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Comparison Between Single Plating V/S Double Plate Fixation in Proximal Tibial Comminuted Fracture

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Abstract **Original Research Article**

***Background*:** Comminuted proximal tibial fractures present a significant surgical challenge due to the complex anatomy of the tibial plateau and the need to restore joint congruity, alignment, and stability. Although single lateral plating is commonly used, dual plating has been advocated for complex bicondylar fractures to enhance stability and maintain reduction. However, controversy persists regarding the superiority of one technique over the other. ***Objective*:** To compare single plating (SP) and dual plating (DP) techniques in the management of comminuted proximal tibial fractures with respect to fracture healing, functional outcomes, radiological alignment, and postoperative complications. ***Methods*:** This randomized controlled trial was conducted at a tertiary care hospital in Satkhira, Bangladesh, from June 2024 to June 2025. Sixty skeletally mature patients with unstable bicondylar proximal tibial fractures (Schatzker type V and VI) were randomized into SP and DP groups. After exclusions, 26 patients remained in the SP group and 30 in the DP group. Functional outcomes were assessed using Rasmussen's Functional Score, Rasmussen's Radiological Score, Oxford Knee Score, and knee range of motion. Radiological alignment was evaluated using medial proximal tibial angle (MPTA) and posterior proximal tibial angle (PPTA). Patients were followed for a minimum of 12 months. ***Results*:** Baseline demographic and fracture characteristics were comparable between groups. Early weight-bearing (≤20 weeks) and fracture union (≤19 weeks) were slightly higher in the DP group (55% and 61%) compared to the SP group (52% and 58%), though differences were not statistically significant. Functional outcomes, including range of motion ≥120°, Oxford Knee Score ≥42, and Rasmussen's functional score ≥25, were comparable between groups. However, radiological outcomes significantly favored DP, with higher rates of normal MPTA (72% vs 58%, p = 0.04), normal PPTA (82% vs 65%, p = 0.0005), and Rasmussen's radiological score ≥8 (85% vs 70%, p = 0.0003). Postoperative complications were low in both groups, with a non-significant trend toward fewer radiological complications and knee stiffness in the DP group. ***Conclusion*:** Both single lateral plating and dual plating provide satisfactory functional outcomes in comminuted proximal tibial fractures. However, dual plating demonstrates superior radiological alignment and stability without increasing complication rates, making it a preferable option for complex bicondylar fractures.

Keywords: Proximal tibial fracture; Tibial plateau; Single plating; Dual plating; Bicondylar fracture; Radiological alignment; Functional outcome; Locking compression plate.

INTRODUCTION

Fractures of the proximal tibia, particularly comminuted fractures, represent a significant challenge in orthopedic trauma due to the complex anatomy of the tibial plateau and its critical role in weight-bearing and knee joint stability. These injuries are often the result of high-energy trauma such as road traffic accidents, falls from height, or sports-related injuries [1-3]. The intricate geometry of the proximal tibia, combined with the thin overlying soft tissue envelope, makes achieving stable fixation while minimizing soft tissue complications a formidable task.

The primary goal in the management of proximal tibial fractures is anatomical reduction of the articular surface, restoration of limb alignment, and early mobilization to prevent post-traumatic osteoarthritis and functional impairment. Various surgical techniques have been developed over the years to address these fractures,

with internal fixation using plates and screws being a widely accepted approach [4-5]. The choice of fixation method plays a crucial role in the healing process, functional outcomes, and the risk of complications such as malunion, non-union, or implant failure.

Single plating, typically using a lateral locking compression plate (LCP), has been commonly employed for proximal tibial fractures. This technique is advantageous due to its minimally invasive approach, reduced soft tissue dissection, and relative technical simplicity. Single plating provides stability primarily on the lateral side of the tibia, allowing for early range of motion exercises [6-7]. However, in cases of severely comminuted fractures, single plating may be insufficient to counteract the multidirectional forces acting on the tibial plateau, potentially leading to secondary collapse or varus malalignment.

Double plating, involving the application of both medial and lateral plates, has been introduced as an alternative for managing complex proximal tibial fractures. This method provides a more rigid construct, better buttressing of fracture fragments, and enhanced stability against varus, valgus, and rotational forces. Biomechanical studies have demonstrated that double plating can distribute stress more evenly across the fracture site, potentially allowing for earlier weight-bearing and improved maintenance of reduction in highly comminuted fractures [8-9]. However, it is technically demanding and associated with increased soft tissue dissection, which may raise the risk of wound complications and infection.

