

Comparative Study on Outcomes of Ilizarov External Fixator Versus Traditional Hoffmann External Fixator in First-Day Surgery for Gustilo-Anderson Type II Open Tibial Fractures

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Abstract

Background: Open tibial fractures are common and challenging due to the tibia's vulnerable blood supply and soft tissue coverage, increasing the risk of non-union and infection. This study aims to compare the clinical outcomes of Ilizarov versus Hoffmann external fixators in first-day surgeries for Gustilo-Anderson Type II open tibial fractures.

Aim of the study: The aim of the study was to evaluate and compare the clinical outcomes of Ilizarov versus Hoffmann external fixators in first-day surgeries for Gustilo-Anderson Type II open tibial fractures.

Methods: This prospective comparative study at the Department of Orthopaedics and Traumatology, President Abdul Hamid Medical College Hospital (January 1–December 31, 2024) included 50 patients with Gustilo-Anderson Type II open tibial fractures, randomized to Ilizarov (n=25) or Hoffmann (n=25) fixators. Surgeries were performed with standard protocols, and outcomes assessed were fracture healing, infection rates, functional recovery (LEFS), complications, and cure rate. SPSS v26 was used for analysis (t-tests for continuous variables and chi-square for categorical, p<0.05).

Results: The Ilizarov fixator demonstrated superior outcomes vs. Hoffmann in Gustilo-Anderson Type II tibial fractures (n=50), with faster healing (24.0 vs. 31.2 weeks, p<0.001), better function (LEFS 78 vs. 70, p<0.001), and fewer complications (pin infections: 20% vs. 48%; malunion: 8% vs. 32%; both p<0.05). Cure rates favored Ilizarov (84% vs. 56%, p=0.031), supporting its use for early stabilization.

Conclusion: The Ilizarov external fixator demonstrates superior clinical outcomes over the Hoffmann fixator for first-day management of Gustilo-Anderson Type II open tibial fractures, offering faster healing, better function, and fewer complications.

Keywords: Ilizarov, Hoffmann, Open Tibial Fractures

1. INTRODUCTION

Open tibial fractures are the most frequent type of open fractures involving long bones, with an annual incidence of 5.6 per 100,000 individuals.[1] These fractures present

significant challenges for orthopedic surgeons due to the tibia's vulnerable blood supply and insufficient soft tissue coverage, which increases the risk of non-union and infection.[2] The primary goals of treatment for open tibial

diaphyseal fractures include preventing infection, maintaining proper length, alignment, and rotation, minimizing damage to soft tissues and bone, preserving circulation, and creating an environment conducive to bone healing.[3] Open tibial fractures are classified into three main categories: type I, type II, and type III, based on factors like wound size, soft tissue injury, bone fracture type, and injury velocity. Type III fractures are further divided into A, B, and C, reflecting increasing severity of soft tissue injury and bone exposure.[4] Although these fractures are common, the optimal management approach remains debated. Plate fixation and conventional half-pin fixators have high rates of non-union, prompting exploration of alternative methods such as the Ilizarov external fixator (IEF).[5,6] The IEF is a minimally invasive technique that offers effective wound management, allows early weight-bearing, and supports definitive treatment, particularly in areas with limited advanced medical facilities and plastic surgery expertise.[7,8]

The management of open tibial fractures is influenced by factors such as wound size, soft tissue injury, and contamination level. In developed countries, the standard treatment typically involves primary debridement followed by intramedullary nailing or bypass plating.[9] However, in developing nations like Bangladesh, where patients often present at later stages and advanced medical resources may be scarce, external fixators such as the Ilizarov system are frequently used. While these fixators provide an effective solution for managing bone loss and delayed presentations, they come with a high risk of infection and mal-union.[10] Recent studies have highlighted those external fixators, including the Ilizarov and AO systems, show variable efficacy, with success rates ranging from 20-31%.[11] This variability has raised concerns about the method's effectiveness, emphasizing the challenge of achieving optimal fracture stabilization while preventing complications like infection and non-union. Moreover, the high incidence of complications such as deep infection, delayed union, and mal-union reinforces the need for careful selection of fixation methods based on available resources and the specific clinical context.

