



Assessment of Functional Outcome from the Hybrid Ilizarov Technique in Patients with Complicated Tibial Plateau Fractures

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Complex tibial plateau fractures pose challenges in orthopedic trauma care due to their intricate nature, potential for functional impairment, and involvement of articular disruption, metaphyseal comminution, and soft tissue injuries. Restoring joint alignment and ligament stability is crucial for favorable outcomes. Surgical methods like the Ilizarov technique and its adaptations have gained attention. Existing literature reports around 50% satisfactory results regardless of closed or operative approaches. Failures result in pain, limited motion, deformities, and knee instability. Ilizarov's circular fixator is valuable for high-energy fractures with compromised soft tissues, offering stability and indirect reduction.

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Aim of the Study: This study evaluates the hybrid Ilizarov technique's outcomes in restoring structure and function for complex tibial plateau fractures.

Methods: This was a retrospective study. The study was conducted at the department of Orthopedics in North Bengal Medical College and Hospital, Sirajgonj, Bangladesh. One hundred and fifty-two patients were prospectively recruited with knee osteoarthritis over one year of the study period from January 2020 to December 2022.

Results: The study used the hybrid Ilizarov technique to investigate 27 patients who underwent surgical treatment for complex tibial plateau fractures. Most patients (74.07%) were aged 20-40, with the rest (25.93%) aged 41-60. Males made up 81.48% of participants, while females were 18.52%. BMI distribution showed that 44.44% had normal BMI, 29.63% were overweight, and 11.11% were obese. More injuries occurred on the right side (59.26%). Complications affected 44.44% of patients, including pin tract infections (22.22%) and joint stiffness (7.41%). Clinical outcomes varied, with around 60% achieving good outcomes, 25.93% excellent, 7.41% fair, and a similar number of poor.

Conclusion: The Hybrid Ilizarov Technique demonstrates promise in addressing complicated tibial plateau fractures, showcasing favorable functional outcomes. This approach can potentially enhance patient recovery and warrants further exploration in orthopedic practice.

Keywords: Functional outcome; tibia plateau fracture; hybrid ilizarov.

1. INTRODUCTION

Complex tibial plateau fractures present a significant challenge in orthopaedic trauma management due to their intricate nature and potential for substantial functional impairment [1]. These fractures commonly involve disruption of the articular surface, comminution of the metaphysis, and concomitant injuries to soft tissues, necessitating a nuanced approach that addresses both the bony and ligamentous components [2]. The inability to restore proper alignment of the joint surfaces and instability within the ligaments are the main factors contributing to unfavourable long-term outcomes [3]. Over time, surgical techniques have evolved, giving rise to various treatment approaches, among which the Ilizarov technique and its hybrid adaptations have garnered increasing attention. A review of existing literature reveals that many authors report slightly over 50% satisfactory results regardless of whether closed or operative methods are employed [4,5]. Instances of treatment failure often manifest as lingering pain, restricted motion, deformity, recurrent joint effusions, and instances of the knee giving way. Insights into the causes of these failures have been gleaned from examining more than 140 such fractures treated using closed and operative methods [6,7]. Standard open reduction and internal fixation (ORIF), employing dual or lateral locking plates, have successfully restored proper bony alignment. However, these procedures often lead to surgical complications, intense infections and tissue necrosis. The Ilizarov technique offers solutions

to many of these challenges, presenting a closed reduction and fixation method that minimizes the need for extensive manipulation of soft tissues and reduces the risk of tissue damage [8,9]. The Ilizarov circular ring fixator is a valuable alternative in cases involving high-energy fractures with significant intra-articular comminution and compromised soft tissues. It provides stability even when traditional internal fixation devices struggle to maintain secure fixation. The Ilizarov approach employs ligament manipulation by spanning the knee, allowing for indirect reduction. Once the leg is aligned correctly, the articular surface can be reconstructed using indirect methods, employing percutaneous fixation through K-wires or olive wires [10,11]. This study delves into the functional outcomes of the hybrid Ilizarov technique for individuals with complex tibial plateau fractures. By evaluating parameters such as joint mobility, pain levels, radiographic alignment, and the ability to return to activities undertaken prior to the injury, a comprehensive assessment of the technique's effectiveness in restoring anatomical structure and functional capabilities can be attained.

