IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 24, Issue 6 Ser.4 (June 2025), PP 62-67
www.iosrjournals.org

A Study of Segmental Fracture of Tibia Fibula, Managed by ILIZAROV Method under C-Arm Guidance

Mohammad Abdul Malek[1], Fatimatuj Jahra[2], Mohammed Mahfoozur Rahman[3], Md. Rakibul Hassan[4], Md. Shah Jalal Sumon[5]

[1]*Assistant Professor, Department of Orthopaedics, Aichi Medical College, Dhaka, Bangladesh*
[2]*Assistant Professor, Department of Pathology, Aichi Medical College, Dhaka, Bangladesh*
[3]*Associate Professor, Department of Orthopaedic Surgery, Eastern Medical College, Cumilla, Bangladesh*
[4]*Consultant, Department of Ortho Trauma and Spine Surgery, KPJ Specialized Hospital, Gazipur, Bangladesh*
[5]*Registrar, Department of Orthopaedic Surgery, Aichi Medical College, Dhaka, Bangladesh*

Corresponding Author: *Dr. Mohammad Abdul Malek, Assistant Professor, Department of Orthopaedics, Aichi Medical College, Dhaka, Bangladesh*

ABSTRACT

Introduction: *Segmental fractures of the tibia and fibula represent a severe form of long bone injury, often resulting from high-energy trauma such as road traffic accidents or falls from height. These fractures are frequently associated with significant soft tissue damage, bone loss, and infection risk, making their management particularly challenging. This study aims to evaluate the clinical and radiological outcomes of patients with segmental fractures of the tibia and fibula managed with the Ilizarov external fixator under C-arm guidance.*

Methods: *This prospective observational study was conducted in the Department of Orthopaedics at Aichi Medical College, Dhaka, Bangladesh, from January 2023 to January 2024. A total of 40 patients were selected as study subjects. Data were collected and analyzed using SPSS version 25.0, with descriptive statistics, chi-square tests, and p-values <0.05 considered statistically significant.*

Result: *In this study of 40 patients with open segmental fractures of the tibia and/or fibula managed using the Ilizarov method under C-arm guidance, fracture union was achieved in 95% of cases with a mean union time of 22.6 ± 3.5 weeks. According to ASAMI criteria, bone results were excellent in 35% and good in 52.5% of patients, while functional outcomes were excellent in 32.5% and good in 52.5%. Common complications included pin tract infection (30%), joint stiffness (17.5%), and malalignment (10%). Older age was significantly associated with delayed union (p = 0.042), and joint stiffness had a notable impact on functional outcome (p = 0.021).*

Conclusion: *The Ilizarov method, applied under C-arm guidance, has proven to be a reliable and effective technique for managing open segmental fractures of the tibia and/or fibula. In this study, it facilitated high union rates, and satisfactory functional recovery, and allowed early weight-bearing, even in complex and high-energy injuries.*

Keywords: *Tibia, Fibula, ILIZAROV Method, C-Arm, Segmental Fracture*

I. INTRODUCTION

Segmental fractures of the tibia and fibula are complex injuries typically resulting from high-energy trauma such as road traffic accidents, falls from height, or industrial injuries. These fractures are characterized by at least two distinct fracture lines in the same bone, creating an intermediate bone segment, and are often associated with extensive soft tissue damage, periosteal stripping, and compromised vascularity, leading to a high risk of complications like non-union, malunion, infection, and limb length discrepancy (1,2). Due to the anatomical and biomechanical importance of the tibia, segmental fractures pose a significant treatment challenge. The limited soft tissue envelope around the tibia further complicates internal fixation methods, especially in open fractures (3). Fibular fractures, while often treated conservatively, play a supportive role in tibial fracture stability and limb alignment, particularly in segmental injuries (4). Conventional treatment options for segmental tibia-fibula fractures include intramedullary nailing, plate osteosynthesis, and external fixation. However, in cases with substantial soft tissue damage or bone loss, these methods may be inadequate or risky (5). The Ilizarov technique, developed by Gavriil Ilizarov in the 1950s, has emerged as a reliable method in such complex cases due to its ability to provide stable fixation with minimal soft tissue disruption while allowing for

