

# Analysis of Functional Outcome of Column-specific Fixation of Complex Tibial Plateau Fractures: A Prospective Study

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## Abstract

**Introduction:** Most complex tibial plateau fractures are a result of the high-energy injury. Resulting comminution makes interpreting of fracture patterns difficult. Fully understanding these fractures is the basis for successful treatment.

**Aim:** The aim of this study was to analyze the functional and radiological outcome of column-specific fixation of tibial plateau fracture.

**Materials and Methods:** This was a prospective cohort study; 10 patients with tibial plateau fractures with displaced complex tibial plateau fractures operated at Government Rajaji Hospital, Madurai, were included in this study. The follow-up period was 36 months. The fractures were evaluated by computed tomography using Lu three-column concepts and managed with low-profile locking plate system as per column-specific fixation. Follow-up analysis was made using Modified Rasmussen's Clinical and Radiological Criteria.

**Results:** In our study, 70% of the patients were in active productive age group (30–50 years). 90% of the patients were male. 30% of single-column fractures (LUO) (Schatzker type IV 10% and Hohl and Moore Type I coronal split fracture 20%), 30% of two-column fracture (LUO) (Schatzker Type IV 20% and Type V 10%), and 40% of three-column fractures (LUO) (Schatzker Type V 40%) were included. In this study, 40% of patients had an excellent outcome, 50% of patients had a good outcome, 10% of patients had poor clinical, and 10% had fair radiological outcome. One patient developed wound necrosis, for which flap cover is done and eventually patient developed deep infection for whom implant removal was done after 6 months.

**Conclusion:** Three-column fixation is a new fixation concept in treating complex tibial plateau fractures, especially useful for multiplanar fractures involving posterior column with excellent functional outcome.

**Key words:** A combined approach, Three-column fixation, Tibial plateau fracture

## INTRODUCTION

Fractures of the tibial plateau involve the articular surface of the proximal tibia. Imaging studies need to be of good quality to demonstrate the location of the fracture, the fracture pattern, and the degree of displacement, and

there is controversy on which the type of imaging is optimal. Assessing associated soft tissue injuries around the knee is critically important. Certain fracture patterns have a high risk of limb-threatening complications such as compartment syndrome, although, for other fracture patterns, these risks are negligible.<sup>[1-3]</sup> Treatment concepts based on restoring or preserving limb alignment will lead to a satisfactory outcome for most patients; poor alignment often will result in a poor outcome. Conventionally, the treatment for tibial plateau fractures is based on two-dimensional classification systems. Several authors have noted that computed tomography (CT)-based three-dimensional consideration of the fracture pattern was important in the treatment of tibial plateau fractures.

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<sup>[4,5]</sup> In recent years, “three-column fixation” technique to treat the multiplanar complex tibial plateau fractures, which is based on the three-dimensional understanding of the fractures. Most of the current classification systems for tibial plateau fractures use two-dimensional images, which usually direct surgeons to pay attention to medial and lateral fixation without thinking of posterior fixation. With careful review and application of the CT scan for the evaluation for these fractures,<sup>[3,4,6,7]</sup> some surgeons have realized the importance of considering posterior fixation in tibial plateau fractures, especially for the posteromedial fragment.

### Aim

The aim of this study was to analyze the functional and radiological outcome of column specific fixation of tibial plateau fracture.

