International Journal of Research in Orthopaedics
*Hasan MMA et al. Int J Res Orthop. 2026 May;12(3):572-577*
http://www.ijoro.org

**Original Research Article**

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20261202

# Schatzker V-VI fractures of tibial plateau healed fast within 3.5 months: Ilizarov fixation with 6 weeks femoral ring offload

**M. Maruf Al Hasan[1]*, Nazmul Huda Shetu[2], S. M. A. Rahim[3], M. Sahidur Rahman Khan[4], Ahmad Hussain Siddique[4], M. Zahidur Rahman[4], M. Jamal Uddin[5]**

[1]Department of Orthopedics, National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka, Bangladesh
[2]Department of Orthopedics & Traumatology, National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka, Bangladesh
[3]Department of Orthopedics Joints & Spine Surgery, UNICO Hospital, Dhaka, Bangladesh
[4]Department of Orthopedics, National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka, Bangladesh
[5]Department of Orthopedics, 250 Bed General Hospital, Feni, Bangladesh

**Received:** 25 January 2026
**Accepted:** 21 April 2026

***Correspondence:**
Dr. M. Maruf Al Hasan,
E-mail: maruf.alhasan14@gmail.com



## ABSTRACT

**Background:** Schatzker V and VI tibial plateau fractures with significant soft-tissue injury, the Ilizarov circular fixator provides essential, stable fixation while minimizing further disruption. A key advantage is the staged removal of the distal femoral ring, which allows for earlier knee mobilization and is critical for preserving long-term joint function. To evaluate the effectiveness of a three-and-a-half-month union strategy using Ilizarov fixation with distal femoral ring removal at six weeks in patients with Schatzker type V and VI tibial plateau fractures.
**Methods:** This prospective cohort study was conducted at Department of Orthopedics, National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka, Bangladesh, Bangladesh, from January 2023 to December 2024. A 41-patient cohort undergoing Ilizarov fixation with femoral ring removal at six weeks was assessed for union, knee motion, alignment, weight-bearing, and complications. Data analysis was performed using SPSS version 23.0 to evaluate these outcomes.
**Results:** The study cohort (mean age 38.6±9.4 years, 70.7% male) showed favorable outcomes. Radiological union was achieved in 87.8% of patients at a mean of 14.2±1.6 weeks, with 90.2% maintaining acceptable alignment. Final mean knee flexion was 118°±12°. Complications included pin-tract infection (14.6%) and stiffness (9.8%), with no deep infections or non-unions.
**Conclusions:** Ilizarov fixation with planned distal femoral ring removal at six weeks is an effective strategy for managing Schatzker type V and VI tibial plateau fractures, promoting early union, functional recovery, and low complication rates.

**Keywords:** Ilizarov fixation, Distal femoral ring removal, Schatzker classification, Tibial plateau fracture, Union strategy

## INTRODUCTION

Tibial plateau fractures account for approximately 1–2% of all fractures and represent a significant challenge in orthopedic trauma due to their intra-articular involvement and potential for long-term functional impairment.[1] High-energy mechanisms such as road traffic accidents and falls from height commonly result in bicondylar tibial plateau fractures, classified as Schatzker type V and VI, which are frequently associated with metaphyseal comminution, articular depression, ligamentous injuries, and severe soft-tissue compromise.[2,3] The primary goals of management

include restoration of articular congruity, maintenance of limb alignment, stable fixation, early mobilization, and prevention of complications such as infection, nonunion, stiffness, and post-traumatic osteoarthritis.[4] Open reduction and internal fixation (ORIF) has traditionally been considered the standard treatment for these fractures; however, its use in high-energy injuries is often limited by compromised soft tissues and a high risk of wound complications and deep infection, reported to range from 10% to 25% in some series.[5,6] These concerns have led to increasing interest in minimally invasive and external fixation techniques that respect the soft-tissue envelope while providing adequate mechanical stability. The Ilizarov circular external fixator has emerged as a valuable alternative in the management of complex tibial plateau fractures. Its biomechanical advantages include multiplanar stability, axial micromotion that promotes osteogenesis, and the ability to allow early weight bearing without compromising fracture alignment.[7,8] Additionally, the technique minimizes surgical dissection, thereby reducing soft-tissue complications and infection rates, which is particularly beneficial in Schatzker type V and VI injuries.[9] In bicondylar tibial plateau fractures, spanning the knee joint with a distal femoral ring during the initial postoperative period is commonly employed to enhance stability and protect the articular reconstruction. However, prolonged knee spanning may contribute to joint stiffness, delayed rehabilitation, and patient discomfort.[10] Early removal of the distal femoral ring, once sufficient fracture stability is achieved, has been proposed as a strategy to facilitate knee mobilization while maintaining adequate fixation.[11] Despite its potential advantages, there remains limited prospective evidence regarding the optimal timing of distal femoral ring removal and its effect on fracture union and functional outcomes. Recent studies have emphasized the importance of balancing stability and mobility in external fixation constructs to achieve timely union and satisfactory knee function.[12] Achieving fracture union within a shorter duration, such as three to four months, may reduce external fixator-related complications, improve patient compliance, and enhance overall outcomes. However, data supporting a structured "early union strategy" combined with staged frame modification in high-energy tibial plateau fractures are scarce, particularly in resource-limited settings. In Bangladesh, the burden of high-energy lower limb trauma is increasing due to rapid urbanization and rising road traffic accidents. There is a paucity of local prospective studies evaluating advanced external fixation strategies for complex tibial plateau fractures.[13] Therefore, this study was designed to evaluate a three-and-a-half-month union strategy using Ilizarov fixation with planned distal femoral ring removal at six weeks in patients with Schatzker type V and VI tibial plateau fractures, focusing on fracture union, alignment, knee function, and complications.