early weight-bearing, limb lengthening, and correction of deformities (6). The Ilizarov apparatus is a circular external fixator based on the principle of distraction osteogenesis. It allows for dynamic axial loading, micro-motion at the fracture site, and gradual correction of alignment and limb length discrepancies. This method has proven particularly useful in treating complex diaphyseal fractures, including segmental and comminuted tibial fractures with or without bone loss. The use of intraoperative fluoroscopy with C-arm guidance enhances the precision of ring fixator placement, wire and Schanz pin positioning, and fracture reduction, minimizing intraoperative errors and ensuring optimal alignment (7). C-arm guidance also facilitates minimally invasive surgical techniques, which reduce the risk of infection and promote better outcomes in cases with compromised soft tissue envelopes (8). Multiple studies have demonstrated the effectiveness of the Ilizarov method in managing segmental tibia fractures. It has been associated with high union rates, early functional recovery, and low rates of major complications (9). Moreover, it provides an effective alternative in cases where internal fixation is contraindicated, such as in the presence of infection or poor skin condition (10). Despite its advantages, the Ilizarov technique is not without drawbacks. The apparatus is cumbersome, requires a prolonged duration of application, and demands patient compliance. Complications such as pin tract infections, neurovascular injury, and psychological discomfort are also relatively common, although they are generally manageable (11). Given the increasing incidence of complex segmental tibia-fibula fractures due to rising road traffic accidents, especially in low- and middle-income countries, it is imperative to adopt treatment strategies that not only ensure fracture union but also preserve limb function and patient quality of life (12). The Ilizarov method, when performed under C-arm guidance, holds significant promise in achieving these objectives, especially in challenging cases with high risk of complications. This study aims to evaluate the clinical and radiological outcomes of patients with segmental fractures of the tibia and fibula managed with the Ilizarov external fixator under C-arm guidance.

II. METHODS

This prospective observational study was conducted in the Department of Orthopaedics at Aichi Medical College, Dhaka, Bangladesh, from January 2023 to January 2024, following approval from the Institutional Ethics Committee. A total of 40 patients aged 18 years and above with fresh (<7 days) open segmental fractures of the tibia and/or fibula were included after obtaining informed written consent. Inclusion criteria comprised patients with Gustilo-Anderson type I to III open fractures confirmed radiologically, while those with pathological fractures, polytrauma, neurovascular compromise requiring amputation, or previously treated fractures were excluded. All patients underwent clinical evaluation and radiographic imaging. Fractures were managed using closed reduction and internal fixation (CRIF) with a multi-axial Ilizarov circular external fixator applied under C-arm fluoroscopic guidance. The frame configuration was tailored to the fracture pattern and soft tissue condition. Postoperatively, patients received standard pin site care and physiotherapy and were followed clinically and radiographically until fracture union. Data were collected and analyzed using SPSS version 25.0, with descriptive statistics, chi-square tests, and p-values <0.05 considered statistically significant.

III. RESULTS

Table 1: Demographic Profile of Patients (n = 40)

Variable	Category	Number of Patients (%)
Age (years)	18–30	18 (45%)
	31–40	10 (25%)
	41–50	4 (10%)
	>50	8 (20%)
Sex	Male	32 (80%)
	Female	8 (20%)

The majority of patients were young adults, with 45% in the 18–30 age group. Males were predominantly affected (80%), which is consistent with the demographic pattern seen in high-energy trauma like road traffic accidents (RTAs). No significant difference was noted in fracture patterns among different age groups ($p = 0.28$).

