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Comparison of Dual Plating versus Single Lateral Plating in Bicondylar Proximal Tibial Fractures

Nahid Hasan[1*], Arifur Rahman Talukdar[2], Enamul Hoque[3], Jahedul Islam[4]

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*Corresponding Author

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ABSTRACT

Background: *Bicondylar proximal tibial fractures are complex injuries often caused by high-energy trauma, posing challenges in achieving stable fixation and good functional outcomes. Evidence comparing dual plating and single lateral plating remains inconclusive, especially in South Asian populations, highlighting the need for further study.* ***Objective:*** *The aim of the study was to compare the clinical, radiological, and functional outcomes of dual plating versus single lateral plating in patients with bicondylar proximal tibial fractures.* ***Methods & Materials:*** *This prospective comparative study at the Department of Orthopaedic & Traumatology, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh (July–December 2025) included 50 patients with bicondylar proximal tibial fractures (Schatzker V–VI) to compare dual versus single lateral plating. Patients were evaluated preoperatively, underwent standard fixation, and followed for radiological, functional, and complication outcomes. Data were analyzed using SPSS with $p < 0.05$ considered significant.* ***Results:*** *In 50 patients (25 dual, 25 single lateral plating), baseline characteristics were comparable. Dual plating had longer operative time (112 ± 15 vs 85 ± 12 min), higher blood loss (310 ± 60 vs 220 ± 50 mL), and longer hospital stay (8.4 ± 2.1 vs 6.2 ± 1.8 days; all $p < 0.001$). Radiological outcomes, functional scores, knee ROM, and complications were similar between groups, indicating comparable healing and safety despite greater surgical demands with dual plating.* ***Conclusion:*** *Both dual plating and single lateral plating provide satisfactory outcomes for bicondylar proximal tibial fractures, with dual plating offering slightly better stability but increased surgical demands.*

Keywords: *Dual Plating, Single Lateral Plating, Bicondylar Tibial Fractures.*

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1. *Assistant Professor, Department of orthopedics and Traumatology, Shaheed Ziaur Rahman Medical College Hospital, Bogura Bangladesh (ORCID: 0009-0006-9016-9329)*
2. *Assistant Professor, Department of Orthopaedic Surgery, Shaheed Ziaur Rahman Medical College Hospital, Bogura Bangladesh (ORCID: 0009-0003-5962-2920)*
3. *Assistant Professor, Department of Orthopaedic Surgery, 250 Beded Mohammad Ali Hospital, Bogura, Bangladesh (ORCID: 0009-0000-5628-8195)*
4. *Junoir Consultant, Department of Orthopaedic Surgery, Gurudaspur Upazila Complex, Natore, Bangladesh (ORCID: 0009-0008-2639-7460)*

INTRODUCTION

Fractures of the proximal tibia represent approximately 1% of all fractures, with incidence rising to 8% among the elderly population. Among these injuries, lateral tibial plateau fractures are the most frequently observed, constituting around 70% of cases, while medial and bicondylar fractures each account for roughly 15% [1]. Tibial plateau fractures typically result from either varus or valgus forces acting in combination with axial loading from the femoral condyle [2,3]. The specific fracture pattern depends on both the direction and magnitude of the force applied. Lateral plateau injuries usually occur from low-energy trauma, whereas medial or combined medial and lateral plateau fractures are generally caused by high-energy axial loads. A significant proportion of tibial plateau fractures, nearly 96%, are associated with motorcycle-related road traffic accidents [4]. These fractures show a bimodal distribution: elderly individuals over 60 years often experience low-energy injuries from same-level falls, while younger adults are more likely to sustain high-energy fractures due to traffic accidents or falls from substantial heights [5].

Management of complex tibial plateau fractures remains technically demanding and is often subject to debate [6-8]. Severe intra-articular damage or soft tissue compromise, as well as inappropriate treatment, can result in complications such as infection, skin necrosis, nonunion, deformity, and post-traumatic arthrosis. High-energy tibial plateau fractures, characterized by joint comminution, meta-diaphyseal separation, and soft tissue injury, present particular challenges in treatment [9,10]. Bicondylar fractures are especially difficult to manage [11], and the optimal approach remains controversial, with a high risk of suboptimal outcomes if not addressed appropriately [12,13]. According to the Schatzker classification, types V and VI, or the AO/OTA classification type 41-C, these injuries are classified as complex unstable bicondylar tibial plateau fractures, which are associated with increased comminution and pose challenges in achieving and maintaining articular congruity [14].

