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Prospective analysis of clinical and radiological outcomes of dual plating in tibial plateau fractures

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Abstract

Background: Tibial plateau fractures are high-energy articular injuries demanding anatomical reduction and stable fixation for optimal outcomes. Dual plating has gained importance in bicondylar fractures, providing superior stability and alignment compared with single lateral plating. However, controversies persist regarding single versus dual plating and incision strategies.

Objective: To evaluate clinical and radiological outcomes of dual plating in Schatzker type V and VI fractures and to analyze the surgical indications, approaches, and comparative results with single plating.

Materials and Methods: Thirty patients with bicondylar tibial plateau fractures (Schatzker V-VI) underwent dual plating after soft-tissue optimization. Follow-up assessments were conducted at 6 weeks, 3 and 6 months post-surgery. Clinical outcomes were evaluated using the Oxford Knee Score (OKS), while radiological assessments utilized standard imaging techniques to monitor fracture healing. Complications and technical details regarding incision approaches were also analyzed.

Results: The mean age was 42.8 years, with 24 males. Twelve (40%) had excellent OKS, 10 (33.3%) good, 6 (20%) fair, and 1 (3.3%) poor at six months. Radiological union occurred in 27 (90%) at 14 weeks. Complication rate was 16.7%.

Conclusion: Dual plating offers superior biomechanical stability and reliable union in types V-VI fractures. Two-incision approaches help preserve soft tissue integrity in complex bicondylar or medial column fractures. Single incisions may suffice in select low-energy or noncomminuted patterns. Future studies with larger cohorts and extended follow-up are essential to validate these results and establish long-term efficacy.

Keywords: Tibial Plateau Fractures, Schatzker Classification, Dual Plating, Surgical Fixation, Radiological Outcome, Complications, Fracture union, Oxford Knee Score (OKS), Complications, Functional Recovery

Introduction

Tibial plateau fractures constitute complex intra-articular injuries, typically resulting from high-energy trauma such as road traffic accidents or falls. These fractures disrupt the structural integrity of the tibial plateau, which is a crucial load-bearing structure in the knee. When improperly treated, tibial plateau fractures can lead to long-term joint dysfunction, knee instability, and post-traumatic osteoarthritis ^[1]. The Schatzker classification remains the cornerstone for grading, with type V and VI fractures representing bicondylar involvement, joint depression, and metaphyseal-diaphyseal dissociation ^[2].

The key surgical goal is to reestablish the articular surface, restore limb alignment, and prevent collapse or post-traumatic arthritis ^[3]. Although single lateral locked plating was historically common, it often fails to address medial column instability and posteromedial comminution, resulting in malalignment or varus collapse ^[4]. Dual plating is advocated to achieve stability through bicolumnar fixation, especially in high-grade fractures ^[5, 6].

This study prospectively evaluates outcomes of dual plating for complex tibial plateau fractures, compares them with findings from single plating studies, and discusses appropriate incision choices for optimized results.

Materials and Methods

A prospective cohort study was conducted between September 2023 and September 2024 on thirty patients who sustained Schatzker type V-VI fractures. Institutional ethical approval and informed consent were obtained.

Inclusion criteria:

1. Adults aged 18-65 years
2. Radiologically confirmed Schatzker type V or VI
3. Adequate soft tissue healing at the time of surgery.

The exclusion criteria were:

1. Pathological fractures,
2. Patients presenting with severe systemic illness or medical conditions not suitable for surgery,
3. Schatzker types 1 to 4 tibial plateau fractures by radiology.

Patients with Schatzker type 5 and type 6 fractures, as confirmed by X-rays, were admitted and clinically assessed for neurovascular injuries and observed for skin conditions. Skeletal traction was applied in patients where the skin condition was poor until the skin showed the wrinkle sign. CT scan with 3D reconstruction was done in cases where the fracture morphology could not be adequately assessed.

Surgical technique

All surgeries were performed by a team of orthopaedic surgeons experienced in managing complex fractures. The surgery was performed in the supine position under spinal anaesthesia with a tourniquet. The procedure involved the use of two incisions depending upon the fracture pattern [7, 8]. The anterolateral approach permitted fixation of the lateral condyle while a separate anteromedial or posteromedial incision allowed reduction of medial condyle. Fracture reduction was achieved and held using position K-wires. Depression, wherever found, was elevated using a bone punch and the void was filled with bone graft. Two locking plates were applied: a proximal tibial lateral locking compression plate for the lateral condyle and a medial T-type, L-type or buttress plate for the medial condyle. Fixation was done with either 3.5mm or 4.5mm side-specific proximal tibial plates depending on the fracture geometry. The fixation aimed at achieving anatomical reduction and optimal joint congruence, which is crucial for restoring knee function and preventing post-traumatic osteoarthritis.

