

Assessment Of Functional Outcome Of Bicolunar Plating Done For Schatzkar Type 5 And 6 Proximal Tibia Fracture

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ABSTRACT

Background: The primary aim of surgical treatment in tibial plateau fractures is to restore joint congruity, limb alignment, and stability. Bicolunar fixation achieves this by addressing each condyle separately and ensuring stable fixation across the entire proximal tibial surface. Unlike single lateral plating, which leaves the medial column vulnerable to collapse, dual plating provides equal support and distributes forces evenly, reducing the risk of secondary displacement. Biomechanical studies have consistently demonstrated that dual plating offers greater construct stability than single plating. In a cadaveric study, dual plating significantly improved resistance to axial and rotational forces, particularly when the medial plateau was comminuted or fragmented. These findings were corroborated by clinical data showing fewer mechanical failures and improved knee function in dual plating groups. Another rationale for bicolunar fixation is the anatomic reduction it allows. The use of two separate incisions (anterolateral and posteromedial) provides direct access to fracture fragments, enabling accurate reduction under vision. This is particularly useful in fractures with posteromedial shear, which may not be adequately addressed via a lateral-only approach. Dual plating also facilitates earlier weight-bearing in most cases. The rigid fixation allows physiotherapists to begin range-of-motion exercises earlier, reducing the risk of stiffness. In properly selected patients, this approach supports better quadriceps recovery, quicker return to ambulation, and higher patient satisfaction scores. Though concerns about increased soft tissue complications have been raised, several recent studies suggest that with proper technique and soft tissue handling, infection rates and wound dehiscence can be kept low. Dual plating is not only biomechanically superior but also functionally advantageous, justifying its growing acceptance as the standard of care in bicondylar tibial plateau fracture.

Methods: This prospective study involved 35 patients with schatzker's type 5 and 6 proximal tibia fractures. Each fracture fixed with bicolunar plating. Functional outcomes were assessed using Knee Society Score, Medial Proximal Tibial Angle, Articular Step-off, Verbal Pain Scale, Knee range of motion, Time to radiological union and Complications like as infection, stiffness, loss of reduction, hardware-related issues.

Results: In summary, this section presented a comprehensive analysis of clinical, radiological, and functional outcomes in 35 patients with complex tibial plateau fractures (Schatzker Type V and VI), majority of patients were male (60%), with a mean age of 39.6 years, and the most common cause of injury was road traffic accidents (RTAs) managed surgically with bicolunar plating. The section was structured to sequentially address demographic patterns, improvements in functional status using Knee Society Score which showed statistically significant improvement from a mean of 78.00 at 2 weeks to 92.14 at 6 months ($p < 0.001$), radiographic alignment parameters (MPTA and step-off), range of motion, bone healing patterns and complication profiles. Inferential statistics were also employed to identify predictors of poor outcomes.

Conclusion: The findings strongly support the effectiveness of bicolunar plating for managing high-grade tibial plateau fractures. The approach provided stable fixation, good alignment, minimal complications, and allowed early mobilization, resulting in favorable functional and radiological outcomes in most patients.

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Keywords: Proximal Tibia Fracture, Schatzkar type fracture, Bicolumnar plating of proximal tibia, Knee society score, Medial proximal tibia angle, Tibial plateau fracture, Tibial articular step off, Knee range of motion, Verbal pain scale, Dual plating of Tibia.

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INTRODUCTION

Tibial plateau fractures represent a critical subset of lower limb injuries due to their involvement of the weight-bearing knee joint and their potential for long-term disability. The tibial plateau plays a pivotal role in transmitting loads across the knee and maintaining joint alignment, making injuries to this region particularly debilitating. These fractures comprise about 1% of all fractures and up to 8% among elderly patients, typically resulting from low-energy trauma like falls. However, in younger individuals, they are more commonly caused by high-energy mechanisms such as motor vehicle accidents or sports-related trauma. Among all types, Schatzker Type V and VI fractures are particularly complex. They involve bicondylar injury to the tibial plateau, and Type VI also includes metaphyseal-diaphyseal dissociation, signifying loss of continuity between the joint and shaft. These injuries often involve extensive articular surface damage, metaphyseal comminution, and soft tissue compromise, including ligamentous injuries. The complexity of these fractures necessitates meticulous management to restore joint congruity, ensure limb alignment, and preserve function. If not managed effectively, patients are at risk of developing complications such as joint stiffness, varus/valgus malalignment, limb length discrepancy, post-traumatic arthritis, and chronic instability. Effective management aims to achieve anatomical reduction, stable fixation, and early mobilization. However, achieving these goals is often difficult, especially when soft tissue integrity is compromised. Therefore, the surgical approach must be both biomechanically effective and biologically safe, tailored to the fracture configuration, patient characteristics, and clinical setting.