## METHODS

This prospective cohort study was conducted at Department of Orthopedics, National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka, Bangladesh, from January 2023 to December 2024. Patients presenting with acute tibial plateau fractures were screened in the orthopedic trauma unit. A total of 41 patients diagnosed with Schatzker type V and VI tibial plateau fractures were enrolled using a purposive sampling technique. All participants were followed from admission until radiological fracture union and final clinical assessment.

### *Inclusion criteria*

Adult patients aged 18 years and above with closed or Gustilo–Anderson type I open Schatzker type V or VI tibial plateau fractures were included. Only patients who presented within two weeks of injury and were deemed suitable for Ilizarov circular external fixation were enrolled. Written informed consent was obtained from all participants prior to inclusion in the study.

### *Exclusion criteria*

Patients with pathological fractures, Gustilo–Anderson type II or III open fractures, associated ipsilateral femoral fractures, neurovascular injury requiring repair, polytrauma requiring prolonged intensive care, or pre-existing knee pathology affecting function were excluded. Patients unwilling to participate or lost to follow-up were also excluded.

### *Study procedure*

All patients underwent Ilizarov circular external fixation with an initial distal femoral ring to provide knee-spanning stability. Limited internal fixation was used when necessary for articular reduction. The distal femoral ring was electively removed at six weeks postoperatively, followed by progressive knee mobilization and weight bearing as tolerated. Patients were reviewed at regular intervals with clinical and radiological assessments until fracture union.

### *Data analysis*

Data on demographic variables, fracture characteristics, time to union, alignment, range of motion, weight bearing, and complications were recorded using a structured data sheet. Statistical analysis was performed using SPSS version 23.0. Descriptive statistics were expressed as mean±standard deviation or frequencies and percentages.

## RESULTS

A total of 41 patients with Schatzker type V and VI tibial plateau fractures were included in this prospective cohort study. The mean age of the patients was 38.6±9.4 years (range: 22–58 years). The majority were male (70.7%), and road traffic accidents were the most common mechanism of injury (63.4%). Schatzker type VI fractures were more frequent than type V fractures (56.1% vs.

43.9%). Radiological union was achieved in 36 patients (87.8%) within three and a half months. The overall mean time to union was 14.2±1.6 weeks. Schatzker type V fractures demonstrated a slightly shorter mean union time compared to type VI fractures (13.6±1.4 vs. 14.7±1.6 weeks), though this difference was not statistically significant (p=0.087). Delayed union beyond 16 weeks was observed in 5 patients (12.2%), all of whom had Schatzker type VI fractures. Functional outcomes were satisfactory in most patients. At final follow-up, the mean knee flexion was 118°±12°, with 73.2% of patients achieving knee flexion ≥120°. Schatzker type V fractures showed better functional outcomes compared to type VI fractures, with a significantly higher proportion achieving knee flexion ≥120° (83.3% vs. 65.2%, p=0.041). Early removal of the distal femoral ring at six weeks facilitated knee mobilization without compromising fracture stability. Alignment was maintained within acceptable limits in 90.2% of cases. Malalignment (>5° varus or valgus) was observed in 4 patients (9.8%), predominantly in Schatzker type VI fractures, although the difference was not statistically significant (p = 0.192). Progressive weight bearing was initiated after distal femoral ring removal, and full weight bearing was achieved at a mean of 15.1±2.3 weeks. Complications were relatively low. Pin-tract infection was the most common complication, occurring in 14.6% of patients, all of whom had superficial infections that were managed conservatively. Knee stiffness was noted in 9.8% of patients and was more frequent in Schatzker type VI fractures. No cases of deep infection, implant failure, or nonunion were recorded. Overall, the three-and-a-half-month union strategy yielded favorable radiological and functional outcomes, accompanied by acceptable complication rates.