Fluoroscopy was used intraoperatively to confirm proper fracture reduction and alignment. Suction drains were used in all cases and removed on postoperative day 2. Postoperatively, the patients were given prophylactic antibiotics. Patients began isometric quadriceps strengthening exercises and range of motion exercises from day 3. Weight-bearing was avoided for the first 6 weeks. Partial weight-bearing was started after this period, and full weight-bearing was allowed after radiological healing of the fracture, i.e., bony union of a minimum of 3 cortices.

Evaluation

Patients were assessed preoperatively and at 6 weeks, 3 months, and 6 months postoperatively. Functional outcomes were evaluated using the Oxford Knee Score (OKS), a well-established scoring system that quantifies knee function based on pain, stiffness, and the ability to perform daily activities [9, 10].

Radiologically, fracture healing was assessed using anteroposterior (AP) and lateral radiographs, as well as CT scans where necessary. Healing was defined as the presence of callus formation in 3 out of 4 cortices and no motion at the fracture site. Complications such as infection, implant failure, and loss of reduction were assessed during all follow-up visits.



Fig 1: Proximal tibial plates

Results

A total of 30 patients were enrolled, with a mean age of 42.8 years (range: 19-65 years). 24 of them were males and 6 were females. 21 had right sided injury while 9 had left sided injury. The majority of fractures were Schatzker type 5 (20 cases), with 10 cases classified as Schatzker type 6. The injuries predominantly resulted from high-energy trauma: motor vehicle accidents (MVA) accounted for 60% of cases, and falls from height contributed to 40%. In 10% of patients, there were associated poor skin condition.

Table 1: Demographics and Preoperative Data

Parameter	Findings
Total Number of Patients	30 (100%)
Mean Age	42.8 years (range: 19-65 years)
Gender Distribution	24 males (80%), 6 females (20%)
Injury Side	21 right-sided (70%), 9 left-sided (30%)
Fracture Classification	20 cases of Schatzker type 5 (66.7%), 10 cases of Schatzker type 6 (33.3%)
Cause of Injury	18 MVAs (60%), 12 falls from height (40%)
Associated Poor Skin Conditions	3 patients (10%)

Table 2: Intraoperative Parameters

Parameter	Findings
Mean Duration Between Injury and Surgery	8 days
Average Duration of Surgery	70 minutes
Average Blood Loss	150 mL
Average Duration of Hospital Stay	14 days

The mean duration between injury and definitive surgery was 8 days. The average duration of surgery was 70 minutes, with an average blood loss of 150ml. The average duration of hospital stay was 14 days.

At the 6-month follow-up, the functional outcomes based on the Oxford Knee Score (OKS) were as follows:

- 12 patients (40%) had excellent scores (41-48),
- 10 patients (33.3%) had good scores (33-40),
- 6 patients (20%) had moderate scores (25-32),
- 1 patient (3.3%) had poor scores (below 25).

On radiological evaluation, 27 patients (90%) achieved radiological union at 6 months, defined by the presence of

bridging callus and no movement at the fracture site average duration of union was 14 weeks.

The overall complication rate was 16.7%. Specific complications included:

- Two patients who developed superficial wound infections, which were successfully managed with organism specific antibiotics.
- One patient required reoperation for implant failure at 3 months.
- Two patients experienced transient soft tissue irritation from the plates, which resolved with conservative management and needed implant removal after bony union at 6 months.

There were no cases of deep vein thrombosis or pulmonary embolism.



