International Journal Dental and Medical Sciences Research
Volume 7, Issue 6, Nov – Dec 2025 pp 150-157 www.ijdmsrjournal.com ISSN: 2582-6018

Evaluation of Functional Recovery Following Dual Plate Fixation for Proximal Tibia Fracture

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Date of Submission: 01-12-2025 Date of Acceptance: 10-12-2025

ABSTRACT
Tibial Plateau fractures occurs when the proximal Tibia is subjected to excessive axial force, most commonly seen in high-energy road traffic accidents and athletic injuries. They account for nearly 1% of all orthopaedics fractures and approximately 8% among the elderly. Management of these fractures , particularly complex bicondylar variants,continues to develop due to the complex nature of the fracture patterns and their associated soft tissue involvement.
Significant challenges arise from comminution of the articular surface, metaphyseal collapse, extensive soft tissue insult, the possibility of compartment syndrome, and the risk of post operative infection. Precise evaluation with radiographs and computed tomography is eesential to accurately determine the fracture configuration and formulate an appropriate treatment strategy. Core principles of management include anatomic reconstructioncof the joint surface, achieving stable fixation, safeguarding soft tissues, and facilitating early range of motion exercises.
Management approaches range from conservative treatment – reserved for minimally displaced fractures – to operative intervention. Surgical options most often involve open reduction and internal fixation using plates, screws, or staged external fixation in cases with severe soft tissue compromise and polytrauma. Structured rehabilitation following treatment is critical for restoring function and optimizing long term outcomes.
In summary, tibial plateau fractures represent a complex orthopedic problem requiring individualized decision making, careful surgical execution, and vigilant soft tissue care to achieve successful results.
METHODS-A prospective observational study was carried out at Hi-Tech Medical College and Hospital, BHUBANESWAR for 35 cases Proximal Tibia fractureswho underwent internal fixation using double plate osteosynthesis. Patients between 18 and 60 years of age, presenting to the outpatient department or emergency services between 1 May 2023 and 31 October 2024 were included. All enrolledcases were managed surgically with open reduction and internal fixation (ORIF) following standard operative protocols.
PostOperatively, patients were monitored through scheduled clinical and radiological evaluations to assess knee function, progression of fracture union, incidence of non union, secondary displacement, implant integrity, and the occurrence of any procedure related complications.
RESULTS –In this study, 35 patients underwent operative management with the ORIF technique. Of these, 22 patients demonstrated excellent outcomes, while 7 patients achieved good functional results. Two patients exhibited fair outcomes based on the applied evaluation criteria.
CONCLUSION – The results of the study concluded that by using minimal invasive approach of bi condylar fracture fixation are excellent without any major complications.
KEYWORDS –Proximal tibial plateau fractures, Open Reduction Internal Fixation (ORIF), Schatzker Type V and VI fractures.

I. INTRODUCTION

The knee joint is one of the principal weight-bearing joints of the lower limb, and injuries around this region can significantly impact mobility and function. Proximal tibial plateau fractures constitute approximately 1% of all fractures in younger individuals and are broadly classified into low-energy and high-energy injury patterns. Fractures involving the proximal tibial metaphysis extending into the articular surface are particularly challenging to manage due to their complexity and the delicate nature of the surrounding soft tissues.

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Several patient and injury-related factors—including skin condition, age, bone quality, soft-tissue status, and the risk of compartment syndrome—play a crucial role in determining surgical planning and influence wound healing. The majority of proximal tibial fractures occur due to high-energy mechanisms such as falls from height and high-speed road traffic accidents. These injuries typically result from direct axial loading combined with varus or valgus forces, along with additional shear stresses.[1]

Restoring joint congruity, maintaining ligamentous stability, and addressing the intricatebiomechanics of knee loading are primary concerns in managing tibial plateau fractures. The overarching goal of surgical treatment is to re-establish normal knee function by achieving anatomical reductionof the articular surface, preserving the mechanical axis, ensuring ligament stability, and enabling a pain-free range of motion.

