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FUNCTIONAL OUTCOME OF COMPLEX PROXIMAL TIBIA FRACTURE (SCHATZKER TYPE 5 AND 6) MANAGED WITH HYBRID EXTERNAL FIXATOR VERSUS LOCKING PLATE

Muhammad Shahman*[1], Syed Wasif Ali Shah[2], Muhammad Noman Azeem[3], Muhammad Hassan Saleem[4], Muhammad Sohaib Naeem[5], Muhammad Ibtisam[6]

[1,3,4,5] MBBS, Postgraduate Resident (PGR), Department of Orthopaedics, PGMI/Shaikh Zayed Hospital, Lahore
[2] MBBS, FCPS, AO Fellow (Belgium), Associate Professor Department of Orthopaedics, PGMI/Shaikh Zayed Hospital, Lahore
[6] MBBS, House Officer Islam Teaching Hospital Sialkot
*Correspondence to Muhammad Shahman, Muhammadshahman84@gmail.com

ABSTRACT

Background: Complex proximal tibia fractures, particularly Schatzker types V and VI, are challenging injuries due to articular involvement, instability, and associated soft-tissue damage. Hybrid external fixation and locking plate fixation are commonly used surgical options, but their functional outcomes may differ.

Objectives: To compare the functional outcome of hybrid external fixator versus locking plate in the treatment of complex proximal tibia fractures (Schatzker type V and VI).

Study Design & Setting: This study was conducted in the Department of Orthopaedics, PGMI/Shaikh Zayed Hospital, Lahore from 1st December 2025 to 1st May 2026.

Methodology: A total of 222 patients aged 18–60 years with isolated Schatzker type V or VI proximal tibia fractures were enrolled and randomly allocated into two equal groups. Group A (n=111) was treated with a hybrid external fixator, while Group B (n=111) underwent locking plate fixation. Functional outcome was assessed after 12 weeks using Rasmussen's functional grading. A score of 27–30 was considered an excellent functional outcome. Data were analyzed using SPSS version 26, and a p-value <0.05 was considered statistically significant.

Results: The mean age was 38.74±11.26 years in Group A and 39.51±10.84 years in Group B. Excellent functional outcome was achieved in 19 (17.1%) patients treated with a hybrid external fixator compared with 34 (30.6%) patients treated with a locking plate. The difference between the groups was statistically significant (p=0.018).

Conclusion: Locking plate fixation resulted in a significantly higher frequency of excellent functional outcomes than hybrid external fixation in patients with complex proximal tibia fractures.

KEYWORDS: Complex proximal tibia fracture; Functional outcome; Hybrid external fixator; Locking plate; Schatzker classification; Tibial plateau fracture.

INTRODUCTION

Schatzker type V and VI tibial plateau fractures present complex surgical challenges and may be associated with complications such as neurovascular injury, compartment syndrome, and soft-tissue and ligament damage.[1] Important factors affecting long-term prognosis include failure to restore articular congruity and the presence of ligamentous instability.[2,3] Successful treatment requires restoration of the articular surface, preservation of biological integrity, realignment of the mechanical axis, stabilization of the joint, and maintenance of mobility.[4] Although standard open reduction and internal fixation (ORIF) with a lateral locking plate can successfully restore osseous alignment, it is associated with considerable surgical morbidity, particularly severe infection and wound necrosis. The Ilizarov technique provides a viable alternative by allowing closed reduction and fixation without extensive soft-tissue complications.[5] Tibial fractures may result from high- or low-energy trauma, with complex and open fractures occurring more commonly following high-energy injuries. Open fractures are associated with a higher risk of complications and long-term disability. Tibial plateau fractures remain challenging to treat, and management options include both non-operative and surgical approaches. Non-operative treatment, such as the Sarmiento program, may be suitable for stable, non-displaced fractures, sub-meniscal fractures, and selected patient populations, including elderly patients.[6]