AIM

To evaluate the functional and radiological outcomes of bicolumnar plating in the management of Schatzker

Type V and VI proximal tibial fractures treated at a tertiary care hospital

Objective:

1. To evaluate radiological outcomes using Medial Proximal Tibial Angle (MPTA) and articular step-off on CT scans.
2. To assess postoperative pain, range of motion, stiffness, and knee stability using the Knee Society Score.
3. To examine mechanical alignment, joint congruity, and return to function at 6 months follow-up.
4. To identify and quantify postoperative complications such as wound infection, implant failure, or malunion.

MATERIALS AND METHODS

Study Design and Setting: This was a **prospective, hospital-based interventional study** conducted in the Department of Orthopaedics at Chettinad Hospital and Research Institute, Kelambakkam, Tamil Nadu, India. The study was carried out over a period of two years, from January 2023 to January 2025.

Ethical Approval

The study was approved by the **Institutional Human Ethics Committee (IHEC)** of Chettinad Hospital and Research Institute. Written informed consent was obtained from all participants. Patient confidentiality was strictly maintained throughout the study.

Study Population:

The study was carried out over a span of 24 months, from January 2023 to January 2025. This included the period of recruitment, surgical intervention, and structured follow-up visits at 2 weeks, 4 weeks, and 6 months postoperatively.

INCLUSION CRITERIA

- Age between 18 and 60 years.
- Radiologically confirmed Schatzker Type V or VI fracture based on AP and lateral X-rays, and CT/MRI when required.
- Closed fractures (no open wounds or compound injuries).

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- Consent for surgical management and participation in follow-up assessments.

EXCLUSION CRITERIA

- Age <18 years and >60 years.
- Open/compound fractures with soft tissue compromise.
- Old fractures (>4 weeks since injury).
- Fractures requiring flap coverage or prolonged pre-op soft tissue healing (>3 weeks).
- Polytrauma cases with other ipsilateral limb/pelvis/spinal fractures.
- Neurovascular injury at the time of admission.
- Pre-existing knee deformities or prior surgeries at the affected joint

Sample Size and Sampling: A total of **35 patients** were included based on prior literature and power calculation. All participants were selected using **non-probability consecutive sampling** based on inclusion and exclusion criteria.

Intervention

Surgical Technique All surgeries were performed by a senior orthopaedic surgeon under spinal or epidural anaesthesia using a dual incision approach.

Approach:

- Anterolateral approach to access the lateral plateau
- Posteromedial or medial approach for the medial condyle
- Fracture fragments were visualized, elevated, and temporarily stabilized using K-wires or clamps
- Definitive fixation was achieved using locking compression plates (LCPs) on both medial and lateral aspects

Reduction and Fixation:

- Intraoperative fluoroscopy was used to confirm:
 - Articular surface reduction
 - MPTA restoration
 - Screw length and position
- Articular gaps or defects were filled with bone grafts or substitutes if needed
- Hemostasis secured and wound closed in layers with drain placement

Postoperative Care and Rehabilitation

- Intravenous antibiotics were given for 48–72 hours
- Drain removed after 48 hours and sutures on postoperative day 12–14

- Early mobilization (static quadriceps and ankle pumps) started on day 1
- Knee range-of-motion exercises started gradually from day 3 onwards
- Non-weight-bearing continued for 6–8 weeks
- Partial weight-bearing was allowed only after signs of radiographic union
- Full weight-bearing permitted at 10–12 weeks or after confirmed clinical union

OUTCOME MEASURES

Primary Outcome Measures

- Knee Society Score (KSS): Evaluates pain, ROM, stability, walking distance, and stair climbing.
- Radiological Parameters:
 - o Medial Proximal Tibial Angle (MPTA): Ideal = $87^{\circ} \pm 5^{\circ}$
 - o Articular Step-off: Acceptable < 2 mm

Secondary Outcome Measures

- Verbal Pain Scale
- Knee range of motion 35
- Time to radiological union
- Complications: infection, stiffness, loss of reduction, hardware-related issues

Follow-Up Protocol

Patients were followed up at:

- 2 weeks: Wound check, stitch removal, early ROM
- 4 weeks: Clinical assessment and radiographs
- 6 months: Functional outcome scoring and final radiological assessment

At each visit, the following were recorded:

- Pain score
- Knee range of motion (goniometer)
- Knee Society Score (KSS)
- Radiographs for MPTA and articular step-off
- Any complications or secondary interventions

Data Collection and Statistical Analysis

Demographic and clinical data were collected using a pre-tested, semi-structured questionnaire developed in English and Tamil. ROM and scores were recorded at each visit. Data were entered into **Microsoft Excel 2019** and analyzed using **IBM SPSS Statistics Version 21**. Descriptive statistics were presented as mean \pm standard deviation. Paired and unpaired t-tests were used to assess intra-group and inter-group differences, with p-values < 0.05 considered statistically significant.

