Original Article

Journal of Brahmanbaria Medical College
Volume 08 Issue 02 July 2026 ; 10-14
DOI: https://doi.org/10.3329/jbrmc.v8i2.91013

Limited Open Reduction and Fixation by Ankle-Spanning Ilizarov Fixator in High Energy Pilon Fractures

Tapos Kumar Roy[1*] Sujan Tripura[2] Shanaullah Khandakar[3] Raihanul Haque[4]
Md. Ziaur Rahman[5] Md. Rabiul Islam[6] Md. Asaduzzaman Shah[7] Md. Rezaul Karim[8]

ABSTRACT

Background: High-energy pilon fractures were intricate ankle injuries that contrast with standard ankle fractures. Their management poses considerable difficulties for orthopedic surgeons, especially due to the frequent presence of extensive soft tissue damage. Despite the multitude of potential treatment alternatives, the unique characteristics of each injury complicate the endorsement of a unique standard methodology. To see the outcome of high energy pilon fractures treated by limited open reduction combined with Ilizarov external fixator.

Materials and methods: This prospective observational study was conducted in National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR) Dhaka. Data were collected during the period from May 2017 to August 2019. Thirty-two patients with AO/OTA type C pilon fractures were included. Initial soft tissue injury was managed by calcaneal traction on a Braun-Bohler frame. Following the management of soft tissues, fixation done by limited open reduction and ankle spanning Ilizarov fixator. The outcome measures included restoration of joint congruence, pin tract infection, wound infection, osteomyelitis, union, malunion, nonunion, ankle joint function etc. Data were analyzed using Statistical Package for Social Science (SPSS) 20.0.

Results: The patients were followed for an average of 18 months (Range 4-29). Fracture healing was observed in all patients, and the mean fracture healing time was 16 weeks (Range 14-20). No major wound complications were observed. Pin site infection was observed in 8 cases that resolved with local wound care. Chronic osteomyelitis with ring sequestrum was developed in one patient. Except for 1 case that developed an angular deformity, no loss of reduction was observed. According to AOFAS scoring system, the average ankle-hindfoot score was 77 (Range 39-98)

Conclusion: With minimum complication and good healing results, fixation by limited open reduction and ankle spanning Ilizarov fixator was particularly useful for high energy pilon fractures.

1. Assistant Professor of Orthopaedic Oncology & Musculoskeletal Tumor
Rangpur Medical College, Rangpur.
2. Medical Officer
Upazila Health Complex, Chakaria, Cox's Bazar.
3. Assistant Professor of Orthopaedic Surgery
Brahmanbaria Medical College, Brahmanbaria.
4. Registrar of Orthopaedics
National Institute of Traumatology and Orthopaedic
Rehabilitation (NITOR) Dhaka.
5. Assistant Professor of Spine Surgery
Rangpur Medical College, Rangpur.
6. Assistant Professor of Paediatric Orthopaedic Surgery
Rangpur Medical College, Rangpur.
7. Junior Consultant of Orthopaedics
Upazila Health Complex, Badargonj, Rangpur.
8. Assistant Professor of Orthopaedics
Rangpur Medical College, Rangpur.
*Correspondence : Tapos Kumar Roy
Email: taposkumarroy2013@gmail.com
Cell : +88 01712 26 18 39

Date of Submission : 15.04.2026
Date of Acceptance : 10.05.2026

KEY WORDS
Ankle spanning Ilizarov fixator; Pilon fracture; Tibial plafond.

