International Journal of Research in Orthopaedics
*Babu NS et al. Int J Res Orthop. 2023 Mar;9(2):412-417*
http://www.ijoro.org

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20230472

**Case Series**

# Tibia fractures managed with minimally invasive internal fixation: a case series of 20 cases

**Narendra Babu S., Prashanth Dhanraj*, Ehtesham Raza Sayeed, Syeda Sakina Amatul Ali**

Kamineni Academy of Medical Sciences and Research Centre Hospital, Hyderabad, Telangana, India

**Received:** 04 January 2023
**Revised:** 07 February 2023
**Accepted:** 17 February 2023

***Correspondence:**
Dr. Prashanth Dhanraj,
E-mail: plachuriya@yahoo.co.in



## ABSTRACT

Distal tibia fractures are frequently associated with an extensive soft tissue injury, leading to a higher risk of complications such as skin complications, infection, non-union, and eventually poor overall outcome. This study aims to measure the outcome of open/closed distal tibia fractures treated with minimally invasive internal fixation. We aim to propose an algorithm for the management of distal tibia fractures by evaluating the treatment options, outcomes, and risk factors present. This study is a case series study of all distal tibia fractures treated surgically in Kamineni Academy of Medical Sciences, LB Nagar from 2018 to 2022. Patient records were reviewed to analyze the outcomes of surgical treatment and the risk factors associated with it.

**Keywords:** Distal tibia fractures, Minimally invasive, Internal fixations

## INTRODUCTION

A distal tibia fracture is a fracture that involves the metaphyseal area of the distal tibia and may extend to its weight-bearing articular surface. It is also known as tibial Pilon fracture or tibial plafond fracture if it involves the articular surface.[1]

Etienne Destot introduced the term tibial Pilon in 1991 where Pilon is a French word for pharmacist's pestle that has a similar shape to the area of distal tibia metaphysis extending 5 cm from the ankle joint. Plafond also comes from a French word that means ceiling which describes the horizontal articular surface of the distal tibia.[2]

The incidence of distal tibia fracture ranged from as low as 3 per 10,000 per year to as high as 28 per 10,000 per year depending on age and gender. Pilon fractures are rare. They account for 1% of all lower limb fractures, 3% to 10% of all fractures of the tibia, and approximately 20% to 40% are open fractures. These fractures are usually associated with high-energy trauma, caused by falls from heights or motor vehicle accidents thus they are frequently associated with extensive soft tissue injury and are often open fractures.

A distal tibia fracture is classified using the Arbeitsgemeinschaft für Osteosynthesefragen/Orthopaedic Trauma Association AO/OTA 43 classification 2018, which divides it into A, B, and C. 43A is extra-articular with subtypes A1 (simple), A2 (wedge) and A3 (multi fragmentary). 43B is partial articular with subtypes B1 (split fracture), B2 (split-depression fracture), and B3 (depression fracture) with subtypes C1 (simple articular, simple metaphyseal fracture), C2 (simple articular, multi fragmentary metaphyseal fracture), and C3 (multi fragmentary articular and metaphyseal fracture).[5]

Additionally, intra-articular distal tibia pilon fracture is categorized into three types by Ruedi et al depending on articular surface dislocation and fracture comminution (Figure 1).[6] These associations lead to a higher risk of infection, malunion, non-union, and eventually poor overall outcome.

Distal tibia fractures can be treated with a wide range of treatment methods including a variety of external fixators, intramedullary nailing, and internal plate fixation. Minimally invasive techniques have been preferred recently with the hope of better outcomes.[7-9]

The purpose of the current study was to test the hypothesis of whether minimal intervention and external fixation can provide better outcomes with fewer complications in comparison to the results of open reduction and internal fixation in all types of distal tibial fractures.

The objective of the study is to evaluate the functional and radiological outcome of distal tibia fractures treated by external fixation and by minimal invasive internal fixation.

