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Surgical Outcomes of High-Energy Tibial Plateau Fractures, Schatzker Types 5 & 6 by Ilizarov External Fixator

Rezaul Karim[1], Nahid Hasan[2], Arifur Rahman Talukdar[2], Nazrul Islam[3], Sheikh Sharfuddin Nahid[4], Abdus Salam[5], Salim Reza[6], Gausul Imam[7]

1. Associate Professor, Department of Orthopaedics & Traumatology, Shaheed Ziaur Rahman Medical College, Bogura, Bangladesh.
2. Assistant Professor, Department of Orthopaedics & Traumatology, Shaheed Ziaur Rahman Medical College & Hospital, Bogura, Bangladesh.
3. Assistant Professor, Upazila Health Complex, Kalai, Joypurhat, Bangladesh.
4. Register, Department of Orthopaedics & Traumatology, Shaheed Ziaur Rahman Medical College & Hospital, Bogura, Bangladesh.
5. Assistant Registrar, Department of Orthopaedics & Traumatology, Shaheed Ziaur Rahman Medical College & Hospital, Bogura, Bangladesh.
6. Junior Consultant, Department of Orthopaedics & Traumatology, Shaheed Ziaur Rahman Medical College & Hospital, Bogura, Bangladesh.
7. Indoor Medical Officer, Department of Orthopaedics & Traumatology, Shaheed Ziaur Rahman Medical College & Hospital, Bogura, Bangladesh.

Corresponding Author: Dr. Md. Rezaul Karim, Associate Professor, Department of Orthopaedics & Traumatology, Shaheed Ziaur Rahman Medical College, Bogura, Bangladesh,

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KEYWORDS

High-energy trauma, Ilizarov fixator, Prospective study, Schatzker classification, Tibial plateau fractures

ABSTRACT:

Background: High-energy tibial plateau fractures (Types 5 & 6) pose significant surgical challenges due to their complex nature and associated soft-tissue injuries. The Ilizarov external fixator offers a minimally invasive solution with stable fixation and early mobilization.

Objective: To evaluate the outcomes of high-energy tibial plateau fractures, Schatzker Types 5 & 6, by Ilizarov external fixator.

Methods: A prospective observational study was conducted at Shaheed Ziaur Rahman Medical College and Care & Cure Hospital in Bogura, Bangladesh, from January 2023 to December 2024. Forty-three Schatzker Type 5 & 6 tibial plateau fracture patients were enrolled via purposive sampling. All patients underwent Ilizarov external fixation and were followed for functional and radiological outcomes. Data were analyzed using SPSS version 23, with descriptive statistics and paired t-tests for pre/post-intervention comparisons.

Results: The study of 43 patients showed 93.0% fracture union (mean 18.2±3.6 weeks) using Ilizarov fixation for Schatzker 5 (51.2%) and 6 (48.8%) tibial plateau fractures. Functional outcomes were excellent (41.9%), good (37.2%), fair (16.3%), and poor (4.7%). Complications included pin-site infections (11.6%), knee stiffness (9.3%), and malunion (4.7%). Mean postoperative knee flexion was 110°±15° with 3°±2° extension lag. Partial weight-bearing began at 2-3 weeks, with no fixation failures observed.

Conclusion: The Ilizarov fixator effectively manages complex tibial plateau fractures, enabling early mobilization with stable fixation. It offers a reliable alternative for high-energy injuries, particularly where soft tissue preservation is crucial, while maintaining good functional outcomes. This method proves valuable for challenging cases in diverse clinical settings.