In the present study, we evaluated the functional outcomes of intra-articular proximal tibial fractures treated using double-plate osteosynthesis. Functional recovery was assessed at the 6-month follow-up using the Knee Society Score to determine the effectiveness of this fixation technique.

II. METHODOLOGY

This prospective case series was conducted between 1 May 2023 and 31 October 2024 at Hitech Medical CollegeAndHospital, Bhubaneswar, a tertiary care center. Patients aged 18 to 60 years presenting with proximal tibial fractures and meeting the predefined inclusion criteria were enrolled. A total of 35 patients planned for operative management with dual-plate osteosynthesis were included in the study.

All fractures were evaluated clinically and radiographically and subsequently classified according to the Schatzker classification.

Inclusion Criteria

Age between 18 and 60 years
Proximal tibial fractures classified as Schatzker type V or VI
Exclusion Criteria
Skeletally immature patients
Schatzker type I, II, III, or IV fractures
Patients medically unfit for surgery
Fractures associated with ipsilateral neurovascular compromise
Fractures associated with knee joint dislocation

Operative Protocol

On admission, the affected limb was immobilized using an above-knee POP slab or knee immobilizer with a window to permit serial soft-tissue evaluation and ice-pack application. Oral or injectable NSAIDs were administered for analgesia. Indicators of adequate soft-tissue recovery—including reduction in swelling, resolution of fracture blisters, and the appearance of skin wrinkling around the proximal tibia—were carefully monitored.[5 – 6]

Preoperative imaging included anteroposterior, lateral, and oblique radiographs of the knee, along with CT scans and three-dimensional reconstruction. Routine laboratory investigations (CBC, blood grouping, blood sugar, LFT, RFT, urine analysis), chest radiography, ECG, and echocardiography were performed. Serological tests were completed prior to surgery for all patients.

Surgery was performed with the patient in the supine position on a radiolucent orthopedic table. After tourniquet application, a small round support was placed beneath the knee to maintain slight flexion. The anterolateral approach was initiated 1–2 cm lateral to the patella, extending distally over Gerdy's tubercle and 1 cm lateral to the tibial crest. Subperiosteal dissection was kept limited to the fracture site and the diaphyseal area planned for plate placement. Depressed articular fragments were elevated and supported with autologous cancellous graft harvested from the iliac crest.

Following anatomical reduction, a locking plate was applied on the side with greater comminution, while the contralateral side was stabilized with a buttress plate.[6 – 7]

Medial column fixation was accomplished through an anteromedial incision along the tibial metaphysis, dissecting between the pes anserinus tendons and the medial head of the gastrocnemius. Depressed articular fragments were elevated using a punch under fluoroscopic guidance after creating a cortical window. Subchondral k-wires were used for provisional stabilization, followed by placement of a pre-contoured medial locking plate using locking screws. Care was taken to minimize soft-tissue stripping and preserve the periosteum.[8]

All patients followed a uniform postoperative protocol and were reviewed clinically and radiologically at 8, 12 and 24 weeks , with a minimum follow up of six months.

Post-operative Protocol

Following surgery, immediate postoperative management focused on optimizing

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patient stability and comfort. This included administration of analgesics, maintenance of intravenous fluid balance, and prophylactic antibiotics. Early mobilization was encouraged as tolerated. Full weight-bearing was initiated only after radiographic confirmation of definitive bony union.[7]

At each scheduled follow-up visit, radiographic evaluations and functional assessments were performed, and any postoperative complications were documented. Functional assessment of the knee joint was conducted no earlier than six months postoperatively, utilizing the Knee Society Score for standardized outcome measurement.[8 –9]

Malreduction was defined as an intra-articular step-off of ≥2 mm, as measured on calibrated radiographs. Alignment of the proximal tibia was assessed using two parameters:

Tibial Plateau Angle (TPA): the medial angle between the tangential joint line and the anatomical axis of the tibia on anteroposterior radiographs.

Posterior Slope Angle (PSA): the angle formed between the medial plateau's tangential line and a line perpendicular to the anterior tibial cortex on lateral radiographs.