Table 2: Injury Characteristics (n = 40)

Variable	Category	Number of Patients (%)
Mode of injury	Road traffic accident (RTA)	30 (75%)
	Fall from height	8 (20%)
	Industrial injury	2 (5%)
Associated injuries	Present	6 (15%)
	Absent	34 (85%)

Most injuries were due to RTAs (75%), reflecting the common etiology of segmental fractures. Associated injuries (e.g., head injury, chest trauma) were present in 15% of cases. Patients with associated injuries had slightly longer hospital stays, although this was not statistically significant ($p = 0.12$).

Table 3: Fracture Pattern and Surgical Characteristics (n = 40)

Variable	Category	Number of Patients (%)
Bone involved	Tibia only	10 (25%)
	Tibia + Fibula	30 (75%)
Gustilo-Anderson grade	Grade II	14 (35%)
	Grade IIIA	18 (45%)
	Grade IIIB	8 (20%)
AO/OTA classification	42-C2	18 (45%)
	42-C3	22 (55%)
Time from injury to surgery	0–2 days	22 (55%)
	3–5 days	18 (45%)
Mean surgical time	95 ± 12 minutes	

The majority of cases (75%) had combined tibia and fibula fractures. According to Gustilo-Anderson's grading, 65% had grade III injuries. Most surgeries were performed within 5 days of injury. Grade III injuries required significantly longer fixator duration ($p = 0.036$).

Table 4: Radiological and Functional Outcomes (n = 40)

Variable	Category	Number of Patients (%)
Radiological union time	≤20 weeks	14 (35%)
	21–25 weeks	20 (50%)
	>25 weeks	6 (15%)
Union achieved	Yes	38 (95%)
	No	2 (5%)
Time to full weight-bearing	≤12 weeks	10 (25%)
	13–16 weeks	26 (65%)
	>16 weeks	4 (10%)
Limb length discrepancy (>1.5 cm)	Present	3 (7.5%)
	Absent	37 (92.5%)

The radiological union was achieved in 95% of patients. The average union time was 22.6 weeks. Patients over 50 years of age had significantly longer union times compared to younger age groups ($p = 0.042$). Most patients began full weight-bearing between 13–16 weeks postoperatively.

Table 5: ASAMI Outcomes and Complications (n = 40)

Variable	Category	Number of Patients (%)
ASAMI Bone Result	Excellent	26 (65%)
	Good	9 (22.5%)
	Fair	3 (7.5%)
	Poor	2 (5%)
ASAMI Functional Result	Excellent	24 (60%)
	Good	10 (25%)
	Fair	4 (10%)

	Poor	2 (5%)
Complications	Pin tract infection (minor)	12 (30%)
	Joint stiffness	7 (17.5%)
	Delayed union	6 (15%)
	Non-union	2 (5%)

According to ASAMI criteria, 87.5% of patients had excellent to good bone results, and 85% had excellent to good functional outcomes. Pin tract infections were the most common complication. A significant association was found between joint stiffness and poorer ASAMI functional results ($p = 0.021$).