Various internal and external fixation techniques have been developed for the treatment of these fractures [15,16]. Bilateral open reduction and internal fixation has historically been recommended by the Association for Osteosynthesis/Association for the Study of Internal Fixation [17]. However, the use of dual plating often requires extensive soft tissue dissection, increasing the risk of wound complications and potentially compromising osteosynthesis. To minimize additional soft tissue trauma, minimally invasive

approaches are preferred. Some studies have suggested that certain bicondylar tibial plateau fractures can be stabilized using a unilateral locked plating technique, which avoids medial soft tissue dissection [18,19]. While this approach reduces the complications associated with dual plating, its ability to maintain articular reduction compared to bilateral plate fixation remains unclear. Biomechanical studies indicate that dual plating offers greater mechanical stability than a single lateral locking plate, although single lateral locked plates can still provide reliable fixation [20]. Long-term outcomes reported in the literature suggest similar functional results for both fixation methods, and no definitive consensus exists regarding the superior technique. Cadaveric studies demonstrate that dual plate fixation provides higher biomechanical strength and less subsidence compared to single lateral locked plates. Stabilizing both medial and lateral columns through dual plate fixation using two incisions has been shown to yield favorable functional outcomes in complex tibial plateau fractures [21]. Conversely, single lateral plating requires less soft tissue dissection, which may help reduce postoperative wound complications [22].

Evidence from biomechanical investigations shows that unilateral buttress plate fixation in bicondylar fracture models may result in greater medial plateau reduction loss under axial loading compared to dual plate fixation, potentially contributing to pain and osteoarthritic changes over time. Nevertheless, other biomechanical studies found no significant difference between the two fixation techniques. Clinical outcomes have similarly shown comparable results with isolated lateral locked plating. However, some reports indicate that lateral locked plating may be associated with higher rates of reduction loss, malunion, and hardware-related complaints [19]. Other studies have noted no significant differences in infection rates, operative times, or hospitalization duration between the two approaches. Overall, the literature provides both supporting and conflicting evidence regarding the relative advantages of dual plating versus single lateral locked plating in bicondylar tibial plateau fractures.

Despite numerous biomechanical and clinical studies comparing dual plating and single lateral locked plating, the evidence remains inconclusive. Some investigations report superior mechanical stability and lower subsidence with dual plating, while others demonstrate comparable functional outcomes with single lateral plating. Additionally, most studies are limited by small sample sizes, heterogeneous patient populations, or a lack of long-term follow-up. There is also a scarcity of data from South Asian populations, where fracture patterns, patient demographics, and healthcare resources may differ. Consequently, the optimal fixation strategy for bicondylar proximal tibial fractures—balancing mechanical stability, soft tissue preservation, and functional recovery—remains uncertain. The purpose of the study is to compare the clinical, radiological, and functional outcomes of dual plating versus single lateral plating in patients with bicondylar proximal tibial fractures.

OBJECTIVE

To compare the clinical, radiological, and functional outcomes of dual plating versus single lateral plating in patients with bicondylar proximal tibial fractures.

METHODS & MATERIALS

This prospective comparative study was conducted at the Department of Orthopaedic & Traumatology, Shaheed Ziaur Rahman Medical College Hospital, Bogura, Bangladesh, from July 2025 to December 2025. A total of 50 patients diagnosed with bicondylar proximal tibial fractures (Schatzker types V and VI) were enrolled based on predefined inclusion and exclusion criteria. The study aimed to compare the clinical, radiological, and functional outcomes of dual plating versus single lateral plating in these patients.

Inclusion Criteria

- Patients aged 18–65 years with bicondylar proximal tibial fractures (Schatzker types V and VI).
- Presentation within 3 weeks of injury.
- Fractures amenable to fixation by either dual plating or single lateral plating.
- Provision of informed written consent.

Exclusion Criteria

- Open fractures (Gustilo-Anderson grade II or III).
- Pathological fractures secondary to tumors or metabolic bone disease.
- Polytrauma patients with life-threatening injuries interfering with follow-up.
- Severe uncontrolled comorbidities affecting fracture healing.
- Previous surgery or implants in the affected knee.
- Refusal to participate or loss to follow-up.

All patients underwent comprehensive preoperative evaluation including detailed history, physical examination, plain radiographs, and computed tomography (CT) scans of the affected knee. Baseline demographic and injury-related data such as age, sex, mechanism of injury, and fracture classification were recorded.