A TPA > 90°, a PSA > 15° or < 25°, or a proximal tibial intra-articular malalignment angle ≥ 80° were considered indicative of malalignment.[9]

Secondary loss of reduction was defined as an increase of ≥2 mm in the intra-articular step-off compared with immediate postoperative imaging. A change of ≥3° in alignment relative to the initial postoperative radiograph was classified as secondary loss of alignment.[9]

Bony union was considered present when at least three cortices demonstrated bridging callus on follow-up radiographs. Non-union was defined as the absence of radiographic evidence of healing beyond nine months.

III. RESULTS

Of the 35 patients initially enrolled in the study, 4 were lost to follow-up, leaving 31 patients with a minimum follow-up duration of six months. The age of the cohort ranged from 18 to 60 years. The study population consisted of 28 males and 7 females. Road traffic accidents accounted for approximately 75% of the injury mechanisms. Among the fractures, 25 were classified as Schatzker type V and 10 as Schatzker type VI.[5]

All patients underwent operative management using dual plating—either locking plates, buttress plates, or a combination—through a minimally invasive dual-incision approach. Postoperative complications were minimal. Three patients developed superficial surgical site infections, all of which were successfully managed with intravenous antibiotics and appropriate wound care. Malreduction and malalignment were not observed on immediate postoperative radiographs. The most commonly reported postoperative symptom was mild knee discomfort.

Functional outcomes were assessed using the Knee Society Score. Of the 35 patients evaluated, 22 achieved excellent results (scores 80–100), and 7 demonstrated good outcomes (scores 70–79). Two patients showed fair functional recovery (scores 60–69), and no patient fell into the poor outcome category (<60). The mean knee flexion achieved at final follow-up was 110°

The New Knee Society Score (KSS) consists of five structured components –

1. Patient Demographics
2. Objective Knee Score, completed by the treating surgeon
3. Patient Expectations, recorded by the patient
4. Patient Satisfaction Score, provided by the patient
5. Functional Knee Score, self reported by the patient.

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1. **Type of Fracture (Schatzker)**