2. METHODOLOGY AND MATERIALS

This was a retrospective study. The study was conducted at the department of Orthopedics in North Bengal Medical College and Hospital, Sirajgonj, Bangladesh. One hundred and fifty-two patients were prospectively recruited with knee osteoarthritis over one year of the study period from January 2020 to December 2022.

During this period, the study encompassed a total of 27 patients who had undergone surgical intervention utilizing the hybrid Ilizarov technique to treat intricate tibial plateau fractures. Prior to inclusion in the study, all participants provided written informed consent.

Inclusion criteria:

- Patients age more than 18 years and less than 60 years.
- Patients with both schatzkers V and VI tibial plateau fractures.
- Patients with both open (involving skin wound) and closed fractures.

Exclusion criteria:

- Patients with previous surgery.
- Patients with intervention for tibial fractures.
- Patient with advanced osteoporosis as diagnosed by x-ray.
- Patients with bilateral tibial plateau fractures.

Demographic details, encompassing name, age, and gender, were meticulously documented within a structured questionnaire. This was accompanied by diligent monitoring of outcome variables, such as clinical and radiological union, functional outcome, and incidences of pin tract infection. A standardized hybrid external fixation protocol was uniformly embraced for the procedures. This entailed utilizing an Anterior T frame, a half-pin external fixator, and percutaneous internal fixation specifically tailored to manage intricate injuries. The configuration of proximal half-pins was strategically designed, involving the insertion of Schanz pins in an anterior-posterior direction into the lateral and medial condylar fragments, complemented by an oblique pin running from anteroinferior to posterosuperior in the proximal tibial metaphysis. This approach created a triangulation effect, stabilizing the metaphyseal segment across three dimensions. In severely comminuted fractures, bone grafting and minimal internal fixation using cannulated screws were judiciously employed. The utmost care was exercised during the percutaneous placement of the articular wires to ensure minimal disruption to bone and its periosteum. The time interval between the occurrence of trauma and the surgical intervention exhibited variability. Comprehensive patient follow-ups were conducted at 6 weeks and 3 months post-surgery. The assessment of functional outcomes was executed using

Rasmussen's knee functional score, which served as the operational definition for gauging performance. This scoring system stratified functional outcomes into distinct categories: an outcome falling within the 27-30 range was classified as excellent, 20-26 as good, 10-19 as fair, and 6-9 as poor.

The information was organized effectively, with all data being meticulously arranged into appropriate tables and graphs based on their relationships. Each table and graph were accompanied by a comprehensive explanation, facilitating a clear understanding of their contents. Statistical procedures were conducted using the Statistical Package for the Social Sciences (SPSS) software on the Windows platform. Mean values and corresponding standard deviations were used to express continuous parameters, while categorical parameters were conveyed through frequency and percentage representations.

3. RESULTS

A total of 27 patients were included and assessed in the investigation, all of whom had undergone surgical intervention using the hybrid Ilizarov technique for the treatment of complex tibial plateau fractures. The majority, constituting 74.07% of the patient were from the age range of 20-40 years, while the remaining 25.93% were between the ages of 41-60 years (Table 1). In terms of gender distribution, the study consisted mostly of male participants, accounting for 81.48%, with the female representation being 18.52% (Fig. 1). The distribution of BMI status among the subjects is displayed in Table 2. It is worth noting that the majority, specifically 12 individuals (44.44%), exhibited a normal BMI, followed by 8 patients (29.63%) classified as overweight, and 3 patients (11.11%) classified as obese. Notably, a higher proportion of patients sustained injuries on the right side (59.26%), as indicated in Fig. 2. Regarding complications, the overall complication rate was 44.44%. Within this subset, 6 patients (22.22%) experienced pin tract infections, while 2 patients (7.41%) encountered joint stiffness. Various issues such as malunion, re-fracture, malalignment, and bleeding from the pin site each accounted for 3.70% of the total complications. The clinical outcomes of the study population are outlined in Table 4. Approximately 60% of patients achieved a good outcome, 7 individuals (25.93%) experienced an excellent outcome, and 2 patients (7.41%) had a fair outcome. Similarly, an equal number of patients had a poor outcome.