Patients were allocated into two groups of 25 each. The dual plating group underwent fixation with both medial and lateral plates, whereas the single lateral plating group received a lateral locking plate alone. All procedures were performed under standard operative protocols. Operative time, intraoperative blood loss, and duration of hospital stay were documented.

Postoperative follow-up included serial clinical and radiological assessments to evaluate fracture union, malalignment (>5°), loss of reduction, and implant failure. Functional outcomes were assessed using the Rasmussen functional scoring system and measurement of knee range of motion (ROM) at scheduled intervals. Complications such as superficial infection, deep infection, knee stiffness, delayed union, and hardware irritation were recorded.

Data were analyzed using SPSS software. Continuous variables were expressed as mean ± standard deviation and compared using the independent t-test. Categorical variables were expressed as frequencies and percentages and analyzed using the Chi-square test or Fisher's exact test as appropriate. A p-value <0.05 was considered statistically significant.

RESULTS

Table I presents the baseline demographic and clinical characteristics of patients undergoing dual plating (n = 25) and single lateral plating (n = 25) for bicondylar proximal tibial fractures. The mean age of patients in the dual plating group was 41.2 ± 9.8 years compared to 39.6 ± 11.3 years in the single lateral plating group (p = 0.59). The majority of patients were male (68.0% vs 72.0%, p = 0.76). Road traffic accidents were the most common mechanism of injury in both groups. No statistically significant differences were observed in gender, mechanism of injury, or fracture type between the two groups.

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Table I: Baseline Demographic and Clinical Characteristics of the Study Population (*n* = 50)

Characteristic		Dual Plating (n=25)	Single Lateral Plating (n=25)	p-value
Age (years)	Mean ± SD	41.2 ± 9.8	39.6 ± 11.3	0.59
Gender	Male	17 (68.0%)	18 (72.0%)	0.76
	Female	8 (32.0%)	7 (28.0%)	
Mechanism of Injury	Road Traffic Accident (RTA)	16 (64.0%)	16 (64.0%)	1.00
	Fall from Height	7 (28.0%)	7 (28.0%)	
	Others	2 (8.0%)	2 (8.0%)	
Fracture Type (Schatzker)	Type V	11 (44.0%)	12 (48.0%)	0.78
	Type VI	14 (56.0%)	13 (52.0%)	

Table II summarizes operative parameters including mean operative time, intraoperative blood loss, and hospital stay for both groups. Patients undergoing dual plating had significantly longer operative times (112 ± 15 min vs 85 ± 12 min, $p < 0.001$), higher blood loss (310 ± 60 mL vs 220 ± 50 mL, $p < 0.001$), and longer hospital stays (8.4 ± 2.1 days vs 6.2 ± 1.8 days, $p < 0.001$) compared to the single lateral plating group.

Table II: Operative Parameters of Patients Undergoing Dual or Single Lateral Plating (*n* = 50)

Variables	Dual Plating (n=25)	Single Lateral Plating (n=25)	p-value
Mean Operative Time (minutes)	112 ± 15	85 ± 12	<0.001
Mean Blood Loss (mL)	310 ± 60	220 ± 50	<0.001
Mean Hospital Stay (days)	8.4 ± 2.1	6.2 ± 1.8	<0.001

Table III presents radiological outcomes, including time to union, malalignment, loss of reduction, and implant failure. The mean time to union was 16.4 ± 2.1 weeks in the dual plating group and 17.2 ± 2.8 weeks in the single lateral plating group ($p = 0.26$). Malalignment (>5°) occurred in 8.0% of patients in the dual plating group compared to 24.0% in the single lateral plating group ($p = 0.25$). Loss of reduction and implant failure were higher in the single lateral plating group, although differences were not statistically significant.

Table III: Radiological Outcomes of Dual vs Single Lateral Plating (*n* = 50)

Variables	Dual Plating (n=25)	Single Lateral Plating (n=25)	p-value
Mean Time to Union (weeks)	16.4 ± 2.1	17.2 ± 2.8	0.26
Malalignment (>5°)	2 (8.0%)	6 (24.0%)	0.25
Loss of Reduction	1 (4.0%)	5 (20.0%)	0.19
Implant Failure	0 (0.0%)	2 (8.0%)	0.49

Table IV shows functional outcomes assessed using the Rasmussen functional score and mean knee range of motion (ROM). In the dual plating group, 48.0% of patients achieved an excellent score compared to 32.0% in the single lateral plating group ($p = 0.36$). Mean knee ROM was slightly higher in the dual plating group (118° ± 10° vs 112° ± 12°, $p = 0.06$), though this difference did not reach statistical significance.

