

ISSN (E): 2708-2601

ISSN (P): 2708-2598

Medical Journal of South Punjab

Article DOI:10.61581/MJSP.VOL06/01/01

Volume 6, Issue 1, 2025



www.mjsp.com.pk

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Publication History

Received: Jan 25, 2025 Revised: Feb 11, 2025
Accepted: Feb 27, 2025 Published: Mar 30, 2025

Authors and Affiliation:

Ahmad Usman¹, Muhammad Haseeb Zia²,
Muhammad Noman Razzaq³, Hafiz Ali Haider⁴,
Muhammad Saad Farooq⁵, Muhammad Imran
Haider⁶

¹⁻⁶Department of Orthopaedic Surgery, Nishtar
Hospital Multan, Pakistan.

*Corresponding Author Email:

mr Ahmadusman@gmail.com

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acknowledgment of the work's authorship and
initial publication in this journal.

Conflict of Interest:

Author(s) declared no conflict of interest.

Acknowledgment:

No Funding received.

Citation: Usman A, Zia MH, Haider AH,
Razzaq MN, Haider HA, Farooq MS, Haider MI.
Functional Outcome of Bicondylar Tibial Fractures
Schatzker Type V and VI Treated with Ilizarov
External Fixator. Medical Journal of South Punjab.
2025 March 30; 6(1):1-7.

Please scan me to access online.



An official publication of

Medteach Private Limited, Multan, Pakistan.

Email: farman@mjsp.com.pk, Website: <https://mjsp.com.pk/index.php/mjsp>



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Ahmad Usman¹, Muhamad Haseeb Zia², Muhammad Noman Razzaq³, Hafiz Ali Haider⁴,
Muhammad Saad Farooq⁵, Muhammad Imran Haider⁶

¹⁻⁶Department of Orthopaedic Surgery, Nishtar Hospital Multan, Pakistan.

*Corresponding Author Email: mrahmadusman@gmail.com

ABSTRACT

Objective: To evaluate the functional outcome of Schatzker type V and VI bicondylar tibial plateau fractures treated with Ilizarov external fixation.

Methods: Fifty-nine patients with closed Schatzker type V or VI tibial plateau fractures treated with Ilizarov external fixation within 14 days of injury were included. Fractures were reduced via closed or mini-open techniques under fluoroscopic guidance, and fixed with a three or four ring external fixator. Postoperatively, patients underwent supervised physiotherapy. Functional outcomes were assessed using the Karlström-Olerud (KO) score at the final follow-up. Data was analyzed using IBM SPSS, and an independent samples T-test was used to compare mean functional outcome scores.

Results: The mean age of the 59 patients, of whom 79.7% were male, was 37.3 ± 14.1 years. The mean KO score was 28.33 ± 3.2 , with 11.9% achieving excellent, 39.0% good, 25.4% satisfactory, 15.3% moderate, and 8.5% poor results. Schatzker type VI fractures had significantly lower KO scores than type V fractures ($p < 0.001$). A significant negative correlation was found between the duration from injury to surgery and the KO score ($p = 0.01$).

Conclusion: While Ilizarov external fixation can be an effective tool for treating complex bicondylar tibial plateau fractures, the functional outcomes are variable, and careful patient selection and timely intervention are crucial. The complexity of tibial plateau fractures necessitates a tailored management plan for each patient.

Keywords: Bicondylar Fracture, External Fixation, Ilizarov, Karlström-Olerud Score, Tibial Plateau.

1. INTRODUCTION

Fractures of the tibial plateau, constituting 1.2% of total body fractures and 18.6% of tibial fractures, present a formidable challenge owing to their complex nature¹. These injuries result from high-energy trauma, implying a variety of direct and indirect forces acting upon the lower extremities. Approximately one-third of these fractures comprise bicondylar Schatzker type V and VI or the Arbeitsgemeinschaft für Osteosynthesefragen (AO) 41C (C1, C2, C3) fractures². The intricate anatomy of the tibial plateau, involvement of intra-articular surfaces, fracture comminution, compromised osseous integrity of the proximal tibia, limited soft tissue coverage, and heightened risk of complications make these fractures demanding even for seasoned surgeons. Primary treatment involves surgery seeking restoration of the limb alignment, achieving articular reduction, ensuring knee stability, and establishing stable fixation conducive to early knee motion while minimizing soft tissue compromise³. Despite advancements in imaging and treatment modalities, long-term outcomes remain suboptimal.

In the existing literature, a consensus on the preferred fixation method for bicondylar tibial plateau fractures is notably absent. The decision-making process is intricate, with some endorsing open reduction and internal fixation (ORIF) with plate osteosynthesis as the gold standard for complex fractures. This approach, while facilitating fracture reduction under direct vision, achieving joint congruity and absolute fracture stability, also entails drawbacks such as multiple incisions, periosteal stripping, and, a risk of soft tissue complications, necessitating staged or delayed surgery^{4,5,6}.