**Table 1: Demographic characteristics of the study population (n=41).**

| Variable | N | % |
|---|---|---|
| **Male** | 29 | 70.7 |
| **Female** | 12 | 29.3 |
| **Mean age (years)** | 38.6±9.4 | — |
| **Road traffic accident** | 26 | 63.4 |
| **Fall from height** | 15 | 36.6 |

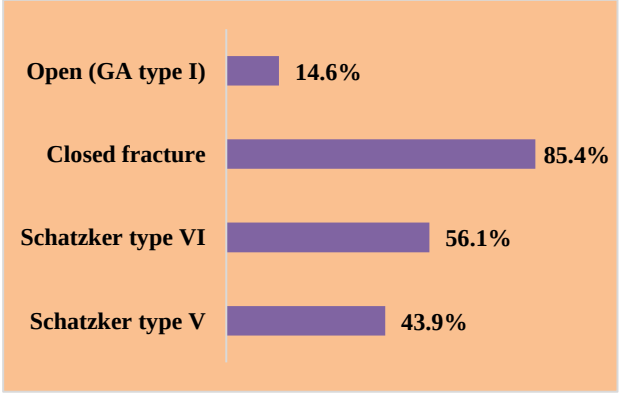


**Figure 1: Fracture pattern distribution.**

**Table 2: Radiological union time according to fracture type.**

| Fracture type | Union time (Weeks) | P value |
|---|---|---|
| **Schatzker type V** | 13.6±1.4 | 0.087 |
| **Schatzker type VI** | 14.7±1.6 | |

Statistical test used: Independent samples t-test.

**Table 3: Functional outcome (knee range of motion).**

| Knee flexion | Type V | Type VI |
|---|---|---|
| | N (%) | N (%) |
| **≥120°** | 15 (83.3) | 15 (65.2) |
| **<120°** | 3 (16.7) | 8 (34.8) |
| **P value** | 0.041 | |

Statistical test used: Chi-square test.

**Figure 2: Tibial plateau type V fracture.**

**Figure 3: At 6 week post operative duration femoral ring is ready to removal.**

**Figure 4: At 3.5 months post operative duration, healed type V ready for Ilizarov ring removal.**

**Table 4: Alignment outcome at final follow-up.**

| Alignment status | N | % |
|---|---|---|
| **Acceptable (≤5°)** | 37 | 90.2 |
| **Malalignment (>5°)** | 4 | 9.8 |
| **P value (type V vs VI)** | 0.192 | |

Statistical test used: Fisher's exact test.

**Table 5: Complications observed during follow-up.**

| Complication | N | % |
|---|---|---|
| **Pin-tract infection** | 6 | 14.6 |
| **Knee stiffness** | 4 | 9.8 |
| **Delayed union** | 5 | 12.2 |
| **Deep infection / nonunion** | 0 | 0 |

