

Comparison of Functional Outcome between Locking Plate Technique versus Ilizarov Technique in Patients with Complex Tibial Plateau Fractures

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Abstract: Complex tibial plateau fractures are challenging to manage because of articular comminution, soft tissue compromise, and the need for early mobilization. Locking plate fixation and hybrid Ilizarov external fixation are commonly used strategies, but comparative evidence on functional outcomes remains limited. **Objective:** To compare the mean functional knee score between the locking plate technique and the Ilizarov technique in patients with complex tibial plateau fractures. **Methods:** This randomized controlled trial was conducted in the Department of Orthopedics at Nishtar Hospital, Multan, over 9 months, from 3 August 2024 to 3 April 2025. Adults presenting with complex tibial plateau fractures were enrolled and randomly allocated to Group A (locking plate fixation) or Group B (Ilizarov fixation) using a lottery method with sealed opaque envelopes. All procedures were performed by the same orthopedic surgical team according to institutional protocols, prioritizing meticulous pin tract care and early initiation of knee range of motion. Functional outcome was assessed using the Rasmussen knee score, and radiological union was evaluated on standard follow-up radiographs. Categorical functional outcome was graded as excellent, good, fair, or poor. Continuous variables, including the mean Rasmussen knee score, were compared using an independent-samples t-test. In contrast, categorical variables, such as union status and functional grade, were analyzed using a chi-square test, with $p < 0.05$ considered statistically significant. **Results:** Group A demonstrated a significantly higher rate of radiological union than Group B (50.9% vs 17.5%; $\chi^2 = 14.1$, $p < 0.001$). The mean Rasmussen knee score was also significantly superior in the locking plate group (25.74 ± 4.52) compared with the Ilizarov group (23.58 ± 3.72 , $t = 2.78$, $p = 0.006$). Categorical functional outcomes differed significantly between the two groups ($\chi^2 = 17.41$, $p = 0.001$), with Group A showing a higher proportion of excellent results (50.9% vs 17.5%) than Group B. **Conclusion:** Locking plate fixation provides better radiological union and superior functional knee outcomes compared with the hybrid Ilizarov technique in patients with complex tibial plateau fractures, supporting its use as a more reliable and outcome driven option in this clinical setting.

Keywords: Tibial Plateau fracture, Ilizarov technique, Locking plate, Rasmussen functional knee score

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Introduction

Tibial plateau fractures are complicated injuries and are typically the result of high-energy trauma, such as motor vehicle accidents or falls from height (1). These fractures involve the articular surface of the proximal tibia, which provides key support for knee stability and range of motion. Managing complex tibial plateau fractures remains one of the most challenging tasks in orthopedic surgery due to their complex anatomy and the compromise of the soft tissues (2). Surgery is usually indicated to reduce the joint and the fracture and allow early mobilization. According to treatment methods, the two most commonly used are the locking plate technique and the Ilizarov-type external fixator, both of which have advantages and disadvantages (3).

The locking plate fixation technique provides rigid internal fixation, which permits anatomical reduction of fracture fragments and firm fixation (4). This technique is valuable, especially in osteoporotic bone and in comminuted fractures, where screw purchase is difficult. Nevertheless, multiple soft tissues need to be stripped. The wound is monitored for infectious susceptibility, delayed wound healing, or other problems, and is common in high-energy fractures with severe soft tissue injury (5). Alternatively, circular external fixation using the Ilizarov technique provides minimally invasive stabilization, decreasing soft-tissue disruption and the risk of infection. The semi-rigid stabilization system's independence from dynamization enables progressive correction and early weight-bearing, thereby improving fracture healing and functional recovery (6).

Despite the widespread use of the two approaches, the relative auxiliaries between them to achieve optimal functional capacity in complex tibial plateau fractures remain under debate. Previous investigations have reported conflicting results, with some supporting locking plates for superior articular reduction and others supporting the Ilizarov technique because of fewer complications and greater versatility in severe fractures (8,9). Functional results, such as knee motion, pain relief, and return to daily activities, are the most important criteria for success in these patients. Consequently, comparing the two methods to support clinical decision-making and benefit the patient is necessary (10).

