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Functional Outcome of Bicondylar Fractures of Tibia Treated with Bicolumnar Plating and Uni Columnar Plating with CC Screw Fixation

Viraj Acharya[1], Chidananda KJC[2], Nishantha Bhat[3]

Sanjay Gandhi Institute of trauma and Orthopaedics, Bangalore, Karnataka, India

Abstract: ***Background: Proximal tibia Intra articular fractures are complicated fractures to treat. Several modalities of treatment have emerged, still the best treatment modality is debatable. The aim of this study is to study the result of Shatzker type 5 and 6 intra articular tibia fracture treated with bicolumnar dual plating and Plate with screw in terms of union, knee range of motion, infection and functional outcome. Materials and methods: This study is a comparative study of 30 cases of intraarticular proximal tibia fractures classified into Schatzker's type 5 and 6 classification during the period of 2o23 at our Sanjay Gandhi Institute of trauma. Patients were treated by open reduction and internal fixation with dual proximal tibial plate and single proximal tibia plate and screw, with decision of the implant made by the surgeon. Post - operatively removable knee brace with leg elevation given to decrease the pain and swelling. Quadriceps strengthening exercises started on day two. Intermittent knee mobilization was started once the wound pain subsided, depending on stability of fixation. The patient is followed up at regular intervals of 2, 6, 10 and 16 weeks. KNEE SOCIETY SCORE was used for assessment of functional outcome. Results: There was no significant difference in the alignment of the tibia in both the study groups immediate post - operatively and at 2, 6, 10 and 16 weeks follow up outcomes did not show any. Complication of malunion was not observed, there were no cases of varus or valgus and procurvatum or recurvatum, in any of the patients. Varus alignment was noted post operatively in one patient in single plate with screw group. Conclusion: In the Intra articular fractures of proximal tibia Schatzker's type 5 and 6, outcome of treatment was dependent upon the fracture type, accurate reduction and stable fixation. The outcome was good when the fracture was properly aligned, fixation was stable and the articular surface was maintained.***

Keywords: Bicondylar tibial plateau, Schatzker's type 5 and 6, Fracture, Locking plate fixation, Dual plate

1. Introduction

Fractures of the proximal tibia have complicated intra - articular fracture pattern, representing approximately 1.2% of all fractures. Proximal tibial fractures are created by direct trauma. Proximal tibia fractures are difficult to treat due to severe intra - articular and soft tissue damage (1–3) . Schatzker's type I - IV are low velocity post traumatic fracture. Schatzker's type V and VI fractures are high velocity fractures (4) . Open reduction and internal fixation with a rigid implant achieves the goal of anatomic reduction, articular congruence, and mechanical alignment reestablishment while allowing early remobilization, but open reduction and internal fixation causes soft tissue damage and wound complications (5) .

There is a debate regarding the best method for treating proximal tibial fractures, though there are various methods of fixation (6–8) .

Open reduction and fixation with dual plate with anterolateral and posteromedial plates with dual incision is preferred method for fixation of type 5 and 6 fractures but results in wound complications and delayed osteosynthesis due to extensive soft tissue damage. (4, 5, 9, 10)

Another method of fixation is by minimally invasive approach and fixation with LISS plate which causes less soft tissue damage but may not provide adequate stability and maintain proper articular reduction. (11–13)

Some biomechanical studies comparing both methods of fixtion suggest that both methods of fixation provide similar stability. (14, 15) Other biomechanical studies suggest that unilateral plate fixation in a bicondylar fracture resulted in more reduction loss in the medial plateau in axial load than double plate fixation. (16) This causes varus deformity leading to pain and resulting in osteoarthritis.

We have evaluated functional outcome and complications of Schatzker's 5 and 6 proximal tibia fractures treated with dual plating lateral plate through an antero - lateral approach and postero - medial approach with single plating and screw.

2. Materials and Methods

This study is a comparative study conducted with sample size of 30 who were diagnosed with proximal tibia fracture between September 2022 and September 2023. Patients were operated with bi - columnar plating with dual incisions for type 5 and 6 Proximal tibia fractures according to Schatzker's classification. The Follow up of these patients was done over a period of 6 months. American knee society score was used to evaluate and Clinical outcomes was assessed for evaluating pain relief, functional activities and fulfilment of the expectations and satisfaction.