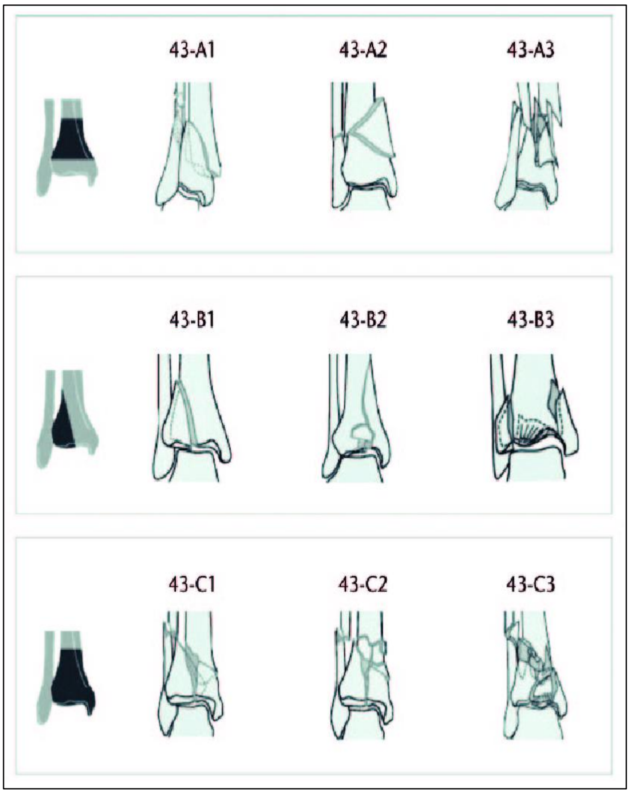


**Figure 1: AO classification of distal tibia fractures.**

## CASE SERIES

A 4-year between 2018 to 2022 cases series of 20 patients was conducted which included all patients with tibia fractures managed by minimally invasive internal fixation and external fixation in Kamineni Academy of Medical Sciences, LB Nagar.

All fractures were also assigned to the proximal, midshaft, and distal third of the tibia. Patients were required to be aged a minimum of 14 years. Exclusion criteria included malunions/non-unions of pre-existent tibial fractures, pathologic tibial fractures, and active malignancy were excluded from the study.

### *Operative technique*

Surgery was performed under spinal anesthesia/general anesthesia based on the patient’s condition following the trauma, patient was in a supine position with a sandbag under the gluteal region in a radiolucent or fracture table, with side placement of an image intensifier to allow viewing along the axis from the knee to the ankle joint.

Thorough irrigation and debridement were performed to eliminate all contaminants, as well as highly contaminated or necrotic soft tissue, closed reduction of the fracture was conducted under the image intensifier and once the good alignment of the fracture is achieved, the fracture site is temporarily stabilized with converging Kirschner wire and followed by, three 5.0 mm Schanz screws were inserted into the proximal bone segment and calcaneal pin and another over the 1st metatarsal is placed.

Frames of the Hoffmann II external fixation system were assembled in the shape of a triangular fashion.

Intra-operative radiographs were obtained to evaluate the final reduction. Next, the wound was sutured primarily or secondarily based on specific circumstances.

### *Post-operative management*

Wound dressing and pin tract dressing was done on post-operative day 2, post-operative day 5, and 14, primary sutures are removed based on the healing pattern, and one month after the initial operation, follow-up radiographs were obtained to evaluate the progress of the fracture union. Subsequently, gradual weight-bearing was permitted.

Patients returned for both clinical and radiological assessment every 2 months until the fracture united. During this period, full weight bearing was allowed when an adequate bridging callus was visible on radiographs.

The union of the fracture was defined as the presence of a bridging callus in at least three cortices based on the radiograph, the external fixation system was removed, as an outpatient procedure, after the complete union of the fracture. PTB cast was applied for the period of 1 month.

The Karlsson and Peterson scoring system was used for ankle function assessment on the 1st post-operative day, at 6 weeks of post-operative day, and during 3 months and at 6 months of follow-ups to know the outcome.[11]