Surgical treatment becomes necessary for displaced fractures, fractures associated with vascular injury or compartment syndrome, and certain fracture patterns. Surgical methods include internal fixation techniques such as biological fixation,

arthroscopic fixation, and standard double plating, as well as external fixation methods using devices such as the Ilizarov apparatus or hybrid fixators. Balloon tibioplasty, although promising, lacks established evidence regarding its long-term efficacy.[7] Studies evaluating functional outcomes according to Rasmussen's knee functional score have demonstrated varying results with the hybrid Ilizarov technique and locking plate fixation.[8] In a comparative study conducted by Subash Y et al., among patients managed with a hybrid external fixator, 16.66% achieved an excellent outcome, 73.3% achieved a good outcome, and 10% had a fair outcome.[9] In another study by Jafree B et al., among patients treated with a locking plate, 30.8% achieved an excellent outcome, 41.0% achieved a good outcome, and 28.2% had a fair outcome.[10]

The rationale of the study was to compare the functional outcomes of hybrid external fixation and locking plate fixation in the treatment of complex proximal tibia fractures (Schatzker type V and VI). A limited number of comparative studies have been conducted, and local evidence is lacking. The findings of this study may help guide the selection of an appropriate fixation method for complex proximal tibia fractures to achieve better functional outcomes. The objective of this study was to compare the functional outcome of hybrid external fixator versus locking plate in the treatment of complex proximal tibia fractures (Schatzker type V and VI).

METHODS

This comparative study was conducted after approval from the hospital ethical committee & synopsis approval from CPSP at Department of Orthopaedic Surgery, PGMI/Shaikh Zayed Hospital, Lahore1st December 2025 to 1st May 2026, who fulfilled the inclusion criteria were enrolled in the study. Informed consent was obtained from all patients. A sample of 222 patients, with 111 patients in each group, was calculated using a 5% level of significance and 80% power of the test, taking the expected excellent functional outcome as 16.66% in the hybrid external fixator group[9] and 30.8% in the locking plate group.[10] A non-probability consecutive sampling technique was used. Patients aged 18–60 years of either gender with isolated proximal tibia fractures (Schatzker type V and VI), as per the operational definition, were included. Patients with ipsilateral lower limb fractures, floating knee, or neurovascular injury were excluded.

Patients were allocated into two groups using the lottery method. Group A was managed with a hybrid external fixator, while Group B was managed with a locking plate. All procedures were performed under spinal anaesthesia and fluoroscopic guidance. In Group A, intravenous cefazolin was administered at the time of induction of anaesthesia and was continued for three days postoperatively. The fractures were assessed under fluoroscopic guidance, and traction was initially applied to restore length, followed by valgus or varus stress according to the fracture pattern and displacement. A 1.8-mm wire was then passed from the lateral to the medial aspect at a distance of 15 mm from the joint surface to prevent septic arthritis. The wire was tensioned in the standard manner, and a 5/8 ring was attached. A second wire was passed from the anterolateral to the posteromedial direction, ensuring an angle of at least 60° from the first wire to provide a stable construct, followed by tensioning of the wire. Two 5-mm Schanz pins were then placed along the anteromedial border of the tibia, and the Ilizarov ring and Schanz pins were connected using 250-mm tubular rods, universal clamps, and a hybrid clamp. Final fracture reduction was checked in both AP and lateral views and confirmed to be anatomical. In patients with depression of the lateral condyle, a mini-incision was made over the anterior aspect of the tibia, and the fragment was elevated with a bone tap and fixed with a K-wire. None of the cases required supplementation with cancellous screws or mini-plates. Group B received the locking plate technique. After preoperative preparation and assessment of fitness, patients were placed in the supine position on a traction table, and the knee was flexed to 90° after spinal anaesthesia. A tourniquet was used to restrict blood flow during locking compression plate fixation. C-arm imaging was used to verify fracture reduction and fixation. Lateral or medial plating was performed through the respective incision. Active range-of-motion exercises were started at the end of the first week, and patients remained non-weight-bearing with crutch walking for two months. Regular follow-up and radiological evaluations were performed, and excellent functional outcome was determined after 12 weeks using the Rasmussen clinical-functional assessment score, as per the operational definition. All data were recorded on a predesigned proforma.