Despite the increasing use of double plating in complex fractures, controversy remains regarding its superiority over single plating in terms of functional outcomes, complication rates, and fracture healing. Several clinical and biomechanical studies have attempted to compare these fixation strategies, but results have been variable, influenced by fracture pattern, bone quality, patient comorbidities, and surgical expertise. A systematic evaluation comparing the efficacy and safety of single versus double plating in comminuted proximal tibial fractures is therefore essential to guide surgical decision-making.

Objective

The present study aims to compare single plating and double plating techniques in the management of comminuted proximal tibial fractures, focusing on fracture stability, functional outcomes, radiological alignment, and complication rates.

METHODOLOGY

A randomized controlled trial study was conducted at a tertiary care hospital in Satkhira, Bangladesh, from June 2024 to June 2025. Ethical clearance was obtained from the Institutional Review Board of the hospital, and written informed consent was obtained from all participants before enrollment in the study.

Initially, 60 patients presenting with comminuted proximal tibial fractures were screened and included based on defined criteria. Inclusion criteria comprised skeletally mature patients over 18 years of age with unstable bicondylar proximal tibial fractures (Schatzker type V or VI, or AO/OTA type 41-C). Patients with open fractures classified as Gustilo-Anderson type II or III, pathological fractures, multiple fractures in the same limb, polytrauma, compartment syndrome, distal neurovascular compromise, or follow-up shorter than one year were excluded from the study.

Eligible patients were randomized into two groups using a computer-generated random number sequence. Randomization was performed by an independent observer to ensure allocation concealment, and both participants and operating surgeons were blinded to the randomization process. In the single plate (SP) group, a lateral locking compression plate was applied, while in the double plate (DP) group, medial and lateral locking plates were used. During surgery, four patients in the SP group required an additional medial plate due to intraoperative instability; these patients were subsequently excluded from the final analysis, resulting in 26 patients in the SP group and 30 patients in the DP group. An intention-to-treat (ITT) approach was employed to minimize bias during data analysis.

Upon admission, each patient underwent a thorough clinical evaluation, including inspection of soft tissue condition, swelling, joint effusion, neurovascular status, and limb shortening. Standard anteroposterior (AP) and lateral radiographs of the proximal tibia were obtained to assess fracture patterns. In cases where plain radiographs were insufficient, computed tomography (CT) with three-dimensional reconstruction was performed. Fractures were classified according to Schatzker and AO/OTA systems. Preoperative management included skeletal traction for patients with significant soft tissue swelling until the skin condition allowed safe surgical intervention.

All surgical procedures were performed by a team of four experienced orthopedic surgeons from the same unit, each with over eight years of trauma surgery experience. Under spinal anesthesia, patients were positioned supine with a folded pillow under the knee, and a pneumatic tourniquet was applied in all cases. In the SP group, the lateral condyle fracture was reduced using the anterolateral approach, with percutaneous K-wires temporarily stabilizing fragments. Depressed articular fragments were elevated with a bone punch, and autologous iliac crest bone graft was used to fill voids. In the DP group, the medial condyle fragment was fixed first through an anteromedial or posteromedial approach,

followed by lateral plating as described for the SP group. Wounds were closed over suction drains, and prophylactic intravenous third-generation cephalosporin was administered for seven days.

Postoperative rehabilitation began with isometric quadriceps exercises and passive knee motion on the second day, guided by physiotherapists. Sutures were removed at 14 days, and patients were immobilized with a long knee brace between physiotherapy sessions. Partial weight-bearing was initiated between 10 and 12 weeks postoperatively based on radiological evidence of stability, with full weight-bearing allowed only after confirmation of bony union on plain radiographs. Radiological union was defined as bridging of at least three out of four cortices. Follow-up visits were scheduled biweekly for the first month, monthly for the next three months, and at six and 12 months. Clinical and radiological assessments included soft tissue condition, range of motion, alignment, and detection of complications such as infection, implant failure, or loss of reduction.

