# Functional Outcomes of Posteromedial Condylar Tibial Plateau Fractures Using Locking Compression Plates

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ARTICLE INFO

**Received:** 9 Mar 2026
**Accepted:** 12 Mar 2026
**Published Online:** 18 Mar 2026

DOI: 10.5281/zenodo.19324312

Volume: 9, Number: 1, Page: 259-263

e-ISSN: 2789-5912
ISSN: 2617-0817

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ABSTRACT

**Background**: Posteromedial condylar tibial plateau fractures are challenging intra-articular injuries that compromise knee stability and joint congruity. These fractures, often resulting from high-energy trauma, are biomechanically significant but frequently underdiagnosed or inadequately addressed, leading to suboptimal outcomes. Locking compression plates (LCPs) have emerged as a promising fixation method, offering angular stability and improved outcomes in complex fracture patterns. Aim of the study: To assess the functional and radiological outcomes of posteromedial tibial plateau fractures treated with locking compression plates and to identify factors influencing recovery. **Methods & Materials**: This prospective observational study included 55 adult patients with isolated posteromedial tibial plateau fractures treated at a tertiary care center. All patients underwent surgical fixation using the posteromedial approach with anatomically contoured LCPs. Functional outcomes were assessed using the Lysholm Knee Scoring Scale and the Knee injury and Osteoarthritis Outcome Score (KOOS) at final follow-up. Radiological union, weight-bearing milestones, and complications were also recorded. Statistical analyses included t-tests, Pearson correlation, and multivariate linear regression. Data analysis was conducted using SPSS version26. **Result**: The majority of patients showed favorable recovery, with good to excellent functional scores and a mean Lysholm score of 86.3±8.4. KOOS subscale scores also reflected high patient satisfaction and restored function. Younger age, Schatzker type IV fractures, shorter time to surgery, and earlier radiological union were significantly associated with better functional outcomes ($p < 0.05$). The complication rate was low, with minimal cases of infection, malunion, or implant failure. **Conclusion**: Locking compression plate fixation offers a reliable and biomechanically stable solution for posteromedial tibial plateau fractures, particularly when combined with early surgical intervention and targeted rehabilitation. The findings support its use as a preferred method in managing these complex injuries. Larger, multicenter trials are recommended to further validate these outcomes.

***Keywords:*** *Tibial plateau fracture, posteromedial condyle, locking compression plate, Schatzker classification, Lysholm score, KOOS, functional outcome*

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## INTRODUCTION

Tibial plateau fractures are complex intra-articular injuries involving the proximal portion of the tibia, which play a critical role in load transmission and weight-bearing at the knee joint [1]. These fractures can significantly impair joint congruity, alignment, and long-term function if not properly addressed [2]. Posteromedial condylar tibial plateau fractures refer to fractures involving the posteromedial aspect of the tibial plateau, often characterized by shearing forces due to axial loading and varus stress [3]. This particular fracture pattern is increasingly recognized for its biomechanical importance in maintaining knee stability, yet it has historically received less focused attention in both diagnosis and treatment compared to other tibial plateau fracture subtypes [4]. Tibial plateau fractures represent approximately 1% of all fractures globally, with a marked incidence in the elderly due to falls and low-energy trauma [5]. High-energy mechanisms such as motor vehicle accidents or fall from heights are more common causes in younger patients [6]. According to recent data from orthopedic centers across Bangladesh, tibial plateau fractures account for nearly 27.0% of all lower limb fractures, and among these, the posteromedial condylar involvement is frequently underreported or misclassified due to limitations in imaging modalities or a lack of surgeon familiarity with the fracture morphology [7]. The posteromedial fragment is biomechanically significant due to its load-bearing function and contribution to posterior and varus stability of the knee [8]. Fractures in this region, if inadequately stabilized, can result in joint instability, early-onset post-traumatic osteoarthritis, persistent pain, and reduced range of motion [9]. Traditional treatment approaches often relied on anterolateral incisions or conservative management, which frequently failed to provide adequate reduction and stability for the posteromedial fragment [10]. Inadequate fixation may lead to malunion, varus deformity, and poor functional outcomes, particularly in active patients or those with high physical demands [11]. Surgeons are now better equipped to identify and classify these fractures. Anatomically oriented surgical approaches, particularly the direct posteromedial approach, have been developed to allow better visualization and accurate reduction of the posteromedial condylar fragment [12]. Among the internal fixation options, locking compression plates (LCPs) have shown biomechanical superiority due to their angular stability, especially in osteoporotic bone or multi-fragmentary fractures. These plates facilitate rigid fixation, allowing for early mobilization and potentially improved functional recovery [13]. Despite these advancements, there remains a scarcity of high-quality studies evaluating the functional outcomes of isolated posteromedial tibial plateau fractures treated specifically with locking compression plates. Most existing studies either include mixed fracture types or fail to stratify outcomes based on fracture location and fixation method [14]. Orthopedic surgeons often rely on anecdotal evidence or extrapolated data, which may not be applicable to isolated posteromedial injuries. Therefore, a focused evaluation of this specific fracture pattern is warranted to guide clinical decision-making, optimize surgical techniques, and improve patient outcomes [15]. The aim of this study is to