The operational definitions used in this study were as follows. Complex proximal tibia fracture was assessed on anteroposterior (AP) and lateral-view X-rays. Schatzker type V was defined as a wedge fracture involving both the lateral and medial tibial plateaus, as seen on X-ray of the lower limb. Schatzker type VI was defined as a transverse tibial meta-diaphyseal fracture along with any type of tibial plateau fracture (metaphyseal-diaphyseal discontinuity), as seen on X-ray of the lower limb. Functional outcome was assessed using Rasmussen's functional grading after 12 weeks of treatment. The grading was based on a total score of 30, with a score of <10 classified as poor, 10–19 as fair, 20–26 as good, and 27–30 as an excellent outcome. Excellent functional outcome was evaluated in this study.

Data were entered and analyzed using SPSS version 26. Categorical variables, including gender, anatomical side, and excellent functional outcome, were presented as frequencies and percentages, whereas quantitative variables, including age, BMI, and duration of fracture, were presented as mean ± standard deviation. The two groups were compared for excellent functional outcome using the chi-square test. Data were stratified with respect to age, gender, anatomical side, duration of

fracture, and BMI, and the post-stratification chi-square test was applied. A p-value of <0.05 was considered statistically significant.

RESULTS

The mean age of patients was 38.74 ± 11.26 years in the hybrid external fixator group and 39.51 ± 10.84 years in the locking plate group (p=0.604). The mean BMI was 25.83 ± 3.41 kg/m² and 26.12 ± 3.56 kg/m², respectively (p=0.536), while the mean duration of fracture was 6.42 ± 2.31 days and 6.18 ± 2.27 days, respectively (p=0.435). In Group A, 76 (68.5%) patients were male and 35 (31.5%) were female, compared with 73 (65.8%) males and 38 (34.2%) females in Group B (p=0.665). Right-sided fractures were present in 60 (54.1%) and 58 (52.3%) patients, while left-sided fractures were present in 51 (45.9%) and 53 (47.7%) patients in Groups A and B, respectively (p=0.788). Schatzker type V fractures were observed in 58 (52.3%) patients in Group A and 56 (50.5%) in Group B, whereas Schatzker type VI fractures were observed in 53 (47.7%) and 55 (49.5%) patients, respectively (p=0.788), as shown in Table 1.

Table 1. Baseline Demographic and Clinical Characteristics of the Study Groups (n = 222)

Variable	Type	Group A Hybrid External Fixator (n = 111)	Group B Locking Plate (n = 111)	p-value
Age (years)	Mean ± SD	38.74 ± 11.26	39.51 ± 10.84	0.604
BMI (kg/m²)	Mean ± SD	25.83 ± 3.41	26.12 ± 3.56	0.536
Duration of fracture (days)	Mean ± SD	6.42 ± 2.31	6.18 ± 2.27	0.435
Gender	Male	76 (68.5%)	73 (65.8%)	0.665
	Female	35 (31.5%)	38 (34.2%)	
Anatomical side	Right	60 (54.1%)	58 (52.3%)	0.788
	Left	51 (45.9%)	53 (47.7%)	
Fracture type	Schatzker type V	58 (52.3%)	56 (50.5%)	0.788
	Schatzker type VI	53 (47.7%)	55 (49.5%)	

At 12 weeks, poor functional outcome was observed in 8 (7.2%) patients in the hybrid external fixator group and 4 (3.6%) patients in the locking plate group. Fair outcome was observed in 25 (22.5%) and 17 (15.3%) patients, respectively, while good outcome was observed in 59 (53.2%) and 56 (50.5%) patients, respectively. Excellent functional outcome was achieved by 19 (17.1%) patients in the hybrid external fixator group compared with 34 (30.6%) patients in the locking plate group, as shown in Table 2.

Table 2. Comparison of Functional Outcome Categories Between the Study Groups at 12 Weeks (n = 222)

Functional Outcome	Group A: Hybrid External Fixator (n = 111)	Group B: Locking Plate (n = 111)
Poor	8 (7.2%)	4 (3.6%)
Fair	25 (22.5%)	17 (15.3%)
Good	59 (53.2%)	56 (50.5%)
Excellent	19 (17.1%)	34 (30.6%)
Total	111 (100%)	111 (100%)

Excellent functional outcome was achieved in 19 (17.1%) patients treated with the hybrid external fixator compared with 34 (30.6%) patients treated with the locking plate. Conversely, 92 (82.9%) patients in Group A and 77 (69.4%) patients in Group B did not achieve an excellent functional outcome. The difference between the two groups was statistically significant (p=0.018), as shown in Table 3.

