Original Article | Journal of Orthopaedic Case Reports 2026 September:16(9):Page 548-552

Prospective Evaluation of Functional Outcomes in Schatzker Type V–VI Proximal Tibia Fractures Managed with Locking Compression Plate Using Minimally Invasive Percutaneous Plate Osteosynthesis

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Learning Point of the Article:

Locking compression plate fixation using the Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO) technique is a reliable and effective method for managing Schatzker type V–VI proximal tibial fractures. It provides stable fixation, promotes timely fracture union, and preserves soft tissue integrity, thereby reducing complications.

Abstract

Introduction: Proximal tibial fractures, especially Schatzker type V and VI injuries, are complex bicondylar fractures usually associated with severe soft tissue damage and significant functional morbidity. Managing these fractures remains challenging. Locking compression plate fixation using the minimally invasive percutaneous plate osteosynthesis (MIPPO) technique has gained popularity because it preserves the biology at the fracture site, minimizes soft tissue disruptions, and provides stable fixation.

Materials and Methods: This prospective study was conducted in the Department of Orthopaedics at Gajra Raja Medical College and JAH Hospital from May 2023 to October 2024, over a period of 18 months. A total of 40 patients with proximal tibial fractures, Schatzker type V and VI, were included in this study. This study was conducted to evaluate the functional outcome of proximal tibial fractures of Schatzker type V and VI managed with locking compression plate fixation by the MIPPO technique. Patients with closed proximal tibial fractures and selected open fractures fulfilling the inclusion criteria were treated surgically and followed up at 1 month and 3 months. Functional outcomes were assessed clinically using the Modified Rasmussen scoring system. Standard criteria, including range of motion, fracture union, complications, and knee function scoring at the final follow-up, were used.

Results: Most fractures achieved satisfactory union within an acceptable period. Functional outcomes were good to excellent in the majority of the patients, with restoration of knee movement and stable fracture fixation. The results demonstrate statistically significant improvements in functional scores at both time points. At 1 month, the mean score was 10.20 ($t = 10.743$, $df = 39$, $P < 0.001$), with a 95% confidence interval of 8.28-12.12, indicating a fair level of knee function according to the Modified Rasmussen scale. At 3 months, the mean score markedly increased to 26.90 ($t = 81.583$, $df = 39$, $P < 0.001$), with a 95% confidence interval of 26.23 to 27.57, reflecting a good to excellent functional outcome.

Conclusion: Locking compression plate fixation using the MIPPO technique is an effective method for managing Schatzker type V and VI proximal tibial fractures. It provides stable fixation, promotes fracture union, preserves soft tissue integrity, and results in favorable functional outcomes when proper surgical technique and rehabilitation are followed.

Keywords: Proximal tibial fractures, Schatzker type V–VI, proximal tibial fractures, Schatzker type V–VI.

Access this article online

Website: www.jocr.co.in

DOI: https://doi.org/10.13107/jocr.2026.v16.i09.8148

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Submitted: 20/06/2026; Review: 04/07/2026; Accepted: August 2026; Published: September 2026

DOI: https://doi.org/10.13107/jocr.2026.v16.i09.8148

Introduction

Proximal tibial fractures are significant intra-articular injuries that profoundly impact knee stability, alignment, and overall function [1,2]. Schatzker type V and VI fractures represent complex bicondylar injuries, frequently resulting from high-energy trauma such as road traffic accidents (RTAs) or falls from height [3, 4]. These fractures are commonly accompanied by extensive soft tissue damage, articular depression, and an increased risk of complications, which collectively render their management particularly challenging [5,6]. The primary objective in treating these fractures is to achieve anatomical reduction, restore joint congruity, and provide stable fixation while preserving the integrity of the surrounding soft tissue envelope [7]. Minimally invasive percutaneous plate osteosynthesis (MIPPO) using locking compression plates has gained prominence as an effective surgical technique, as it maintains fracture biology and minimizes surgical trauma [8,9]. By reducing periosteal stripping and preserving the blood supply, this approach facilitates early fracture healing and promotes superior functional recovery [10]. This study aims to comprehensively evaluate the functional outcomes and complication rates associated with the treatment of Schatzker type V and VI proximal tibial fractures using the MIPPO technique, thereby contributing to optimize management protocols for these complex injuries.

