Section: Orthopaedics

Original Research Article

EVALUATION OF ILIZAROV TECHNIQUE IN THE MANAGEMENT OF OPEN TIBIAL FRACTURES: A PROSPECTIVE STUDY FROM A TERTIARY CARE CENTRE IN MANIPUR

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ABSTRACT

Background: Compound tibial fractures remain one of the most difficult orthopaedic injuries to treat because of their high risk of infection, delayed union and associated soft tissue problems. Conventional internal fixation methods often lead to complications in such cases. The Ilizarov external fixator, based on the principles of circular fixation and distraction osteogenesis, offers stable fixation, promotes bone healing, and allows early mobilization while simultaneously addressing infection, deformity, and bone loss. The current study was done to evaluate the effectiveness of the later model of treatment. **Materials and Methods:** A prospective study was conducted on patients with compound tibial fractures managed with Ilizarov external fixation at the Department of Orthopaedics, JNIMS, Manipur, in 2024-25. All patients underwent initial debridement and appropriate antibiotic therapy prior to definitive Ilizarov fixation. In cases with bone loss, corticotomy and bone transport were performed. Patients were followed up at regular intervals and assessed for union, infection control, deformity correction and limb length discrepancy. Final outcomes were evaluated using the ASAMI bone and functional scoring system. **Result:** Our study population comprised of 26 patients, out of which 18 were males and 8 females. Most patients fell in 21-30 years age group (n= 8) with mean age being 31.2 years. Involvement of right side was seen in 61.53% (n=16). RTA was the most common mode of injury (69.23%) followed by fall from height (19.23%). Average hospital length of stay was 9.2 days. **Conclusion:** In this study no case developed deep infection, 02 cases developed non-union. The construct through Ilizarov is stable and enables the patient to bear weight on the affected limb a short time after the surgery, even in cases of comminuted fractures.

INTRODUCTION

Open fractures of the tibia represent one of the most challenging injuries in orthopaedic trauma, particularly in developing regions where road traffic accidents remain a major cause of high-energy injuries. These fractures are often associated with extensive soft tissue damage, contamination, and high risk of infection, which complicate fracture union and increase morbidity and cost of treatment.[1,2] Management goals include stable fixation, early soft tissue cover, infection control, and restoration of limb function.

Conventional treatment options for open tibial fractures include intramedullary nailing, external fixation, and plating. However, these methods have limitations—especially in severe (Gustilo-Anderson type III) injuries where extensive soft tissue compromise and contamination make internal fixation risky.[3] The Ilizarov technique, introduced by Gavriil Ilizarov in the 1950s, provides a circular external fixation system that allows stable fixation, axial micromotion, and early weight-bearing while preserving the biological environment of the fracture.[4] It also enables limb lengthening, bone transport, and deformity correction when bone loss is present.[5]

Multiple studies have demonstrated the effectiveness of the Ilizarov fixator in achieving high union rates, infection control, and early mobilization in open tibial fractures.[6-8] A prospective study in Maharashtra (2021) on 30 patients with open tibial fractures treated with the Ilizarov fixator reported 100% union with satisfactory functional outcomes,

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though pin-site infections occurred in 37% of cases.[6] Similarly, an Indian comparative study found that, the Ilizarov fixator provided better alignment and earlier weight-bearing than the Limb Reconstruction System (LRS) in compound tibial fractures.[7] A recent systematic review (2023) confirmed that, Ilizarov fixation allows effective management of soft tissue defects and reduces the need for secondary procedures compared to conventional external fixation.[8]

Despite these encouraging results, regional variations in patient characteristics, delay in presentation, nutritional status and access to follow-up care can influence outcomes. The North-East Indian population, particularly in Manipur, faces unique logistical and healthcare challenges, making it essential to evaluate the effectiveness of the Ilizarov technique in this context. Therefore, the present study aims to evaluate the outcomes of open tibial fractures treated with the Ilizarov technique at Jawaharlal Nehru Institute of Medical Sciences (JNIMS), Imphal, focusing on rate and time to fracture union, functional outcomes and early weight-bearing, incidence and management of complications and overall efficacy of the Ilizarov method in local clinical conditions The findings of this study will help determine the applicability and effectiveness of the Ilizarov technique in the regional setting and guide the development of optimal management protocols for open tibial fractures in Manipur

Aim & objective:

The objective of this study was to evaluate the effectiveness of the Ilizarov technique in the management of open tibial fractures, particularly in terms of bone union, functional outcome and complication profile. The study aimed to assess the role of Ilizarov external fixation as a limb salvage and reconstructive method in compound tibial fractures of varying severity (as per the modified Gustilo–Anderson classification), and to analyze its outcomes using the Association for the Study and Application of the Method of Ilizarov (ASAMI) scoring system for bone and functional results.

