ORIGINAL ARTICLE

Functional Outcomes of Schatzker Type III–VI Tibial Plateau Fractures Treated with Anatomical Locking Compression Plates: An Observational Study

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Abstract

Introduction: Tibial plateau fractures, frequently caused by road traffic accidents, disrupt articular congruity and elevate the risk of secondary osteoarthritis. Although anatomical locking compression plates are widely used for fixation, outcomes for Schatzker III-VI fractures remain underexplored. This study evaluated the functional and radiological outcomes of Schatzker type III-VI fractures treated with locking compression plates.

Methods: In this observational study, 30 patients with Schatzker III-VI fractures underwent locking compression plates fixation at a single center between November 2021 and December 2022. Ethical clearance was obtained from the Institutional Review Committee (15 August 2021). Functional outcomes were assessed using the Knee Society Score at a minimum 4-month follow-up. Radiographic union was evaluated on standard anteroposterior and lateral radiographs, defined as bridging callus across at least three of four cortices on two orthogonal views with no visible fracture line. Data were analyzed descriptively, continuous variables were expressed as mean ± standard deviation, and categorical variables as frequencies and percentages.

Results: The mean patient age was 44.50±14.38 years, with road traffic accidents being the predominant injury mechanism. At the 4-month follow-up, the mean Knee Society Score was 75.33±7.53. Good outcomes were observed in 21 (70%) of patients and excellent outcomes in 5 (16.70%). Fair and poor outcomes were each observed in 2 (6.70%) of cases. Radiographic union was evident in 28 (93.30%) of fractures. Complications included superficial infection 6 (20%) and knee stiffness 4 (13.30%).

Conclusions: In patients with Schatzker type III-VI fractures, treatment with locking compression plates achieved high rate of good-to-excellent functional outcomes and fracture union at 4 months, supporting its role as an effective surgical strategy for these injuries.

Keywords: *knee joint; locking plate; tibia fracture.*

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Introduction

Tibial plateau fractures, particularly high-energy Schatzker type III-VI patterns, represent a significant burden of trauma injuries where high-velocity road traffic accidents are prevalent.[1] If not optimally managed, they disrupt articular congruity and metaphyseal stability, leading to a high risk of post-traumatic osteoarthritis and impaired function.[2,3] Anatomical reduction, stable internal fixation, and early rehabilitation to restore knee mechanics and mobility are the mainstay treatment goals.[4] For simpler fracture patterns external fixation and conventional plating, are effective but they often provide insufficient stability for complex, depressed, or comminuted articular fractures.[5] This led to the adoption of locked internal fixation. Anatomical locking compression plates (LCPs), pre-contoured to the proximal tibial geometry, provide a critical biomechanical advantage through angular-stable, fixed-angle screw fixation.[6] This construct offers superior stability in osteoporotic or multifragmentary bone and supports a biologically friendly approach by minimizing soft-tissue disruption.[7]

Despite these theoretical benefits and increasing clinical use, a clear evidence gap persists. Many published outcome studies encompass a broad spectrum of fracture severity. This grouping can obscure the specific results for the most challenging high-type fractures (Schatzker III-VI), where implant performance and surgical technique are most critical.[8]

This study aimed to evaluate the functional and radiological outcomes of Schatzker type III-VI tibial plateau fractures treated with anatomical locking compression plates.

Methods

A hospital-based longitudinal observational study was conducted on patients with proximal tibia fractures admitted to the Department of Orthopedics, Manipal Teaching Hospital, Pokhara, between November 2021 and December 2022. Patients aged 18 years and above with Schatzker type III to VI tibial plateau fractures who provided written informed consent were included. Patients with pathological fractures, compartment syndrome, major medical illnesses, polytrauma, neurovascular deficits, or those medically unfit for surgery were excluded.

As a single-center study conducted over a defined period, a consecutive sample of all eligible patients was enrolled. During this period, 30 patients meeting the inclusion criteria were treated and was included in the study. This sample size is consistent with similar observational studies on complex tibial plateau fractures.[1,2] Demographic and injury data were recorded using a structured proforma. Radiographic assessment included anteroposterior and lateral radiographs for all patients; computed tomography (CT) scans were performed to further assess fracture patterns. All patients underwent open reduction and internal fixation using locking compression plates via anterolateral, posteromedial, or combined approaches based on the fracture pattern.