**Table 1: Karlsson and Peterson scoring system of ankle.[11]**

| Health issues | Degrees |
|---|---|
| **Pain** | None |
| | During exercise |
| | Walking on uneven surface |
| | Walking on even surface |
| | Constant |
| **Swelling** | None |
| | After exercise |
| | Constant |
| **Instability** | none |
| | 1-2/year (during exercise) |
| | 1-2/month (during exercise) |
| | Walking on uneven ground |
| | Walking on even ground |
| | Constant (severe) using ankle support |
| **Stiffness** | None |
| | Moderate (morning, after exercise) |
| | Marked (constant, severe) |
| **Stair climbing** | No problems |
| | Impaired (instability) |
| | Impossible |
| **Running** | No problems |
| | Impaired |
| | Impossible |
| **Work activities** | Same as pre-injury |
| | Same work, less sports, normal leisure activities |
| | Lighter work, no sports, normal leisure activities |
| | Severe impaired work capacity, decreased leisure activities. |
| **Support** | None |
| | Ankle support during exercise |
| | Ankle support during daily activities |

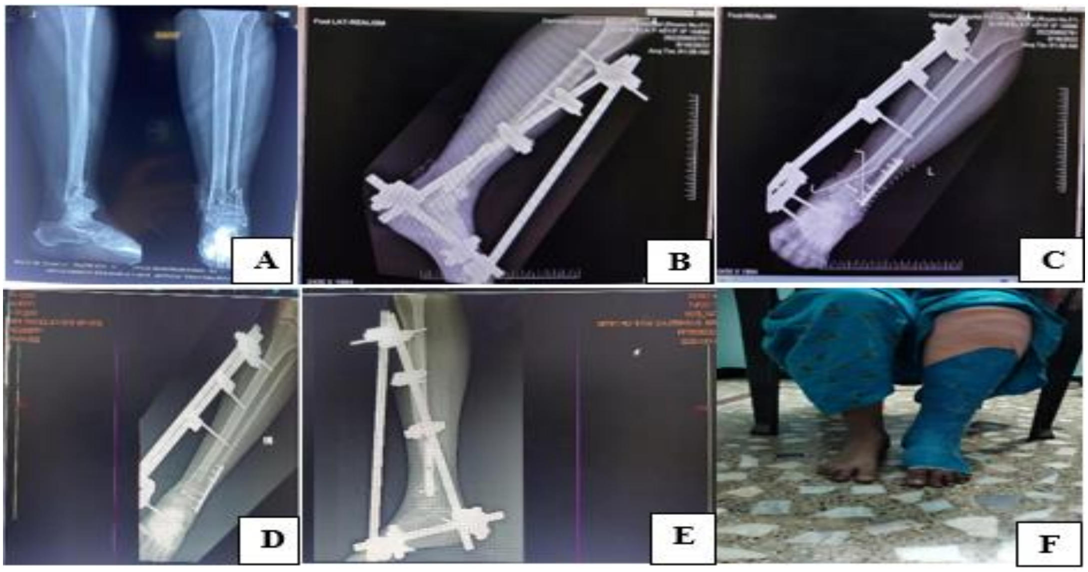


**Figure 2: Case 1 (A) pre-operative radiograph; (B) immediate post-operative radiograph (lateral view); (C) immediate post-operative radiograph (AP view); (D) post-operative radiograph after k wire removal (AP view); and (E) ost-operative radiograph after k wire removal (lateral view); (F) PTB cast application and allowing guarded weight bearing after external fixator removal.**


**Figure 3: Pre-operative radiographs (A) pre-operative radiograph (AP view); (B) pre-operative radiograph (lateral view); (C) immediate post-operative X-ray (AP view); (D) immediate post-operative X-ray (lateral view); (E) post-operative radiograph after k wire removal (AP view); (F) post-operative radiograph after k wire removal (lateral view); (G) post-operative radiograph after ex-fix removal (AP view); and (H) post-operative radiograph after ex-fix removal (lateral view).**

## RESULTS

In our study a total of 20 patients fulfilled the inclusion criteria during the data collection period had been included in the study, the mean age of presentation for 20 patients was 43 years (20 years to 67 years). Of these 13 males (68.42%) and 6 females (31.58%) (Table 2). 18 (90%) patients were involved in a motor vehicle accident and 2 (10%) patients were due to household injury. Pin tract infection 3 patients (15%) and delayed union 2 (10%) were the highest complication seen in patients in our study.

Other deep infections, ankle arthritis, and nonunion were not seen (Table 3). Fracture union was noted in all patients who were followed up, till fracture union was present measured in the form of callus formation and external fixator removal and was made to walk with PTB cast and without.