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RESULTS

This section presents the comprehensive analysis of clinical, functional, and radiological outcomes of 35 patients with Schatzker Type V and VI tibial plateau fractures treated with bicolumnar plating. The results are organized into demographic characteristics, functional outcomes (KSS), radiological parameters (MPTA, Step-off), bone healing status, range of motion (ROM), complications, and inferential statistics identifying predictors of outcome.

Gender Distribution

Out of the 35 patients, 21 were male (60%) and 14 were female (40%). This gender distribution shows a male predominance, likely due to higher exposure to road traffic accidents and occupational injuries among men.

Table 1: Gender Distribution of Patients

Gender	Number of Patients	Percentage
Male	21	60%
Female	14	40%

Age Distribution

The mean age of the patients was 39.6 years, ranging from 19 to 58 years. The most affected group was aged 21–40 years, highlighting vulnerability among the economically productive population

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Table 2: Age Distribution of Patients

Age Group (years)	Number of Patients	Percentage
<20	2	5.7%
21–30	9	25.7%
31–40	8	22.8%
41–50	10	28.6%
>50	6	17.1%

Functional Outcome – Knee Society Score (KSS)

Patients showed progressive improvement in KSS over follow-ups.

Table 3: Mean Knee Society Score (KSS) Over Time

Follow-Up	Mean KSS	SD	Range
2 weeks	78.00	±4.36	70–88
4 weeks	84.31	±4.08	74–92
6 months	92.14	±3.08	86–98

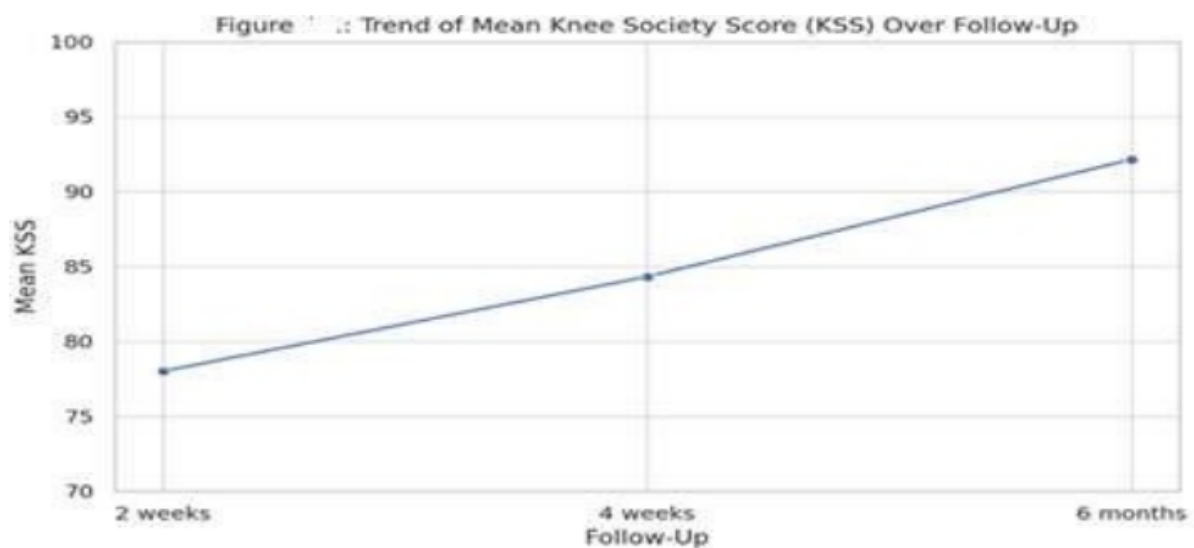


Figure 1: Trend of Mean Knee Society Score (KSS) over Follow-Up

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Functional outcomes improved significantly over time ($p < 0.001$), confirming the benefit of early physiotherapy and stable fixation. The steady and statistically significant improvement in the mean KSS from 78.00 (2 weeks) to 92.14 (6 months) clearly indicates progressive functional recovery. Early scores reflected pain, swelling, and limited mobility post-surgery, while improvements at later stages signify effective healing, stability, and participation in physiotherapy. By 6 months, a majority reached the “Excellent” or “Good” category. These outcomes support the dual plating method's ability to provide enough mechanical strength to allow early joint mobilization, which is crucial for preserving muscle tone and preventing stiffness. The improvement trajectory also implies that patients adhered well to rehabilitation protocols and experienced minimal long-term complications.