Materials and Methods

Study setting and duration

This study was conducted in the Department of Orthopaedics, Trauma Centre and JA Groups of Hospitals, Gajra Raja Medical College, Gwalior, Madhya Pradesh, over a period of 18 months (May 2023 – October 2024). The consecutive sampling method was used.

Study design

A prospective observational study was undertaken to evaluate the functional outcomes of Schatzker type V–VI tibial plateau fractures managed with locking compression plate fixation using the MIPPO technique.

Participants

- Sample size: 40 patients.
- Inclusion criteria:
  - o Schatzker type V–VI tibial plateau fractures
  - o Patients of both sexes aged 18–60 years
  - o Closed fractures
  - o Open fractures classified as Gustilo–Anderson type I.
- Exclusion criteria:
  - o Open fractures type II and III
  - o Patients aged <18 years or >60 years
  - o Fractures associated with vascular injury
  - o Pathological fractures.

Surgical procedure

All surgeries were performed under spinal anesthesia with the patient in the supine position using either a bolster for knee flexion or a traction table. Fracture patterns were visualized intraoperatively using a C arm image intensifier.

Anterolateral MIPPO approach

- A curvilinear incision was made between Gerdy's tubercle and anterior to the fibular head
- Fascia was incised in line with the skin incision
- Indirect fracture reduction was achieved using a femoral distractor or manual traction, with articular reduction maintained by reduction clamps
- Temporary fixation was performed with K wires.
- An extraperiosteal plane was created using a blunt dissector, and the locking compression plate was introduced extraperiosteally.
- Plate position was confirmed under C arm in both AP and lateral views
- The plate was temporarily fixed proximally and distally with K wires to prevent the "helicopter effect"
- Axial alignment was verified using the cable technique before screw application
- A 6.5 mm locking cancellous screw was applied proximally, parallel to the articular surface
- In cases of difficulty reducing distal fragments (varus/valgus),

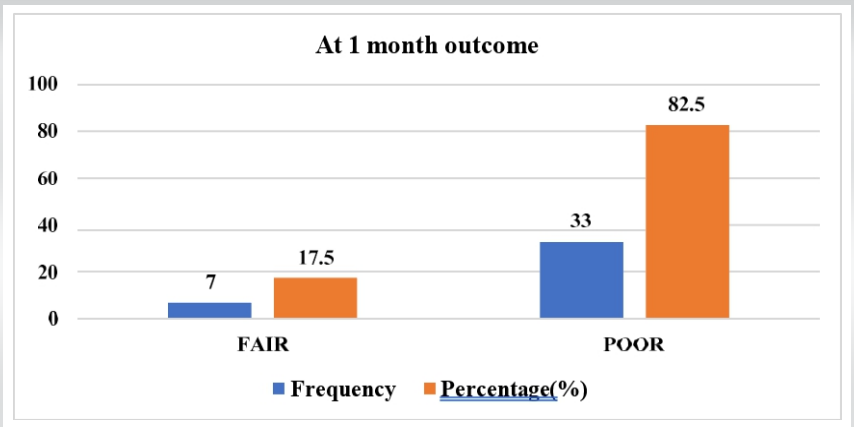

Figure 1: Functional outcome assessment at 1 month.

Table 1: Distribution of study participants according to age groups

Age Group	Frequency	Percentage
18–30 Years	10	25
31–40 Years	15	37.5
41–50 Years	12	30
51–60 Years	3	7.5

4.5 mm non locking cortical screws were used for reduction

• Remaining screws were applied through multiple stab incisions after removal of K wires.

Outcome assessment

Functional outcomes were assessed using the Modified Rasmussen scoring system, evaluating:

• Range of motion

• Fracture union

• Complications

• Knee function at final follow up.

Patients were followed up at 1 month and 3 months postoperatively, with clinical and radiological evaluation performed at each visit. Articular step-off, condylar widening, posterior slope, varus/valgus alignment, and restoration of mechanical axis are not quantitatively reported.

