation. An X-ray of the involved leg with ankle was done to assess fracture union and implant-bone interaction.

Cases were considered to have achieved union when there was no relative motion between fracture fragments and no tenderness at fracture sites clinically; union of any three cortices out of four in AP and lateral views radiologically. Delayed union was defined as when a fracture had not healed in the time frame that would be expected. Non-union was defined as no union for up to 9 months or no radiological evidence of union for three consecutive months.[14] The cuts off for various deformity were varus<5°, valgus <5°, apex anterior/posterior<10°, rotation <0–10°, shortening<10–12 mm. Functional assessment was done at 6 months.[17,18]

2.1. Statistical analysis

The statistical analysis of the data was performed using the computer program, Statistical Package for Social Sciences (SPSS for Windows, version 20.0. Chicago, SPSS Inc.) and Microsoft Excel 2010. Results on continuous measurements are presented as mean ± standard deviations and are compared using the student t-test. Discrete data are expressed as numbers (%) and are analyzed using the Chi-square test and Fischer's exact test (where the cell counts

were <5 or 0). The statistical significance was fixed at a 5% level (p value<0.05) for all analyses.

3. Results

Table 1: Pre-operative variables

Variables	Cases treated with HEF (n=17)
Mean Age	40.9 years
Sex	Male: 11 (64.7%); Female: 6 (35.3%)
Mode of injury	RTA:11 (64.7%); self fall:4 (23.6%); sports injury:2 (11.7%)
Side of involvement	Right:10 (58.8%); Left:7 (41.2%)
AO classification type 43AO/OTA [19]	A1:2 (11.8%); A2:2(11.8%); A3:1 (5.9%) B1:2 (11.8%); B2:5 (29.4%); B3:2 (11.8%) C1:1(5.9%); C2:1 (5.9%); C3:1 (5.9%)
Gustilo and Anderson [20,21] classification type of open fracture	Type I:6 (35.3%); Type II:5 (29.4%); Type III-A: 4 (23.5%); Type III-B: 2 (11.8%)
Time interval between trauma and surgery	0-2 days: 13 (76.5%); 3-7 days: 4 (23.5%)
Mean duration of surgery	67.6 minutes

Table 2: Union and functional outcome

Variables	Results of cases treated with HEF (n=15)
Mean AOFAS score [16] at 6 months	84.59 (43AO type- A: 89.0; B: 83.5; C: 78.7) (open type- I: 89; II: 84.4; III: 80.3)
Mean time to union (in weeks)	16.47 (open type- I: 14; II: 16.4; III: 19.5)
John and Wruh's criteria [22]	Excellent: 8 (47.05%); Good:7 (41.2%); Fair:2 (11.8%)

Table 3: Complications

Complications	Complications of cases treated with HEF
Valgus malalignment ~15°	1 (5.9%)
Superficial pint-tract infection	4 (23.5%)

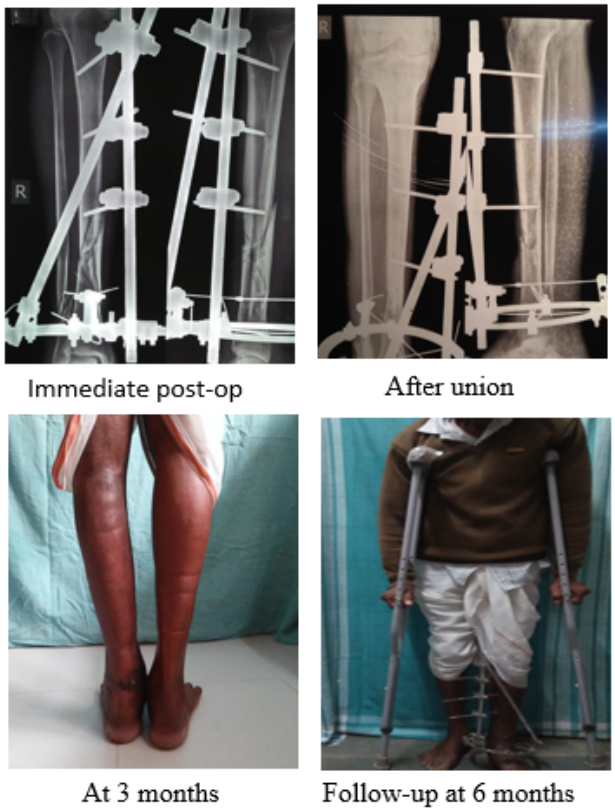

Fig. 1:

4. Discussion

We conducted a study on the efficacy of HEF in the treatment of 17 cases of open distal tibia fractures. The mean age in the study was 40.9 years. The mean duration of surgery was 67.6 minutes. All cases were united with a mean time of 16.5 weeks. The mean AOFAS score at 6 months was 84.59. Good-excellent functional outcome was seen in 88.25% of cases, with a mean duration of hospital stay of 11.76 days. Union time was increased as the fracture severity increased. Status of soft tissue, degree of comminution, and precarious blood supply make the plan of management difficult in distal tibial fractures. Long-term clinical outcome is affected by the mechanism of injury, the status of soft tissues, the degree of comminution, and articular damage. Open distal tibial fractures can be managed with conventional plating, minimally invasive plate osteosynthesis, uniplanar, biplanar or circular external fixators, and intramedullary interlocking nails. HEF provides stable fracture fixation; respects soft tissue, allows early range of motion and weight-bearing. It brings new complications like pin-tract infection. It can be used as a primary or temporary device. [8]

5. Conclusion

In our study of a 1 year period, we conclude that HEF is effective in the treatment of open distal tibia fractures as it provides stable fracture fixation, early joint motion, and weight-bearing with minimal complications without jeopardising the status of soft tissue condition.

Table 4: Comparison with various studies

Study	Sample size	Mean follow-up	Results
Tornetta et al[23] (1993)	26	36 months	Mean time to union at 4.2 months 81% Good-excellent outcome 3.85% varus malunion 11.5% pin-tract infection
Babis et al[8] (2010)	48	14 months	89.6% union rate Mean time to union at 3.6 months 10.4% non-union 14% superficial pin-tract infection
Galante et al[24] (2016)	162	52 months	98.15% union rate Mean time of union at 4.17 months 1.85% non-union 26% pin-tract infections
Scaglione et al[25] (2019)	75	2 years	94% union rate 84% Good-excellent outcome 30% pin-tract infection
Our study	17	6 months	100% union rate Mean time to union at 4.1 months 88.2% good-excellent & 11.8% fair outcome 23.5% pin-tract infection

6. Source of Funding

None.

7. Conflict of Interest

The authors declare no conflict of interest.