Table 3. Comparison of Excellent Functional Outcome Between the Study Groups at 12 Weeks (n = 222)

Excellent Functional Outcome	Group A: Hybrid External Fixator (n = 111)	Group B: Locking Plate (n = 111)	p-value
Yes	19 (17.1%)	34 (30.6%)	0.018
No	92 (82.9%)	77 (69.4%)	
Total	111 (100%)	111 (100%)	

After stratification, among patients aged ≤40 years, excellent functional outcome was achieved in 12/62 (19.4%) patients in Group A and 21/60 (35.0%) in Group B (p=0.052), while among those aged >40 years, the corresponding frequencies were 7/49 (14.3%) and 13/51 (25.5%) (p=0.161). Among males, excellent outcome was achieved in 14/76 (18.4%) patients in

Group A and 24/73 (32.9%) in Group B (p=0.043), whereas among females, it was achieved in 5/35 (14.3%) and 10/38 (26.3%) patients, respectively (p=0.204). For right-sided fractures, excellent outcome occurred in 11/60 (18.3%) and 19/58 (32.8%) patients (p=0.072), while for left-sided fractures, it occurred in 8/51 (15.7%) and 15/53 (28.3%) patients (p=0.121). Among patients with fracture duration ≤7 days, excellent outcome was achieved in 13/67 (19.4%) patients in Group A and 22/65 (33.8%) in Group B (p=0.060), compared with 6/44 (13.6%) and 12/46 (26.1%) among those with fracture duration >7 days (p=0.140). Among patients with BMI ≤25 kg/m², excellent outcome was achieved in 9/45 (20.0%) and 14/43 (32.6%) patients (p=0.180), whereas among those with BMI >25 kg/m², it was achieved in 10/66 (15.2%) and 20/68 (29.4%) patients, respectively, with a statistically significant difference (p=0.048), as given in Table 4.

Table 4. Stratification of Excellent Functional Outcome According to Effect Modifiers (n = 222)

Effect Modifier	Category	Group A: Hybrid External Fixator Excellent n/N (%)	Group B: Locking Plate Excellent n/N (%)	p-value
Age (years)	≤40	12/62 (19.4%)	21/60 (35.0%)	0.052
	>40	7/49 (14.3%)	13/51 (25.5%)	0.161
Gender	Male	14/76 (18.4%)	24/73 (32.9%)	0.043
	Female	5/35 (14.3%)	10/38 (26.3%)	0.204
Anatomical side	Right	11/60 (18.3%)	19/58 (32.8%)	0.072
	Left	8/51 (15.7%)	15/53 (28.3%)	0.121
Duration of fracture	≤7 days	13/67 (19.4%)	22/65 (33.8%)	0.060
	>7 days	6/44 (13.6%)	12/46 (26.1%)	0.140
BMI (kg/m²)	≤25	9/45 (20.0%)	14/43 (32.6%)	0.180
	>25	10/66 (15.2%)	20/68 (29.4%)	0.048

DISCUSSION

Complex proximal tibia fractures, particularly Schatzker types V and VI, are challenging injuries involving the articular surface and surrounding soft tissues. These fractures commonly result from high-energy trauma and may lead to joint instability, stiffness, and impaired function. The primary goals of treatment are anatomical reduction, stable fixation, restoration of the mechanical axis, and early mobilization.[11] Locking plate fixation provides stable internal fixation and facilitates restoration of osseous alignment. Hybrid external fixation offers an alternative approach with relatively limited soft-tissue disruption.[12] Comparison of these techniques is important for selecting an appropriate treatment strategy and achieving better functional outcomes. The present study compared functional outcomes of hybrid external fixation and locking plate fixation in 222 patients with complex proximal tibia fractures (Schatzker types V and VI), with 111 patients in each group. Baseline characteristics were comparable, including mean age (38.74 ± 11.26 vs. 39.51 ± 10.84 years; p=0.604), BMI (25.83 ± 3.41 vs. 26.12 ± 3.56 kg/m²; p=0.536), and fracture duration (6.42 ± 2.31 vs. 6.18 ± 2.27 days; p=0.435). At 12 weeks, excellent functional outcome was significantly higher with locking plate fixation than hybrid external fixation (30.6% vs. 17.1%; p=0.018), while good outcomes occurred in 50.5% and 53.2%, respectively.

