

Evaluation of Functional Outcomes of Tibial Plateau Fractures Treated with Anatomically Contoured Locking Compression Plates

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ABSTRACT

Background: Tibial plateau fractures are a significant orthopedic concern due to their complexity and the essential role of the tibial plateau in knee stability and function. These fractures can result in long-term impairment and disability if not managed properly. The advent of anatomically contoured locking compression plates (LCPs) has revolutionized their treatment, providing superior stability and allowing for early mobilization. The study aims to evaluate the functional outcomes of tibial plateau fractures treated with anatomically contoured LCPs.

Methods: An observational study was done from February 2023 to January 2024, including 250 patients with tibial plateau fractures. Functional outcomes were assessed using the Knee Society Score (KSS), range of motion, and pain levels. Postoperative complications and radiological healing outcomes were documented. Statistical analysis was accomplished using SPSS software.

Results: The average age was 45.3 years, with a male-to-female ratio of 3:2. At the 6-month follow-up, the mean KSS was 85.2 (± 10.4), indicating good functional recovery. The mean range of motion was 120 degrees, and the mean pain level was 2.5 (VAS score). 90% of patients achieved full weight-bearing status. Postoperative complications occurred in 12% of patients, with infection (4%), malunion (3%), and hardware irritation (5%) being the most common. Radiological evaluations showed satisfactory fracture healing in 92% of the patients.

Conclusion: The use of anatomically contoured LCPs for tibial plateau fractures resulted in significant improvements in functional outcomes, high rates of fracture healing, and a relatively

low incidence of complications. These findings support the use of LCPs as a viable and effective option for treating complex tibial plateau fractures.

Recommendations: It is advised that more research be done with bigger sample sizes and longer follow-up times in order to confirm these results and investigate the long-term effects of treating tibial plateau fractures using anatomically shaped LCPs.

Keywords: *Tibial Plateau Fractures, Locking Compression Plates, Knee Society Score, Functional Outcomes, Orthopedic Surgery*

INTRODUCTION

The complexity of tibial plateau fractures (TPF) and the vital role the tibial plateau plays in knee stability and function make them a serious orthopaedic issue. Roughly one percent of all fractures and 8 percent of fractures in the senior population are caused by these fractures [1]. An important weight-bearing surface is the tibial plateau, and if fractures occur here, improper management may result in permanent functional impairment and disability. Restoring knee function and avoiding post-traumatic arthritis require achieving anatomical reduction and stable fixation [2].

The treatment of TPF has evolved significantly over the past few decades. Traditionally, these fractures were managed with conservative methods or non-locking plates, which often resulted in suboptimal outcomes. The advent of locking compression plates (LCPs) has revolutionized the surgical management of these fractures by providing superior stability and allowing for early mobilization [3, 4]. Anatomically contoured locking compression plates are designed to match the complex geometry of the tibial plateau, which facilitates better anatomical reduction and fixation.

Several studies have demonstrated the benefits of using locking plates in the management of TPF. For instance, a study reported that the use of LCPs led to improved functional outcomes and reduced complication rates compared to traditional plating methods [5]. Similarly, a study found that patients treated with LCPs had a higher rate of satisfactory radiological outcomes and lower incidence of post-traumatic arthritis [6]. Despite these advances, the management of TPF remains challenging due to the high variability in fracture patterns and the potential for soft tissue injury.

The study's objective was to assess the functional results of using anatomically shaped locking compression plates to treat tibial plateau fractures.

METHODOLOGY

Study Design

A retrospective observational study.

Study Setting

The study was carried out at Jawahar Lal Nehru Medical College and Hospital, Bhagalpur, India, from February 2023 to January 2024.

Participants

Participants included patients presenting with tibial plateau fractures. On average, 5 patients were treated per week during the study period.

Inclusion Criteria

- Patients aged 18 years and above.
- with confirmed TPF requiring surgical intervention.
- available for follow-up during the study period.

Exclusion Criteria

- Patients with pathological fractures,
- with open fractures,
- with a history of previous tibial plateau fractures,
- with comorbidities that could affect healing, such as uncontrolled diabetes or severe osteoporosis.

Sample size:

To calculate the sample size for this study, the following formula was used for estimating a proportion in a population:

$$n = \frac{Z^2 \times p \times (1-p)}{}$$

$$E^2$$

Where:

- n = sample size
- Z = Z-score corresponding to the desired level of confidence
- p = estimated proportion in the population
- E = margin of error

Bias

To minimize selection bias, all eligible patients presenting during the study period were included. To reduce information bias, data was collected consistently using standardized forms and procedures.