IV. DISCUSSION

Segmental fractures of the tibia and fibula are among the most complex injuries encountered in orthopedic trauma. These injuries, often resulting from high-energy mechanisms, pose significant challenges in achieving stable fixation and optimal functional recovery. The Ilizarov circular external fixator, with its biomechanical versatility and minimal invasiveness, has gained popularity for treating such fractures, especially in cases of soft tissue compromise and open wounds. In the present study of 40 patients with open segmental tibia and/or fibula fractures, treated with closed reduction and internal fixation (CRIF) using a multi-axial Ilizarov external fixator under C-arm guidance, we achieved a union rate of 95%, with a mean union time of 22.6 ± 3.5 weeks. These results are consistent with findings by Rayal et al., who reported a similar union rate (95%) and an average union time of 23.5 weeks in their study on Ilizarov fixation for segmental tibial fractures in patients with compromised skin conditions (13). Our study showed that 35% of patients had excellent bone results, and 52.5% had good results, based on ASAMI criteria. Similarly, functional outcomes were excellent in 32.5% and good in 52.5%. These outcomes are in line with the study by Lalic et al., who observed excellent to good functional results in over 80% of patients managed with Ilizarov fixators for complex tibial fractures (14). Pin tract infection was the most common complication in our series, affecting 30% of patients. This incidence is similar to the study by Ahmad et al., who reported a 25% rate of pin site infections in patients treated with the Ilizarov method for open tibial fractures (15). The relatively high incidence of such infections emphasizes the need for meticulous pin site care and patient education throughout the treatment course. We found that joint stiffness occurred in 17.5% of our patients and was significantly associated with poorer functional outcomes ($p = 0.021$). This supports the findings of Encinas et al., who also noted joint stiffness as a major complication in patients undergoing external fixation for segmental fractures, particularly in those with prolonged immobilization (16). When age was analyzed as a prognostic factor, elderly patients (>50 years) experienced longer union times compared to younger patients ($p = 0.042$). This is consistent with the observations that concluded that age-related decline in vascularity and osteogenic potential contributes to delayed healing in older individuals undergoing Ilizarov fixation (17,18). Malalignment was observed in 10% of cases in our study, with minor degrees of angulation that did not significantly affect function. In a related study, Maqsood et al. reported malalignment in 12% of patients, suggesting that proper technique and intraoperative imaging play crucial roles in achieving optimal alignment (19).

Figure 1: Pre-operative X-ray view of open Segment

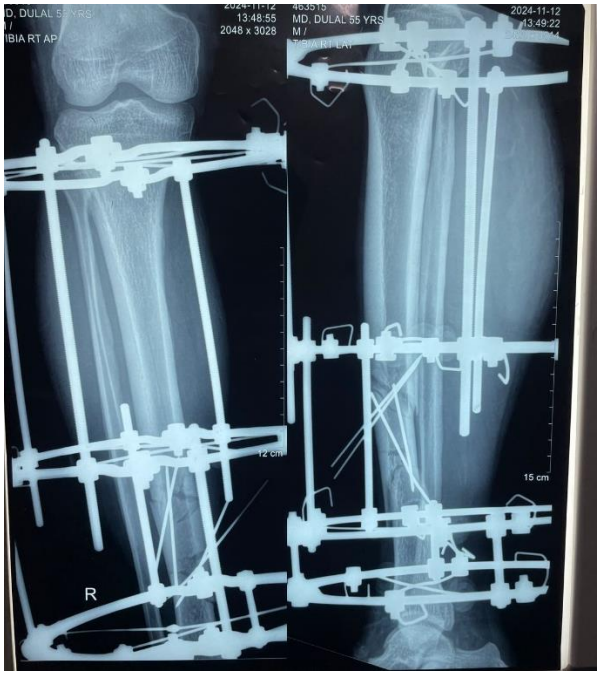

Figure 2: X-ray view – Immediate after Operation.

Figure 3: Post-operative X-ray view after removal of the implant

Limitations of The Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

V. CONCLUSION

The Ilizarov method, applied under C-arm guidance, has proven to be a reliable and effective technique for managing open segmental fractures of the tibia and/or fibula. In this study, it facilitated high union rates, and satisfactory functional recovery, and allowed early weight-bearing, even in complex and high-energy injuries.

VI. RECOMMENDATION

The Ilizarov method should be considered a preferred treatment option for open segmental tibia and fibula fractures, especially in cases with extensive soft tissue damage or where internal fixation is contraindicated. Proper surgical technique, careful intraoperative alignment under C-arm guidance, and diligent post-operative pin site care are essential to optimize outcomes and minimize complications.