## MATERIALS AND METHODS

This prospective study was conducted in the Department of Orthopaedics, Government Rajaji Hospital. 10 patients with displaced tibial plateau fractures with posterior column involvement were selected for the study. This is a prospective study done for 3 years from September 2015 to August 2018. Mode of injury was road traffic accident in all 10 patients. Patients were evaluated with X-rays (AP and lateral views) and CT (axial, coronal, and sagittal with three-dimensional [3D] reconstruction views). Fractures were classified based on three-column concept classification. The functional and radiological outcome was assessed using Modified Rasmussen’s Clinical and Radiological Criteria. Patients with tibial plateau fractures with posterior column involvement, closed injury, and age >18 years were included in this study. Patients with fractures with zero columns (pure depression type), pure lateral or medial column involvement without posterior column involvement, open injury, and associated head/chest/abdomen/pelvis/spine injury, patient below 18 years of age, and patient not fit for surgery and not willing for surgery were excluded from the study. Pre-operative planning with clinical examination, knee aspiration for confirmation of intra-articular fractures & to drain haemarthrosis, temporary immobilisation with above slab, X-ray knee: AP and lateral view taken and CT knee with 3D reconstruction for column involvement. Routine blood investigations such as HB, blood sugar, urea, creatinine, viral markers, and electrocardiogram for anesthetic assessment are taken. The fractured limb was temporarily stabilized with above knee slab and control of comorbid conditions such as diabetes and hypertension. Three patients were operated between 4 and 7 days. Five patients were operated between 7 and 14 days. Two patients were operated between 14 and 21 days. The mean time interval between injury and surgery was 11.7 days.

### Implants and Instruments

Any of the below implants were used according to the fracture patterns. Proximal tibial locking plates, T/L buttress plates, posteromedial and posterior tibial locking plate, 6.5, and 5 mm cancellous screws (locking, non-locking), 4.5, 5 mm cortical screws (locking, non-locking). After careful pre-operative evaluation of, the fracture morphology surgical approach and patient position planned. In our study, posteromedial plate osteosynthesis was done in both supine and prone positions. Posterior plate osteosynthesis was done in the prone position using Stevens *et al.*<sup>[8]</sup> approach. In dual plate osteosynthesis for 3 column fractures, patient positioned in supine.

### Post-operative Follow-up

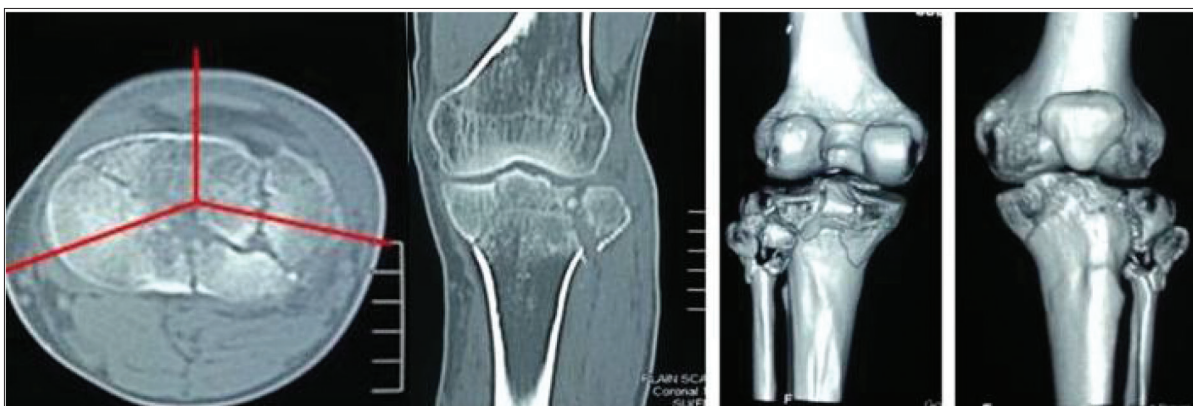
Patients were treated with i.v. antibiotics for 5 days postoperatively. EOT is done on POD 2, 5, 8, and 10. Sutures removal was done on POD 12. Patients were mobilized as early as possible. Ankle pump and quadriceps exercises were performed from the 2<sup>nd</sup> POD. Knee bending exercises were started after the pain subsides and as tolerated by the patient. Partial weight bearing using walkers was started after 6 weeks and full weight bearing was allowed after 3–4 months depending on the union of the fracture site. Physical therapy was continued until the range of motion and muscle strength was regained. Postoperatively, patients were evaluated with X-ray AP and lateral views at 6 weeks, 6 months, and 1<sup>st</sup>, 2<sup>nd</sup>, and 3<sup>rd</sup> year.