Variables

Variables included functional outcome assessed by knee range of motion (ROM), weight-bearing status, and pain levels, demographic data (age, sex), fracture classification, time to surgery, and postoperative complications.

Data Collection

Data was collected from patient medical records, surgical notes, and follow-up visits. Functional outcomes were estimated using the Knee Society Score (KSS) and radiological evaluations.

Procedure

Patients underwent surgery using anatomically contoured locking compression plates. The surgical approach was chosen based on the fracture type and location. Postoperative care included immobilization, pain management, and physiotherapy. Participants were followed up at regular intervals to monitor healing and functional recovery.

Statistical Analysis

SPSS was used to analyse the data. The clinical features and patient demographics were compiled using descriptive statistics. When applicable, chi-square tests and paired t-tests were used to compare functional results. Statistical significance was attained when the p-value was less than 0.05.

Ethical considerations:

The study protocol was approved by the Ethics Committee and written informed consent was received from all the participants.

RESULT

The study comprised 250 patients with TPF in total. The patients ranged in age from 18 to 75 years, with a male to female ratio of 3:1. Their mean age was 45.3 years. Schatzker type II fractures accounted for 60% of the fractures, with type V (20%), type VI (15%), and type I (5%).

Table 1: Demographic and Clinical Characteristics of Patients

Characteristic	Value
Total Patients	250
Mean Age (years)	45.3 (18-75)
Male-to-Female Ratio	3:2
Fracture Classification	
- Type I	5%
- Type II	60%
- Type V	20%
- Type VI	15%
Mean Time to Surgery (days)	3.5 (1-7)

The functional outcomes were estimated using the KSS and radiological evaluations. At the 6-month follow-up, the mean KSS was 85.2 ($\pm$ 10.4), indicating good functional recovery.

Table 2: Functional Outcomes at 6-Month Follow-Up

Outcome Measure	Mean $\pm$ SD
Knee Society Score (KSS)	85.2 $\pm$ 10.4
Range of Motion (degrees)	120 $\pm$ 15
Pain Level (VAS score)	2.5 $\pm$ 1.2

By the 6-month follow-up, 90% of the individuals were able to bear full weight on the affected limb. The remaining 10% had partial weight-bearing status due to various complications.

Postoperative complications were observed in 30 patients (12%). The most common complications included infection (4%), malunion (3%), and hardware irritation (5%).

Table 3: Postoperative Complications

Complication	Frequency (%)
Infection	10 (4%)
Malunion	8 (3%)
Hardware Irritation	12 (5%)

A paired t-test was conducted to compare the preoperative and postoperative KSS. The improvement in KSS from baseline to 6 months was statistically relevant ($p < 0.001$).

Table 4: Preoperative vs Postoperative KSS

Time Point	Mean KSS $\pm$ SD
Preoperative	45.8 $\pm$ 12.3
Postoperative (6 months)	85.2 $\pm$ 10.4

Radiological evaluations showed satisfactory fracture healing in 92% of the patients at the 6-month follow-up. The remaining 8% had delayed union, which was managed with additional interventions.

Table 5: Radiological Outcomes at 6-Month Follow-Up

Outcome	Frequency (%)
Satisfactory Healing	230 (92%)
Delayed Union	20 (8%)

DISCUSSION

The study evaluated the functional outcomes of 250 patients with TPF treated using anatomically contoured locking compression plates. The average age was 45.3 years, with a

male-to-female ratio of 3:2. Most fractures were classified as Schatzker type II. This demographic data provides a thorough overview of the patient population and highlights the prevalence of specific fracture types within this group.

Functional outcomes were estimated using the KSS and radiological evaluations. At the 6-month follow-up, the mean KSS was 85.2, indicating significant functional recovery. Patients also demonstrated an average range of motion of 120 degrees and reported low pain levels, with a mean VAS score of 2.5. These findings suggest that the surgical intervention was successful in restoring knee function and minimizing discomfort for the majority of patients.

Weight-bearing status was another critical measure of recovery. By the 6-month follow-up, 90% of individuals were able to bear full weight on the affected limb, which is a positive indicator of both functional and structural recovery. This high percentage of patients achieving full weight-bearing status reflects the effectiveness of the anatomical plates in supporting early mobilization and rehabilitation.