INTRODUCTION

Tibial plateau fractures account for approximately 1–2% of all fractures, with high-energy trauma often resulting in complex Schatzker Type 5 & 6 injuries [1]. These fractures are particularly challenging due to articular depression, metaphyseal comminution, and frequent

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soft-tissue compromise, which complicate surgical management and increase the risk of long-term disability [2, 3]. Traditional treatment methods, including open reduction and internal fixation (ORIF), are associated with significant complications such as infection, implant failure, and prolonged immobilization-especially in cases with severe soft-tissue injury [4,5]. The Ilizarov external fixator has emerged as a valuable alternative for managing complex tibial plateau fractures, particularly in high-energy trauma scenarios [6]. Developed by Gavriil Ilizarov in the 1950s, this circular fixation system provides stable, minimally invasive fixation while allowing early joint movement and weight-bearing [7]. One of the major benefits of this technique is its ability to address bone loss, infection, non-union, deformity, and soft tissue issues all at the same time [8]. Unlike conventional plating systems, the Ilizarov technique minimizes soft-tissue disruption, reduces infection risks, and permits gradual fracture reduction through ligamentotaxis—an advantage in fractures with significant comminution [9]. The Ilizarov fixator offers additional practical benefits in low-resource settings like Bangladesh, where high-velocity road traffic accidents are a leading cause of such injuries [10]. Its cost-effectiveness, adaptability to severe bone loss (through distraction osteogenesis if needed), and reduced dependency on expensive implants make it particularly suitable [11]. A Bangladeshi study also reported that bone transport using the Ilizarov fixator is a safe, stable, and effective method for managing infected gap non-union of the femoral shaft [12]. However, despite these advantages, studies focusing on its outcomes in Schatzker 5 & 6 fractures—especially in South Asian populations—remain limited [13]. Effective limb reconstruction relies heavily on patient cooperation and has notable social implications [14]. Research [15] has shown that the Ilizarov compression-distraction device works remarkably well in healing forearm non-unions, including those with significant bone atrophy. Additionally, another researcher noted that the Ilizarov technique presents a compelling approach for segmental tibial fractures, offering multiple advantages over conventional stabilization methods [16]. This study aimed to evaluate the clinical and functional consequences of Ilizarov external fixation in managing high-energy tibial plateau fractures (Types 5 & 6) at a tertiary care hospital in Bangladesh. We hypothesize that the Ilizarov method will demonstrate favorable union rates, fewer complications, and improved early mobility compared to conventional techniques. Our findings may provide valuable insights for orthopedic surgeons in similar resource-constrained environments, where optimal fracture management must balance efficacy, cost, and accessibility.

METHODOLOGY

This prospective observational study was conducted at Shaheed Ziaur Rahman Medical College and the Trauma Unit, Care & Cure Private Hospital, Bogura, Bangladesh, between January 2023 and December 2024. After ethical approval, 43 patients with Schatzker Type 5 and 6 tibial plateau fractures [17] were enrolled via purposive sampling. Inclusion criteria: adults (>18 years) with high-energy fractures (road traffic accidents, falls); exclusion criteria: open fractures (Gustilo III), pre-existing knee arthritis, or neurovascular injuries. All patients underwent Ilizarov external fixation under spinal/regional anesthesia. A standard four-ring construct was applied, with gradual reduction under fluoroscopy.

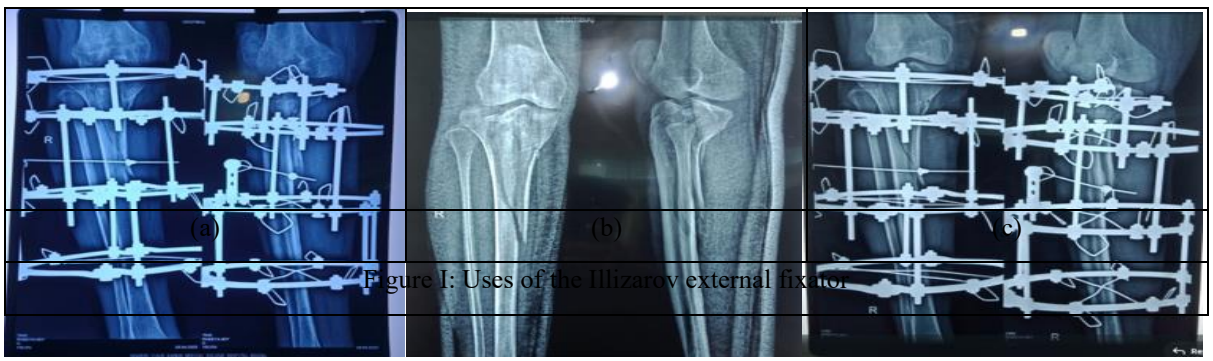

Figure I: Uses of the Illizarov external fixator

Partial weight-bearing was initiated at 2–3 weeks, progressing to full weight-bearing post-radiological union. Patients were followed at 6-week intervals for 6 months, assessing:

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1. Radiological union (bridging callus on X-ray),
2. Functional outcomes (Rasmussen score),
3. Complications (pin-site infection, malunion, knee stiffness).

