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Functional outcome of tibial plateau fractures treated with dual plating

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Abstract
Purpose: To assess the functional outcome and complications of Bicondylar Tibial Plateau fractures treated with ORIF with Dual plating. 10-30 percent of tibial plateau fractures are bicondylar fractures with comminution or coronal fracture, a single lateral LCP is unable to offer appropriate reduction of the Posteromedial condylar fragment. Despite having varying modes of fixation there is no defined protocol as to when the surgeon has to prefer dual plating.
Methodology: In this prospective study, 30 patients (19-65 years) with bicondylar tibial plateau fractures underwent dual plating between January 2020 and November 2022 in SSIMS and RC, Davangere. Each patient underwent anterolateral and posteromedial plating through two seperate incisions. Standard physiotherapy was administered to all patients. Over a 24-month follow up was done with questionaaires. The Range of motion of the knee joint, and Rasmussen's functional grading system were used to evaluate functional outcomes.
Results: Average fracture union time was 18 weeks. Average Knee Range of movements Flexion 100^{o} -135^{o} and 0 -10^{o} of extension lag). Mean Rasmussen functional grading score of 26.75.
Conclusion: Dual plating in bicondylar tibial plateau fractures has good functional outcome and also helps in attaining anatomical fixation of articular surface. Limitations of the study would be small study cohort and no control group for comparison. The results obtained could be used to compare a variety of other modes of fixation and to arrive at definite protocols for management of bicondylar tibial plateau fractures.

Keywords: Functional outcome, dual plating, tibial plateau

Introduction

Tibial plateau fractures involve the weight-bearing surface of the proximal tibia, which articulates with the femoral condyles, making them critical to knee joint stability and function. The treatment of these fractures, especially those affecting the posteromedial region, has evolved over the years.

The treatment of bicondylar fractures of the proximal tibia has seen significant advancements over time. Initially, non-surgical methods like traction and casting were prevalent, but they often resulted in complications such as stiffness and malunion. Traditional external fixation techniques, including hybrid fixators, aimed to correct the metaphysio-diaphyseal alignment but were associated with risks like septic arthritis, pin site infections, and poor patient compliance. Modern approaches, such as the use of locking plate systems and minimally invasive plate osteosynthesis (MIPO), have transformed the treatment of these complex fractures.

A single lateral locking plate can effectively stabilize bicondylar tibial plateau fractures while minimizing soft tissue damage by avoiding the need for an additional medial plate. This approach uses limited dissection and percutaneous insertion of locking screws through guide arms, reducing soft tissue injury during surgery. However, maintaining axial alignment can be challenging in unstable bicondylar fractures, especially when the medial column fracture has a coronal fracture line. Traditional anterolateral plating methods often fall short for posteromedial fragments, leading to suboptimal outcomes. Therefore, the dual plating technique, which involves both anterolateral and posteromedial plates, has gained popularity for providing more comprehensive stabilization of the fracture.

Fractures of the tibial plateau are commonly classified using the Schatzker classification system. Types IV, V, and VI represent more severe fractures, where there is a greater risk of articular surface damage and instability:

- **Type IV:** Fractures of the medial tibial condyle
- **Type V:** Bicondylar fractures involving both condyles
- **Type VI:** Fractures where the tibial shaft is dissociated from the metaphysis

Given the complexity of these injuries, appropriate surgical intervention is crucial to restore joint function and prevent long-term complications, such as arthritis and joint instability. This study examines the use of dual plating for such fractures and evaluates the functional outcomes in terms of fracture healing, knee mobility, and overall patient recovery.

This paper aims to provide a comprehensive understanding of the indications for dual plating, the surgical approach, and the outcomes, with particular attention to the role of medial support in complex tibial plateau fractures.

Objectives

- To assess the functional outcomes of dual plating in tibial plateau fractures involving the medial condyle and bicondylar patterns.
- To compare dual plating with lateral locking plates in terms of fixation stability, articular congruity, and postoperative function.
- To evaluate the incidence of complications associated with dual plating.
- To propose guidelines for surgical timing and approach in dual plating procedures.

Methodology

Study design

This prospective study was conducted at the S. S. Institute of Medical Sciences, Davangere. Thirty patients diagnosed with Schatzker type IV to VI tibial plateau fractures underwent dual plating between July 2022 and January 2024. Patients were selected based on specific criteria and followed up for 12 months to assess functional recovery and complications.

Patient Selection

Inclusion criteria

- Fractures with a step-off >2.5 mm in the medial tibial plateau
- Condylar widening >5 mm
- Schatzker type V or VI fractures with bicondylar involvement or comminution
- Patients aged between 19 and 65 years

Exclusion criteria

- Open fractures or pre-existing knee pathology
- Patients unable to complete the follow-up period
- Fractures involving only the lateral condyle

Preoperative imaging

Patients underwent detailed preoperative evaluation through:

- **Radiographs** to identify fracture patterns and assess joint alignment.
- **CT scans** to confirm the extent of comminution and posteromedial involvement.