Post-operative protocol:

1. Early knee immobilization encouraged
2. Non-weight bearing initially
3. Partial weight bearing after 8 weeks
4. Full weight bearing after radiological union (12–14 weeks)

Table 2: Rasmussen score outcome assessment at 1 month and after 3 months

Rasmussen score	At 1 Month	At ≥3 Months
Excellent	0	21 (52.5 %)
Good	0	15 (37.5 %)
Fair	7 (17.5%)	4 (10.0%)
Poor	33 (82.5%)	0

Statistical analysis

The statistical analysis of this study was carried out by Chi-square test and paired t-test. $P > 0.05$ is statistically insignificant, $P < 0.05$ is statistically significant, and $P < 0.01$ is statistically highly significant. The statistical analysis will be done using Jamovi 2.3.28 and the Statistical Package for the Social Sciences software (Version 20).

Results

This study evaluated the management of fractures using the anterolateral approach for minimally invasive plate osteosynthesis (MIPO) technique and assessed the functional outcomes. The majority of respondents (37.5%) are aged 31–40 years, followed by 41–50 years (30.0%) and 18–30 years (25.0%) as seen in Table 1. RTAs are the leading cause of injury, accounting for 90.0% of cases. The data show that Schatzker Type VI fractures are more common, accounting for 55.0% of cases, while Type V fractures make up 45.0%, as shown in Table 2. Based on the one-sample statistics and applying the Modified Rasmussen Criteria for functional assessment. At 1-month post-treatment, the mean score was 10.20 (SD = 6.005), which generally corresponds to a fair outcome according to the Modified Rasmussen Criteria. By 3 months, the mean score had significantly increased to 26.90 (SD = 2.085), indicating a shift toward a good to excellent functional outcome. At 1 month postoperatively, the majority of patients (82.5%, 33 cases) had a poor Rasmussen's score, while 17.5% (7 cases) showed a fair outcome. However, by 3 months or more, there was a significant improvement in functional outcomes. 52.5% (21 cases) achieved an excellent score, and 37.5% (15 cases) attained a good score. Only 10% (4 cases) remained in the fair category, with no patients classified as having a poor outcome, reflecting a notable recovery over time as shown in Table 3.

Discussion

This study evaluated the management of fractures using the anterolateral approach for MIPO and assessed the functional

Table 3: Distribution of study participants according to Schatzker type

Schatzker type	Frequency	Percentage
V	18	45
VI	22	55

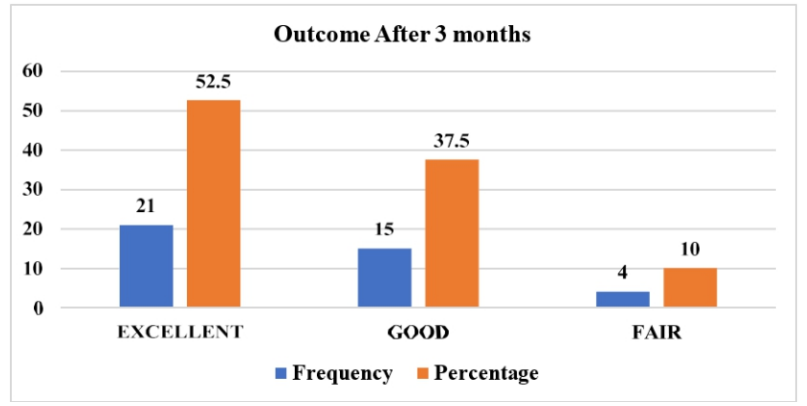

Figure 2: Functional Outcome assessment after 3 months.

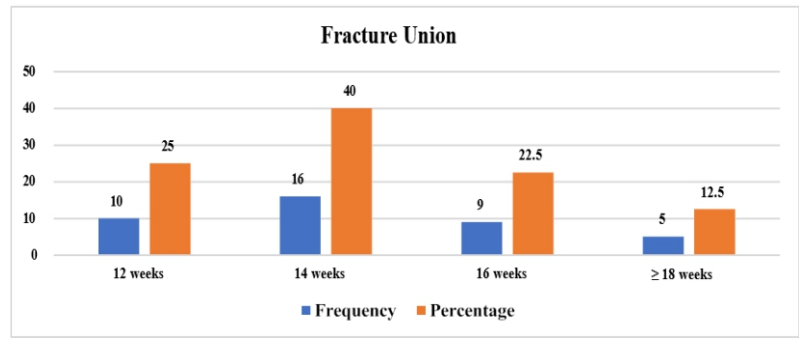

Figure 3: Frequency distribution of duration taken for fracture union.