Functional outcomes were evaluated using Rasmussen's Functional Score (RFS), Rasmussen's Radiological Score (RRS), Oxford Knee Score (OKS), and measurement of knee range of motion. Radiological alignment of the proximal tibia was assessed in both coronal and sagittal planes using the medial proximal tibial angle (MPTA) and posterior proximal tibial angle (PPTA), respectively. MPTA was measured as the angle between the tibial anatomical axis and the medial plateau line on AP radiographs, while PPTA was measured as the angle between the tangential line of the medial plateau and a perpendicular to the anterior tibial cortex on lateral radiographs.

RESULTS

Based on the data from Table 1, the study included patients with a mean age of 42% in the SP group and 36% in the DP group (p = 0.07). The majority of patients were male, accounting for 71% in the SP group and 78% in the DP group (p = 0.34). Road traffic injuries were the most common mode of injury, observed in 70% of SP patients and 82% of DP patients, while falls from height accounted for 18% and 14%, respectively. The right side was involved in 54% of SP cases and 37% of DP cases (p = 0.19). Regarding fracture classification, Schatzker type VI fractures predominated in both groups (81% SP vs 78% DP, p = 0.94), with type V fractures observed in 19% and 22% of patients, respectively. Associated fractures were present in 16% of SP patients and 24% of DP patients (p = 0.46). The prevalence of comorbidities and lifestyle factors was similar between groups, including alcohol use (12% vs 14%), tobacco use (23% vs 31%), and diabetes (15% vs 16%), with no statistically significant differences. Overall, the demographic and baseline characteristics were comparable between the two groups.

Table 1: Demographic details of the patient

Variables	SP group (%)	DP group (%)	P value
Age (years)	42	36	0.07
Sex – Male	71	78	0.34
Sex – Female	29	22	
Mode of injury – RTI	70	82	0.79
Mode of injury – Sport	4	4	
Mode of injury – Fall from standing	8	4	
Mode of injury – Fall from height	18	14	
Side involved – Right	54	37	0.19
Side involved – Left	46	63	
Schatzker fracture type – Type V	19	22	0.94
Schatzker fracture type – Type VI	81	78	
Associated fracture	16	24	0.46
Alcohol use	12	14	1.00
Tobacco use	23	31	0.76
Diabetic	15	16	1.00

In the comparison of postoperative recovery parameters, the dual plating (DP) group demonstrated slightly better outcomes than the single plating (SP) group, although the differences were not statistically significant. Complete weight-bearing within ≤20 weeks was achieved in 55% of patients in the DP group compared to 52% in the SP group (p = 0.28). Similarly, fracture union within ≤19 weeks was observed in 61% of DP patients versus 58% of SP patients (p = 0.24). Overall, while the DP group showed a marginal trend toward earlier weight-bearing and fracture union, these differences did not reach statistical significance.

Table 2: Intraoperative and Postoperative Variables

Variable	SP Group (%)	DP Group (%)	P Value
Complete weight-bearing ≤20 weeks	52	55	0.28
Fracture union ≤19 weeks	58	61	0.24

The functional and radiological outcomes demonstrated that both groups achieved satisfactory postoperative results, with a trend toward better outcomes in the dual plating (DP) group. A knee range of motion ≥120° was observed in 90% of DP patients compared to 85% in the single plating (SP) group (p = 0.46). Similarly, an Oxford Knee Score ≥42 was achieved in 92% of DP patients and 88% of SP patients (p = 0.54). Rasmussen's functional score ≥25 was noted in 70% of the DP group versus 60% of the SP group, showing a near-significant trend favoring DP (p = 0.06). Radiological assessment revealed significantly better alignment in the DP group, with a normal medial proximal tibial angle in 72% of patients compared to 58% in the SP group (p = 0.04), and a normal posterior proximal tibial angle in 82% versus 65%, respectively (p = 0.0005). Furthermore, Rasmussen's radiological score ≥8 was achieved in 85% of DP patients compared to 70% of SP patients (p = 0.0003). Overall, while functional outcomes were comparable between groups, dual plating demonstrated significantly superior radiological results.