Surgical technique

All patients were treated using a dual plating technique involving separate anterolateral and posteromedial approaches. The posteromedial fragment was stabilized first, followed by fixation of the lateral condyle.

- **Posteromedial Approach:** With the patient supine, the leg was externally rotated into a figure-four position to expose the medial condyle. A locking plate was applied after reduction of the fragment using clamps. This step ensures anatomical reduction of the posteromedial column, which bears a significant portion of the body's weight during ambulation.

- **Anterolateral Approach:** Once the medial side was stabilized, the lateral condyle was approached through a standard anterolateral incision. A locking plate was applied after reducing the lateral condyle to restore the joint surface and achieve overall stability of the fracture.

Postoperative Management

- **Rehabilitation Protocol:** Early knee mobilization exercises were initiated on postoperative day 1. Passive and active knee movements were encouraged, with partial weight-bearing allowed at 4 weeks, based on radiographic healing.

- **Follow-up:** Patients were assessed at 1, 3, 6, and 12 months using radiographs, clinical evaluations, and functional scoring systems.

Results

Fracture Union

All 20 patients achieved fracture union within an average of 12 weeks postoperatively. No cases of nonunion or malunion were observed. The mean time to full weight-bearing was 10 weeks.

Range of Motion

Patients achieved a mean knee flexion of 120° (range 100° to 135°) and an extension lag of less than 5°. These results indicate that dual plating allows for near-normal knee mobility postoperatively, with no significant limitations in daily activities.

Functional outcomes

Using the Rasmussen Functional Score, the average score was 27 out of 30, reflecting excellent recovery in most cases. Patients with posteromedial fractures showed significantly better outcomes with dual plating than would be expected with single lateral plating, largely due to the enhanced stability provided by addressing both columns (tibia dual plate).

Complications

- Two patients experienced delayed wound healing in the anterolateral incision, which required secondary wound closure. Both cases resolved without further complications.
- No deep infections, hardware failures, or nerve injuries were reported.

Discussion

High-energy bicondylar tibial plateau fractures (Schatzker type V and VI) are unstable intra-articular fractures that present significant challenges for orthopedic surgeons. The primary goals of surgical treatment include achieving anatomical reduction of fracture fragments, maintaining articular congruity, preserving the surrounding soft tissues, and minimizing complications, such as infection and malalignment. Various fixation methods have been discussed in the literature, including external fixation, hybrid external fixation, single lateral locking plate fixation, and dual buttress plate fixation. However, the optimal surgical technique for tibial plateau fractures remains a subject of debate.

A single lateral locking plate with screws directed towards the medial fragment can stabilize the medial plateau and prevent varus collapse in bicondylar tibial plateau fractures. Its advantages include less invasive dissection and the insertion of percutaneous screws through guide arms, which lowers the risk of soft tissue damage and wound infection. However, single plating has limitations in providing sufficient stability in all bicondylar tibial fractures. Failures

of single locking plate fixation have been reported, particularly in cases involving a medial intra-articular fracture line, a small comminuted medial plateau fragment, or a medial articular fracture with a coronal component and posteromedial fragment. Studies by Barei *et al*. and Higgins *et al*. showed that the incidence of posteromedial fragments in bicondylar tibial plateau fractures ranges from 28.8% to 59%. These fragments prevent posterior subluxation of the femoral condyle, but single lateral locking plates may not effectively engage them, complicating reduction and fixation. Even when locking screws engage the posteromedial fragment, the fixation may be inadequate to neutralize displacement forces. Furthermore, in fractures with coronal medial fracture lines, the design of the locking plate limits the direction of the locked screws, which are parallel rather than perpendicular to the coronal fracture line.

Schatzker type V and VI fractures typically require the reduction and stabilization of both the medial and lateral condyles. The dual plate technique addresses both columns, providing mechanical stability and adequate fixation. Studies have shown that dual plating offers greater biomechanical strength and a lower rate of subsidence compared to single lateral locking plate fixation. For instance, a biomechanical study by Higgins *et al*. on cadavers found that dual plates resulted in less subsidence in bicondylar tibial plateau fractures than a single lateral plate. Both Barei *et al*. and Yoo *et al*. reported satisfactory functional outcomes using dual plating in complex tibial fractures. Postoperative malalignment has been reported by various authors. In Neogi *et al*.'s study, 10.9% of patients in the single plate group (SP) and 6.2% in the dual plate (DP) group experienced postoperative malalignment. In our study, one patient (3.33%) experienced delayed malalignment, specifically varus collapse, but still showed good functional outcomes at the final follow-up. Another patient (3.33%) had malreduction due to an articular depression of more than 2 mm.

The primary disadvantage of dual plating is the extensive soft tissue dissection required, which may increase the risk of wound complications. Various studies have reported the incidence of deep wound infections with dual plating to be between 4.7% and 8.4%. Patil *et al*. reported superficial wound infections in 2.7% of cases with dual plating, while Neogi *et al*. observed a deep infection rate of 3.12%, which is comparable to the 3.33% found in our study. Superficial infections were observed in two patients (6.66%) in our study, and these were resolved with prolonged antimicrobial therapy. Infection remains the most common complication associated with dual plating, but it can be minimized through careful soft tissue handling and delaying surgery by 5–6 days to allow tissue edema to subside and improve skin conditions

When to use dual plating?