Table 1. Age distribution of the study population (N=27)

Age range (Year)	Frequency (n)	Percentage (%)
20-40	20	74.07
41-60	7	25.93
Total	27	100.00

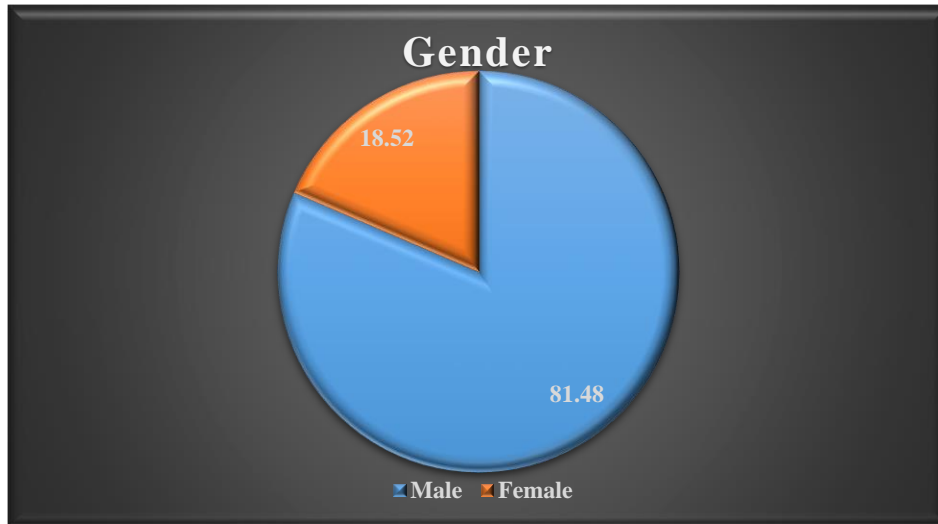


Fig. 1. Gender distribution of the study population (N=27).

Table 2. Patients BMI status

BMI	Frequency (n)	Percentage (%)
Underweight (<18.5)	4	14.81
Normal (18.5-24.9)	12	44.44
Overweight (25-29.9)	8	29.63
Obsess (>30)	3	11.11
Total	27	100.00

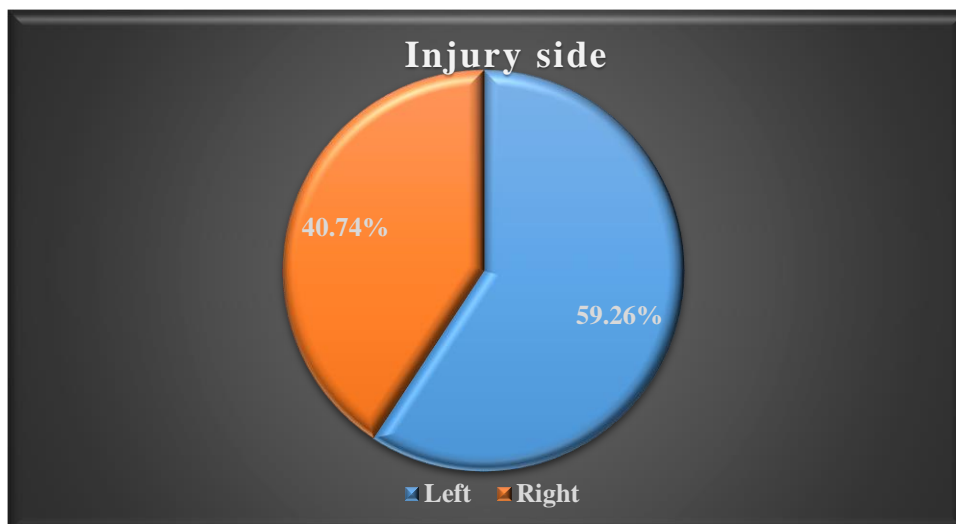


Fig. 2. Injury side of the study population (N=27)

Table 3. Study complication (n=12)

Complications	Frequency (n)	Percentage (%)
Pin tract infection	6	22.22
Joint stiffness	2	7.41
Mal union	1	3.70
Delayed union/non-union	0	0.00
Re-fracture	1	3.70
Mal alignment	1	3.70
Bleeding from the pin site	1	3.70
Total	12	44.44