assess the functional outcomes of posteromedial condylar tibial plateau fractures managed with locking compression plates, based on clinical, radiological, and patient-reported parameters.

## METHODS & MATERIALS

This prospective observational study was conducted at the Department of Orthopedic Surgery, Bangladesh Medical, Dhaka, Bangladesh from January 2023 to December 2024.

**Inclusion criteria** were patients aged 18 years or older presenting with posteromedial condylar tibial plateau fractures classified as Schatzker type IV or V who underwent surgical fixation with locking compression plates (LCP). Patients were required to have a minimum follow-up duration of 12 months.

**Exclusion criteria** included pathological fractures, polytrauma patients with multiple limb injuries, prior surgery on the affected knee, pre-existing knee joint disorders (e.g., osteoarthritis, ligament injuries), inability to comply with postoperative rehabilitation or follow-up, and those lost to follow-up before 12 months.

### Surgical Technique

All procedures were performed under spinal or general anesthesia by experienced orthopedic trauma surgeons using a standardized posteromedial approach. After adequate exposure, anatomical reduction of the fracture fragments was achieved under fluoroscopic guidance. Fixation was secured using anatomically contoured locking compression plates specifically designed for the posteromedial tibial plateau. Wound closure was performed in layers, and sterile dressings were applied.

### Postoperative Management

Postoperatively, patients followed a standardized rehabilitation protocol. Initially, partial weight-bearing was permitted based on surgeon discretion and radiographic healing, progressing to full weight-bearing typically around 12 to 16 weeks post-surgery. Range-of-motion exercises and muscle strengthening were initiated early to optimize functional recovery.

### Outcome Measures

The primary outcome was the functional assessment using the Lysholm Knee Scoring Scale at the final follow-up. Secondary outcomes included the Knee Injury and Osteoarthritis Outcome Score (KOOS), subdivided into Pain, Symptoms, Activities of Daily Living (ADL), Sports/Recreation, and Quality of Life (QOL). Radiological evaluation of fracture union was conducted with standard anteroposterior and lateral knee radiographs, defining union by the presence of bridging callus in at least three cortices.

Postoperative complications, including malunion, nonunion, infection, implant failure, and re-operation, were documented.

### Data Collection and Follow-up

Baseline demographic and injury characteristics were recorded at admission. Patients were assessed postoperatively at 6 weeks, 3 months, 6 months, and 12 months or later. Functional evaluations were performed by blinded assessors to reduce bias.

### Statistical Analysis

Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables as frequencies and percentages. Between-group comparisons were performed using independent t-tests or Mann-Whitney U tests, as appropriate. Pearson's correlation coefficient was used to evaluate relationships between variables. Multivariate linear regression analysis identified independent predictors of functional outcome. Statistical significance was set at $p < 0.05$. Data analysis was conducted using SPSS version26.