INTRODUCTION

Pilon fracture was a comminuted fracture of the distal tibia.[1] They can be caused by high and low-energy mechanisms.[2] The high energy or type C pilon fractures, as described by the AO/OTA were ''complete articular'' injuries of the tibial plafond.[3] The personality of the fracture consists of marked joint incongruity and dissociation of the articular block from the tibial shaft. Joint comminution was the rule, with variable segments of the articular surface impacted into the overlying tibial metaphysis.[4] They were usually associated with massive swelling of the ankle and foot, as well as with open wounds and even skin defects. The swelling may cause signi cant decrease of the blood ow to the ankle, impairment of nerve function, compartment syndrome of the foot or calf, blistering and skin breakdown.[1]

Journal of Brahmanbaria Medical College
Volume 08 Issue 02 July 2026 ; 10-14
DOI: https://doi.org/10.3329/jbrmc.v8i2.91013

Pilon fractures were fortunately rare injuries, accounting for approximately 7–10% of all tibial fractures, and less than 1% of fractures of the lower limbs.[5] Nevertheless, their numbers were rising following the rise of the incidence of road trafic injuries (45.5% of all pilon fractures were attributed to RTI) and of high energy falls.[6] In 85% of high energy tibial pilon fractures the bula was fractured as well since the classic paper by Rüedi and Allgöwer published more than three decades ago, the operative treatment of pilon fractures has been widely accepted.[7,8,9] It became clear that there were two very different types of pilon fractures. One was relatively low energy torsional force that leads to a spiral fracture extending from the distal diaphysis into the metaphysis and joint surface. The results of the surgical treatment of these fractures were generally good.[7,8] In high energy injury the fracture patterns were complex and carry the risk of major complications. The thin soft tissue envelope that surrounds the distal tibia makes treatment of these fractures difficult. Open reduction of these high-energy fractures with a traumatized soft-tissue envelope, may develop devastating complications.[4,10] With the increasing incidence of high energy injuries, however, a rise in complications when using such treatment has been observed including soft tissue dehiscence, infection, osteomyelitis, delayed union or nonunions.[10,11,12]

If complications arise patients may have a lengthy stay in hospital, with multiple operations and may even end up having an amputation.[13] Minimally invasive techniques for reduction of the articular fragments combined with stable fixation through an external device have been employed in more recent years.[14,15] As a result, there has been a move to external fixation with limited internal fixation.[16,17]

Because most of published studies included several types of pilon fractures, the evaluation of the treatment for high energy (AO type C2 & C3) pilon fractures remains unclear. Therefore, we conducted this study to evaluate the outcome of high energy fractures treated with limited open reduction combined with Ilizarovfixatior.

MATERIALS AND METHODS

This prospective observational study was conducted at the National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR) in Dhaka from May 2017 to August 2019. Prior to beginning, the study protocol received ethical approval from NITOR's Research Review Committee. The study included 32 patients of both sexes ranging in age from 15 to 60 years old who presented with AO/OTA type C2 and C3 pilon fractures within 24 hours of injury. Patients with pathological fractures, ankle function-compromising injuries, Gustilo-Anderson IIIB and IIIC open fractures, or fractures caused by neuropathic disorders were excluded.

On admission, calcaneal pin skeletal traction was used, and the affected leg was raised with a Braun-Bohler splint to reduce soft-tissue oedema. During soft-tissue recovery, further imaging was used to precisely describe the fracture shape, including preoperative CT scans with three-dimensional reconstruction. Definitive surgery was conducted after an average delay of 14 days, once soft-tissue problems improved. All procedures were performed under spinal anaesthesia, with the patient lying supine on a radiolucent table. Open fractures were treated immediately with extensive irrigation and debridement, which was repeated after 48-72 hours as needed.

The reduction of anterior Tillaux and posterior Volkmann fragments, when existent, was carefully monitored. Minimally invasive procedures were used to achieve reduction, with a smooth 3-mm wire serving as a joystick under image intensifier guidance, and 1.5-mm olive wires stabilizing the system. Displaced fragments that could be fixed directly were addressed through a tiny incision and fastened with cannulated lag screws or a buttress plate. Associated medial malleolar fractures were stabilized with olive wires or a 4-mm cannulated cancellous screw reinforced with a Kirschner wire.

After restoring articular congruity, 1.8-mm Ilizarov wires were inserted parallel to the joint surface in the anteroposterior plane, about 2 cm proximal to the ankle joint line in the distal tibial metaphysis. These wires were attached to the ring and tensioned properly. In fractures with more metaphyseal involvement, smooth or olive wires were used to improve alignment and construct stability.