The emergence of the Ilizarov technique, using circular external fixation, has introduced a new dimension to such fracture management. Documented benefits include reduced blood loss, shorter hospital stays, quicker recovery, and better functional

outcomes comparable to ORIF⁵. Circular external fixation offers advantages such as single-stage definitive treatment, percutaneous application, protection of fracture biology, respect for soft tissue coverage vulnerable to necrosis and infection, correction in multiple planes, and postoperative adjustability⁷. Kawoosa et al. studied the functional outcome using the Karlström-Olerud scoring system in 35 patients managed with Ilizarov external fixation, with a mean age of 46.5±8.9 years. The mean functional score in their study was 32.11±1.95, with 24 (68.5%) patients having an excellent score and only 1 (2.8%) having a poor score grade⁸. Catagni et al. treated 59 patients with bicondylar tibial fractures using Ilizarov fixation and found excellent functional outcomes in 30 (50.85%) patients and poor outcomes in only 1 (1.695%)⁹.

The current literature does not reach a consensus on Ilizarov fixation and plate osteosynthesis, prompting this study to evaluate the clinical effectiveness of Ilizarov external fixation as a definitive treatment for complex Schatzker V and VI-type tibial plateau fractures in terms of functional outcome.

2. METHODOLOGY

This prospective descriptive study was conducted in the Department of Orthopedic Surgery at Nishtar Hospital, Multan from May 05, 2024, till October 05, 2024. The sample size was calculated by the WHO sample size calculator using the following formula:

$$n = \frac{Z_{1-\alpha/2}^2 \sigma^2}{d^2} \text{ or } \frac{Z_{1-\alpha/2}^2 \sigma^2}{\varepsilon^2 \mu^2}$$

keeping $z = 1.96$, $d=0.5$, confidence interval $1-\alpha=95\%$, population mean $\mu=32.11$, population standard deviation $\sigma=1.958$.

The sampling technique applied was non-probability consecutive sampling. All patients of either gender aged 20 to 70 years, having closed Schatzker V or VI fractures, operated within 14 days of injury were

included in the study. Patients with polytrauma, segmental and pathological fractures, and associated neurovascular injuries were excluded from our study.

The study commenced after obtaining approval from the institutional ethical review board. Informed consent was obtained to ensure confidentiality and that the patient would not be exposed to any risk while taking part in the study.

All patients received a preoperative intravenous dose of antibiotic (Co-amoxiclav 1g). The surgery was performed under spinal or general anesthesia. The reduction was attempted close under fluoroscopic guidance with ligamentotaxis employing a distraction frame. Where required, a mini-incision was used for open reduction or articular surface elevation via a cortical window. Three or four rings were applied using Ilizarov principles with strict limb elevation postoperatively. Range of motion was begun immediately and supervised physiotherapy was initiated during the hospital stay and continued post-discharge. All were kept non-weight bearing for 6 weeks, and depending on articular surface comminution, were allowed to weight bear progressively from the 6th or 8th week. Full weight bearing was deferred until radiological or clinical signs of healing were observed. Follow-up with serial radiographs was done on outdoor basis till signs of union were observed. The rings were removed after union, and at the final appointment, their Karlstorm Olerud (KO) score was calculated. The data was collected and analysed using IBM SPSS v29.0.2.0 software. Independent sample T score was used to compare mean functional outcome scores.

3. RESULTS

Out of 59 patients, 47 (79.7%) were males and 12 (20.3%) females with a mean age of 37.3 ± 14.1 years. The average time from the day of injury to surgery was 7.2

days with a range from 1 to 13 days. The demographic distribution of our study population is given in the Table 1.

Table 1: Demographic distribution

DEMOGRAPHIC	FREQUENCY	PERCENTAGE
GENDER		
MALE	47	79.7%
FEMALE	12	20.3%
MODE OF INJURY		
RTA	49	83.1%
FALL	5	8.5%
ASSAULT	5	8.5%
RESIDENTIAL STATUS		
URBAN	43	72.9%
RURAL	16	27.1%
DIABETES		
YES	13	22.0%
NO	46	78.0%
OBESEITY		
YES	7	11.9%
NO	52	88.1%
SIDE		
RIGHT	33	55.9%
LEFT	26	44.1%
SCHATZKER TYPE		
TYPE V	35	59.3%
TYPE VI	24	40.7%

The mean KO score of our patients was 28.33 ± 3.2 . Excellent scores were seen in 7 (11.9%), Good in 23 (39.0%), Satisfactory in 15 (25.4%), Moderate in 9 (15.3%) and Poor in 5 (8.5%).