outcomes. Relevant literature reports comparable outcomes. The analysis indicates that the majority of participants were male (85.0%), with females comprising 15.0%. The age distribution shows that 37.5% of respondents were aged 31–40 years, followed by 30.0% aged 41–50 years, and 25.0% aged 18–30 years. The data reveal that Schatzker Type VI fractures are more prevalent, accounting for 55.0% of cases, while Type V fractures constitute 45.0%, indicating a higher prevalence of severe tibial plateau fractures in the studied population. The study's findings align with these observations, indicating a consistent pattern. At 1 month postoperatively, the functional outcome showed that 82.5% of patients had a poor outcome, while 17.5% achieved a fair outcome, reflecting limited functional recovery during the early postoperative period as the healing process continues as shown in Fig. 1. By 3 months postoperatively, there was significant improvement in the range of motion, with 87.5% of patients exhibiting good to excellent range of motion; 40.0% scored 5, and 47.5% scored 6. Only 5.0% reported moderate restriction (score 1), and 7.5% had mild limitations (score 3), indicating favorable recovery in joint mobility Fig. 2. Based on one-sample statistics, the mean score at 1-month post-treatment was 10.20 (SD = 6.005), generally corresponding to a fair outcome according to the Modified Rasmussen Criteria. By 3 months, the mean score significantly increased to 26.90 (SD = 2.085), indicating a shift toward a good to excellent functional outcome. Regarding fracture union, 25.0% (10 cases) achieved union within 12 weeks, suggesting a relatively expedited healing process. The majority, 40.0% (16 cases), attained fracture union by 14 weeks, indicating this as a common timeframe for bone healing. In addition, 22.5% (9 cases) experienced fracture union by 16 weeks, reflecting a moderate duration for recovery, while 12.5% (5 cases) required 18 weeks or longer to achieve union Fig. 3.

Limitations

The limited sample size may restrict generalizability; larger multi-center studies are needed. Although range of motion and Rasmussen's score were assessed, other scoring systems could have evaluated recovery such as Oxford Knee Score. As a single-center study, findings may not represent populations, especially regions with different healthcare systems and surgical expertise. Quality of life, return to work, return to pre-injury activity, or patient satisfaction was not evaluated. There may be intersurgeon variability.

Conclusion

This prospective observational study shows that MIPPO via the anterolateral approach improves function in tibial plateau fractures, especially Schatzker Type V and VI. Although 1-month postoperative outcomes were poor, with 82.5% showing suboptimal function, marked recovery occurred by 3 months, when 90% achieved good to excellent outcomes by modified Rasmussen criteria. The mean Rasmussen score improved from 10.20 ± 6.005 at 1 month to 26.90 ± 2.085 at 3 months. Fracture union occurred in all patients, and 65% healed within 12–14 weeks. Complications included knee stiffness (15%), infection (10%), and malunion (7.5%), but 67.5% had no complications. MIPPO is an effective technique with minimal morbidity.

Clinical Message

Locking compression plate fixation using the minimally invasive percutaneous plate osteosynthesis (MIPPO) technique offers a reliable solution for managing complex bicondylar proximal tibial fractures (Schatzker type V–VI). Despite poor early postoperative function, significant recovery is achieved by 3 months, with most patients regaining good to excellent knee function. The technique ensures stable fixation, timely fracture union, and preservation of soft tissue integrity, thereby minimizing complications. MIPPO should be considered a preferred approach in appropriately selected cases to optimize outcomes in high-energy tibial plateau injuries.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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Conflict of Interest: Nil
Source of Support: Nil

Consent: The authors confirm that informed consent was obtained from the patient for publication of this article

How to Cite this Article

Uikey M, Singh V, Dahiya H. Prospective Evaluation of Functional Outcomes in Schatzker Type V–VI Proximal Tibia Fractures Managed with Locking Compression Plate Using Minimally Invasive Percutaneous Plate Osteosynthesis. Journal of Orthopaedic Case Reports 2026 September;16(09): 548-552.