From the second day after surgery, patients were urged to mobile using non-weight-bearing crutches. Early activities included active and passive foot and toe movements, as well as knee range-of-motion exercises. Intravenous antibiotics were given for two to three days, with anti-inflammatory drugs given as needed. Partial weight bearing with high-heeled footwear and axillary crutches was authorized when tolerated, and patients were directed to care for their pin-sites at home twice a week. It was recommended to gradually increase weight bearing with the Ilizarov frame in situ.

Journal of Brahmanbaria Medical College
Volume 08 Issue 02 July 2026 ; 10-14
DOI: https://doi.org/10.3329/jbrmc.v8i2.91013

Patients were seen every two weeks until the calcaneal ring was removed, which typically took 6 to 10 weeks. After the ring was removed, active and passive ankle and foot exercises were started, and follow-up was done every four weeks until the frame was completely removed. A one-month period of protected weight bearing with a short leg cast followed. Full weight bearing was permitted due to radiographic evidence of fracture union and pain tolerance. Subsequently, follow-up visits were arranged every two to three months, or sooner if difficulties developed.

Each patient was followed for at least 24 weeks. Clinical, radiological, and functional outcomes were evaluated and documented for the final report. A pretested structured questionnaire was used to collect data on demographics, clinical findings, laboratory tests, preoperative assessments and postoperative outcomes. Statistical analysis was performed using SPSS version 20.0, with significant results at a 95% confidence interval and a p-value of <0.05.

The functional result and pain were measured at the final follow-up using the American Orthopaedic Foot and Ankle Society (AOFAS) score, where scores of 90-100 were categorized as outstanding, 80-89 as good, 60-79 as fair and less than 60 as bad.

RESULTS

A total of 32 patients with AO type 43C2 and 43C3 fractures were enrolled in the study. The sample consisted of 25 males and 7 females, resulting in a male-to-female ratio of approximately 3.57:1. Patient ages ranged from 15 to 60 years, with the preponderance (54%) within the 31–45-year age group. Six cases involved open fractures and all injuries were caused by high-energy trauma, such as falls from a height or motor vehicle collisions.

The average duration of operation was 126 minute (Range 105- 155min). The fixator was removed at an average of 16.5 weeks post-operatively (range 14-20 weeks). The average duration of clinical follow-up was 18 months (Range: 4 to 26 months).

Soft tissue healing was achieved in all cases and no flap coverage was required. There were four instances of wound dehiscence over the fracture site following fixation.

All fractures achieved union with an average healing duration of 16.5 weeks (Range 14-20
An excellent or good AOFAS result was obtained in 60% (19/32) of the patients.Pin track infection was the most frequently observed complication (25.0%). All participants responded to the increased use of local dressings and oral antibiotics, except for one individual who developed a bone infection characterized by ring sequestrum. The wire was removed and curettage was performed under spinal anesthesia. It was addressed through oral antibiotic treatment in accordance with culture and sensitivity results. Loss of reduction at the medial malleolar fixation was observed in one patient, who was subsequently revised on the second postoperative day using a cannulated cancellous screw. A patient experienced a wire fracture that was subsequently replaced during a routine follow-up. A 20-degree varus malunion occurred in one patient, who has been recommended for arthrodesis.

Table I Baseline characteristics of the study subjects (n=32)

	Frequency (n)	Percentage (%)
Age (Years)		
15-30	8	25.0
31-45	17	53.1
46-60	7	21.9
Gender		
Male	25	78.1
Female	7	21.9
Causes of injury		
RTI	19	59.4
Fall from height	6	18.8
Pedestrian in transport accident	6	18.8
Industrial mishap	1	3.1
Type of fracture according to AO		
43C2	5	15.6
43C3	27	84.4

Table II Status of radiological union (n=32)

	Frequency (n)	Percentage (%)
12 - 16 weeks	12	37.5
17 - 20 weeks	17	53.1
Malunion	3	9.4

Table III Final outcome according to AOFAS ankle hind foot score (n=32)

	Frequency (n)	Percentage (%)
Excellent	11	34.4
Good	8	25.0
Fair	9	28.1
Poor	4	12.5