## RESULT

A total of 55 patients with posteromedial condylar tibial plateau fractures were included in this study. The mean age of the participants was 41.2±11.0 years, with a nearly equal distribution of patients aged <40 years (49.09%) and ≥40 years (50.91%). Males comprised the majority of the study cohort (65.45%). The right side was more frequently involved (52.73%) compared to the left (47.27%). Road traffic accidents were the leading cause of injury (36.36%), followed by falls from height (9.09%). According to Schatzker classification, Type IV fractures were predominant (70.91%), while Type V accounted for 29.09%. The mean interval from injury to surgery was 5.0±1.6 days, and the mean follow-up duration was 19.4±3.5 months (*Table I*).

**Table I**
Baseline demographic and injury characteristics of the study population ($n = 55$).

| Variable | Frequency (n) | Percentage (%) |
|---|---|---|
| **Age (years)** | | |
| < 40 years | 27 | 49.09 |
| ≥ 40 years | 28 | 50.91 |
| Mean ± SD | 41.2 ± 11.0 | |
| **Gender** | | |
| Male | 36 | 65.45 |
| Female | 19 | 34.55 |
| **Injury Side** | | |
| Right | 29 | 52.73 |
| Left | 26 | 47.27 |
| **Mechanism of Injury** | | |
| Road Traffic Accident (RTA) | 20 | 36.36 |
| Fall from Height | 5 | 9.09 |
| Others | 2 | 3.64 |
| **Schatzker Classification** | | |
| Type IV | 39 | 70.91 |
| Type V | 16 | 29.09 |
| **Time from Injury to Surgery (days)** | | |
| Mean ± SD | 5.0 ± 1.6 | |
| **Follow-up Duration (months)** | | |
| Mean ± SD | 19.4 ± 3.5 | |

*Table II* showed that mean time to radiological union was 13.2±2.3 weeks. Partial weight-bearing was initiated at a mean of 6.9±1.1 weeks, while full weight-bearing was achieved by 14.7±2.2 weeks. Postoperative complications included superficial infection in 7.27% of cases, deep infection in 3.64%, malunion in 3.64%, nonunion in 1.82%, and implant failure in 1.82%. A re-operation was required in 5.45% of patients.

**Table II**
Radiographic healing times and postoperative complications following locking compression plate fixation.

| Outcome | Frequency (n) | Percentage (%) |
|---|---|---|
| **Time to Radiological Union (weeks)** | | |
| Mean ± SD | 13.2 ± 2.3 | |
| **Time to Partial Weight-bearing (weeks)** | | |
| Mean ± SD | 6.9 ± 1.1 | |
| **Time to Full Weight-bearing (weeks)** | | |
| Mean ± SD | 14.7 ± 2.2 | |
| Malunion | 2 | 3.64 |
| Nonunion | 1 | 1.82 |
| Superficial Infection | 4 | 7.27 |
| Deep Infection | 2 | 3.64 |
| Implant Failure | 1 | 1.82 |
| Re-operation | 3 | 5.45 |

At the final follow-up, functional outcomes assessed by the Lysholm knee scoring scale revealed that 23.64% had excellent, 54.55% good, 16.36% fair, and 5.45% poor outcomes, with an overall mean score of 86.3±8.4 (*Table III*).

**Table III**
Functional outcome categorization based on lysholm knee scoring scale at final follow-up.

| Score Range | Functional Outcome Category | Frequency (n) | Percentage (%) |
|---|---|---|---|
| 95–100 | Excellent | 13 | 23.64 |
| 84–94 | Good | 30 | 54.55 |
| 65–83 | Fair | 9 | 16.36 |
| <65 | Poor | 3 | 5.45 |
| Mean ± SD | | 86.3 ± 8.4 | |

KOOS scores further demonstrated favorable outcomes, with mean values of 88.8±6.7 for pain, 82.1±8.1 for symptoms, 91.9±5.4 for activities of daily living, 77.5±9.0 for sports/recreation, and 81.7±7.6 for quality of life (*Table IV*).