Because tibial plateau fractures significantly affect quality of life, it is important to determine the best surgical technique. By doing so, the study will provide evidence-based guidelines that will improve fracture care, reduce complications, and optimize functional recovery. Through efforts to fill the gaps in the literature, the authors hope to refine treatment protocols and, in the long run, to benefit patients with complex tibial plateau fractures.

Methodology

The study was conducted in the Department of Orthopedics at Nishtar Hospital Multan as a randomized controlled trial over nine months following synopsis approval .from August 3, 2024 to April 3, 2025 The sample size was calculated using OpenEpi software based on the mean difference formula, with a mean knee score of 24.90 ± 4.266 in the locking plate group and 22.23 ± 5.783 in the Ilizarov fixation group, a 95%



confidence level, and 80% power, resulting in a total sample size of 114 patients (57 in each group). Non-probability consecutive sampling was employed for patient selection.

Patients aged 25–65 years, of either gender, with proximal tibial fractures of duration ≤ 7 days and Schatzker type V and VI fractures were included. Exclusion criteria comprised patients with vascular injury, pathological fractures, previous fracture surgery, poly-trauma, compartment syndrome, or those requiring surgical intervention by other specialties. Anteroposterior (AP) and lateral X-rays were used in classifying type V and VI tibia fractures (Schatzker type V and VI) as type V (bicondylar tibia plateau) and type VI (transverse subcondylar metaphyseal-diaphyseal dissociated). The Rasmussen functional knee score was used to assess functional outcomes by evaluating six clinical parameters: pain, walking capacity, knee extension, total range of motion, stability, and quadriceps power. They were assessed clinically and using a goniometer. A total score of 30 was achieved, with excellent being 28–30, good being 24–27, fair being 20–23, and poor being less than 20 and The total score was obtained six months after surgery. The fracture union criteria were met, with bridging callus across the fracture bed, as revealed on X-rays at 1, 3, and 6 months during the postsurgical period. The definition of obesity was based on body mass index (BMI) of more than 30 kg/m², calculated using the formula: weight (kg)/height squared (m²). Individuals with a daily use of 10 cigarettes or more were considered to be in the smoking category based on their continued smoking over a duration of two or more years. Among already known patients, diabetes mellitus was detected in patients who have been under hypoglycemic medication for at least two years.

Following the approval/informed consent by the ethics committee, patient characteristics, including age, gender, BMI, obesity status, smoking history, diabetes, and mode of injury (fall, road traffic accident, assault), were taken. They were randomized to group A (locking plate) or group B (Ilizarov fixation) using a lottery with sealed opaque envelopes. All operations were performed by a single surgical team and followed hospital protocols, with special attention to pin tract management and early range of motion. Regular visits were marked in the first month, weekly thereafter, and monthly thereafter. Toe-touch walking with a walker began at 4–6 weeks, cane use at 12 weeks, and full weight bearing at 20 weeks if clinical and radiological union were observed. At 24 weeks post-surgery, radiological union, knee range of motion, and Rasmussen functional knee score were assessed.

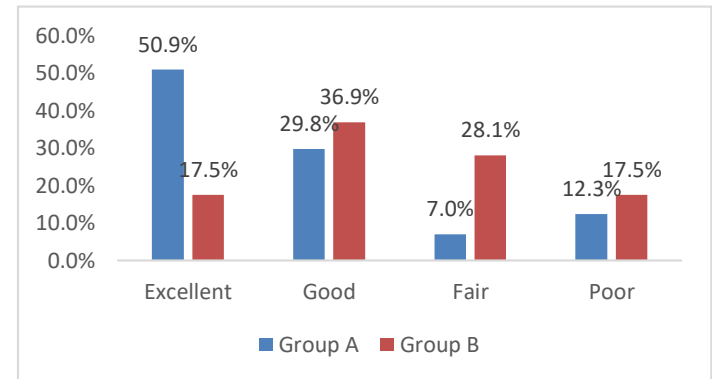
The structured proforma was used to record the data and analyze them through SPSS v. 23. Mean \pm SD were used to display numerical variables,