The tibia is the most commonly fractured long bone, with open fractures becoming increasingly prevalent due to road traffic accidents, particularly in developing countries where trauma care systems are often inadequate.[12] Despite its high incidence, the optimal management of open tibial fractures remains a

subject of debate, with ongoing discussions on fixation methods as modern treatment emphasizes early stabilization and functional recovery.[13] Hoffmann's external fixation device has been widely used for decades, but concerns over infection risks and stability have affected its reputation. Modifications such as the Vidal-Adrey system have attempted to address these issues, yet their effectiveness remains unclear. Comparatively, the Ilizarov external fixator offers advantages in wound management and early weight-bearing. However, no comparative study has systematically assessed clinical outcomes between these systems for acute Type II fractures. This gap in research persists despite the urgent need to evaluate outcomes, as infection remains a major complication, leading to prolonged morbidity and costly treatments.

The high failure rates of conventional methods and the Ilizarov system's potential for better stability and functional recovery highlight the necessity of a direct comparison. Analyzing healing time, complication rates, and rehabilitation outcomes in first-day surgical settings could provide valuable insights, particularly in cases where immediate stabilization plays a crucial role in patient prognosis. The purpose of the study was to assess and compare the clinical outcomes of Ilizarov versus Hoffmann external fixators in first-day surgeries for Gustilo-Anderson Type II open tibial fractures.

2. OBJECTIVE

- The aim of the study was to evaluate and compare the clinical outcomes of Ilizarov versus Hoffmann external fixators in first-day surgeries for Gustilo-Anderson Type II open tibial fractures.

3. METHODOLOGY & MATERIALS

This prospective comparative study was conducted at the Department of Orthopaedics and Traumatology, President Abdul Hamid Medical College Hospital, from January 1 to December 31, 2024. A total of 50 consecutive patients with Gustilo-Anderson Type II open tibial fractures requiring immediate surgical stabilization were enrolled.

Inclusion Criteria

- Adults aged 18-65 years with acute (<24 hours) Type II open tibial fractures
- Isolated unilateral injuries

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- No pre-existing bone pathology

Exclusion Criteria

- Polytrauma patients (Injury Severity Score >16)
- Pathological fractures
- Pre-existing neurovascular deficits

Patients were randomly assigned to one of two fixation techniques: the Ilizarov External Fixator Group (n=25), which involved circular frame fixation using 1.8mm K-wires and 6mm half-pins, allowing early weight-bearing, and the Hoffmann External Fixator Group (n=25), which utilized a unilateral rail system with 5mm Schanz pins and followed a delayed weight-bearing protocol.

All procedures were performed within 12 hours of injury by senior orthopaedic trauma surgeons, adhering to standard wound debridement protocols and hospital antibiotic guidelines. The

primary outcomes assessed were fracture healing time (radiographic union) and infection rates (superficial and deep infections), while secondary outcomes included functional recovery (evaluated using the Lower Extremity Functional Scale [LEFS] at 6 months), complication rates (malunion, nonunion, pin tract infection), and the cure rate (union without major complications). Patients were followed up weekly for the first month, then biweekly until fracture union, with a final assessment at 6 months. Data were analyzed using SPSS v26, with continuous variables (e.g., age, fracture healing time, LEFS score) compared using independent t-tests and categorical variables (e.g., infection rates, malunion, nonunion, cure rates) analyzed using chi-square tests, considering $p < 0.05$ statistically significant. Written informed consent was obtained from all participants before enrollment.

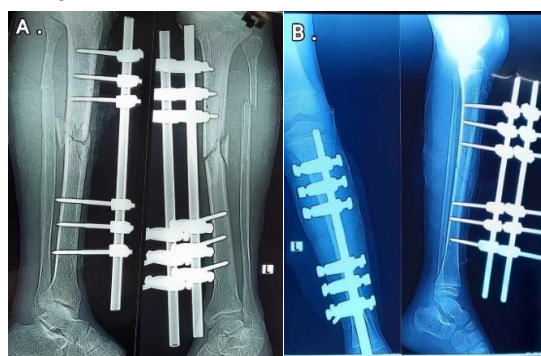


Figure 1. Postoperative X-ray Views Showing External Fixation Using Hoffmann Fixator for Gustilo-Anderson Type II Open Tibial Fracture.