Type of Fracture	No. of Patients
Type V	25
Type VI	10

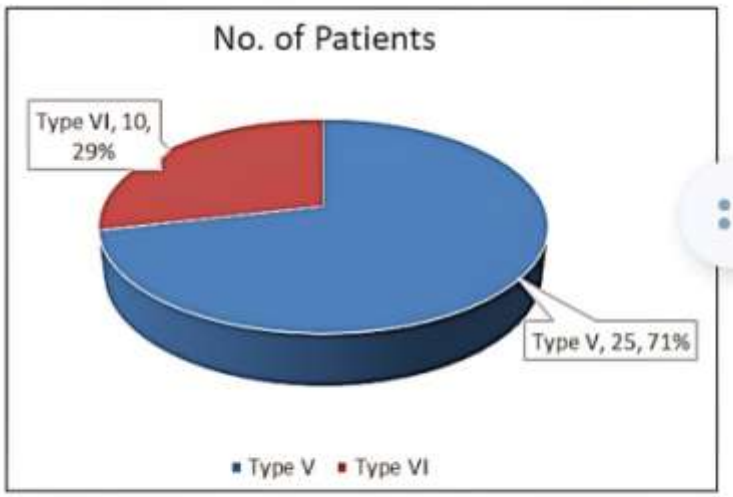

Fig 1: Types of fractures

2. **Side of Fracture**

Side of Injury	No. of Patients
Left	11
Right	24
Left and right	00

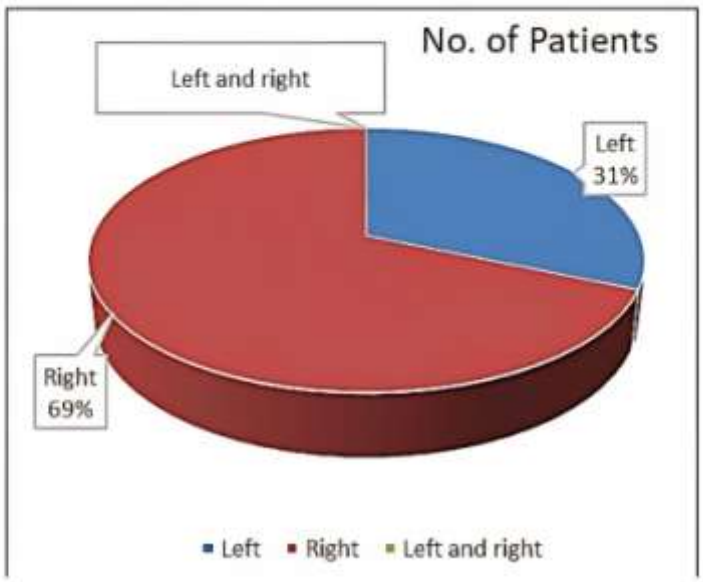

Fig 2: Side of fracture

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3. Sex

Gender	No. of Patients
Male	28
Female	07

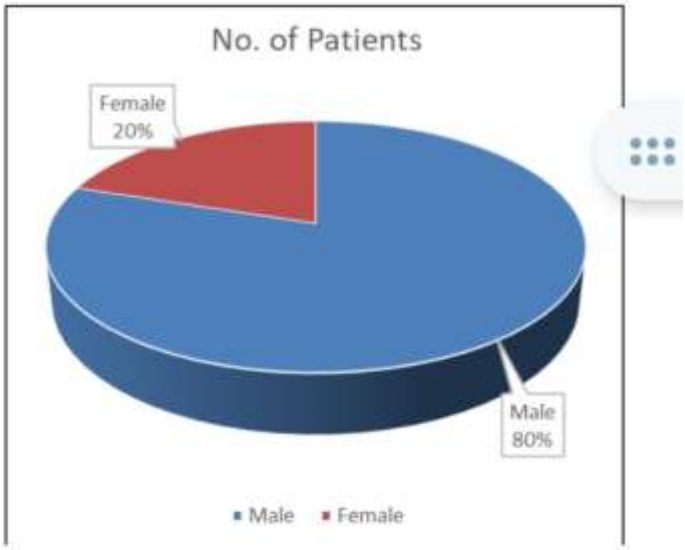

Fig 3: Gender Distribution

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4. Complications

Name of Complication	Affected number of patients
Infection	03
Wound Dehiscence	00
Residual Deformity	00
Change of Work	00
Unable to Work	00
Significant Pain	00
Walking Difficulty	00
Stiffness in Knee Joint	00

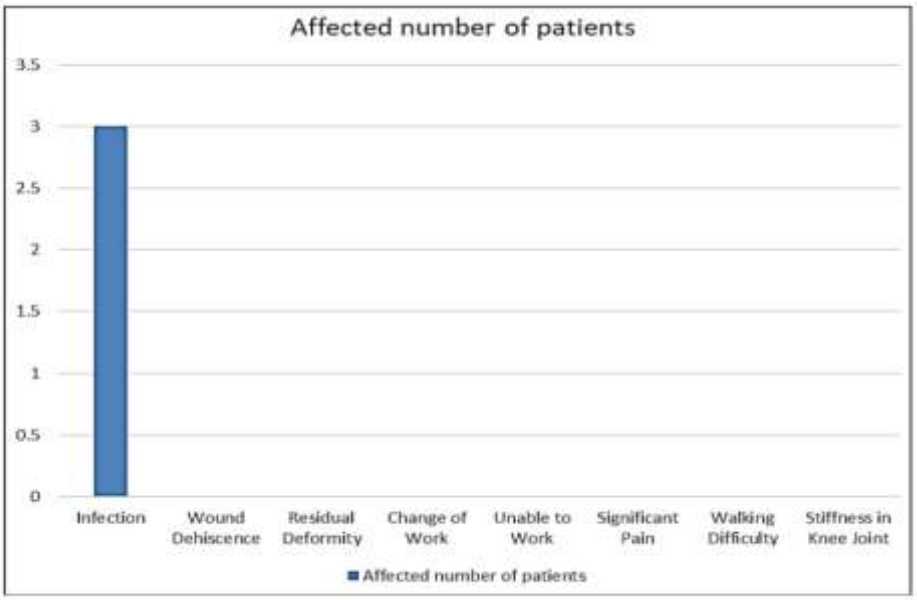

Fig 4: Complications

5. Functional Outcome Evaluation by Knee Society Scoring System

Grading	Patient's Number	Percentage
Excellent	22	70.96
Good	7	22.58
Fair	2	6.45
Poor	0	0
Total	31	88.57