including age, BMI, and Rasmussen score. Conversely, the categorical variables (gender, obesity, and smoking, and diabetes, mode of injury, radiological union, and functional outcome) were presented in terms of frequencies and percentages. The stratification was performed by age, gender, obesity, smoking, diabetes, and mode of injury to evaluate the impact of these variables on the union, Rasmussen score, and functional outcome groups. The chi-square test for union and functional outcome categories and the independent sample t-test for Rasmussen score were used in the post-stratification analysis, with significance set at $p \leq 0.05$.

Results

The sample size of the study was 114 patients, evenly categorized as Group A and Group B (57 patients each). No significant differences in age (Group A: 40.89 positive mean, SD 8.86 vs. Group B: 42.12 positive mean, SD 10.45 years, $p = 0.500$), BMI ($p = 0.661$), smoking status ($p = 0.558$), diabetes ($p = 0.691$), or mode of injury were found ($p = 0.804$). Nevertheless, the trend was towards an increased number of males in Group A (80.7% vs. 64.9%, $p = 0.058$). (Table-1)

Functional outcomes significantly favored Group A, with a higher rate of radiological union (50.9% vs. 17.5%, $\chi^2 = 14.1$, $p < 0.001$) and superior Rasmussen knee scores (25.74 ± 4.52 vs. 23.58 ± 3.72 , $t = 2.78$, $p = 0.006$) compared to Group B. Additionally, categorical functional outcomes (excellent/good/fair/poor) differed significantly ($\chi^2 = 17.41$, $p = 0.001$), with Group A exhibiting a greater proportion of "excellent" results



(50.9% vs. 17.5%) than Group B. (Table 1) (Fig. 1).

Figure 1: Functional outcome of the patients.

Table. 1: Demographics and baseline characteristics of patients

Characteristic	Group A (Locking plate) 57 (50.0%)	Group B (Ilizarov fixation) 57 (50.0%)	Test of Sig.
Age (years)	40.89 \pm 8.86	42.12 \pm 10.45	$t = -0.68$, d.f=112, $p = 0.500$
25-40	32 (56.1)	27 (47.4)	$\chi^2 = 0.88$, d.f=1, $p = 0.349$
41-65	25 (43.9)	30 (52.6)	
Gender			
Male	46 (80.7)	37 (64.9)	$\chi^2 = 3.58$, d.f=1, $p = 0.058$
Female	11 (19.3)	20 (35.1)	
BMI (kg/m ²)	27.12 \pm 3.01	26.88 \pm 2.68	$t = 0.44$, d.f=112, $p = 0.661$
<25	12 (21.1)	13 (22.8)	$\chi^2 = 0.58$, d.f=2, $p = 0.752$
25-29.9	34 (56.9)	36 (63.2)	
≥ 30	11 (19.3)	8 (14.0)	
Smoker	22 (38.6)	19 (33.3)	$\chi^2 = 0.34$, d.f=1, $p = 0.558$
Diabetes	18 (31.6)	20 (35.1)	$\chi^2 = 0.16$, d.f=1, $p = 0.691$
Mode of injury			
Fall	20 (35.1)	18 (31.6)	$\chi^2 = 0.44$, d.f=2, $p = 0.804$
RTA	24 (42.1)	23 (40.4)	
Assault	13 (22.8)	16 (28.1)	

n (%) chi-square test was applied. Mean \pm S.D. t-test was applied

Table 2: Functional outcome of the patients

Functional outcome	Group A 57 (50.0%)	Group B 57 (50.0%)	Test of Sig.
Radiological union	29 (50.9)	10 (17.5)	$\chi^2=14.1$, d.f=1, $p<0.001$
Rasmussen functional knee score	25.74±4.52	23.58±3.72	t=2.78, d.f=112, $p=0.006$
Functional outcome			
Excellent	29 (50.9)	10 (17.5)	$\chi^2=17.41$, d.f=3, $p=0.001$
Good	17 (29.8)	21 (36.9)	
Fair	4 (7.0)	16 (28.1)	
Poor	7 (12.3)	10 (17.5)	

n (%) chi-square test was applied. Mean±S.D. t-test was used.