MATERIALS AND METHODS

A prospective observation study was done in 2024-25 among patients of open tibial fractures treated with the Ilizarov technique in the Department of Orthopaedics, Jawaharlal Nehru Institute of Medical Sciences (JNIMS), Imphal. All patients were managed and followed up for a minimum duration of 12 months. Patients aged 18 years and above, fractures classified as Gustilo–Anderson Type II, IIIA, and IIIB, fit for surgery and willing to provide informed consent. Closed fractures or pathological fractures of the tibia, patients with neurovascular injury requiring amputation were excluded.

Preoperative Evaluation: On admission, detailed history and clinical examination were performed. The soft-tissue injury was graded using the modified Gustilo–Anderson classification. Routine laboratory investigations and radiographs of the affected limb were obtained. Initial management included wound debridement, saline irrigation, and temporary stabilization when required.

Surgical Technique: Definitive fixation was performed using the Ilizarov circular external fixator under spinal or general anaesthesia. The fixator construct consisted of two to four rings connected by threaded rods, with tensioned trans-osseous wires to achieve stable fixation and appropriate alignment. Bone transport, corticotomy or autogenous bone grafting were performed in selected cases with bone loss or non-union. Soft-tissue defects were managed by primary closure, delayed closure, split-thickness skin grafting (STSG), or musculocutaneous flap cover, depending on the wound condition and fracture type.

Postoperative Management: Postoperatively, patients were encouraged to perform early range of motion exercises for knee and ankle joints. Pin tract care was initiated on the first postoperative day. Broad-spectrum antibiotics were administered for 5–7 days and modified according to wound culture sensitivity. Patients were mobilized with partial or full weight-bearing as tolerated. Regular follow-up was done at 06 weeks, 03 months, 06 months and 12 months with clinical and radiological evaluation.

Outcome Assessment: Results were evaluated according to the ASAMI criteria for both bone and functional outcomes. Bone results were graded as excellent, good, fair or poor based on union, infection, deformity and limb-length discrepancy. Functional results were assessed based on pain, gait, joint stiffness, return to work and the need for orthotic support.

Statistical Analysis: All data were compiled and analyzed using descriptive statistics. Results were expressed as mean (standard deviation) and proportions. Comparisons were made between groups according to the severity of fracture (Type II, IIIA, and IIIB) to evaluate variations in healing time and outcome.

Ethical considerations: Ethical approval for the study was obtained from the Institutional Ethics Committee of JNIMS, Imphal, and written informed consent was obtained from all participants prior to inclusion in the study.

RESULTS

Our study comprised of 26 patients, out of which 18 were males and 8 females. Most patients fell in 21-30 years age group (n= 8) with mean age being 31.2 years. Involvement of right side was seen in 61.53% (n=16). RTA was the most common mode of injury (69.23%) followed by fall from height (19.23%) (Table 1). Average hospital length of stay was 9.2 days. Most of the cases (19; 73.07%) were operated in < 5 days. [Table 1]

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Table 1: Demographic data of study participants

Demographic indicators	Frequency (%)
Gender	
• Male	18 (69.23)
• Female	08 (30.76)
Mechanism of injury	
• Road traffic accident	18 (60.23)
• Fall from height	05 (19.23)
• Sports injuries	03 (11.53)
Site of involvement	
• Right	16 (61.53)
• Left	10 (38.46)
Fracture pattern	
• Comminuted	12 (46.15)
• Transverse	04 (15.38)
• Oblique	05 (19.23)
• Spiral	02 (7.69)
• Segmental	03 (11.53)
Distribution according to Modified Gustilo Anderson classification	
• Type II	
• Type IIIA	05 (19.23)
• Type IIIB	13 (50.0)
	08 (30.76)
Fracture location	
• Upper one-third	03 (11.53)
• Middle one-third	19 (73.07)
• Distal one-third	04 (15.38)

The average time of union varied from 20.3 weeks to 29.8 weeks depending upon the type of fractures. [Table 2]

Table 2: Average time of union in different group of patients as per modified Gustilo Anderson classification

Type of fracture	Average time for union (in weeks)
Type II	20.3
Type IIIA	23.6
Type IIIB	25.4
Those with bone loss	29.8

In our study, we observed that, excellent bone result was obtained in 53.84%, good result in 30.76% and fair in 7.69%. Functional results were excellent in 38.40% and good in 50% cases. In type II open fractures, all the patients showed excellent bone results and 80% with excellent functional scoring. In case of Type IIIA group 12.5% reported with excellent bone results and 38.46 with excellent functional outcome as per ASAMI scoring. Good bone results were seen in 38.46% and good functional scoring was seen in 53.8 % patients in same group (Type-IIIA). In group IIIB excellent bone result was obtained in 12.5%, good result in 37.50%, fair in 25%. Functional results were excellent in 12.5% and good in 50% cases as per ASAMI criteria. [Table 3]