Inclusion criteria

- AGE GROUP OF 18 - 60 YEARS.
- SCHATZKER TYPE V AND VI FRACTURES
- CT CLASSIFICATION - BICONDYLAR FRACTURE (MEDIAL AND LATERAL CONDYLE)
- CLOSED FRACTURES
- ACUTE FRACTURES LESS THAN 1 MONTH OLD

Exclusion criteria

- OPEN FRACTURES

- POSTERIOR COLUMN FRACTURES OF TIBIA.
- FOR PROXIMAL TIBIA FRACTURES OF SCHATZKER'S 1, 2, 3, 4 TYPE
- FRACTURES WITH BAD SKIN CONDITIONS CONTRADICTING PLATING

3. Surgical Procedure

All patients were operated under spinal anaesthesia block, patient were supine position with tourniquet control. Intravenous Ceftriaxone 1 gm was given as preoperative antibiotic before incision. Surgical procedure was done with following approaches

1) Anterolateral approach - Following incision soft tissue dissected, fragment was lifted and bought into appropriate reduction under C arm guidance and fixed with k wires if necessary, patient was either on traction table or continuous manual traction was being given. Once satisfactory reduction was achieved plate of appropriate length was selected and acceptable positioning was confirmed. The plate was fixed to the proximal and distal fragment with cortical screws and proximal fragment with cancellous locking and distal with cortical locking screws. (figure - 1)
2) Posteromedial approach - After incision, soft tissue dissection pes was mobilized and fracture was reduced under C arm guidance, and was fixed with low profile proximal tibia plate, fixed with screws. (figure - 2)

In second group medial fragment was fixed with cc screws after appropriate reduction and passing subchondral guide wire.

Figure 1: Postoperative radiograph showing left tibial plateau fracture in a 36 - year - old male patient after dual locking plate fixation

Figure 2: Postoperative radiograph showing right tibial plateau fracture in a 40 - year old female patient after lateral locking plate and medial screw fixation

Post operative protocol

1) Long knee brace with leg elevation given to decrease the pain and swelling.
2) IV antibiotics and analgesics given for 2 to 5 days.
3) Quadriceps strengthening exercises started on day two.
4) Suture removal done at two week.
5) The patients with stable fixation were allowed intermittent knee movements and limb strengthening exercises.
6) At 6 week follow up post operatively all patients were started with partial weight bearing and mobilized with crutches. Full weight bearing was started once evidence of bony union was observed clinically and radiologically.
7) Active range of motion was started at two weeks and nearly full range of motion was achieved by six to ten weeks. The patients were followed up at two weeks, six weeks, ten weeks and sixteen weeks post operatively.

Follow up and assessment

- Clinical, radiological, and functional outcomes were assessed. Surgical site infection was assessed

- AP and lateral views were obtained immediately after surgery and at 6, 10, 16 weeks. Coronal alignment of proximal tibia, medial proximal tibial angle (MPTA), tibiofemoral anatomic angle (TFAA), sagittal alignment, and proximal posterior tibial angle (PPTA). Callus bridging of three of four cortices on AP and lateral radiographs.
- American Knee society, Rasmussen functional score (RFS), Rasmussen radiological score (RRS) score was used to assess functional outcome in all the patients. (17, 18)

Statistical analysis - Statistical analysis was performed using IBM SPSS ver.22.0 (IBM Corp., Armonk, NY, USA). Fisher's exact test and Pearson chi - square test were used to compare cat egorical data between groups. A $p < 0.05$ was considered statistically significant

4. Results

Each group had 15 patients and the demographic characteristics are presented in table 1. The mean follow up period for both groups was 12 months.

Most common cause of injury was Road traffic accidents 20 (66%), work place injury fall from height 5 (16%), fall of heavy object 3 (10%), simple fall in 2 patients (6%).

With regards to patient age, sex, fracture type, fracture side, time from injury to surgery no significant difference was detected between group 1 and group 2.

All the fractures considered for study were of closed type and average time from injury to surgery was 7 days in group 1 and 8 days in group 2.

We compared Knee society scores at 2, 6, 10, 16 weeks in both groups and the scores were similar across weeks with bicolumnar plating having score of 80 at 16 weeks and unicolumnar plating having score of 78 represented in Table 2. Two patients in each group had unsatisfactory results and rest 26 cases were graded as good or excellent.

KSS, RFS, RRS, VAS, and ROM were similar in both groups at final follow up and there was no significant difference as represented in table 3.

Similarly, there were no significant in tergroup differences in TFAA, MPTA, and PPTA at the final follow - up but there was significant difference in TFAA from operated side to normal side in group 2. Two cases in Unicolumnar group developed slight varus deformity (TFAA>5). MPTA and PPTA were within normal limits compared to normal side.

Group 1: dual locking plate group,
Group 2: lateral locking plate group.