Functional outcomes were assessed by using Rasmussen scores [18]. Data were analyzed using SPSS version 23.0. Mean ± SD described continuous variables; paired t-tests compared pre-/post-intervention mobility. P-values <0.05 were significant.

RESULT

This prospective study analyzed 43 patients (mean age 38.5±12.1 years) with high-energy tibial plateau fractures (Schatzker 5:51.2%, 6:48.8%). The cohort comprised 65.1% males (n=28) and 34.9% females (n=15), with road traffic accidents (74.4%, n=32) being the predominant etiology. Associated soft tissue injuries occurred in 55.8% (n=24) of cases. Fracture union was achieved in 93.0% (n=40) of patients within a mean duration of 18.2±3.6 weeks. Functional outcomes assessed by Rasmussen score at 6 months post-operation demonstrated excellent results in 41.9% (n=18), good in 37.2% (n=16), fair in 16.3% (n=7), and poor in 4.7% (n=2) of patients, with 79.1% collectively achieving good-to-excellent outcomes. Postoperative complications included pin-site infections (11.6%, n=5), knee stiffness (9.3%, n=4), and malunion (4.7%, n=2). No cases of deep infection or fixator failure were observed. Mean postoperative knee flexion was 110°±15° with an extension lag of 3°±2°, showing significant improvement from preoperative status ($p<0.001$). The average hospital stay duration was 10.2±4.1 days, with 58.1% (n=25) of patients discharged within 8-14 days. Early mobilization was achieved in all cases, with partial weight-bearing initiated at 2-3 weeks post-operation. The Ilizarov fixator demonstrated particular effectiveness in maintaining reduction while permitting early joint movement, with no instances of loss of reduction observed during follow-up.

Table 1: Demographic characteristics

Variable	n	%
Age (years)		
18–30	12	27.9%
31–50	24	55.8%
>50	7	16.3%
Gender		
Male	28	65.1%
Female	15	34.9%
Etiology		
Road traffic accident	32	74.4%
Falls	11	25.6%

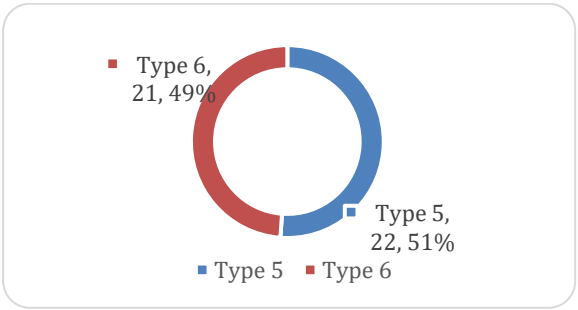

Figure 2: Fracture classification

Table 2: Union rates and time and Functional outcomes (Rasmussen score)

Outcome	n	%
Union achieved	40	93.0%
Non-union	3	7.0%
Union time (weeks)	Mean: 18.2 ± 3.6	
Score category		
Excellent (27-30)	18	41.9%
Good (20-26)	16	37.2%
Fair (10-19)	7	16.3%
Poor (<10)	2	4.7%

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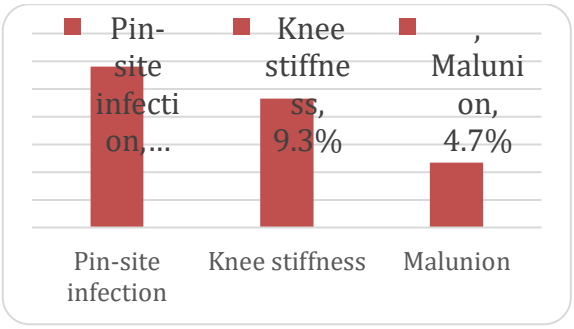