Dual plating is indicated in cases where the medial tibial condyle is involved, particularly in bicondylar fractures (Schatzker type V and VI) or in fractures with a posteromedial fragment. The additional support provided by medial fixation prevents collapse and ensures long-term stability (tibia dual plate).

This technique is especially important in cases with:

- 2.5 mm step-off in the medial plateau
- Condylar widening >5 mm
- Comminution or coronal split fractures involving the medial tibial condyle

Surgical advantages

Dual plating provides several key advantages over single lateral plating:

- **Enhanced Stability:** By addressing both the anterolateral and posteromedial columns, dual plating provides superior fixation, even in comminuted fractures.
- **Better Articular Reduction:** This technique allows for precise reduction of the joint surface, minimizing the risk of post-traumatic arthritis.
- **Earlier Mobilization:** The increased stability facilitates earlier knee mobilization, leading to faster recovery and better long-term outcomes (tibia dual plate).

Disadvantages

The primary disadvantage of dual plating is the increased risk of soft tissue complications, particularly delayed wound healing. Additionally, the use of two incisions may increase the risk of periosteal blood supply disruption, which could affect healing in some cases (tibia dual plate).

Comparison with existing literature

While single lateral locking plates are adequate for many tibial plateau fractures, dual plating offers distinct advantages in complex fracture patterns. Studies by Higgins *et al*. and Egol *et al*. have shown that dual plates provide better biomechanical stability, although clinical outcomes in less severe fractures may not differ significantly (tibia dual plate) (tibia dual plate).

Fig 1: Preoperative and postoperative xrays

Fig 2: Knee ROM at 3 month follow up

Fig 3: Preoperative and postoperative xrays

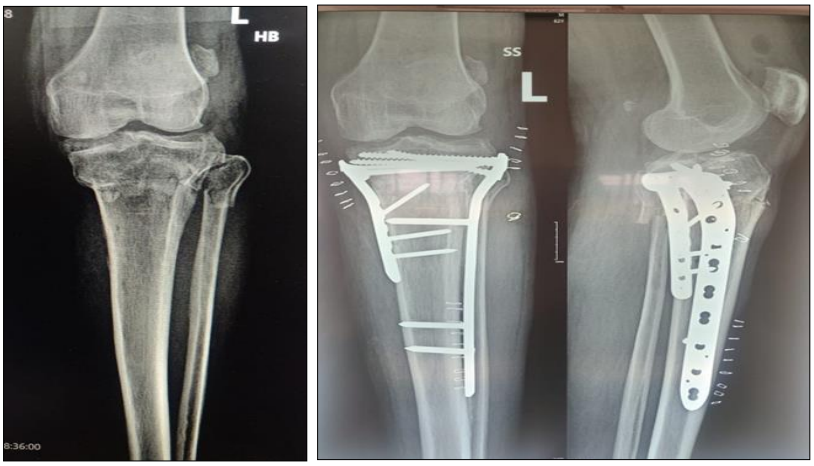

Fig 4: Preoperative and postoperative xray

Fig 5: Preoperative and postoperative xray

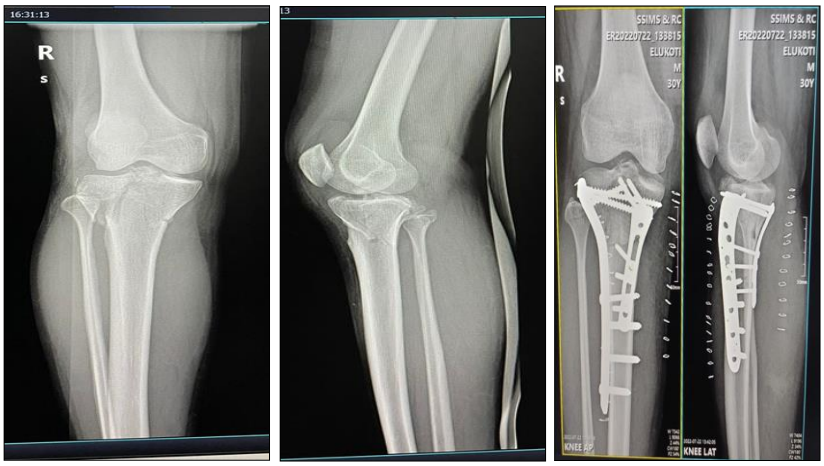

Fig 6: Preoperative and postoperative xray

Conclusion

Dual plating is an effective method for managing complex tibial plateau fractures, particularly in cases involving the medial condyle or posteromedial fragment. This study demonstrates that dual plating provides superior stability, earlier mobilization, and better functional outcomes compared to single lateral plating. While the risk of soft tissue complications is higher, the benefits of improved articular reduction and fixation outweigh these risks in appropriately selected cases.

Further studies with larger sample sizes and longer follow-up periods are needed to establish definitive guidelines for the use of dual plating in tibial plateau fractures.

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