Fracture union was noted in all most all cases that are followed earliest was at 5 weeks and the maximum duration was 11 weeks. 2 patients in our stunderwentwent bone grafting at 8 weeks, either patients with decreased or no callus formation (Table 4). There are other factors that influence fracture healing those are age, sex, smoking, open or closed fractures, menopause, and diabetes. Which, in young, non-smokers fracture healing was earlier with a good outcome whereas in elderly, postmenopausal women, diabetic, open fractures with bone loss, patients required bone grafting, and healing was delayed. Fracture in the distal 1/3rd watershed area with decreased blood supply, any open surgery can Cause a great threat to the fracture union and wound healing, closed reduction and external fixation with minimal K wire for fracture stability without any vascular supply compromise which intern provide a good biological environment for fracture healing.

Infection, wound healing problems, osteomyelitis, and nonunion have been reported more commonly in open reduction and internal fixation with plating as in the literature. Poor skin condition, Subclinical infection, and soft tissue edema has been reported as a threat to Open reduction and internal fixation with plating. External fixation has the advantage of healing by secondary callus formation (Table 5).

**Table 2: Sex distribution.**

| Sex | N | % | Exact 95%CI |
|---|---|---|---|
| **Female** | 6 | 31.58 | 12.58-56.55 |
| **Male** | 13 | 68.42 | 43.45-87.42 |
| **Total** | 19 | 100.00 | - |

**Table 3: Wound infection.**

| Infection | N | % | Exact 95%CI |
|---|---|---|---|
| **No** | 16 | 84.21 | 60.42-96.62 |
| **Yes** | 3 | 15.79 | 3.38-39.58 |
| **Total** | 19 | 100.00 | - |

**Table 4: Need for bone grafting.**

| Need | N | % | Exact 95%CI |
|---|---|---|---|
| **No** | 17 | 89.47 | 66.86-98.70 |
| **Yes** | 2 | 10.53 | 1.30-33.14 |
| **Total** | 19 | 100.00 | - |

**Table 5: Fracture healing.**

| Fracture healing | N |
|---|---|
| **Before 7 weeks** | 14 |
| **After 7 weeks** | 5 |

For all 19 patients, using the Karlsson and Peterson scoring system for ankle function, each patient was assessed and followed up for 6 months. On assessing the score statistically, there was a significant improvement in the ankle ROM, walking, and other functions at 1st post-operative day, 6th week, 3 months, and 6 months with a significant p value of <0.0001 (F=1477.68) and average fracture healing were noted at 7 weeks.

**Table 6: Repeated measures ANOVA.**

| Group at | No | Mean | SD | 95% CI | SEM |
|---|---|---|---|---|---|
| **1st POD** | 19 | 33.37 | 2.753 | 32.0415 to 34.6953 | 0.6316 |
| **6 weeks** | 19 | 58.47 | 2.913 | 57.0697 to 59.8777 | 0.6683 |
| **3 months** | 19 | 74.74 | 2.281 | 73.6373 to 75.8364 | 0.5234 |
| **6 months** | 19 | 92.89 | 5.606 | 90.1925 to 95.5970 | 1.286 |

## DISCUSSION

One of the more challenging fractures to treat is a distal tibial fracture. These fractures can be fixed using a number of techniques, including open reduction and internal fixation, IM nailing, and external fixators. External fixation is only advised for temporary stabilization of open fractures with substantial soft tissue damage since external fixation for distal metaphyseal fractures has been linked to greater rates of nonunion, malunion, and pin tract infections.[12,13]

Interlocked intramedullary nailing has the benefit of providing tight fixation of the fracture while maintaining the surrounding soft tissues and hematoma. The distal tibia has a circular cross-section and a thinner cortex than the triangular diaphysis, so as the medullary canal widens at the dia-metaphyseal junction, the IM nail, which is designed for a tight interference fit at the diaphysis, cannot provide the same stability at the distal fracture, leading to complications like loss of reduction and malunion.[14,15]

Open reduction and internal fixation technique causes loss of hematoma at the fracture site and thereby increasing the chance of no union and the need for bone grafting procedures at any later date, however after the invention of MIPPO technique, yields a good outcome and chance of nonunion have been decreased.[16]

However in our study when the external fixation was combined with minimally invasive fixation techniques like k-wire fixations, and CC screw fixations, bone contact is established and the union is achieved without the need for definitive procedures. In our study of 20 patients except for 2 patients who demanded bone grafting, in remaining all patients' fracture healing was achieved without any need for definitive fixation.