Patients were followed at 2 weeks, and 1, 2, 3, and 4 months postoperatively. All 30 patients completed the minimum 4-month follow-up, with no loss to follow-up. Clinical assessment included pain evaluation via the Visual Analogue Scale (VAS) at 1 and 4 months. The primary functional outcome was the Knee Society Score (KSS) at the 4-month visit. The KSS is a surgeon-reported assessment that evaluates pain (50 points), stability (25 points), and range of motion (25 points), providing a total score from 0 to 100. Knee range of motion, a component of the KSS, was measured clinically using a standard long-arm goniometer. The measurements were taken by the attending orthopedic surgeon or a senior resident under supervision, with the patient in the supine position. The values for active flexion and extension were recorded in degrees on the patient's assessment proforma. Outcomes were categorized based on established clinical criteria as: Excellent (80-100), Good (70-79), Fair (60-69), and Poor (<60).[9] Fracture healing was evaluated as a secondary outcome on standard anteroposterior and lateral radiographs obtained at each visit. Union was defined as the presence of bridging callus across at least three of four cortices on two orthogonal views and the absence of a visible fracture line. The 4-month radiograph was used for the final determination of union status. Data were analyzed using descriptive statistics. Continuous variables (e.g., age, KSS) are presented as mean ± standard deviation, and categorical variables (e.g., Schatzker type, outcome category) as frequencies and percentages.

Results

The demographic characteristics of the 30 patients included in the study are summarized in Table 1. The cohort consisted of both male and female patients with a mean age in the mid-forties. The age distribution spanned early adulthood to over 60 years. Fractures occurred on both the right and left sides. Road traffic accidents were the predominant mechanism of injury, with other causes including falls and sports injuries. According to the Schatzker classification, all high-type fractures (III through VI) were represented, with a specific distribution. The choice of surgical fixation technique varied among

the patients, with the frequency for each method detailed in Table 1.

Table 1: Baseline Demographic and Clinical Characteristics (n= 30).

Demographic Characteristic	Value
Male:Female	2:1
Mean Age (years)	44.50±14.38
Mode of injury	
RTA	15(50%)
Fall from height	8(26.66%)
Sports Injuries	4(13.34%)
Fall from level ground	3(10%)
Schatzker classification of fractures	
Type III	6(20%)
Type IV	4(13.33%)
Type V fractures	11(36.67%)
Type VI	9(30%)
Surgical technique	
Dual locking plate fixation	15(50%)
Single locking plate fixation	8(26.66%)
Single plating with cannulated cancellous screw (CCS) fixation	7(23.34)

Table 2: Radiological fracture healing at 3 and 4 months postoperatively (n= 30).

Duration	Obliteration of fracture line	No visible fracture line
At 3 months	19(63.33%)	11(36.67%)
At 4 months	28(93.33%)	2(6.67%)

Radiologic assessment of fracture healing (Table 2) demonstrated progressive union over time. While 19 (63.3%) of fractures were united at 3 months, this significantly increased to 28 (93.30%) by the 4-month follow-up.

Pain was assessed using the Visual Analogue Scale (VAS) across follow-up visits. At 1 month, the mean VAS score was 7.07. It decreased to 1.80 at 4 months.

Table 3: Mean visual analogue scale.

Visual Analog Scale (n=30)	Mean
VAS score at 1 month	7.07±0.583
VAS score at 4 months	1.80±0.407

Functional outcomes were evaluated at 4 months using the Knee Society Score (KSS).9 The majority of patients 26 (86.70%) achieved good to excellent outcomes (Table 4). The mean Knee Society Score was 75.33±7.53.

Table 4: Functional outcomes (Knee Society Score) at 4 months (n= 30).

Knee society score at 4 months	Frequency n(%)
Poor (<60)	2(6.70)
Fair (60-69)	2(6.70)
Good (70-84)	21(70)
Excellent (85-100)	5(16.70)

ROM was also assessed across Schatzker fracture types at 1 and 4 months (Table 5). At 1 month, 20(66.7%) of patients achieved 120-129° flexion, with Type IV fractures showing the most restriction 30(100%). By 4 months, 22(73.3%) reached >140° flexion, where all Type IV cases showed complete recovery 30(100%). No significant differences existed between fracture types were noted (1-month p=0.662; 4-month p=0.987). All patients achieved range of motion >120°, demonstrating consistent recovery regardless of initial fracture severity.

Table 5: Postoperative range of movement by Schatzker Classification at 1 and 4 months

Degree of Flexion	Schatzker Type				Total (n= 30)
	III (n= 6)	IV (n= 4)	V (n= 11)	VI (n= 9)	
1 month					
120˚-129˚	4(66.70%)	4(100%)	7(63.60%)	5(55.60%)	20(66.70%)
130˚-139˚	1(16.70%)	-	4(36.40%)	3(33.30%)	8(26.70%)
>140˚	1(16.70%)	-	-	1(11.10%)	2(6.70%)
4 months					
120˚-129˚	1(16.70%)	-	1(9.10%)	1(11.10%)	3(10%)
130˚-139˚	1(16.70%)	-	2(22.20%)	2(22.20%)	5(16.70%)
>140˚	4(66.70%)	4(100%)	8(72.70%)	6(66.70%)	22(73.30%)

Postoperative complications were observed in 11 (36.70%) patients. These included superficial infection in 6 (20%) patients, knee stiffness in 4 (13.40%) patients, and persistent pain in 1 (3.30%) patient.