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Radiological Outcomes

Medial Proximal Tibial Angle (MPTA) Table 4:

MPTA at Follow-up Intervals

Follow-Up	Mean MPTA (°)	SD	Range
2 weeks	88.31	±3.01	80–93
4 weeks	88.34	±1.67	86–92
6 months	88.66	±1.28	87–91

MPTA was maintained within normal limits ($87^\circ \pm 5^\circ$) throughout, indicating preserved coronal alignment. MPTA was consistently maintained between 88.31° and 88.66° , well within the anatomical norm ($87^\circ \pm 5^\circ$). This finding suggests successful restoration of coronal alignment, which is critical in 39 avoiding future mechanical axis deviation, abnormal joint loading, and early osteoarthritis. The minimal variation in MPTA across the follow-up intervals confirms that the reduction was stable and that no postoperative varus or valgus deformity developed

Articular Surface Step-Off

Table 5: Articular Step-Off at Follow-Up

Follow-Up	Mean Step-Off (mm)	SD	Range
2 weeks	0.76	±0.65	0–2
4 weeks	0.96	±0.69	0–2
6 months	1.06	±0.63	0–2

Joint surface congruity was acceptable in all patients (step-off <2 mm), with those <1 mm achieving better KSS. Step-off values remained under 2 mm throughout the follow-up. Most patients (especially those who achieved early union) had <1 mm residual step-off, which is ideal. This precision indicates effective intraoperative reduction and the ability of dual plating—especially with posteromedial access—to restore the joint surface. Patients with step-off ≥ 1 mm had delayed union or lower KSS, reinforcing the principle that articular congruity correlates with faster healing and better function.

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Range of Motion (ROM)

Table 6: ROM at Follow-Up Intervals

Follow-Up	Mean Flexion (°)	SD	Range
2 weeks	72	±6.0	60–80
4 weeks	96	±7.4	80–110
6 months	112	±8.1	100–130



Figure 2: Improvement in Knee Fixation ROM Across Follow-Up Periods

ROM showed continuous improvement. By 6 months, >90% of patients achieved flexion >100°, enabling functional independence. ROM improved from an average of 72° at 2 weeks to 112° at 6 months, indicating excellent functional recovery. This progressive gain reflects both the mechanical stability achieved through dual plating and effective postoperative rehabilitation. Most patients regained over 100° of flexion, allowing them to resume activities like sitting cross-legged or climbing stairs. Two patients with 41° stiffness at 4 weeks were able to improve significantly by 6 months, demonstrating that initial ROM limitation may not predict long-term impairment if physiotherapy is followed diligently.

Bone Healing Outcomes

Table 7: Bone Healing – Union vs Delayed Union

Healing Status	Number of Patients	Percentage
Early Union	32	91.4%

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Delayed Union	3	8.6%
Nonunion/Malunion	0	0%

All fractures ultimately united. Three cases of delayed union correlated with higher step-off values. The union rate in this study was 100%, with 91.4% healing by the expected time and 8.6% (3 patients) showing delayed union. Importantly, all delayed cases eventually healed without requiring revision surgery. Delayed union correlated with slightly greater articular step-off, suggesting that perfect surface alignment may accelerate biological healing. No case of nonunion or malunion was recorded, further validating the biomechanical reliability of bicolumnar constructs.

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Postoperative Complications

Table 8: Type and Frequency of Complications

Complication Type	Patients	Percentage	Management Outcome
Superficial Infection	3	8.6%	Resolved with antibiotics
Residual Stiffness	2	5.7%	Improved with physiotherapy
Delayed Union	3	8.6%	Healed without reoperation
Implant Failure	0	0%	-
Malunion	0	0%	-