References

1. Rudloff JM. Fractures of the lower extremity. In: Azar FM, Beaty JH, Canale ST, editors. Campbell's Operative Orthopaedics. Philadelphia PA: Elsevier; 2017. p. 2740.
2. Mahmood A, Kumar G. *Foot Ankle Surg*. 2014;20(2):151.
3. Lerner A, Stein H. Hybrid thin wire external fixation: an effective, minimally invasive, modular surgical tool for the stabilization of periarticular fractures. *Orthopaedics*. 2004;27(1):59–62.
4. Cheng W, Li Y, Manyi W. Comparison study of two surgical options for distal tibia fracture-minimally invasive plate osteosynthesis vs. open reduction and internal fixation. *Int Orthop*. 2011;35(5):737–42.
5. Wood FM, Beaty JH, Canale ST. General principles of fracture treatment. In: Campbell's Operative Orthopaedics. Philadelphia PA: Elsevier; 2003. p. 2671–2723.
6. Rudloff MJ. Fractures of the lower extremity. In: Azar FM, Beaty JH, Canale ST, editors. Campbell's Operative Orthopaedics. Philadelphia PA: Elsevier; 2013. p. 2741.
7. Huebner EJ, Ibiher N, Kubosch DC, Suedkamp NP, Strohm PC. Distal tibial fractures and pilon fractures. *Acta Chir Orthop Traumatol Cech*. 2014;81(3):167–76.
8. Babies GC, Kontovazenitis P, Evangelopoulos DS, Tsailas P, Nikolopoulos K, Soucacos PN. Distal tibia fractures treated with hybrid external fixation. *Injury*. 2010;41(3):253–8.
9. May JD, Paavana T, Mcgregor-Riley J, Royston S. Closed Tibial shaft fractures treated with the Ilizarov method: A ten years case series. *Injury*. 2017;48(7):1613–5.
10. Hess F, Sommer C. Minimally invasive plate osteosynthesis of the distal fibula with the locking compression plate: First experience of 20 cases. *J Orthop Trauma*. 2011;25(2):110–5.
11. Bugler KE, Watson CD, Hardie AR, Appleton P, McQueen MM, Court-Brown CM, et al. The treatment of unstable fractures of the ankle using the Acumed fibular nail: development of a technique. *J Bone Joint Surg Br*. 2012;94(8):1107–12.
12. Baird RA, Jackson ST. Fractures of the distal part of the fibula with associated Disruption of the deltoid ligament. Treatment without repair of the deltoid ligament. *J Bone Joint Surg Am*. 1987;69(9):1346–52.
13. Rajasekaran S, Devendra A, Perumal R, Dheenadhayalan J, Sundararajan SR. Initial Management of Open Fractures. In: Rockwood and Green's fractures in Adults. vol. Vol 1. Walter Kluwert; 2015. p. 371–2.
14. Ali AM, Mcmaster JM, Noyes D, Brent AJ, Cogswell LK. Experience of managing open fractures of the lower limb at a major trauma centre. *Ann R Coll Surg Engl*. 2015;97(4):287–90.
15. Ristiniemi J, Flinkkila T, Hyvonem P, Lakovaara M, Pakarinen H, Biancari F, et al. Two ring hybrid external fixation of distal tibial fractures:a review of 47 cases. *J Trauma*. 2007;62(1):174–83.
16. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. *Foot Ankle Int*. 1994;15(7):349–53.
17. Weinlein JC. Delayed union and non-union of fractures. In: Azar FM, Beaty JH, Canale ST, editors. Campbell's Operative Orthopaedics. Philadelphia: Elsevier; 2017. p. 3081–2.
18. Boulton C, O'Toole RV. Tibia and Fibula Shaft Fractures. In: Charles MC, Heckman JD, McQueen MM, Ricci WM, editors. Rockwood and Green's fractures in Adults. Philadelphia: Wolter Kluwer Health; 2015. p. 2429.
19. Müller ME, Heim U, Nazarian S, Koch P, Schatzker J. The Comprehensive Classification of Fractures of Long Bones. Springer Science & Business Media; 2012.
20. Gustilo RB, Anderson JT. Prevention of infection in the treatment of one thousand and twenty-five open fractures of long bones: Retrospective and prospective analyses. *J Bone Joint Surg Am*. 1976;58(4):453–8.
21. Gustilo RB, Mendoza RM, Williams DN. Problems in the management of type III (severe) open fractures: A new classification of type III open fractures. *J Trauma*. 1984;24(8):742–6.
22. Johner R, Wruhs O. Classification of tibial shaft fractures and correlation with results after rigid internal fixation. *Clin Orthop Relat Res*. 1983;178:7–25.
23. Tornetta P, Weiner L, Bergman M, Watnik N, Steuer J, Kelley M, et al. Pilon fractures: treatment with combined internal and external fixation. *J Orthop Trauma*. 1993;7(6):489–96.
24. Galante VN, Vicenti G, Corina G, Mori C, Abate A, Picca G, et al. Hybrid external fixation in the treatment of tibial pilon fractures: a retrospective analysis of 162 fractures. *Injury*. 2016;47:131–7.
25. Scaglione M, Celli F, Casella F, Fabbri L. Tibial pilon fractures treated with hybrid external fixator: analysis of 75 cases. *Musculoskelet Surg*. 2019;103(1):83–9.

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Cite this article: Borah PJ, Patowary C, Das A, Shirdinayak TS. Outcome of hybrid external fixator in the treatment of open distal tibia fractures. *Indian J Orthop Surg* 2022;8(2):171-175.