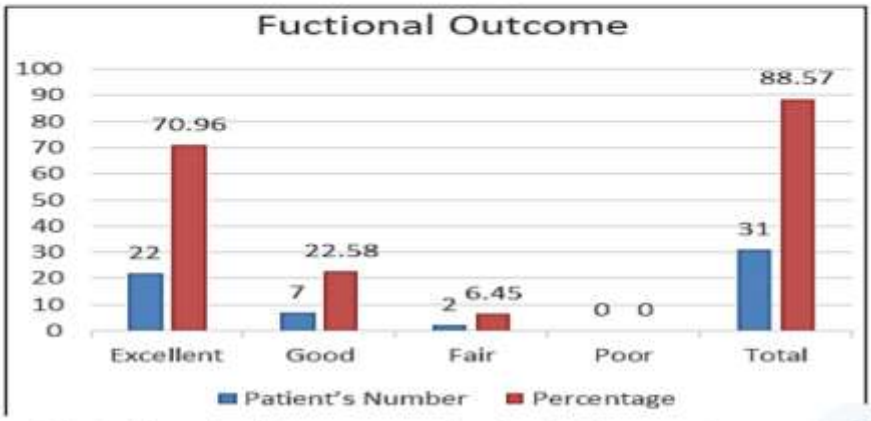

Fig 5: Functional Outcome evaluation by knee society score

IV. DISCUSSION

The present study was conducted in the Department of Orthopedics at Hi-Tech Medical College and Hospital, Bhubaneswar. ODISHA , with the aim of evaluating the functional outcomes of internal fixation for proximal tibial plateau fractures using plate osteosynthesis. Managing intra-articular fractures of the proximal tibia remains a significant challenge for orthopedic surgeons due to substantial soft-tissue swelling around the knee joint and the inherent difficulties associated with wound coverage and surgical exposure.

In recent years, the increasing adoption of minimally invasive surgical approaches has transformed the management of these fractures. Multiple studies have demonstrated that minimally invasive plate osteosynthesis (MIPO) achieves excellent outcomes, largely because it preserves periosteal blood supply, minimizes soft-tissue disruption, and reduces the incidence of postoperative wound-related complications [9, 11, 12]. By limiting extensive soft-tissue stripping, this approach facilitates stable fracture reduction while simultaneously lowering the risk of iatrogenic injury.

The fundamental objectives in the treatment of complex proximal tibial fractures include restoring the anatomical congruity of the articular surface, ensuring adequate stability at the fracture site, promoting early mobilization to achieve optimal knee range of motion, and minimizing postoperative complications [13, 14]. Achieving mechanical stability in bicondylar and severely comminuted fractures requires precise anatomical reduction and rigid fixation of both the medial and lateral tibial columns.

Dual-plate fixation through a minimally invasive or mini-open technique has shown considerable success in fulfilling these requirements. This strategy provides robust buttressing of both columns, enhances construct stability, and has been associated with a consistently low rate of complications. The outcomes observed in our study align with these findings, reinforcing the value of dual-plating constructs in the comprehensive management of complex proximal tibial plateau fractures.

V. CONCLUSION

This study demonstrates that dual plating for bicondylar fractures of the proximal tibia—particularly those classified as Schatzker types V and VI—provides superior postoperative functional outcomes with a low incidence of complications. Careful preoperative evaluation of the skin and soft-tissue envelope is essential, and adequate time should be allowed for edema to subside and for wrinkle sign to appear before proceeding with surgical intervention. Furthermore, thorough preoperative imaging, including specialized radiographic views and 3D CT reconstruction, plays a pivotal role in optimizing surgical planning and achieving stable, anatomically aligned fixation.

Conflict of Interest Not available Financial Support Not available References:

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