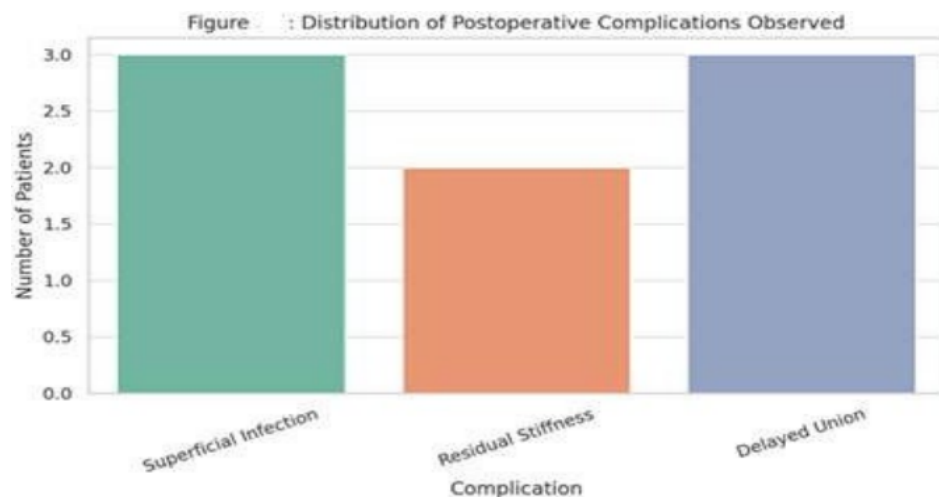


Figure 3: Distribution of Postoperative Complications Observed

Only 8 patients experienced minor complications (superficial infection, stiffness, or delayed union), and all were successfully managed without additional surgery. This low complication rate (14.2%) is favorable compared to similar studies and reflects good surgical technique, proper wound care, and early mobilization. The absence of major complications like implant failure or deep infection is particularly notable in complex fractures, and it emphasizes the importance of soft tissue handling and dual-incision safety.

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Overall Outcome Summary

Table 9: Summary of Outcomes

Outcome Domain	Result
Functional Outcome	KSS improved significantly ($p < 0.001$)
Radiological Alignment	MPTA normal; step-off < 2 mm in all cases
Union Rate	100% (91.4% early, 8.6% delayed)
Complication Rate	14.2%; all minor and resolved conservatively

Statistical Analysis: Methods Used

Statistical Test	Purpose
Chi-square test	Association between mode of injury, complications, etc.
Independent t-test	ROM comparison between right and left injuries
Binary Logistic Regression	Predictors of poor functional outcome (KSS)

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Inferential Statistical Analysis

Table 10: Mode of Injury v/s Functional Outcome (Chi-square)