Table IV: Functional Outcomes of Patients Undergoing Dual and Single Lateral Plating (*n* = 50)

Outcome		Dual Plating (n=25)	Single Lateral Plating (n=25)	p-value
Rasmussen Score	Excellent	12 (48.0%)	8 (32.0%)	0.36
	Good	9 (36.0%)	10 (40.0%)	
	Fair	3 (12.0%)	5 (20.0%)	
	Poor	1 (4.0%)	2 (8.0%)	
Mean Knee ROM (degrees)	Mean ± SD	118° ± 10°	112° ± 12°	0.06

Table V summarizes postoperative complications in both groups, including superficial infection, deep infection, knee stiffness, delayed union, and hardware irritation. Superficial infection occurred in 12.0% of patients in the dual plating group versus 4.0% in the single lateral plating group ($p = 0.61$). No statistically significant differences were observed for any of the complications between the two groups.

Table V: Postoperative Complications in Dual and Single Lateral Plating Groups (*n* = 50)

Complications	Dual Plating (n=25)	Single Lateral Plating (n=25)	p-value
Superficial Infection	3 (12.0%)	1 (4.0%)	0.61
Deep Infection	1 (4.0%)	0 (0.0%)	1.00
Knee Stiffness (Flexion < 90°)	1 (4.0%)	3 (12.0%)	0.61
Delayed Union	2 (8.0%)	3 (12.0%)	1.00
Hardware Irritation	4 (16.0%)	1 (4.0%)	0.35

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DISCUSSION

Bicondylar proximal tibial fractures are complex orthopedic injuries that pose significant challenges in achieving stable fixation and restoring joint congruity. These fractures often result from high-energy trauma and are frequently associated with soft tissue compromise, making optimal management critical to prevent malalignment, nonunion, or post-traumatic arthritis. The findings of this study indicate that dual plating provides enhanced mechanical stability and better maintenance of alignment compared to single lateral plating, while single lateral plating offers the advantages of reduced operative time, blood loss, and soft tissue disruption. These findings emphasize the importance of selecting an appropriate fixation strategy to balance stability, minimize complications, and optimize functional recovery in patients with bicondylar proximal tibial fractures.

In the present study, the baseline demographic and clinical characteristics of patients treated with dual plating and single lateral plating for bicondylar proximal tibial fractures were comparable, with no statistically significant intergroup differences. The mean age in the dual plating group was 41.2 ± 9.8 years compared to 39.6 ± 11.3 years in the single lateral plating group ($p = 0.59$). These findings closely resemble those of Raj et al., who reported mean ages of 41.3 ± 8.8 years and 35.6 ± 13.8 years in dual and single lateral plating groups, respectively, without statistically significant difference ($p = 0.07$) [23]. Similarly, Arouca et al. demonstrated no significant demographic variation between double plating and single lateral locked plate cohorts [24]. With regard to gender distribution, our study showed a clear male predominance in both groups (68.0% vs 72.0%), consistent with the findings of Wang et al., who reported approximately 71.7% male patients, again without significant intergroup disparity [25]. Road traffic accidents constituted the most common mechanism of injury in both groups (64.0%), followed by falls from height and other causes, reflecting the high-energy trauma pattern widely described in bicondylar tibial plateau fractures. Fracture morphology, classified according to Schatzker types V and VI, was similarly distributed between groups (44.0% vs 48.0% for type V; 56.0% vs 52.0% for type VI), paralleling the comparable fracture distributions observed in the studies by Raj et al. [23], Arouca et al. [24], and Wang et al.[25] Overall, the absence of significant demographic or injury-pattern differences between groups in our cohort strengthens the internal validity of subsequent comparisons and minimizes confounding bias in assessing operative and postoperative outcomes.

Analysis of operative parameters in our study revealed statistically significant differences between fixation techniques. Dual plating was associated with longer operative time (112 ± 15 minutes vs 85 ± 12 minutes, $p < 0.001$), greater intraoperative blood loss (310 ± 60 mL vs 220 ± 50 mL, $p < 0.001$), and prolonged hospital stay (8.4 ± 2.1 days vs 6.2 ± 1.8 days, $p < 0.001$). These findings are in agreement with those reported by Raj et al., who demonstrated significantly longer surgical duration and increased blood loss in dual plating cases compared to single lateral fixation, although their difference in hospital stay did not reach statistical significance [23]. Similarly, Kumar et al. observed significantly reduced operative time, intraoperative bleeding, and hospitalization in the lateral plating group [26]. Neogi et al. also highlighted that single lateral locking plate fixation generally requires less surgical exposure, avoids the need for a second incision, and thereby reduces operative complexity and soft tissue dissection, contributing to shorter operative time and lower blood loss [27]. Collectively, these observations suggest that while dual plating may offer enhanced mechanical stability, single lateral plating demonstrates clear perioperative advantages, particularly in terms of operative efficiency and reduced resource utilization.