Discussion

Fracture reduction reverses a fracture's initial displacement, restoring the broken bone fragments' original anatomical position. In intra-articular fractures, the damaged cancellous bone and displaced articular pieces must also be removed to ensure proper healing and joint function (11). A laterally placed locked plate in the proximal tibia provides mechanical stability and stiffness comparable to dual plating (12). The Ilizarov technique offers advantages, including minimal soft-tissue disruption, reduced blood loss, and early weight-bearing due to stable fixation (13). The current study observed a trend toward higher male prevalence in Group A (80.7% vs. 64.9%, $p = 0.058$). Similarly, a survey by Jafree et al (14). Reported that in Group A (Hybrid Ilizarov Technique), 84.6% of participants were male and 15.4% were female, while in Group B (locking plate technique), 82.1% were male and 17.9% were female.

The study conducted by Hall et al (15). Compared plate fixation and circular external fixation (Ilizarov) in 82 Canadian patients, finding no significant differences in WOMAC scores for pain ($p=0.923$), stiffness ($p=0.604$), or function ($p=0.827$) at 2-year follow-up. Both techniques yielded similar clinical outcomes, suggesting comparable effectiveness. The results indicate neither method was superior in improving long-term post-injury recovery.

In this study, Group A demonstrated significantly higher radiological union rates (50.9% vs. 17.5%) and better Rasmussen knee scores (25.74±4.52 vs. 23.58±3.72) than Group B. Additionally, Foster et al¹⁶ reported in their study of 40 patients (21 closed and 19 open fractures) that injuries were treated within an average of 8 days (range: 0-35 days), with a mean union time of 187 days (range: 87-370 days), and observed non-union in four cases.

Jafree et al¹⁴ found that while the locking plate technique (Group B) yielded a higher postoperative Rasmussen's functional knee score (24.90±4.266) compared to the Ilizarov technique (Group A, 22.23±5.783), Group A had a higher proportion of excellent functional outcomes (46.2% vs. 30.8%), suggesting the locking plate technique may be superior for complex tibial plateau fractures.

Ghori et al. (17) compared ORIF and Ilizarov fixation in 56 patients with Schatzker type V and VI tibial plateau fractures, finding that 100% of patients in both groups achieved excellent extension lag. Most patients also had excellent outcomes in knee flexion (54.1% vs. 59.37%), thigh atrophy (87.5% vs. 81.2%), and instability (83.3% vs. 87.5%) for ORIF and Ilizarov, respectively.

In this study, categorical functional outcomes (excellent/good/fair/poor) differed significantly, with the locking plate showing a higher proportion of "excellent" results compared to the Ilizarov technique (50.9% vs. 17.5%). These findings contrast with those of Karunakaran et al. (18), where the locking plate technique was rated excellent in 35% of cases, good in 42%, fair in 15%, and poor in 8% based on Rasmussen's knee functional score.

In a study by Raza et al. (19), 25% excellent, 60% good, 10% fair, and 5% poor outcomes were reported, while Vélez et al (20) reported. Found 40% excellent, 40% good, 15% fair, and 5% poor. Differences may stem from patient selection, technique, or rehabilitation. Most outcomes were favorable ("good" to "excellent"), but some were suboptimal ("fair" or

"poor"). Further research is needed to optimize consistency in knee functional recovery.

Conclusion

The locking plate technique is a more reliable and outcome-driven approach to treating complex proximal tibial fractures than the hybrid Ilizarov technique.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-24)

Consent for publication

Approved

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Not applicable

Conflict of interest

The authors declared no conflict of interest.

Author Contribution

MAA (POR)

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Review of Literature, Data entry, Data analysis, and drafting an article.

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Review of Literature, Data entry, Data analysis, and drafting an article.

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the study's integrity.

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