Figure 2. Preoperative and Postoperative X-ray Comparisons of Patients Treated with Ilizarov External Fixators for Gustilo-Anderson Type II Open Tibial Fracture.

4. RESULTS

Table 1. Baseline Demographic and Injury Characteristics of the Ilizarov and Hoffmann Groups (n=50)

Characteristics		Ilizarov Group (n=25)	Hoffmann Group (n=25)
Age (years)		37.6 ± 10.52	39.2 ± 9.8
Gender	Male	20 (80.0%)	22 (88.0%)
	Female	5 (20.0%)	3 (12.0%)
Mechanism of Injury	Road Traffic Accident	22 (88.0%)	20 (80.0%)
	Bomb Blast	2 (8.0%)	3 (12.0%)
	Fall from Height	1 (4.0%)	2 (8.0%)

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The study included 50 patients divided equally into two groups: the Ilizarov group (n=25) and the Hoffmann group (n=25). The mean age of patients was 37.6 ± 10.52 years in the Ilizarov group and 39.2 ± 9.8 years in the Hoffmann group. In the Ilizarov group, 20 patients (80.0%) were male and 5 patients (20.0%) were female, while the Hoffmann group comprised 22 males (88.0%) and 3 females (12.0%). Regarding the

mechanism of injury, road traffic accidents were the most common cause in both groups, reported in 22 patients (88.0%) in the Ilizarov group and 20 patients (80.0%) in the Hoffmann group. Bomb blast injuries accounted for 2 patients (8.0%) in the Ilizarov group and 3 patients (12.0%) in the Hoffmann group, while falls from height occurred in 1 patient (4.0%) and 2 patients (8.0%) respectively.

Table 2. Comparison of Clinical Outcomes between the Ilizarov and Hoffmann Groups

Outcome Measure	Ilizarov Group (Mean \pm SD)	Hoffmann Group (Mean \pm SD)	P-value
Fracture Healing Time (weeks)	24.00 \pm 5.29	31.17 \pm 8.30	<0.001
Infection Rate (%)	18%	21%	0.785
LEFS Functional Score	78 \pm 6	70 \pm 7	<0.001

The Ilizarov group demonstrated significantly faster fracture healing (24.00 \pm 5.29 weeks) compared to the Hoffmann group (31.17 \pm 8.30 weeks, $p < 0.001$). Infection rates were slightly lower in the Ilizarov group (18%) versus

Hoffmann group (21%), though not statistically significant ($p = 0.785$). Functional outcomes, measured by LEFS scores, favored the Ilizarov group (78 \pm 6) over the Hoffmann group (70 \pm 7, $p < 0.001$).

Table 3. Comparison of Postoperative Complications between Ilizarov and Hoffmann Groups

Complication	Ilizarov Group (n=25)	Hoffmann Group (n=25)	p-value
Pin tract infection	5 (20%)	12 (48%)	0.037
Malunion	2 (8%)	8 (32%)	0.034
Nonunion	1 (4%)	6 (24%)	0.042
Cure rate	21 (84%)	14 (56%)	0.031

Table 3 compares the postoperative complications and cure rates between the Ilizarov group (n=25) and the Hoffmann group (n=25). Pin tract infection was observed in 5 patients (20.0%) in the Ilizarov group and 12 patients (48.0%) in the Hoffmann group ($p = 0.037$). Malunion occurred in 2 patients (8.0%) in the Ilizarov group compared to 8 patients (32.0%) in the Hoffmann group ($p = 0.034$). Nonunion was reported in 1 patient (4.0%) in the Ilizarov group and 6 patients (24.0%) in the Hoffmann group ($p = 0.042$). The cure rate was significantly higher in the Ilizarov group, achieved in 21 patients (84.0%) versus 14 patients (56.0%) in the Hoffmann group ($p = 0.031$).

5. DISCUSSION

This study evaluates the clinical outcomes associated with two commonly used external fixators, the Ilizarov and Hoffmann systems, in the management of Gustilo-Anderson Type II open tibial fractures. Open tibial fractures, particularly of the Type II variety, present significant challenges due to the risk of infection, delayed healing, and functional impairment. The

findings highlight the comparative effectiveness of these two fixation methods, focusing on fracture healing time, infection rates, functional recovery, and postoperative complications. By assessing these outcomes, the study aims to provide valuable insights into the optimal choice of external fixator for improving patient recovery and minimizing complications.