Kumar et al. (2025) reported excellent Rasmussen knee outcomes in 84.4% of proximal tibial fractures treated with hybrid external fixation, considerably higher than the 17.1% observed in our study. Despite our findings favoring locking plates (30.6% vs. 17.1%; p=0.018), hybrid external fixation remains valuable for fractures with significant soft-tissue compromise.[13] Lee et al. (2008) similarly reported a significantly higher mean functional score with dual plating than hybrid external fixation (73 vs. 62), although union time was comparable (13.8 vs. 14.2 weeks), supporting our finding of superior functional outcomes with plate fixation.[14] Rohra et al. (2016) also reported excellent objective Knee Society scores in 85.29% of patients treated with dual plates, further supporting favorable outcomes with plate-based fixation, although this rate was higher than the 30.6% observed in our study.[15] Ahmad et al. (2018) reported acceptable outcomes in 76.8% of 125 patients treated with hybrid external fixation, with non-union in 8.0% and pin-track infection in 15.2%. Similarly, 70.3% of patients in our hybrid external fixator group achieved good-to-excellent outcomes.[16] Tahir et al. (2019), however, found no significant differences in functional, clinical, subjective, or radiological outcomes between ORIF and Ilizarov fixation, contrasting with our significant difference in excellent functional outcome (p=0.018).[17]

Verma et al. (2020) reported excellent, good, fair, and poor functional outcomes in 53.3%, 23.3%, 13.3%, and 10.0% of patients treated with Ilizarov fixation, respectively. All fractures united at a mean of 23.9 weeks, while pin-tract infection occurred in 13.3%. Their good-to-excellent outcome rate of 76.6% was comparable to 70.3% in our hybrid external fixator group.[18] Singhroha et al. (2021) reported a mean age of 45 years, 84.4% male predominance, union at 17.4 weeks, and a mean knee ROM of 110.75°, with only three complications. These findings support satisfactory recovery following operative fixation of complex tibial plateau fractures.[19]

A 2020 study of 30 patients treated with an Ilizarov external fixator reported excellent, good, fair, and poor outcomes in 53.3%, 23.3%, 13.3%, and 10.0%, respectively, with a good-to-excellent outcome rate of 76.6%, compared with 70.3% in our hybrid external fixator group. Another study reported a mean age of 45 years, mean time from trauma to surgery of 7.6 days, union at 17.4 weeks, mean knee ROM of 110.75°, and complications in three patients, supporting generally favorable functional recovery after surgical fixation. Rao et al. (2024) compared 32 patients treated with hybrid external fixation and 34 with plate osteosynthesis.[20] Their mean age of 38.55 ± 11.76 years was comparable to our study, while 86.4% were male. Both groups had similar complication and reoperation rates, with superficial or pin-track infection occurring in 12 patients. Overall, although both techniques provided satisfactory outcomes, our findings and much of the available evidence suggest that locking plate fixation offers a greater likelihood of achieving an excellent functional outcome in complex proximal tibia fractures.

STUDY LIMITATIONS

This study was conducted at a single center with a relatively short follow-up period of 12 weeks. Long-term functional outcomes and late complications were not evaluated. Further multicenter studies with longer follow-up are required to confirm these findings.

CONCLUSION

Locking plate fixation resulted in a significantly higher frequency of excellent functional outcomes compared with hybrid external fixation. Excellent outcomes were achieved in 30.6% of patients treated with locking plates versus 17.1% treated with hybrid external fixators. Therefore, locking plate fixation appeared to provide better short-term functional outcomes for complex proximal tibia fractures.

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Conflict of Interest: No

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