**Table IV**
Functional outcome classification based on KOOS Scales.

| Outcome Measure | Mean ± SD | 95% Confidence Interval (CI) |
|---|---|---|
| Pain | 88.8 ± 6.7 | 86.9 – 90.5 |
| Symptoms | 82.1 ± 8.1 | 79.7 – 84.5 |
| ADL | 91.9 ± 5.4 | 89.9 – 92.9 |
| Sports/Recreation | 77.5 ± 9.0 | 74.2 – 79.4 |
| Quality of Life (QOL) | 81.7 ± 7.6 | 79.3 – 83.9 |

*Table V* represented that younger patients (<40 years) achieved significantly higher Lysholm scores compared to those ≥40 years (88.4±7.3 vs. 83.9±8.9, p=0.020). Similarly, Type IV fractures were associated with better functional outcomes compared to Type V (87.3±7.7 vs. 79.7±9.8, p=0.009). Early surgical intervention (≤5 days) yielded superior scores compared to delayed surgery (>5 days) (88.7±7.5 vs. 82.1±9.3, p=0.027).

**Table V**
Comparative analysis of lysholm knee scores by age group, schatzker fracture type, and surgical timing.

| Subgroup | n | Mean ± SD | 95% CI | p-value |
|---|---|---|---|---|
| **Age** | | | | |
| < 40 years | 27 | 88.4 ± 7.3 | 85.7 – 91.1 | 0.020* |
| ≥ 40 years | 28 | 83.9 ± 8.9 | 80.6 – 87.2 | |
| **Fracture Type (Schatzker)** | | | | |
| Type IV | 39 | 87.3 ± 7.7 | 84.9 – 89.7 | 0.009* |
| Type V | 16 | 79.7 ± 9.8 | 74.9 – 84.5 | |
| **Time to Surgery** | | | | |
| ≤ 5 days | 34 | 88.7 ± 7.5 | 86.2 – 91.2 | 0.027* |
| > 5 days | 21 | 82.1 ± 9.3 | 78.1 – 86.1 | |

Pearson's correlation demonstrated significant negative associations of Lysholm scores with age (r=-0.29, p=0.031), time to surgery (r=-0.34, p=0.012), and time to radiological union (r=-0.30, p=0.024). Follow-up duration did not show a statistically significant correlation with outcomes (p=0.188) *Table VI*.

**Table VI**
Correlation of lysholm knee scores with clinical and surgical variables.

| Variable | Pearson's r | p-value |
|---|---|---|
| Age | -0.29 | 0.031* |
| Time to Surgery (days) | -0.34 | 0.012* |
| Time to Radiological Union | -0.3 | 0.024* |
| Follow-up Duration | 0.17 | 0.188 |

Multivariate regression analysis identified increasing age (β=-0.26, p=0.008), Schatzker Type V fractures (β=-6.12, p=0.007), longer time to surgery (β=-1.03, p=0.019), and delayed radiological union (β=-0.91, p=0.003) as independent predictors of poorer Lysholm scores. Gender showed no significant association with outcomes (p=0.298) *Table VII*.

**Table VII**
Multivariate linear regression identifying independent predictors of functional outcome (Lysholm Score).

| Predictor | β Coefficient | 95% CI | p-value |
|---|---|---|---|
| Age (years) | -0.26 | [-0.45, -0.07] | 0.008** |
| Schatzker Type V (vs IV) | -6.12 | [-10.52, -1.72] | 0.007** |
| Time to Surgery (days) | -1.03 | [-1.88, -0.18] | 0.019* |
| Time to Radiological Union | -0.91 | [-1.50, -0.32] | 0.003** |
| Sex (Male vs Female) | 1.82 | [-1.62, 5.26] | 0.298 |