In our study, the Ilizarov group exhibited a mean age of 37.6 ± 10.52 years with 80% male predominance, while the Hoffmann group had a comparable mean age of 39.2 ± 9.8 years and 88% male predominance. These findings suggest that both groups had a similar demographic profile, minimizing potential bias in comparative outcomes. Specifically, our Ilizarov group's age distribution and male predominance are consistent with the results reported by Zargar et al.[14], who observed a similar trend in patients treated with Ilizarov external fixators. In terms of the mechanism of injury, road traffic accidents (RTA) were the leading cause in both groups—88% in the Ilizarov group and 80% in the Hoffmann group—followed by bomb blast

injuries and falls from height. Notably, our Ilizarov group's predominance of RTA cases aligns closely with Kumar et al.[15], who identified RTA as the major mechanism of injury in their series of Ilizarov-treated patients. The consistency of our Ilizarov group with previously reported literature reinforces the validity of our sample selection and sets a reliable basis for comparing postoperative outcomes between the two fixation methods. In our study, the Ilizarov group showed a significantly shorter fracture healing time (24.00 ± 5.29 weeks) compared to the Hoffmann group (31.17 ± 8.30 weeks, $p < 0.001$), which is consistent with the findings of Kumar et al.[16], who reported faster union times with Ilizarov fixators. The infection rate in our series was slightly higher in the Hoffmann group (21%) compared to the Ilizarov group (18%), a trend also observed by Kumar et al., who attributed the lower infection rates in the Ilizarov group to the stability and meticulous pin care associated with the technique. Additionally, the functional outcomes measured by the Lower Extremity Functional Scale (LEFS) were significantly better in the Ilizarov group (78 ± 6) than in the Hoffmann group (70 ± 7 , $p < 0.001$), aligning with the results reported by Çelik et al.[17], who demonstrated superior LEFS scores in patients treated with Ilizarov external fixators, likely due to better alignment, early mobilization, and effective load-sharing properties of the fixator.

In our study, the incidence of pin tract infection was significantly lower in the Ilizarov group (20%) compared to the Hoffmann group (48%) ($p=0.037$). This aligns with the findings of Zargar et al. [14] and Bhosale et al.[18], who also reported relatively low rates of pin tract infections with Ilizarov fixation, attributing it to the stability and better soft tissue handling offered by the circular fixator system. Regarding malunion and nonunion, our results showed fewer cases in the Ilizarov group (8% malunion, 4% nonunion) compared to the Hoffmann group (32% malunion, 24% nonunion), both statistically significant. These findings are consistent with those reported by Ganji et al.[19], who demonstrated better union outcomes and fewer malunion/nonunion rates with Ilizarov fixators due to their capacity for gradual correction and dynamic axial loading, which promotes osteogenesis. Additionally, the cure rate was notably higher in the Ilizarov group (84%) compared to the Hoffmann group (56%), reinforcing the advantages of the Ilizarov method

in achieving satisfactory clinical outcomes in Gustilo-Anderson Type II open tibial fractures.

6. LIMITATIONS OF THE STUDY

This study had some limitations:

- The study was conducted in a selected tertiary-level hospital.
- The sample was not randomly selected.
- The study's limited geographic scope may introduce sample bias, potentially affecting the broader applicability of the findings.

7. CONCLUSION

This comparative study found the Ilizarov external fixator clinically superior to the Hoffmann fixator for treating Gustilo-Anderson Type II open tibial fractures in first-day surgery. Patients treated with the Ilizarov system showed faster fracture healing, better functional recovery, and fewer complications overall. While infection rates were similar between groups, the Ilizarov technique demonstrated clear advantages in maintaining fracture stability and achieving successful outcomes. These results strongly support using the Ilizarov fixator as the preferred treatment approach for these injuries, particularly when early stabilization and optimal functional results are priorities. The system's ability to promote rapid healing while minimizing complications makes it valuable for managing open tibial fractures in the acute setting.