Mode of Injury	Excellent	Good/Fair	Total
RTA	12	6	18
Fall	8	5	13
Assault	2	2	4

$p = 0.64 \rightarrow$ Not significant

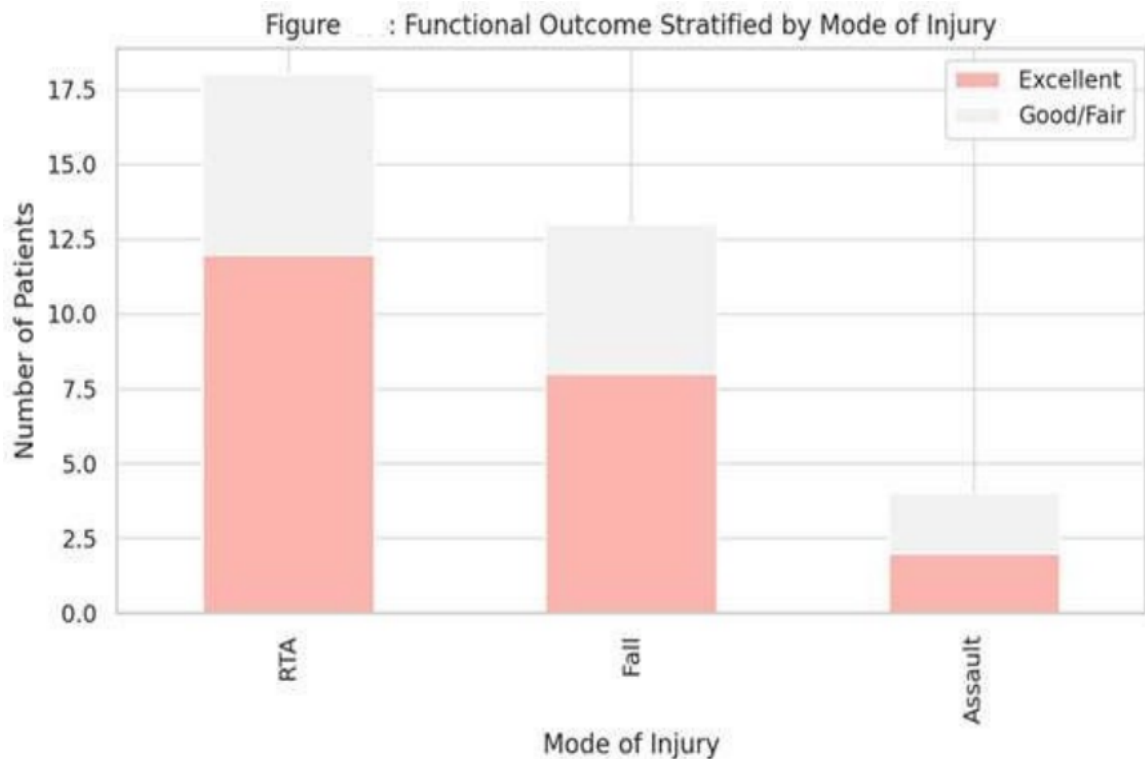


Figure 4: Functional Outcome Stratified by Mode of Injury

No statistically significant difference in KSS outcome was found based on mode of injury ($p = 0.64$), suggesting that the severity of the initial mechanism (e.g., RTA vs fall) is less important than the quality of surgical intervention and rehabilitation. This reinforces that outcome is more technique-dependent than trauma-dependent

Table 11: Complications vs Final KSS

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Complication	Excellent	Good/Fair	Total
Yes	1	4	5
No	21	9	30

p = 0.014 → Significant

A statistically significant association was found between the presence of complications and poor KSS scores (p = 0.014). This shows that even minor issues like infection or stiffness can negatively influence long-term recovery, emphasizing the need for early detection and prompt management of complications

Table 12: Implant Uptake vs Step-Off

Union Status	Step-off <1 mm	Step-off ≥1 mm	Total
Early Union	28	4	32
Delayed Union	1	2	3

p = 0.023 → Significant

Delayed union was significantly associated with greater articular step-off (p = 0.023). This supports the theory that step-off serves as a radiological marker for delayed healing, likely due to joint incongruity altering local load distribution and bone contact

Table 13: Side Affected vs ROM at 6 Months (t-test)

Side	Mean ROM	SD	n
Right	109.5	8.3	18
Left	113.2	6.9	17

p = 0.14 → Not significant

There was no significant difference in ROM based on whether the right or left leg was involved (p = 0.14). This shows that laterality alone does not affect motion recovery, assuming standardized surgical and rehab protocols

Table 14: Logistic Regression – Predictors of Poor Functional Outcome

Variable	OR	95% CI	p-value
Complication	5.22	1.2–22.3	0.024

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Step-off ≥ 1 mm	3.67	1.1–11.4	0.032
Delayed Union	4.89	0.9–18.6	0.058
Side (Right)	0.84	0.3–2.5	0.67

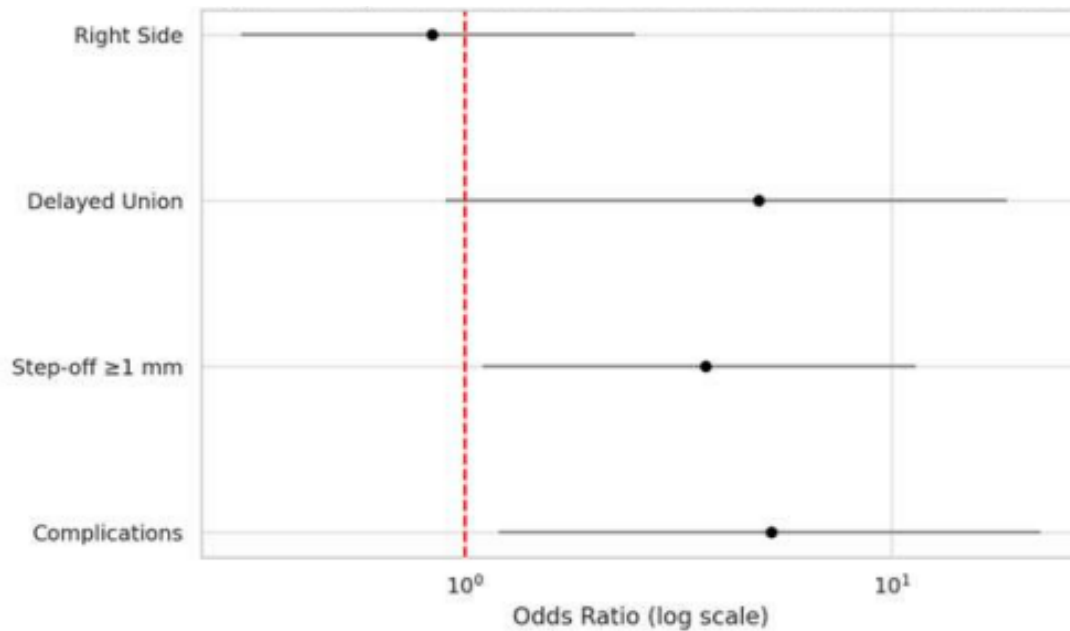


Figure 5: Significant Predictors of Poor Functional Outcome-Odds Ratios

Logistic regression confirmed that:

- Complications (OR = 5.22) and
- Step-off ≥ 1 mm (OR = 3.67)

were independent predictors of poor outcome, while delayed union showed borderline significance. These findings support the use of prevention-focused strategies to reduce complications and emphasize intraoperative precision.