## DISCUSSION

Management of Schatzker type V and VI tibial plateau fractures remains challenging because of extensive articular disruption, metaphyseal comminution, and compromised soft-tissue envelopes. The present study demonstrates that a structured three-and-a-half-month union strategy using Ilizarov circular fixation with planned distal femoral ring removal at six weeks can achieve satisfactory radiological union and functional outcomes with an acceptable complication profile. These findings support the growing preference for circular external fixation in complex bicondylar tibial plateau fractures. Previous studies have reported mean union times ranging from 14 to 18 weeks for high-energy tibial plateau fractures managed with circular fixators.[14,15] The relatively shorter union time in the present cohort may be attributed to stable multiplanar fixation, controlled axial micromotion, and early functional rehabilitation facilitated by staged frame modification. In contrast, open reduction and internal fixation for Schatzker type V and VI fractures has been associated with higher rates of wound complications, deep infection, and delayed union, particularly in high-energy injuries.[16] Reported deep infection rates following dual plating range from 8% to 20%, especially when performed in the presence of significant soft-tissue injury.[17] Notably, no deep infection or nonunion was observed in the present study, highlighting the advantage of minimally invasive fixation with limited soft-tissue disruption. The role of knee-spanning fixation in the acute phase is well established for providing additional stability and protecting articular reconstruction in bicondylar fractures. However, prolonged knee spanning has been linked to postoperative stiffness and delayed rehabilitation.[18] In the current study, elective removal of the distal femoral ring at six weeks allowed early knee mobilization without compromising fracture stability. This approach resulted in a mean knee flexion of 118°, with nearly three-quarters of patients achieving flexion ≥120°. Similar improvements in knee range of motion following early frame modification have been reported by Yin et al and Singh et al, emphasizing the importance of balancing stability with mobility.[19,20] Functional outcomes were marginally better in Schatzker type V fractures compared to type VI fractures, particularly in terms of knee flexion. This finding is consistent with previous reports, as type VI fractures often involve diaphyseal extension and more severe soft-tissue injury, which negatively affect rehabilitation and functional recovery.[21] Nevertheless, even patients with type VI fractures in the present study achieved acceptable alignment and functional outcomes, underscoring the versatility of Ilizarov fixation. Alignment preservation is a critical determinant of long-term outcome in tibial plateau fractures. Malalignment greater than 5° has been associated with increased risk of post-traumatic osteoarthritis and poor functional results.[22] In this cohort, acceptable alignment was maintained in over 90% of cases, reflecting the inherent ability of circular fixators to allow gradual postoperative adjustments when required. This advantage is less readily available with internal fixation techniques. Pin-tract infection was the most common complication, occurring in 14.6% of patients, which is comparable to rates reported in other Ilizarov-based studies.[23] All cases were superficial and responded well to local care and oral antibiotics, reinforcing that pin-tract issues, while common, are generally manageable and rarely jeopardize outcomes. Knee stiffness, observed in fewer than 10% of patients, was likely related to delayed rehabilitation and higher fracture severity rather than fixation method alone. From a broader perspective, the findings of this study are particularly relevant for resource-limited settings. Ilizarov fixation reduces the need for extensive implants, repeated soft-tissue procedures, and prolonged hospital stay, making it a cost-effective and biologically favorable option.[24] Additionally, the predictable union timeline of approximately three and a half months may improve patient compliance and reduce frame-related morbidity. Despite its strengths, this study is limited by the absence of a comparative control group treated with internal fixation and the relatively small sample size. However, the prospective design and

standardized treatment protocol enhance the reliability of the findings. Further randomized or comparative studies with longer follow-up are recommended to evaluate long-term functional outcomes and the incidence of post-traumatic osteoarthritis.[25]

### *Limitations*

This study was limited by a relatively small sample size, a single-center design, and the absence of a comparative internal fixation group. Additionally, short-term follow-up restricted assessment of long-term functional outcomes and post-traumatic osteoarthritis development.

## CONCLUSION

This study concludes that Ilizarov fixation with planned distal femoral ring removal at six weeks is an effective strategy for managing Schatzker type V and VI tibial plateau fractures. The approach facilitates early fracture union, preserves alignment, enables satisfactory knee function, and minimizes major complications, making it particularly suitable for complex high-energy injuries in resource-limited settings.

### *Recommendation*

Ilizarov fixation with early distal femoral ring removal should be considered for Schatzker type V and VI tibial plateau fractures. Further multicenter comparative studies with longer follow-up are recommended to validate long-term functional and radiological outcomes.

*Funding: No funding sources*
*Conflict of interest: None declared*
*Ethical approval: The study was approved by the Institutional Ethics Committee*