Table 4. Clinical outcome of the study population (N=27)

Outcomes	Frequency (n)	Percentage (%)
Excellent (27-30)	7	25.93
Good (20-26)	16	59.26
Fair (10-19)	2	7.41
Poor (6-9)	2	7.41
Total	27	100.00

4. DISCUSSION

Tibial plateau fractures, whether caused by high-velocity incidents or low-velocity events due to osteoporosis, pose considerable challenges for surgeons. Over time, various treatment approaches have emerged to address these complex intra-articular fractures [12]. The primary objective in managing bicondylar tibial plateau fractures is to achieve a painless, mobile, stable, and well-aligned knee joint while minimizing the potential for posttraumatic osteoarthritis. The significance of early joint mobilization has been firmly established through the pioneering work of Apley, underlining the need for accurate fracture reduction and stable fixation to facilitate prompt joint movement [9]. To tackle these challenges, less invasive techniques using external fixators have been introduced to mitigate inadvertent damage to soft tissues. Various non-traditional fixators have demonstrated success in reducing soft tissue complications. However, these methods sometimes fall short in terms of mechanical stability, leading to instances of reduction loss [13,14]. In a study involving 27 patients utilizing the Knee Function Grading System (Rasmussen), outcomes were as follows: 59.26% achieved a good outcome, 25.93% an excellent outcome, and 9.6% each achieved fair and poor outcomes. Similar investigations have reported outcomes using the Rasmussen system with the hybrid Ilizarov technique, showing percentages of excellent (25%), good (60%), fair (10%), and poor (5%) [15]. Another study presented results with percentages of excellent (40%), good (40%), fair (15%), and poor (5%)

using the same technique [16]. Shah Nawaz et al. studied 90 patients and found functional outcomes with the hybrid Ilizarov technique to be 54.4% excellent, 25.56% good, and 7.8% fair [16]. The tibial plateau is a crucial weight-bearing region in the human body; fractures disrupt knee alignment, stability, and motion. Timely identification and appropriate treatment of such fractures are imperative to minimize disability and the risk of complications, particularly posttraumatic arthritis [17]. The extent of soft tissue injury emerged as a significant predictor of functional outcomes. Historically, managing bicondylar fractures involved a single anterior incision and subperiosteal dissection of the proximal tibia on both medial and lateral sides. However, this extensive soft tissue manipulation often led to compromised bone revascularization and a heightened infection risk. Open reduction and internal fixation are the optimal mechanical stabilization approaches for bicondylar tibial plateau fractures. While it ensures precise fracture alignment and secure fixation, it also carries the potential for additional soft tissue damage and infection [15]. The inherent complexity of the injuries, exacerbated by the severity of soft tissue damage, compounds the challenge of achieving optimal outcomes [16]. Comparatively, the functional outcomes of this series align favourably with findings from other studies. Several published papers have consistently reported satisfactory functional results, with average Knee Rating scores ranging from 65.9 to 80.2. It is worth noting that some of these studies encompassed patients with polytrauma, which could have contributed to

lower average scores. Complex tibial plateau fractures typically result from high-energy traumas, causing substantial damage to the joint surface and surrounding soft tissues in a weight-bearing joint. Consequently, restoring the articular surface, joint stability, and alignment necessitates intricate surgical techniques.

5. LIMITATIONS OF THE STUDY

The limitations of this study include its retrospective design, potential selection bias in patient inclusion, limited long-term follow-up, and reliance on subjective functional assessments. Additionally, external factors influencing functional outcomes needed to be comprehensively addressed. These limitations impact the generalizability and conclusive insights of the study.

6. CONCLUSION AND RECOMMENDATIONS

In conclusion, the Hybrid Ilizarov Technique demonstrates promise in enhancing functional outcomes for patients with complex tibial plateau fractures. This study underscores its potential to improve postoperative rehabilitation and mobility. Surgeons should receive specialized training and adhere to meticulous surgical protocols to optimize its application. Further research encompassing larger cohorts and extended follow-up periods is warranted to substantiate its efficacy and refine the technique. As a recommended approach, the Hybrid Ilizarov Technique could revolutionize the management of intricate tibial plateau fractures, offering improved quality of life for affected individuals.

CONSENT

As per international standard or university standard, patient(s) written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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