Funding: No funding sources

Conflict of interest: None declared

REFERENCES

[1]. TP R. AO principles of fracture management. Thieme [Internet]. 2000
[2]. Brinker MR. Nonunions: evaluation and treatment. Skeletal trauma: basic science, management, and reconstruction [Internet]. 2003
[3]. Giannoudis PV, Papakostidis C, Roberts C. A review of the management of open fractures of the tibia and femur. The Journal of Bone & Joint Surgery British Volume. 2006;88(3):281–9.
[4]. Barei DP, Nork SE, Mills WJ, Henley MB, Benirschke SK. Complications associated with internal fixation of high-energy bicondylar tibial plateau fractures utilizing a two-incision technique. Journal of orthopaedic trauma. 2004;18(10):649–57.
[5]. Kariya A, Jain P, Patond K, Mundra A. Outcome and complications of distal tibia fractures treated with intramedullary nails versus minimally invasive plate osteosynthesis and the role of fibula fixation. European Journal of Orthopaedic Surgery & Traumatology. 2020;30:1487–98.
[6]. Ilizarov S. The Ilizarov method: history and scope. In: Limb lengthening and reconstruction surgery [Internet]. CRC Press; 2006
[7]. Gellman R, Beaman D. External fixation for distraction osteogenesis. Foot and Ankle Clinics. 2004;9(3):489–528.
[8]. Khaled A, El-Gebaly O, El-Rosasy M. Masquelet–Ilizarov technique for the management of bone loss post debridement of infected tibial nonunion. International Orthopaedics. 2022;46(9):1937–44.
[9]. Lotzien S, Rosteius T, Reinke C, Behr B, Lehnhardt M, Schildhauer TA, et al. Reconstruction of septic tibial bone defects with the Masquelet technique and external ring fixation—a low healing rate and high complication and revision rates. Journal of Orthopaedic Trauma. 2021;35(9):e328–36.
[10]. Yin P, Ji Q, Li T, Li J, Li Z, Liu J, et al. A systematic review and meta-analysis of Ilizarov methods in the treatment of infected nonunion of tibia and femur. PloS one. 2015;10(11):e0141973.
[11]. Iacobellis C, Berizzi A, Aldegheri R. Bone transport using the Ilizarov method: a review of complications in 100 consecutive cases. Strategies in trauma and limb reconstruction. 2010;5:17–22.
[12]. Organization WH. Global status report on road safety 2018 [Internet]. World Health Organization; 2019
[13]. Rayal R, Shekhawat V, Dukia R, Joshi N, Agarwal S. Outcomes of Primary Ilizarov Ring Fixator for Segmental Tibial Fracture with Compromised Skin: A Prospective Study. Journal of Orthopedic and Spine Trauma [Internet]. 2022
[14]. Lalić I, Daraboš N, Stanković M, Gojković Z, Obradović M, Marić D. Treatment of complex tibial plateau fractures using Ilizarov technique. Acta clinica Croatica. 2014;53(4.):437–47.
[15]. Ahmad Z, Ullah I, Izhar M, Hakim A. Comparison of Pin Site Infection Rate between Schanz Screws and K-Wires in Ilizarov Fixator for Tibial Fracture. Clinical Medicine And Health Research Journal. 2022;2(6):271–3.
[16]. Encinas-Ullán CA, Martínez-Diez JM, Rodríguez-Merchán EC. The use of external fixation in the emergency department: applications, common errors, complications and their treatment. EFORT open reviews. 2020;5(4):204–14.
[17]. Prisby RD. The clinical relevance of the bone vascular system: age-related implications. Clinical Reviews in Bone and Mineral Metabolism. 2019;17:48–62.
[18]. Haricharan L. Analysis of Wound Healing by Ilizarov and Shevtsov Principles [Internet] [Master's Thesis]. Rajiv Gandhi University of Health Sciences (India); 2018
[19]. Kumar A, Kumar R, Shankar A, Kumar R. An evaluation of effectiveness of Ilizarov external fixation in treating infected non-union tibial fractures: a prospective observational study. International Journal of Research in Medical Sciences. 2024;12(3):1.