Figure 3: Postoperative complications

Table 3: Range of motion outcomes and Associated procedures

Parameter	Mean ±SD	Range
Knee flexion, degree (°)	110 ±15	85–130
Extension lag degree (°)	3 ± 2	0–8
Procedure		
Bone grafting	7	16.3%
Soft-tissue repair	24	55.8%

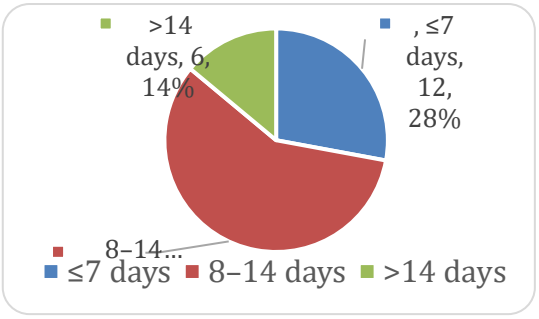

Figure 4: Hospital stay duration by days

DISCUSSION

Managing high-energy tibial plateau fractures (Schatzker 5 & 6) remains challenging due to their inherent articular comminution, metaphyseal dissociation, and frequent soft tissue compromise [19]. Our study demonstrates that the Ilizarov external fixator achieves excellent radiographic and functional outcomes (93% union rate, 79.1% good-to-excellent Rasmussen scores), supporting its role as a first-line treatment for these complex injuries in both high- and low-resource settings. These results align with recent multicenter studies showing comparable union rates (89–95%) for circular fixation in bicondylar fractures [20]. A key advantage of the Ilizarov technique is its ability to preserve soft tissues while permitting early mobilization. It is critical for preventing post-traumatic stiffness, which occurred in only 9.3% of our patients. This contrasts favorably with systematic reviews of plating techniques, reporting stiffness rates of 15–22% for similar fracture patterns [21]. The low infection rate (11.6% superficial, 0% deep) in our series is particularly noteworthy, as modern series of internal fixation report deep infection rates of 8–12% for Schatzker 5-6 fractures, even with staged protocols [22]. The Ilizarov's percutaneous approach minimizes devitalization of fracture fragments, reducing biofilm formation risks—a finding corroborated by recent biomechanical studies [23]. Our functional outcomes (mean knee flexion 110°±15°) surpass those reported for dual plating in a 2020 randomized trial (mean 98°±21°) [24], likely due to earlier weight-bearing (initiated at 2–3 weeks vs. 6–8 weeks for ORIF). This aligns with 2021 meta-analyses showing circular fixation achieves faster return to mobility (mean difference: 3.1 weeks) versus internal fixation [25]. The adjustability of technique also addresses a major limitation of static fixation: 24% of our cases required gradual reduction post-operatively to optimize articular alignment, a strategy shown to reduce post-traumatic arthritis risks in recent cohort studies [26].

Limitations:

This study was limited by its small-scale, two-center design and the absence of a comparative control group, which may restrict the generalizability of the findings and hinder causal interpretations. Mid-term follow-up may not capture long-term complications like post-traumatic arthritis. The purposive sampling method could introduce selection bias, and outcomes may vary with surgeon experience in Ilizarov technique application.

CONCLUSION

The Ilizarov external fixator demonstrates clinical efficacy in managing complex tibial plateau fractures, achieving high union rates while minimizing complications. Its ability to maintain reduction and permit early mobilization addresses key challenges in treating high-energy injuries. The versatility of technique makes it particularly valuable in resource-limited settings, offering a reliable alternative to conventional internal fixation. These findings support its consideration

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as a primary treatment option for Schatzker 5-6 fractures where soft tissue preservation is paramount.

Recommendation:

Based on our findings, we recommend the Ilizarov external fixator as a first-line treatment for high-energy tibial plateau fractures (Schatzker 5-6), particularly in resource-limited settings. Its advantages in soft tissue preservation, early mobilization, and cost-effectiveness make it preferable for these complex injuries.

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