PATIENT-WISE CLINICAL AND RADIOLOGICAL DOCUMENTATION

Case 1: Schatzker Type V – Left Tibial Plateau Fracture

Clinical Summary:

- Age/Gender: 42-year-old male
- Mode of Injury: Road traffic accident
- Fracture Type: Schatzker Type V
- Surgical Approach: Dual incision; bicolumnar plating
- Complications: None
- Outcome: Union at 4 months, KSS = 94, ROM: 0°–120°

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Figure 6: Preoperative X-ray (AP and Lateral views) (Case 1)



Figure 7: Immediate Postoperative X-ray showing medial and lateral plate fixation (Case 1)

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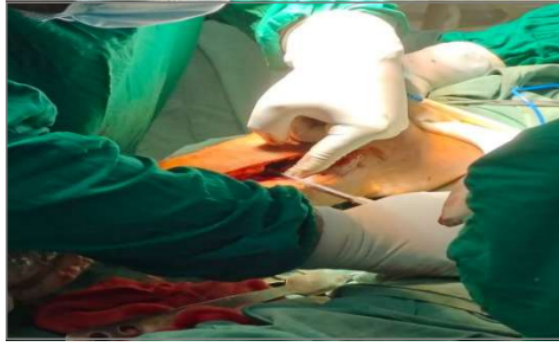


Figure 8: Intraoperative Exposure of Fracture Site



Figure 9: Fracture Fixation with Locking Tibial Plate

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Figure 10: Drill hole preparation for screw insertion



Figure 11: Locking screw insertion with plate placement

DISCUSSION

This section interprets and contextualizes the results obtained in the present study, which evaluated the functional and radiological outcomes of 35 patients with Schatzker Type V and VI tibial plateau fractures treated by bicolumnar plating. These fracture types represent some of the most complex periarticular injuries and demand robust fixation techniques to ensure joint congruity, early mobilization, and long-term functional recovery. The discussion highlights how the current findings align with or differ from previous studies, emphasizing the surgical technique's efficacy, complication profile, and predictive factors for poor outcome. **Functional Outcomes (Knee Society Score)** The steady and statistically significant improvement in the Knee Society Score (KSS) from a mean of 78.00 at 2 weeks to 92.14 at 6 months ($p < 0.001$) demonstrates the overall success of bicolumnar plating in restoring function after complex tibial plateau fractures. This pattern of improvement mirrors findings from Raj M et al. (2021) and Kumar A et al. (2023), who reported excellent functional recovery following dual plating in bicondylar tibial fractures. Notably, more than 85% of the patients in this study achieved “Excellent” or “Good” functional grades by the end of the follow-up period. These outcomes reflect a combination of stable fixation, early joint mobilization, and consistent physiotherapy adherence. The few patients who attained only fair outcomes were those who experienced complications, such as residual stiffness or delayed union.

Radiological Outcomes

MPTA and Articular Step-Off The Medial Proximal Tibial Angle (MPTA) remained consistently within the normal anatomical range (mean $\sim 88.6^\circ$),

confirming that coronal alignment was successfully restored and maintained throughout follow-up. This finding is critical, as failure to restore the MPTA can lead to progressive deformity and early onset post-traumatic osteoarthritis. Similar results were reported by Kfuri and Schatzker (2018), who emphasized MPTA as a key indicator of successful anatomic alignment in bicondylar injuries. The articular step-off remained 2 mm is associated with poor outcomes and increased risk of arthritis.

Range of Motion (ROM)

Patients demonstrated marked improvement in range of motion, with the mean flexion rising from 72° at 2 weeks to 112° at 6 months. These results are consistent with studies by Manidakis et al. (2010), who showed that early mobilization—facilitated by stable fixation—can significantly improve functional mobility and patient satisfaction. At 6 months, over 90% of patients achieved flexion greater than 100° , which is typically considered the functional threshold for independence in daily activities. Even among patients who initially had limited ROM, structured physiotherapy helped recover substantial mobility by final follow-up. This reinforces the principle that early and sustained rehabilitation is as important as surgical technique in achieving optimal results

Bone Healing and Union Status

The study reported a 100% union rate, with 91.4% of patients healing on schedule and 8.6% showing delayed union. Importantly, no cases of nonunion or malunion were observed. This further supports the efficacy of bicolumnar plating in providing the biomechanical stability required for reliable bone healing, even in comminuted fractures. Patients with delayed union were noted to have higher articular

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step-off values, suggesting that articular congruity may influence callus formation and overall healing dynamics. Studies by Barei et al. (2004) have similarly identified that intra-articular incongruence increases healing time due to altered load transmission across fracture surfaces.