REFERENCES

- [1] Wani N, Baba A, Kangoo K, Mir M. Role of early Ilizarov ring fixator in the definitive management of type II, IIIA and IIIB open tibial shaft fractures. *International orthopaedics*. 2011 Jun;35:915-23.
- [2] Giannoudis PV, Papakostidis C, Kouvidis G, Kanakaris NK. The role of plating in the operative treatment of severe open tibial fractures: a systematic review. *International orthopaedics*. 2009 Feb;33:19-26.
- [3] Papaioannou N, Mastrokalos D, Papagelopoulos PJ, Tyllianakis M, Athanassopoulos J, Nikiforidis PA. Nonunion after primary treatment of tibia fractures with external fixation. *European Journal of Orthopaedic Surgery & Traumatology*. 2001 Dec;11:231-5.
- [4] Shamim ML, Adom S, Jowardar AH, Jewel MM. The use of Ilizarov external fixator for open comminuted fractures in different parts of tibia. *Int J Res Orthop*. 2022 May;8(3).
- [5] Bilal C, Leutenegger A, Rüedi T. Osteosynthesis of 245 tibial shaft fractures: early and late complications. *Injury*. 1994 Aug 1;25(6):349-58.

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- [6] Khan MS, Raza W, Ullah H, Khan AS, Siraj M, Askar Z. Outcome of ilizarov fixator in complex non-union of long bones. *J Pak Med Assoc.* 2015 Nov 1;65(11 Suppl 3):S147-51.
- [7] Sidharthan S, Sujith A, Rathod AK, Pathak RH. Management of high energy tibial fractures using the Ilizarov apparatus. *Internet J Orthop Surg.* 2005;2(2):1-6.
- [8] Hosny G, Fadel M. Ilizarov external fixator for open fractures of the tibial shaft. *International orthopaedics.* 2003 Oct;27:303-6.
- [9] Bucholz RW, Heckman JD, Tornetta P, McQueen MM, Ricci WM. Rockwood and Green's fractures in adults. In: *Rockwood and Green's fractures in adults 2010* (pp. 1275-1275).
- [10] Hasankhani E, Payvandi MT, Birjandinejad A. The Ilizarov ring external fixator in complex open fractures of the tibia. *European Journal of Trauma.* 2006 Feb;32:63-8.
- [11] Papaioannou N, Mastrokalos D, Papagelopoulos PJ, Tyllianakis M, Athanassopoulos J, Nikiforidis PA. Nonunion after primary treatment of tibia fractures with external fixation. *European Journal of Orthopaedic Surgery & Traumatology.* 2001 Dec;11:231-5.
- [12] Wani N, Baba A, Kangoo K, Mir M. Role of early Ilizarov ring fixator in the definitive management of type II, IIIA and IIIB open tibial shaft fractures. *International orthopaedics.* 2011 Jun;35:915-23.
- [13] Gustilo RB, Merkow RL, Templeman DA. The management of open fractures. *JBJS.* 1990 Feb 1;72(2):299-304.
- [14] Zargar DSM, Prasad DR, Mir DUF. Complications of ilizarov external fixator. *Nat J Clin Orthop.* 2023;7(3):26-8.
- [15] Kumar H, Ghosh S, Ghosh PK, Sinha S, Sarkar A, De C, Gorain A. Outcome of Primary Ilizarov External Fixator in Gustilo Anderson Type II, IIIa and IIIb Tibial Fractures.
- [16] Kumar P, Singh GK, Bajracharya S. Treatment of grade IIIB opens tibial fracture by Ilizarov hybrid external fixator. *Kathmandu Univ Med J (KUMJ).* 2007 Apr 1;5(2):177-80.
- [17] Çelik M, Bayrak A, Öztürk V, Kızılkaya C, Avkan MC. Functional and Radiological Comparison and Evaluation of Gustilo-Anderson Type 3 Open Tibia Fractures Treated with an Ilizarov External Fixator. *Med J Bakirkoy.* 2024 Dec 25;20(4):308-14.
- [18] Bhosale ND, Naikwade D. Functional outcome analysis of ilizarov ring fixator as definitive fixation of open tibial fractures. *Indian Journal of Orthopaedics Surgery.* 2023 Mar 14;9(1):12-7.
- [19] Ganji SE, Bahrami M, Joukar F. Ilizarov versus AO external fixator for the treatment of tibia open fractures. *Iranian Red Crescent Medical Journal.* 2011 Dec 1;13(12):868.

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