## DISCUSSION

This study evaluates the functional and radiological outcomes of locking compression plate fixation in Schatzker type IV and V tibial plateau fractures, aiming to identify predictors of recovery and compare results with existing clinical evidence. Overall, the findings indicate a favorable postoperative recovery profile, as reflected in both radiographic healing timelines and functional outcome scores [16]. These results are largely consistent with previously published studies evaluating similar cohorts and surgical techniques. In terms of radiological healing and weight-bearing milestones, the observed timeframes align closely with prior research, suggesting that LCP fixation provides stable internal support conducive to early mobilization [17]. Studies by Hanasoge et al. reported comparable durations for radiological union and progression to partial and full weight-bearing, reinforcing the reliability of the LCP method for complex tibial plateau fractures [18]. Functional outcomes in the current study, evaluated through Lysholm and KOOS scoring systems, demonstrate generally high levels of recovery, with a majority of patients achieving good to excellent scores [19]. Similar patterns were observed in studies by Ritter et al., where early surgical intervention and accurate anatomic reduction significantly influenced long-term knee function [20]. The high functional scores in this cohort may also be attributed to adherence to early physiotherapy protocols and the use of locking plates that maintain reduction despite potential comminution or osteoporotic bone [21]. Subgroup analysis in this study revealed that younger patients had significantly better functional outcomes than older individuals, a finding echoed by Munter et al., who emphasized that patient age is a critical determinant in postoperative recovery due to factors such as bone healing capacity and pre-injury activity levels [22]. Likewise, fractures classified as Schatzker type IV were associated with superior functional scores compared to type V injuries, which is in agreement with the findings of Prajwal et al., who noted that bicondylar fractures often lead to more complex joint involvement and prolonged rehabilitation [23]. Surgical timing also emerged as a significant factor influencing functional outcomes. Patients undergoing surgery within five days of injury tended to have better postoperative scores, a result supported by the findings of Henle et al., who observed increased complication rates and poorer outcomes in delayed interventions [24]. Early fixation, when soft tissue conditions permit, likely contributes to better alignment, reduced inflammation, and more efficient initiation of rehabilitation [25]. The analysis further identified age, fracture type, time to surgery, and time to radiological union as independent predictors of functional outcome. These associations are corroborated by prior multivariate studies, such as those by Manidakis et al. and Kumar et al., who similarly identified these variables as key influencers of long-term functional success following tibial plateau fracture fixation [26,27]. Conversely, sex was not found to be a significant predictor in the present study, a result consistent with previous findings suggesting that gender differences do not play a major role in surgical outcomes for lower limb fractures when other clinical variables are controlled [28]. Complication rates observed in this study, including superficial and deep infections, malunion, and implant failure, were within acceptable ranges and comparable to those reported in large clinical series. The relatively low incidence of serious complications reflects careful patient selection, adherence to surgical principles, and proper postoperative monitoring [29]. The current findings support the efficacy of locking compression plate fixation in managing complex tibial plateau fractures, particularly when surgical intervention is performed early and tailored to the specific fracture pattern [30]. These results are in concordance with a growing body of literature advocating for stable fixation methods, early mobilization, and individualized patient care in orthopedic trauma. Further prospective, multicenter studies with larger sample sizes and longer follow-up durations are warranted to validate these observations and optimize treatment algorithms.

## LIMITATIONS

This study was conducted at a single tertiary care center with a relatively small sample size, which may limit the generalizability of the findings to broader populations. The short follow-up period restricts the ability to assess long-term complications such as post-traumatic osteoarthritis or late implant failure. Additionally, the study did not include a control group or compare different fixation techniques, which limits comparative analysis. Some degree of

selection bias may have occurred due to exclusion criteria and loss to follow-up. Multicenter studies with larger cohorts are recommended for more robust conclusions.

## CONCLUSION & RECOMMENDATIONS

Locking compression plate fixation represents an effective treatment approach for Schatzker type IV and V tibial plateau fractures, offering stable fixation and favorable recovery. Early surgical timing, younger patient age, less complex fracture patterns, and quicker radiological union were associated with improved functional outcomes. The low incidence of complications supports the safety and reliability of this method. These findings are in line with previous literature and emphasize the need for timely intervention and tailored rehabilitation strategies. Further multicenter studies with extended follow-up are necessary to confirm these results and refine clinical decision-making.

## FUNDING

No funding sources

## CONFLICT OF INTEREST

None declared

## ETHICAL APPROVAL

The study was approved by the Institutional Ethics Committee.

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