Table 3: ASAMI Functional outcome at the end of 12 months

Type of fracture	Excellent (%)	Good (%)	Fair (%)	Poor (%)
II	04 (80.0)	1 (20.0)	-	-
IIIA	05 (38.5)	07 (20.0)	01 (7.7)	-
IIIB	01 (12.5)	04 (50.0)	01 (12.5)	02 (25.0)
Total	10 (38.4)	13 (50.0)	02 (7.7)	01 (3.8)

No intraoperative complications were seen. Postoperative complications are summarized in Table 4. One patient with Type –IIIB fracture suffered restricted ankle ROM along with severe pin tract infections. It subsided with rigorous physiotherapy after frame removal. Total complication rate in our study was 46.15%. None of the patients had refracture. 02 patients developed non-union. Retrospectively, on analyzing the causes, we found one1 patient was having fibular fracture in syndesmotic region which was fixed with 1/3rd tubular plate in the index surgery and was managed with fibulectomy. In the second patient non-union might have developed due to soft tissue interposition at docking site. [Table 4]

Table 4: Post- operative complications encountered in our patients

Complications	II (n=5)	IIIA (n=13)	IIIB (n=8)	Total
Pin track infections (Moore & Dahl classification)				
• Grade 1	01	03	01	12
• Grade 2	-	01	01	

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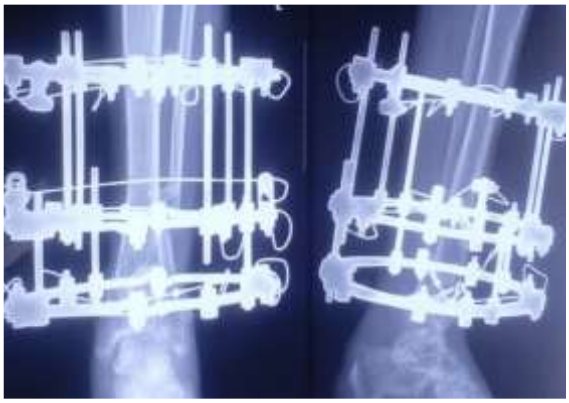
• Grade 3 • Grade 4	- -	- -	02 02	
Restricted ankle movement			01	01

Figures 1: Showing illustration of events

Figures 2: Soft tissue condition at the time of presentation

Figures 3: Initial x-ray

Figures 4: Intraoperative picture



Figures 5: Postoperative clinical picture and v) Follow-up x-ray

DISCUSSION

In the present study, 26 patients with open tibial fractures were treated by the Ilizarov external fixator. The majority were males (69.2%), with road traffic accidents being the predominant cause of injury (69.2%). This finding is consistent with earlier studies, which have identified high-energy trauma as the leading cause of open tibial fractures, especially in young adult males involved in vehicular accidents.[9,10] The middle third of the tibia was the most common site of involvement (73%), which is expected due to its subcutaneous position and limited soft-tissue protection.[11]

The mean time for radiological union in our study was 20.3 weeks for Type II fractures, 23.6 weeks for Type IIIA, and 25.4 weeks for Type IIIB fractures. This correlates with findings by Mahdi et al. (2022) and Khan et al. (2022), who reported average union times of 22–28 weeks depending on fracture severity.[12,13] Excellent-to-good bone results were achieved in 84.6% of cases, comparable to the success rates (80–90%) reported in similar studies using the ASAMI criteria.[14,15]

Two cases (7.7%) developed non-union, both in Type IIIB fractures. These were managed successfully with autogenous bone grafting. The higher non-union rate in severe open fractures can be attributed to extensive periosteal stripping, bone loss, and compromised vascularity, as described by Catagni et al. (2020).[16]

Functional outcomes were excellent or good in 88.4% of patients in the present study, with better results in less severe fractures. Type II fractures showed excellent outcomes in 80% of cases, while Type IIIB fractures had lower scores due to soft-tissue injury and prolonged treatment. Similar observations were made by Fragomen et al. (2020) and Das et al. (2022), who emphasized that early physiotherapy, patient compliance, and soft-tissue condition are major determinants of functional recovery.[17,18]

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The circular fixator provides stable fixation allowing controlled micromotion at the fracture site, promoting osteogenesis and early weight-bearing, which significantly enhances the patient's functional recovery.

The most common complication in our series was pin tract infection (46.1%), mostly of Grade I–II severity as per the Moore and Dahl classification. These were managed successfully with local care and antibiotics. Only one patient developed a severe infection requiring frame modification. The incidence of pin tract infections reported in literature ranges from 30–50%, which is comparable to our findings.[19] One patient developed ankle stiffness, which improved with intensive physiotherapy, underscoring the importance of early rehabilitation. No refracture, limb-length discrepancy, or malunion was noted.

CONCLUSION

The Ilizarov external fixation for open tibial fractures is an effective form of treatment although Pin tract infections may occur in some cases. Further studies with larger samples are recommended to draw a more valid conclusion.

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