Regarding radiological outcomes, both fixation techniques achieved comparable fracture union rates and healing times. The mean time to union was 16.4 ± 2.1 weeks in the dual plating group and 17.2 ± 2.8 weeks in the single lateral plating group ($p = 0.26$), indicating that fracture consolidation was not significantly influenced by implant configuration. However, there was a noticeable trend toward higher rates of malalignment (>5°) (24.0% vs 8.0%), loss of reduction (20.0% vs 4.0%), and implant failure (8.0% vs 0.0%) in the single lateral plating group, although statistical significance was not achieved. These findings parallel the observations of Weaver et al., who reported that isolated lateral locked plating in fracture patterns with coronal medial fragments was associated with significantly increased loss of reduction and subsidence compared to dual plating constructs [28]. Likewise, Tawfiq et al. reported similar overall radiological alignment between dual and single lateral plating but observed a tendency toward greater malunion in the single lateral group [29]. Taken together, these data suggest that while fracture union may be reliably achieved with both methods, dual plating potentially provides superior biomechanical stability and better maintenance of reduction in complex bicondylar fracture patterns, particularly in the presence of medial or posteromedial fragment involvement.

Functional evaluation using the Rasmussen functional score and mean knee range of motion demonstrated generally favorable and comparable outcomes between the two groups. In our study, 48.0% of patients in the dual plating group achieved excellent Rasmussen scores compared to 32.0% in the single lateral group, while good outcomes were similarly distributed; however, these differences were not statistically significant ($p = 0.36$). Mean knee ROM was slightly greater in the dual plating group (118° ± 10°) than in the single lateral group (112° ± 12°), but this difference approached without reaching statistical significance ($p = 0.06$). These results align with the conclusions of Citak et al., who found no significant differences in functional outcomes between lateral locking plate fixation and dual plating at final follow-up when assessed using validated scoring systems such as the Knee Society Score and Rasmussen functional score [30]. Although individual patient distributions may vary across studies, the overall evidence suggests that both fixation techniques are capable of restoring satisfactory knee function in bicondylar proximal tibial fractures when applied appropriately.

Postoperative complication analysis in our study demonstrated low overall complication rates in both groups, without statistically significant differences. Superficial infection was slightly more common in the dual plating group (12.0% vs 4.0%), whereas knee stiffness (flexion <90°) and delayed union were marginally more frequent in the single lateral plating group. Deep infection occurred in only one patient (4.0%) in the dual plating group and in none of the single lateral cases ($p = 1.00$), indicating a low incidence overall. Hardware irritation was observed more frequently in dual plating patients (16.0% vs 4.0%), potentially reflecting increased implant prominence or soft tissue dissection. These findings are consistent with those reported by Neogi et al., who documented complete fracture healing and low deep infection rates (~3.12%) with no marked intergroup differences despite minor variations in soft tissue complications [27]. Similarly, Tawfiq et al. observed differing patterns of complications between fixation groups without

statistical significance [29]. Furthermore, the large cohort study conducted by Guild et al. demonstrated no significant difference in deep infection or reoperation rates between fixation strategies, suggesting that complication rates may be influenced more by fracture severity and soft tissue condition than by the plating construct alone [31].

LIMITATIONS

This study had some limitations:

- Limited sample may restrict the generalizability of the findings.
- Single-center study, which may not reflect diverse populations.
- Geographically restricted participants, potentially affecting applicability to other regions or ethnic groups.

CONCLUSION

Bicondylar proximal tibial fractures require stable fixation to restore joint function. In this study, dual and single lateral plating showed comparable clinical and functional outcomes. Dual plating was associated with longer operative time, greater blood loss, and longer hospital stay, while radiological outcomes suggested slightly better maintenance of alignment, though not statistically significant. Postoperative complications were low and similar between groups. Overall, both methods provide satisfactory outcomes, with dual plating offering potential biomechanical advantages at the cost of increased surgical demands.

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CONFLICTS OF INTEREST

There are no conflicts of interest.

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