## RESULTS

In this study, tibial plateau fractures were more commonly seen in the active productive age group (31–50 years) due to high-energy trauma. Conservative management, external fixators, and routine anterolateral plate osteosynthesis are difficult to reduce and fix the posterior column fractures, especially in posteromedial fragment and coronal splitting Moore Type I fractures. It is extremely important to adequately visualize the fragments, reduce the fracture, regain articular congruity, and obtain stable rigid fixation Table 1, Figures 1 and 2. In our series, the majority of patients were male (90%) as they were involved mostly in road traffic accidents due to their occupation. There was no significant difference in the side affected in this study (right – 5 and left – 5 patients). This study is to analyze functional and radiological outcome and to plan for fracture fixation according to column involvement. Fracture distribution in our study was 30% of single-column fractures (Schatzker Type IV 10% and Hohl and Moore Type I coronal split fracture 20%), 30% of two-column fracture (Schatzker type IV 20% and type V 10%), and 40% of three-column fractures (Schatzker Type V 40%) included. In this study, one patient 68-year-old male

**Table 1: Distribution of surgical approaches**

Position	Post plate	Posteromedial plate	Posteromedial plate and screw	Dual plating (PM/AM)
Supine	0	1	1	4
Prone	2	1	1	0
Total	2	2	2	4


**Figure 1: Preoperative and Postoperative pictures**

**Figure 2: CT Scan with 3D reconstruction**

with three-column fracture developed superficial blisters over the tibial plateau region and the patient was taken into surgery after soft tissue healing and after normalization of erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) on 3<sup>rd</sup> week after the injury. The patient developed wound necrosis for which flap cover is done and eventually the patient developed deep infection for whom implant removal was done after 6 months. Soft tissue complications are a major concern in the treatment of bicondylar tibial plateau fractures with plates. The longest follow-up period was 31 months and the shortest follow-up period was 16 months. Mean follow-up period was 24.7 months. Follow-up analysis was made using Modified Rasmussen's Clinical and Radiological Criteria. In our study, 70% of the patients were in active productive age group (30–50 years). 90% of the patients were male. There was no significant difference in the side affected (right side – 5 patients and left side – 5 patients). All the patients in this study sustained injury due to a road traffic accident. 30% of single column fractures (LUO) (Schatzker Type IV 10% and Hohl and Moore Type I coronal split fracture 20%),

30% of two-column fracture (LUO) (Schatzker type IV 20% and type V 10%), and 40% of three-column fractures (LUO) (Schatzker type V 40%) were included. In this study, 40% of patients had an excellent outcome, 50% of patients had a good outcome, 10% of patients had poor clinical, and 10% had fair radiological outcome Figures 3 and 4.

## DISCUSSION

Tibial plateau fractures, one of the most common intra-articular fractures, occurring as a result of RTA, fall from a height, violence, etc. The management of these fractures has always been in the debate due to their variety of fracture pattern and soft tissue complications. High-energy tibial plateau fractures have associated with more severe fracture pattern, ligament injury, and severe soft tissue injuries. Bicondylar fractures are best treated with dual plating than single lateral plating with better anatomic reduction and rigid fixation, and it also has soft tissue complications as well. There are many approaches