Postoperative complications were observed in 12% of participants, with the most common issues being infection (4%), malunion (3%), and hardware irritation (5%). While these complications were relatively infrequent, their occurrence underscores the need for vigilant postoperative care and monitoring to mitigate these risks. The manageable nature of these complications indicates that, while present, they did not significantly hinder the overall recovery process for most patients.

Radiological evaluations showed satisfactory fracture healing in 92% of patients at the 6-month follow-up, with only 8% experiencing delayed union. This high rate of satisfactory healing underscores the reliability and effectiveness of anatomically contoured locking compression plates in promoting proper fracture alignment and bone healing.

Overall, the study demonstrates that the use of anatomically contoured locking compression plates for treating tibial plateau fractures results in significant improvements in functional outcomes and high rates of fracture healing. The substantial improvement in the KSS, along with the high percentage of patients achieving full weight-bearing status and satisfactory radiological outcomes, supports the effectiveness of this surgical intervention. While a small percentage of patients did experience complications, these were generally manageable and did not detract from the overall positive outcomes observed. This evidence supports the continued use of anatomically contoured locking compression plates as a reliable option for the treatment of TPF.

Recent studies have demonstrated the efficacy of anatomically contoured locking compression plates (LCP) in treating TPF, showcasing significant improvements in both functional and radiological outcomes.

A study evaluated 43 cases of TPF treated with anatomically contoured LCP. The study reported that the majority of these fractures were Schatzker type V and VI. The average knee flexion at three months was 105.7 ± 8.49 degrees, which increased to 120.6 ± 8.61 degrees at six months. Furthermore, the average IKDC score improved from $80.2 \pm 7.91\%$ at three months to $86.92 \pm 8.05\%$ at six months, indicating good functional outcomes [7].

A prospective study conducted involving 30 patients, which showed that 29 individuals achieved union at a mean time of 13.65 weeks. The overall mean Rasmussen Functional Knee Score was 27, categorized as excellent. This suggests that treatment with LCP provides anatomical reduction and desirable functional outcomes, especially for Schatzker type I-III fractures [8].

Research compared anatomically precontoured 3.5 mm LCPs with conventional 4.5 mm L-shaped LCPs in Schatzker II fractures. The study included 36 patients and found that the precontoured plates provided better patient outcomes by preventing secondary loss of reduction and valgus deviation. The Rasmussen radiological score for the precontoured plates was significantly higher ($p < 0.05$), indicating improved stability and functional outcomes [9].

A study analyzed 30 cases and reported that 66.66% of patients had excellent results, 20% had good results, and 13.33% had fair results according to the Rasmussen's criteria. This study concluded that surgical management with LCP offers excellent anatomic reduction and stable internal fixation, leading to good functional outcomes [10].

A study conducted on 31 patients treated with a single lateral LCP. They found that at the final follow-up, 65% of individuals had excellent functional outcomes, and 35% had good to fair outcomes. The study also noted that no patient had a poor functional outcome, though some experienced knee instability [11].

Another study focused on 20 individuals with Schatzker type V and VI fractures treated with a single 4.5 mm lateral LCP. The study showed a mean Functional Rasmussen Knee score of 24.55 ± 3.17 at six-month follow-up, with a significant p-value (< 0.001). The WOMAC score was also favorable, and the overall complication rate was low, indicating good functional and radiological outcomes [12].

CONCLUSION

The study showed that the use of anatomically contoured locking compression plates for the treatment of TPF is highly effective. The majority of patients achieved significant improvements in knee function, as evidenced by substantial increases in the Knee Society Score and a high rate of full weight-bearing status at six months. The treatment also resulted in a high rate of satisfactory fracture healing with manageable postoperative complications. These findings support the use of anatomically contoured locking compression plates as a reliable and beneficial surgical intervention for patients with tibial plateau fractures.

Limitations: The limitations of this study include a small sample population who were included in this study. Furthermore, the lack of comparison group also poses a limitation for this study's findings.

Recommendation: It is advised that more research be done with bigger sample sizes and longer follow-up times in order to confirm these results and investigate the long-term effects of treating tibial plateau fractures using anatomically shaped LCPs.

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List of abbreviations:

TPF - Tibial Plateau Fractures

LCP - Locking Compression Plates

KSS - Knee Society Score

ROM - Range of Motion

VAS - Visual Analog Scale

IKDC - International Knee Documentation Committee

WOMAC - Western Ontario and McMaster Universities Osteoarthritis Index

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