Journal of Brahmanbaria Medical College
Volume 08 Issue 02 July 2026 ; 10-14
DOI: https://doi.org/10.3329/jbrmc.v8i2.91013

Table IV Complications of patients (n=32)

Complications	Frequency (n)	Percentage (%)
Wound breakdown	4	12.50
Pin tract infection	8	25.00
Chronic osteomyelitis	1	3.13
Wire loosening	2	6.25
Wire breakage	1	3.13
Loss of reduction	1	3.13
Mal-union	1	3.13
Ankle stiffness	2	6.25
Deformity (Varus)	2	6.25

DISCUSSION

In this study of 32 consecutive high-energy pilon fractures (AO type 43C2 and 43C3) male predominance (78%) and a mean age concentrated in the 31–45-year group reflect typical epidemiology for severe pilon injuries, which are usually caused by high-energy mechanisms such as falls from height and motor vehicle collisions. This demographic trend is consistent with previous reports that pilon fractures occur predominantly in young to middle-aged males following high-energy trauma.[18]

In the current study, soft-tissue healing occurred in all cases without the need for flap coverage, likely due to the limited open approaches or percutaneous manipulation combined with external fixation. This is concordant with the study by Osman and colleagues, which found that Ilizarov treatment achieved fracture union with soft-tissue healing and no requirement for plastic surgery, despite high-energy trauma.[19]

While four cases experienced wound dehiscence, they healed with conservative dressing care. This contrasts with some ORIF series where deep wound complications are notably higher, underscoring the advantage of minimizing soft-tissue disruption in pilon fracture fixation.[20]

The 100% union rate and mean consolidation time of ~16.5 weeks in this series align with reports from Vidyadhara's series on Ilizarov treatment of pilon fractures, where satisfactory union was also uniformly achieved with external fixation and minimal adverse effects on soft tissues.[21]

Pin tract infection is one of the most commonly reported complications of external fixation. In this study, 25% of patients developed pin tract infections, which were managed successfully with graded interventions (Culture, local care, antibiotics). Similarly, Osman et al. documented pin-tract infection as the primary complication in their Ilizarov series, with deep infection and osteomyelitis being notably absent.[19]

An excellent or good AOFAS score in 60% of patients suggests favorable functional outcomes, especially considering the severity of the fracture patterns treated (Majority type 43C3). Functional results after Ilizarov external fixation have varied in literature but are broadly supportive, many studies report AOFAS scores in the range of good to excellent in a majority of cases treated with external fixation and limited open reduction. For example, Osman and colleagues reported AOFAS scores classified as excellent or good in the majority of patients treated with the Ilizarov technique.[19]

The concept of limited open reduction and fixation combined with external fixation has roots in hybrid treatment approaches described as early as the 1990s. Tornetta et al. suggested that accurate intra-articular reduction with limited internal fixation followed by external stabilization can achieve union with a relatively low rate of serious wound complications compared with extensive plating techniques.[22]

CONCLUSION

Treatment of high energy pilon fractures by Ilizarov external fixator with limited open reduction allows less soft tissue dissection and represents a reliable method for achieving stabilization and healing with a minimum of soft tissue complication.

DISCLOSURE

All of the authors declared no competing interests.

REFERENCES

1. Aggarwal AK, Nagi ON. Hybrid external fixation in periarticular tibial fractures. Good final outcome in 56 patients. Acta orthopaedicabelgica. 2006;72(4):434.

2. Borrelli Jr J, Torzilli PA, Grigiene R, Helfet DL. Effect of impact load on articular cartilage: development of an intra-articular fracture model. Journal of orthopaedic trauma. 1997;11(5):319-326.

3. Swiontkowski MF, Sands AK, Agel J, Diab M, Schwappach JR, Kreder HJ. Interobserver variation in the AO/OTA fracture classification system for pilon fractures: is there a problem?. Journal of orthopaedic trauma. 1997;11(7):467-470.

4. Tarkin IS, Clare MP, Marcantonio A, Pape HC. An update on the management of high-energy pilon fractures. Injury. 2008;39(2):142-154.