Fig 2: preop xray and post-op x-ray



Fig 3: Knee flexion at 6 months

Table 3: Outcomes and Complications

Parameter	Findings (Absolute Numbers and Percentages)
Functional Outcome (OKS at 6 months)	12 patients (40%) with excellent scores (41-48) 10 patients (33.3%) with good scores (33-40) 6 patients (20%) with moderate scores (25-32) 1 patient (3.3%) with poor scores (below 25)
Radiological Union (6 months)	27 patients (90%) achieved union
Average Duration of Union	14 weeks
Complications	5 patients (16.7%) experienced complications: - 2 superficial wound infections (6.7%) - 1 implant failure (3.3%) - 2 patients (6.7%) with soft tissue irritation requiring implant removal

Discussion

Comparison with Single Plating

Several comparative studies affirm the biomechanical and clinical superiority of dual plating [4, 5, 6, 10]. Raina *et al.* and Prasad *et al.* observed higher union rates and fewer alignment issues with dual plating compared to single lateral fixation, especially in fractures with medial comminution [4, 5]. A meta-analysis by Chang *et al.* demonstrated that dual plating achieved improved reduction and prevented varus collapse relative to lateral locked plating. Similarly, a large comparative cohort study by Raj *et al.* (2023) found significantly better functional knee scores with dual plating in unstable bicondylar patterns [2, 6].

Single lateral plating, while minimally invasive and tissue-sparing, often fails in maintaining reduction when the medial column is fragmented or the posteromedial fragment extends to the shaft. Clinical studies from India indicate that 15-25% of single-lateral cases experience postoperative malalignment. Thus, dual plating remains the preferred option for unstable bicondylar or multi-fragmentary patterns [11, 12].

Indications for Dual Plating

Dual plating is recommended in the following settings:

- Bicondylar fractures (Schatzker V & VI) with medial or posteromedial comminution [11].
- Coronal/posteromedial split fractures requiring buttress support [12].
- Metaphyseal-diaphyseal dissociation needing bicolumnar stability [13].
- Inadequate medial cortical continuity compromising varus stability [14].

Biomechanical analysis confirms that dual constructs resist medial subsidence and restore axial load capacity better than single plating [18].

Surgical Incisions and Approaches

Surgical exposure of the proximal tibia can be achieved via several approaches: anterolateral, anteromedial, posteromedial, posterolateral, or midline incisions depending on fracture morphology [16, 19].

Two-Incision Technique

Traditionally, dual plating employs anterolateral and anteromedial or posteromedial incisions, ensuring independent access to each column while preserving vascularity. Studies by Hake *et al.* and Weaver *et al.* demonstrate superior anatomical reductions and alignment restoration with two incisions, albeit with slightly increased soft-tissue handling [8, 9]. A prospective study by Barei *et al.* found the two-incision approach to yield better reduction with only 3% deep infection [21].

Conversely, the single anterior or anterolateral incision may suffice for simple bicondylar fractures with limited medial extension, offering reduced operative time and soft-tissue handling [15]. Yilmaz *et al.* reported comparable infection rates but superior visualization in two-incision groups [15].

The AO Foundation recommends two distinct incisions (>7 cm apart) in bicondylar fractures to prevent skin necrosis and preserve subcutaneous perforators [16, 19]. Single-incision techniques may suffice in lower-energy injuries with limited posteromedial extension.

Comparison to Literature

Our radiological union rate (90%) aligns with Raj et al.^[3] and Lee et al. who observed 85-92% union with dual plating^[20]. Mean union time of 14 weeks was consistent with international studies reporting 12-18 weeks under similar rehabilitation^[20, 21]. Functionally, the 73.3% excellent-to-good OKS parallels global averages for dual plating^[5, 6].

The advantages of dual vs single plating thus include improved alignment, higher union, and early rehabilitation, albeit at the cost of longer incision length and higher soft-tissue demands.

The main limitations of the study were that the sample size was small, limiting the generalizability of the findings. Larger cohort studies with extended follow-up are needed to confirm the long-term benefits of dual plating in Schatzker type 5 and type 6 fractures. The absence of a control group (i.e., patients treated with single plating) is another limitation, as it prevents direct comparison of outcomes. Furthermore, the study was focused on functional outcomes and radiological malalignment was not considered.

Conclusion

Dual plating offers predictable fixation stability and excellent clinical and radiological results in Schatzker type V and VI tibial plateau fractures. Our study supports its use in enhancing stability, fracture union, and functional recovery, especially in complex fractures that involve both medial and lateral condylar regions. The two-incision approach remains the gold standard for complex bicondylar or comminuted fractures, whereas single-incision techniques may be reserved for simpler cases. While this technique offers significant benefits, further multicenter, randomized controlled trials with longer follow-up periods are required to validate these findings and establish its long-term efficacy.

Ethical Standards

Institutional ethics committee approved the study. Informed consent was taken from all individual participants included in the study.

Conflict of Interest

The authors declare no potential conflict of interest in connection with the submitted article.

Each other certifies that he or she has no commercial associations that might pose a conflict of Interest in connection with the submitted article.

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