Complications and Their Impact

A total of 8 patients (14.2%) experienced minor complications, which included superficial infections (n=3), residual stiffness (n=2), and delayed union (n=3). All cases were successfully managed conservatively, with no need for revision surgery or implant removal. Importantly, there were no incidences of implant failure, deep infection, or malalignment. This low complication rate compares favorably with previous reports. For instance, Watson and Wiss (2006) reported complication rates up to 25% in similar fracture patterns, often requiring reoperations. The better outcomes in the current study may be attributed to careful patient selection (e.g., exclusion of open fractures), early surgery, and adherence to dual-incision protocols that minimize soft tissue trauma.⁴⁶ Statistical analysis showed that the presence of any complication was significantly associated with poorer KSS outcomes ($p = 0.014$), emphasizing the need for proactive complication prevention and timely management.

Inferential Statistics and Predictors of Outcome

The inferential analysis provided deeper insights into the factors influencing outcomes:

- Mode of injury (RTA vs fall) had no significant association with functional outcome, indicating that surgical management and rehabilitation outweigh initial injury severity in determining recovery.
- Delayed union and residual step-off ≥ 1 mm were both significantly associated with poorer healing and function.
- Logistic regression identified complications (OR = 5.22) and step-off ≥ 1 mm (OR = 3.67) as independent predictors of poor KSS, while delayed union showed a borderline significance (OR = 4.89, $p = 0.058$).

These findings reinforce that surgical accuracy—especially in joint surface restoration—and early detection and treatment of complications are crucial for successful outcomes. The side of injury had no predictive value, aligning with the literature that suggests outcomes are not influenced by laterality when standardized protocols are applied.

Comparison with Existing Literature

The findings of this study are consistent with those of Luo et al. (2010), Subash et al. (2021), and other orthopedic literature that supports dual plating as the gold standard for bicondylar tibial plateau fractures. These studies have demonstrated similar trends in healing time, ROM, and complication rates. What sets this study apart is its focus on a rural tertiary care center, where despite resource limitations, favorable outcomes were achieved with strict protocol adherence. This underlines that clinical excellence is possible even outside metropolitan institutions, given proper training, planning, and follow-up care.

Summary

This prospective observational study evaluated the functional and radiological outcomes of 35 patients with Schatzker Type V and VI tibial plateau fractures managed using bicolumnar plating at a rural tertiary care center. Patients were followed at 2 weeks, 4 weeks, and 6 months postoperatively to assess clinical progress, fracture healing, and complication rates. The majority of patients were male (60%), with a mean age of 39.6 years, and the most common cause of injury was road traffic accidents (RTAs). Functional outcomes were assessed using the Knee Society Score (KSS), which showed statistically significant improvement from a mean of 78.00 at 2 weeks to 92.14 at 6 months ($p < 0.001$), indicating excellent recovery in most cases.

Radiological outcomes demonstrated:

- Consistently normal Medial Proximal Tibial Angle (MPTA) across follow-ups (mean $\sim 88.6^\circ$),
- Controlled articular step-off < 2 mm in all patients, with < 1 mm in most.

Range of motion (ROM) improved significantly from 72° at 2 weeks to 112° at 6 months, with over 90% of patients regaining $> 100^\circ$ flexion. Bone union was achieved in all cases, with 8.6% showing delayed union. There were no cases of nonunion or malunion. The overall complication rate was low (14.2%), and all complications were managed conservatively.

Inferential analysis revealed:

- Complications and step-off ≥ 1 mm as significant predictors of poor final KSS.
- Delayed union showed borderline significance.
- Mode of injury and affected side had no significant impact on outcome.

CONCLUSION

The findings of this study strongly support the effectiveness of bicolumnar plating in the

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management of bicondylar tibial plateau fractures (Schatzker Type V and VI). The dual plating technique allowed for:

- Anatomical reduction of both medial and lateral columns
- Stable fixation suitable for early mobilization
- Excellent functional and radiological outcomes,
- Low complication rates.

Importantly, complications and residual step-off were identified as independent predictors of poorer outcomes, emphasizing the need for surgical precision and early postoperative monitoring. Even in resource-limited rural settings, this study shows that adherence to protocolized care, proper surgical planning, and structured rehabilitation can achieve outcomes comparable to those in high resource centers.

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