## REFERENCES

1. Papagelopoulos PJ, Partsinevelos AA, Themistocleous GS, Morakis EA, Kontovazenitis PI, et al. Complications after tibia plateau fracture surgery. Injury. 2006;37(6):475-84.
2. Elsoe R, Larsen P, Nielsen NP, Swenne J, Rasmussen S, et al. Population-based epidemiology of tibial plateau fractures. Orthopedics. 2015;38(9):e780-6.
3. Yan H, Cheng L, Tuoheti Y, Wu Y, Tang X, et al. Global research status and trends of tibial plateau fracture over the past 28 years: a historical review and bibliometric analysis. Front Surg. 2023;10:1120023.
4. Rademakers MV, Kerkhoffs GM, Sierevelt IN, Raaymakers EL, Marti RK. Operative treatment of 109 tibial plateau fractures: five- to 27-year follow-up results. J Orthop Trauma. 2007;21(1):5-10.
5. Metcalfe D, Hickson CJ, McKee L, Griffin XL. External versus internal fixation for bicondylar tibial plateau fractures: systematic review and meta-analysis. J Orthop Traumatol. 2015;16(4):275-85.
6. Prat-Fabregat S, Camacho-Carrasco P. Treatment strategy for tibial plateau fractures: an update. EFORT Open Rev. 2016;1(5):225-32.
7. Turkmen I, Esenkaya I. A patellar tendon length conservation method: Biplanar retrotubercle open-wedge proximal tibial osteotomy. North Clin Istanb. 2018;5(3):246-53.
8. Fragomen AT, Livingston KS, Sabharwal S. External Fixators for Deformity Correction. In: Essential Biomechanics for Orthopedic Trauma: A Case-Based Guide. Cham: Springer International Publishing; 2020: 107-126.
9. Girotra P, Singh NK, Kumar S. Functional outcome of locking compression plate in the management of proximal tibia fracture. Int J Orthop. 2020;6(1):152-6.
10. Pirwani MA, Ali M, Memon S, Ahmed G, Sial AH, et al. Evaluation of complex tibial plateau fractures treated with Ilizarov circular fixator. J Liaquat Univ Med Health Sci. 2019;18(01):16-21.
11. Lin XL, Gu JL, Kan SH, Ye WL, Zhang J, et al. Expression of miR-195 and its target gene Bcl-2 in human intervertebral disc degeneration and their effects on nucleus pulposus cell apoptosis. J Orthop Surg Res. 2021;16(1):412.
12. Kaushal P. Radiological and Functional Outcome of Dual Plating in Comminuted Intra-Articular Distal Femur Fractures [Dissertation]. Karnataka: BLDE (Deemed to be University); 2024. Available at: http://dspace.bldedu.ac.in:8080/jspui/handle/123456789/1000. Accessed on 24 April 2026.
13. Islam BZ, Islam S, Hossain S, Islam R, Rahman A, et al. Trauma care scenarios following road traffic crashes in Bangladesh: a scoping review. Glob Health Sci Pract. 2023;11(2):e2200384.
14. El-Barbary H, Abdel-Ghani H, Hegazy M, Wong J. Complex tibial plateau fractures treated with Ilizarov external fixator with or without minimal internal fixation. Int Orthop. 2005;29(3):182-5.
15. Sawant RM, Chaudhari PL. Observational study to evaluate the impact of intraoperative C-arm image-based surgical path planning on improvement of functional outcome in intra-articular proximal tibia fractures. J Med Thesis. 2024;12(1):7-16.
16. Ruffolo MR, Fragomen AT, Rozbruch SR. Complications of high-energy bicondylar tibial plateau fractures treated with dual plating through 2 incisions. J Orthop Trauma. 2015;29(2):85-90.
17. Zhang BB, Zhan Y, Yu MJ, Zhu SN, Zhai QL, et al. Reliability and repeatability of tibial plateau fracture assessment with an injury mechanism-based concept. Bone Joint Res. 2019;8(8):357-366.
18. Ali AM, El-Shafie M, Willett KM. Failure of fixation of tibial plateau fractures. J Orthop Trauma. 2002;16(5):323-9.
19. Hayek K, Garlich JM, Saper D, De Giacomo AF, Tornetta P 3rd. Cost reduction for knee-spanning external fixation in the staged treatment of tibial plateau fractures: a practical intervention. J Orthop Trauma. 2022;36(5):246-50.

20. Yao Y, Lv H, Zan J, Li J, Zhu N, et al. Functional outcomes of bicondylar tibial plateau fractures treated with dual buttress plates and risk factors: a case series. Injury. 2014;45(12):1980-4.
21. Maripuri SN, Rao P, Guyot A, Peter V. The classification systems for tibial plateau fractures: how reliable are they? Injury. 2008;39(10):1216-21.
22. Lansinger O, Bergman B, Körner L, Andersson GB. Tibial condylar fractures: a twenty-year follow-up. J Bone Joint Surg Am. 1986;68(1):13-9.
23. Parameswaran AD, Roberts CS, Seligson D, Voor M. Pin tract infection with contemporary external fixation: how much of a problem? J Orthop Trauma. 2003;17(7):503-7.
24. Catagni MA, Ottaviani G, Maggioni M. Treatment strategies for complex fractures of the tibial plateau with external circular fixation and limited internal fixation. J Trauma. 2007;63(5):1043-53.
25. Prajwal N. Clinical Study of Outcome of Schatzker's Type-V and Type-VI Tibial Plateau Fractures Treated with Dual Plating [Dissertation]. Bengaluru: Rajiv Gandhi University of Health Sciences; 2019. Available at: http://repository-tnmgrmu.ac.in/handle/123456789/1234. Accessed on 24 April 2026.

**Cite this article as:** Hasan MMA, Shetu NH, Rahim SMA, Khan MSR, Siddique AH, Rahman MZ, et al. Schatzker V-VI fractures of tibial plateau healed fast within 3.5 months: Ilizarov fixation with 6 weeks femoral ring offload. Int J Res Orthop 2026;12:572-7.