## CONCLUSION

External fixation with minimal invasive fixation is an excellent technique for managing distal tibia fractures with compromised soft tissue envelope, it is a quick, less technically demanding, and biological procedure with reduced blood loss and operating time, and chances of infection and with an excellent outcome.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: Not required*

## REFERENCES

1. Bartlett CS, Hahn JC, Hall JS, Duffy R. Fracture of the Tibial Pilon. In: Jupiter BBJ, Krettek C, Anderson P, eds. Skeletal Trauma: Basic Science, Management, and Reconstruction. 5th ed. Philadelphia: Elsevier; 2015: 2119.
2. Calori GM, Tagliabue L, Mazza E, de Bellis U, Pierannunzii L, Marelli BM, et al. Tibial pilon fractures: which method of treatment? Injury. 2010;41(11):1183-90.
3. Singer BR, McLauchlan GJ, Robinson CM, Christie J. Epidemiology of fractures in 15,000 adults: the influence of age and gender. J Bone Joint Surg Br. 1998;80(2):243-8.
4. Singer BR, McLauchlan GJ, Robinson CM, Christie J. Epidemiology of fractures in 15,000 adults: the influence of age and gender. J Bone Joint Surg Br. 1998;80(2):243-8.
5. Duckworth AD, Jefferies JG, Clement ND, White TO. Type C tibial pilon fractures: short- and long-term outcome following operative intervention. Bone Joint J. 2016;98-B(8):1106-11.
6. Watson JT, Moed BR, Karges DE, Cramer KE. Pilon fractures. Treatment protocol based on severity of soft tissue injury. Clin Orthop Relat Res. 2000;(375):78-90.

7. Sirkin M, Sanders R, DiPasquale T, Herscovici D. A staged protocol for soft tissue management in the treatment of complex pilon fractures. J Orthop Trauma. 1999;13(2):78-84.
8. Pugh KJ, Wolinsky PR, McAndrew MP, Johnson KD. Tibial pilon fractures: a comparison of treatment methods. J Trauma. 1999;47(5):937-41.
9. Blauth M, Bastian L, Krettek C, Knop C, Evans S. Surgical options for the treatment of severe tibial pilon fractures: a study of three techniques. J Orthop Trauma. 2001;15(3):153-60.
10. Nanchahal J, Nayagam S, Khan U, Moran C, Barrett S, Sanderson F, et al. Standards for the management of open fractures of the lower limb. London: British Association of Plastic, Reconstructive and Aesthetic Surgeons; 2009: 97.
11. Amouzadeh OF, Kazemian G, Salimi S. Evaluation of Syndesmosis Reduction after Removal Syndesmosis Screw in Ankle Fracture with Syndesmosis Injury. Adv Biomed Res. 2019;8:50.
12. Rammelt S, Endres T, Grass R, Zwipp H. The role of external fixation in acute ankle trauma. Foot Ankle Clin. 2004;9(3):455-74.
13. Blauth M, Bastian L, Krettek C, Knop C, Evans S. Surgical options for the treatment of severe tibial pilon fractures: a study of three techniques. J Orthop Trauma. 2001;15(3):153-60.
14. Kneifel T, Buckley R. A comparison of one versus two distal locking screws in tibial fractures treated with unreamed tibial nails: a prospective randomized clinical trial. Injury. 1996;27(4):271-3.
15. Trafton PG. Tibial Shaft fractures. In: Browner DB, Jupiter JB, Levine AN, Trafton PG, Krettek C, eds. Skeletal trauma. 4th ed. Philladelphia: Saunders Elsevier; 2009: 2319-2452.
16. Singla G. A clinical study: management of distal tibial fractures with minimally invasive plating osteosynthesis. Int J Res Orthop. 2019;5:665-9.


**Cite this article as:** Babu NS, Dhanraj P, Sayeed ER, Ali SSA. Tibia fractures managed with minimally invasive internal fixation: a case series of 20 cases. Int J Res Orthop 2023;9:412-7.