Discussion

This study evaluated the functional and radiological outcomes of Schatzker type III-VI tibial plateau fractures treated with anatomical locking compression plates (LCPs). The primary finding was a satisfactory mean Knee Society Score (KSS) of 75.33±7.53 at 4 months, with 26 (86.70%) of patients achieving good-to-excellent functional outcomes. Radiographic union was achieved in 28 (93.30%) of cases within the same period. The most common complications were superficial surgical site infection 6 (20%) and knee stiffness 4 (13.30%).

The demographic profile of our cohort, including age and gender distribution, was consistent with prior reports of similar high-energy fracture populations.[10-12] The pattern of right-sided predominance 19 (63.30%) and road traffic accidents as the primary mechanism 15 (50%) aligns with the high-energy injury profile documented in comparable series.[13,14]

Our results, demonstrating a 28 (93.30%) union rate and 26 (86.70%) good-to-excellent functional outcomes at 4 months, add to the growing body of evidence supporting locked plating for complex peri-articular fractures. These early outcomes align with the proposed biomechanical advantages of LCPs, such as angular stability. For example, Prasad et al. in a study of Schatzker V and VI fractures treated with dual plates, reported 40(100%) good-to-excellent functional outcomes and no deep infections at a mean 4-year follow-up, demonstrating the long-term viability of rigid internal fixation.16 The satisfactory mean KSS (75.33±7.53) in our study, while an early result, approaches the functional excellence reported in such series, suggesting a positive initial trajectory.

However, the optimal management of these injuries remains debated. Some authors emphasize the substantial soft-tissue risks associated with extensive open approaches. In contrast, a less invasive strategy using the Ilizarov external fixator has been shown to achieve excellent union rates 30 (100%) with a notably low incidence of pin-tract infection which was controlled by local dressing and antibiotics in complex plateau fractures, advocating for an alternative surgical philosophy.[17]

Schatzker Type V fractures were most common 11 (36.67%), followed by Type VI 9 (30%). This distribution, where high-energy patterns (Type V-VI) predominate, aligns with findings from similar tertiary-care trauma settings, such as He et al. 92 (28.13%) (Type V and VI) and Venkatesh et al. 19 (82.6%) (Type V and VI).[18,19] This common pattern likely reflects similar patient populations at tertiary trauma centers, where high-energy injuries like road traffic accidents are most frequent, 15 (50%) in our study.

Radiographic evaluations showed progressive healing over the follow-up period. At 3 months, 19 (63.33%) of fractures showed signs of union, which increased to 28 (93.33%) by the 4-month follow-up. This high rate of early union is promising. It suggests a trajectory that may lead to outcomes comparable to those in studies with longer follow-up, such as Shani et al. and Manidakis et al., where the majority of fractures achieved union by 6 months.[20] However, a direct comparison of union rates at these different time points must be made with caution, as healing is a continuous process.

Complications were observed in 11 (36.70%) of cases, predominantly superficial infections 6 (20%), knee stiffness 4 (13.40%), and persistent pain 1 (3.30%). No deep infections or severe complications such as non-union or neurological deficits were noted. This aligns with findings by Phisitkul et al. and Tahririan et al., who reported similar rates of infection and favorable outcomes with appropriate management.[21,22]

Pain assessment via the Visual Analogue Scale (VAS) showed a significant reduction in pain over time: from a mean score of 7.07 at 1 month to 1.80 at 4 months. This trend supports the findings of Wenger D et al., demonstrating effective pain relief postoperatively.[23]

There are some limitations to this study that should be acknowledged. The relatively small sample size and the fact that it was conducted at a single center may limit the generalizability of the results. Furthermore, the follow-up duration of only four months was relatively short, preventing assessment of long-term functional outcomes and complications. These factors should be considered when interpreting the findings, and future studies with larger samples, longer follow-up are warranted.

Conclusions

Locking compression plates provide effective surgical management for Schatzker type III to VI tibial plateau fractures, enabling good fracture healing and functional recovery within four months. Early surgery and stable fixation are key to favorable outcomes, with minimal complications. Further studies with larger samples and longer follow-up are needed to confirm long-term results.

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Conflict of Interest

The authors declare no competing interests. Dr Bikash Thapa is currently serving as Editor of Medical Journal of Armed Police Force Nepal (MJAPFN). He was not involved in the editorial review or decision-making for this manuscript.

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