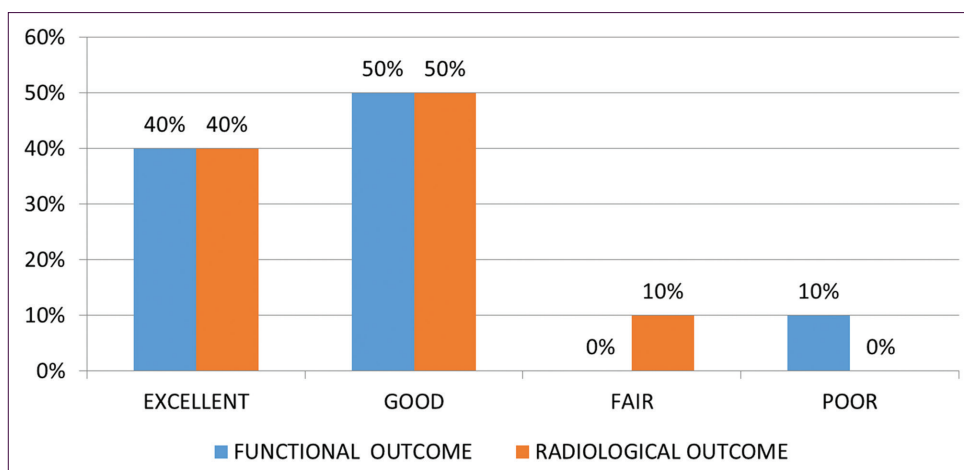


Figure 3: Distribution of the outcome



Figure 4: Scar and Functional outcome

for fixation of tibial plateau fractures; each one has its own merits and demerits. Selection of approach and fixation for tibial plateau fractures are still a debate for better outcomes. In high-energy tibial plateau fractures, posteromedial and posterior fractures are often not able to fix with anterolateral plate alone. Fractures of the posterior tibial plateau are not uncommon, especially in high-energy trauma.<sup>[9]</sup> Fixation of posteromedial and posterolateral fractures is essential in obtaining an excellent clinical and radiological outcome in the high energy tibial plateau fractures. Failure to fix the posteromedial fragment results in varus collapse and decreased range of motion and clinical outcome in displaced tibial plateau fractures, and posterior tibial fractures are best studied and planned for fixation using the three-column fixation proposed by Luo *et al.*<sup>[5]</sup> Posteromedial or posterior approaches either in prone or supine provide better visualization of the fractures and aid in better reduction and fixation, and it also has the advantages of less soft tissue injury even when combined with anterolateral incision and it can also be used to fix the posterior cruciate ligament injury if present. Posterior column fixation through these approaches with an antiglide plate and medial and lateral column fixation

with screws or lateral locking plates provides the accurate reduction of articular surfaces, and rigid fracture fixation, thereby, has advantages of early mobilization, reduced soft tissue complications, better range of movements, and early mobilization than other modes of fixations. Papers reporting the results of dual plate osteosynthesis through a single extensile incision have shown the incidence of deep wound infection of 23%–88%.<sup>[8,10]</sup> With the two-incision dual plating technique, the incidence drops to 4.7–8.4%.<sup>[8,10]</sup> With LISS fixation, it is reported to range from 0% to 22%.<sup>[8,11,12]</sup> In a study conducted by Waddell *et al.*,<sup>[13]</sup> patients treated with single lateral plating developed varus malunion at the fracture site. In a study conducted by Zeng *et al.*,<sup>[14]</sup> West *et al.*,<sup>[15]</sup> and Luo *et al.*<sup>[14]</sup> on tibia bone model, posteromedial T-plate can improve the strength and stiffness of posteromedial fragment fixation and had a buttress effect preventing descent of the fragment under load than other modes of fixation (anteroposterior lag-screws, an anteromedial limited contact dynamic compression plate, and a lateral locking plate). Hence, reduce the varus collapse incidence and increase in the range of movements by fixing the unstable posterior fragments. No patient developed varus collapse in our

study. There was no neurovascular injury, no implant breakage, no varus valgus deformity, no delayed union, or non-union in our study. 90% of the patients attained good-to-excellent outcome in the follow-up study. In our study also, all the fractures were united between 3 and 4 months. 40% of patients had an excellent outcome, 50% of patients had a good outcome, and 10% of patients had a fair radiological outcome with poor clinical outcome.

## CONCLUSION

Three-column fixation is a new fixation concept in treating complex tibial plateau fractures, especially useful for multiplanar fractures involving posterior column with excellent functional outcome.

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