5. Bourne RB. Pylon fractures of the distal tibia. Clinical Orthopaedics and Related Research (1976-2007). 1989;240:42-46.

Journal of Brahmanbaria Medical College
Volume 08 Issue 02 July 2026 ; 10-14
DOI: https://doi.org/10.3329/jbrmc.v8i2.91013

6. RÜEDI TP, ALLGÖWER M. The operative treatment of intra-articular fractures of the lower end of the tibia. Clinical Orthopaedics and Related Research®. 1979;138:105-110.

7. Heim U, Näser M. Operative treatment of distal tibial fractures. Technique of osteosynthesis and results in 128 patients (Author's transl). Archiv fur Orthopadische und Unfall-chirurgie. 1976;86(3):341-356.

8. Helfet DL, Koval K, Pappas J, Sanders RW, DiPasquale T. Intraarticular" pilon" fracture of the tibia. Clinical Orthopaedics and Related Research (1976-2007). 1994;298:221-228.

9. Teeny SM, Wrss DA. Open reduction and internal fixation of tibial plafond fractures: Variables contributing to poor results and complications. Clinical Orthopaedics and Related Research (1976-2007). 1993;292:108-117.

10. Rommens PM, Claes P, De Boodt P, Stappaerts KH, Broos PL. Therapeutic procedure and long-term results in tibial pilon fracture in relation to primary soft tissue damage. Der Unfallchirurg. 1994;97(1):39-46.

11. Pollak AN, McCarthy ML, Bess RS, Agel J, Swiontkowski MF. Outcomes after treatment of high-energy tibial plafond fractures. JBJS. 2003;85(10):1893-900.

12. Wyrsch B, McFerran MA, McAndrew M, Limbird TJ, Harper MC, Johnson KD, Schwartz HS. Operative treatment of fractures of the tibial plafond. A randomized, prospective study. JBJS. 1996;78(11):1646-1657.

13. Trumble TE, Benirschke SK, Vedder NB. Use of radial forearm flaps to treat complications of closed pilon fractures. Journal of orthopaedic trauma. 1992;6(3):358-365.

14. Dickson KF, Montgomery S, Field J. High energy plafond fractures treated by a spanning external fixator initially and followed by a second stage open reduction internal fixation of the articular surface: Preliminary report. Injury. 2001;32:92-98.

15. Tornetta III P, Weiner L, Bergman M, Watnik N, Steuer J, Kelley M, Yang E. Pilon fractures: treatment with combined internal and external fixation. Journal of orthopaedic trauma. 1993;7(6):489-496.

16. BONE L, STEGEMANN P, MCNAMARA K, SEIBEL R. External fixation of severely comminuted and open tibial pilon fractures. Clinical Orthopaedics and Related Research®. 1993;292:101-107.

17. Silluzio N, De Santis V, Marzetti E, Piccioli A, Rosa MA, Maccauro G. Clinical and radiographic outcomes in patients operated for complex open tibial pilon fractures. Injury. 2019;50:S24-28.

18. Bone LB. Fractures of the tibial plafond: The pilon fracture. Orthopedic Clinics of North America. 1987;18(1):95-104.

19. Osman W, Alaya Z, Kaziz H, Hassini L, Braiki M, Naouar N, Laaziz M, Ayeche B. Treatment of high-energy pilon fractures using the ILIZAROV treatment. Pan African Medical Journal. 2017;27(1).

20. Mair O, Pflüger P, Hoffeld K, Braun KF, Kirchhoff C, Biberthaler P, Crönlein M. Management of pilon fractures: Current concepts. Frontiers in surgery. 2021;8:764232.

21. Vidyadhara S, Rao SK. Ilizarov treatment of complex tibial pilon fractures. International orthopaedics. 2006;30(2):113-117.

22. Tornetta III P, Weiner L, Bergman M, Watnik N, Steuer J, Kelley M, Yang E. Pilon fractures: Treatment with combined internal and external fixation. Journal of orthopaedic trauma. 1993;7(6):489-496.