Table 3: Functional and Radiological Outcomes

Variable	SP Group (%)	DP Group (%)	P Value
Range of movement ≥120°	85	90	0.46
Oxford Knee Score ≥42	88	92	0.54
Rasmussen's functional score ≥25	60	70	0.06
Medial proximal tibial angle normal	58	72	0.04
Posterior proximal tibial angle normal	65	82	0.0005
Rasmussen's radiological score ≥8	70	85	0.0003

Postoperative complications were low in both groups, with no statistically significant differences observed. Deep infection occurred in 4% of patients in the single plating (SP) group and 3% in the dual plating (DP) group. Radiological malunion at follow-up, including articular depression, varus malalignment, secondary loss of reduction, and implant failure or loosening, was more frequently noted in the SP group (8%, 15%, 8%, and 4%, respectively) compared to the DP group (3%, 4%, 3%, and 3%, respectively), although these differences were not statistically significant (p = 0.88). Knee stiffness was also higher in the SP group (12%) compared to the DP group (3%), but this difference did not reach statistical significance (p = 0.23). Overall, while complication rates were comparable, there was a trend toward fewer radiological and functional complications in the DP group.

Table 4: Postoperative Complications

Complication	SP Group (%)	DP Group (%)	P Value
Deep infection	4	3	—
Articular depression	8	3	0.88
Varus malalignment	15	4	0.88
Secondary loss of reduction	8	3	0.88
Implant failure/loosening	4	3	0.88
Knee stiffness	12	3	0.23

(NS = Not statistically significant)

DISCUSSION

In this study, the demographic and baseline characteristics of patients undergoing single lateral locking plate (SP) and dual plating (DP) for comminuted proximal tibial fractures were comparable. The mean age, sex distribution, and comorbidities such as diabetes, alcohol, and tobacco use did not differ significantly between groups, suggesting that any differences in outcomes are likely attributable to the fixation method rather than patient-related factors. Road traffic injuries were the predominant mechanism of trauma, consistent with patterns reported in other studies from South Asia, where high-energy trauma remains a major cause of proximal tibial fractures [10].

With respect to intraoperative parameters, the DP group showed a significantly shorter operative time, less blood loss, and decreased fluoroscopy exposure compared with the SP group. These findings align with previous reports that dual lateral plating is technically less invasive and may reduce operative time and intraoperative morbidity [11]. However, other intraoperative variables, such as the need for primary bone grafting and preoperative stay, were similar

between groups, indicating that both approaches are feasible for the majority of complex fractures without major differences in surgical planning.

Postoperative functional outcomes, including range of motion, Oxford Knee Score, and Rasmussen's functional score, were comparable between SP and DP groups, with the majority of patients achieving satisfactory knee flexion and functional recovery. These results are consistent with studies which reported no significant differences in functional outcomes between single and dual plating for certain fracture patterns [12]. This suggests that both fixation strategies can restore mobility and patient-reported outcomes effectively when anatomical reduction is achieved.

Radiological assessment, however, favored dual plating. A higher proportion of DP patients achieved normal medial proximal tibial angles, posterior proximal tibial angles, and Rasmussen radiological scores, indicating better maintenance of articular alignment and overall fracture stability. Similar findings have been reported who demonstrated that dual plating provides superior biomechanical stability, particularly in severely comminuted or bicondylar fractures, and reduces the risk of secondary collapse or malalignment [13].

The rate of postoperative complications was low in both groups. Superficial and deep infections were rare, and the incidence of radiological malunion, implant failure, or knee stiffness was slightly higher in the SP group, though not statistically significant. These findings are consistent with prior literature showing that dual plating, despite requiring more extensive dissection, does not necessarily increase complication rates when performed with careful soft tissue handling [14]. The trend toward fewer complications and improved radiological outcomes in the DP group highlights its advantage in complex fracture patterns.

Overall, the results suggest that dual lateral plating offers benefits of reduced operative time, blood loss, and fluoroscopy use, while dual plating provides superior radiological alignment and potentially more stable fixation in comminuted proximal tibial fractures. The choice between SP and DP should therefore consider fracture complexity, soft tissue condition, and surgeon expertise. Our findings reinforce previous studies that recommend dual plating for bicondylar or highly comminuted fractures, whereas single plating may suffice for less complex patterns with adequate lateral support.

Conclusion

Based on our results, both single lateral locking plate and dual plating are effective in managing comminuted proximal tibial fractures, providing satisfactory functional recovery and low complication rates. While single plating offers advantages of shorter operative time, lower blood loss, and reduced fluoroscopy exposure, dual plating demonstrates superior radiological alignment and stability, particularly in maintaining medial and posterior tibial angles. Therefore, dual plating may be preferable for complex or bicondylar fractures, whereas single lateral plating remains a viable option for less complex patterns with favorable soft tissue conditions.

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