Table 2: Outcome Grades

KO SCORE	SHATZKER	n	MEAN
	TYPE V	35	29.91
	TYPE VI	24	26.04
P= 0.000, t= 5.464			

Table 3: KO score in Schatzker types

OUTCOME GRADE	FREQUENCY	PERCENT
EXCELLENT	7	11.9
GOOD	23	39.0
SATISFACTORY	15	25.4
MODERATE	9	15.3
POOR	5	8.5

4. DISCUSSION

This prospective study evaluated the functional outcome of Schatzker type V and VI bicondylar tibial plateau fractures treated with an Ilizarov external fixator in a cohort of 59 patients. The mean Karlström-Olerud (KO) score of 28.33 ± 3.2 indicates that while many patients achieved satisfactory outcomes, a considerable proportion experienced moderate to poor results, with only 11.9% attaining excellent scores. These findings highlight the challenges inherent in treating complex tibial plateau fractures, even with the application of the Ilizarov technique.

Our results are somewhat lower than the outcomes reported in earlier studies using the Ilizarov method. For instance, Kawoosa et al. reported a mean KO score of 32.11 ± 1.95 with 68.5% of patients achieving excellent results and Catagni et al. found 50.85% of patients with excellent functional outcomes^{8,9}. Ferreira et al. used circular fixator with limited open reduction in 46 cases of Schatzker V and VI tibial plateau fractures, and reported excellent outcomes in 22, good in 16, fair in four, and poor in four¹⁰. Subasi et al. reported an excellent outcome in 20%, good in 46% fair, and poor in 26%¹¹. Salah et al. reported excellent functional outcome in 57.1% of patients of Schatzker type V and VI treated with Ilizarov fixator⁵. The slightly lower scores in our study may reflect differences in patient demographics, such as a higher proportion of Schatzker VI fractures (40.7% vs. 34% in Catagni's cohort) and delays to surgery (mean 7.2 days). Other attributable aspects include surgical

experience and the rigor of post-operative rehabilitation protocols. It is also worth noting that some studies have excluded patients with associated injuries, potentially skewing results toward better outcomes. Moreover, the studies by Catagni, Ferreira and Subasi employed different outcome assessment tools, which further makes a direct comparison difficult.

The finding that Schatzker type VI fractures resulted in significantly lower KO scores than type V fractures (26 ± 2.9 vs 29.9 ± 2.4 ; $p < 0.001$) underscores the impact of fracture complexity on functional outcome. This correlation is not unexpected, as type VI fractures, characterized by more severe articular comminution and metaphyseal involvement, are inherently more challenging to treat and are associated with a higher risk of malalignment, instability, and post-traumatic arthritis^{12,13,14,15}. This finding supports the concept that the extent of comminution and articular disruption is a significant predictor of functional outcome¹⁶. Our study corroborates the findings by other investigators. For instance, while conducting a study of ORIF of bicondylar tibial plateau fractures, Barei et al. concluded that patients with Schatzker VI fracture demonstrated significantly worse outcome scores in terms of ROM, pain and function as compared to Schatzker V type¹⁷.

Interestingly, we found a statistically significant negative correlation between the duration from injury to surgery and the KO score ($p = 0.01$), suggesting that delayed intervention may negatively impact functional outcomes. This emphasizes the importance of timely surgical management in optimizing results. The delay can be attributed to the overwhelming burden of patients presenting in our government-run hospital which makes timely intervention difficult. Nevertheless, the optimal timing of surgery is often debated and delay of a few days is occasionally mandated to allow edema and swelling to subside^{18, 19}. Wier et al. reported in their study that delay of 28.8 hours for surgery was associated with lesser odds of development of compartment syndrome²⁰.

The lack of association between demographic factors like gender, residential status, diabetes, and obesity and functional outcome, despite their potential impact on fracture healing, is noteworthy. This denotes that the Ilizarov method's efficacy is not significantly impacted by these facets²¹. This may also be attributed to the relatively small sample size within our study subgroups or to the complex interplay of factors that determine functional outcomes. Additional research with larger cohorts is needed to clarify this area of investigation.

The use of the Ilizarov external fixator in our study establishes its effectiveness in achieving fracture reduction and stability, respecting soft tissues, and facilitating early motion. The primary advantage of the Ilizarov technique lies in its minimally invasive nature, ability to adapt to complex fracture patterns, and its potential to preserve fracture biology^{9,22}. In our study, the majority of the patients were able to achieve full weight bearing at or after 8 weeks with clinical and radiological signs of union. While ORIF with plate fixation remains a popular technique, several studies proffer that there is no single superior method for treating these complex fractures^{3,23,24}. The choice of fixation should be individualized, considering the fracture pattern, soft tissue status, surgeon's expertise, and patient factors.

5. CONCLUSION

While the Ilizarov external fixator can be a useful tool for treating complex bicondylar tibial plateau fractures, it may not be superior in terms of functional outcomes compared to other techniques. The complexity of tibial plateau fractures needs a tailored management plan for each patient.

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