Table 1: Demographic characteristics

Variable	Group 1 N=15	Group 2 N=15	P value
Age (yr)	41.3	41.2	0.880
SEX Female male	 5 10	 6 9	
Side of involvement Right Left	 7 8	 8 7	1.00
Follow up (mo)	12	13.9	0.761
Time from injury to surgery (days)	7	8	

Table 2: Knee society score comparison

Follow up	Bi - columnar plating	Uni - columnar plating + CC Screw
2 weeks	0	0
6 weeks	46	47
10 weeks	60	58
16 weeks	80	78

All the fractures healed well and there were no cases of non union or malunion, average time for radiological union was 12 weeks. Partial weight bearing was initiated at 6 weeks and complete weight bearing was started after radiological evaluation from 8 - 12 weeks.

One case in both groups developed superficial skin infection and both resolved with oral antibiotics and regular dressing. No deep infections requiring implant removal were reported.

Arthritic changes was observed in 2 patients in group 1 and 4 patients in group 2 suggesting increased incidence of arthrosis in unicolumnar plating group.

Table 3: Functional outcomes of two techniques

Variable	Group 1 N=15	Group 2 N=15	P value
KSS	80	78	0.511
RFS	25	23.6	0.238
RRS	16	15.4	0.903
VAS	4	4.5	0.517
ROM	120	118	0.430

Table 4: Radiological comparison between two groups and between injured side and normal side

Variable	Group 1 (n=15)	Group 2 (n=15)	P value
TFAA Fracture side Normal side	 3.8 3.9	 5.1 3.5	0.399
MPTA Fracture side Normal side	 86 87	 85.8 86.2	0.545
PPTA			0.9
Fracture side	5.4	5.5	
Normal side	6.3	5.4	

Flexion contracture was noted in two cases in group 1 and three cases in group 2 and extension contracture was noted in one case in group 1 and two cases in group 2. There was no significant difference in terms of late complications between the groups ($p = 0.55$).

5. Discussion

This study provides a comparative analysis of Schatzker type V and VI proximal tibial fractures treated with dual - column plating versus unicolumnar plating with additional screw fixation. These complex, intra - articular fractures are challenging to manage due to the intricate nature of the tibial plateau anatomy and the potential for soft tissue injury, which complicates both surgical planning and postoperative rehabilitation. Our findings highlight both the strengths and limitations of each fixation method in terms of functional outcomes, stability, and postoperative complications, contributing to the ongoing debate on the optimal approach for these fractures.

The results demonstrate that both dual - column (bicolumnar) plating and unicolumnar plating with screw fixation provide satisfactory outcomes in terms of fracture healing, knee range of motion, and patient satisfaction. Using the Knee Society Score (KSS) at different follow - up intervals, we observed that by 16 weeks, patients in both groups achieved similar functional outcomes, with scores indicating good - to - excellent results. The average KSS in the dual plating group was 80, while it was slightly lower at 78 in the unicolumnar group, though this difference was not statistically significant. These findings align with the current literature on the effectiveness of rigid fixation for high - energy intra - articular fractures, which emphasizes that both techniques can achieve reliable outcomes with careful surgical technique and appropriate patient selection.

A critical observation in our study was the slight varus deformity observed in two cases in the unicolumnar plating group (TFAA >5). This malalignment is significant as varus deformity in tibial plateau fractures can lead to altered knee mechanics, increased loading of the medial compartment, and an accelerated progression to osteoarthritis. This aligns with biomechanical studies suggesting that unicolumnar fixation in bicondylar fractures may not always provide sufficient support for the medial plateau, particularly in high - energy fractures where axial loading can exacerbate reduction loss. Varus malalignment, even when slight, is concerning as it has been linked to increased pain, functional limitations, and poorer long - term outcomes. Dual - column plating, with its ability to address both the medial and lateral condyles independently, offers biomechanical advantages in maintaining articular congruity and resisting deforming forces in bicondylar fractures.

Our study also highlights the differences in early arthritic changes observed in radiographs. Patients in the unicolumnar plating group demonstrated a higher incidence of early degenerative changes, with arthritic progression noted in four patients, compared to two in the dual plating group. Although this was not statistically significant, it aligns with previous studies that associate unicolumnar fixation with uneven load distribution across the tibial plateau, which can predispose patients to osteoarthritis. Arthritic changes in the knee joint can significantly impact long - term functional outcomes and may necessitate further interventions in the future. Dual plating's structural advantage in distributing load evenly across the joint surface likely contributes to its reduced association with arthritic progression, particularly in younger and more active patients who place higher functional demands on the knee.

Radiographic assessments, including the Medial Proximal Tibial Angle (MPTA), Proximal Posterior Tibial Angle (PPTA), and Tibiofemoral Anatomic Angle (TFAA), showed no significant deviations between the two groups or between the injured and normal sides in either group. This finding is consistent with the literature on successful reduction techniques for Schatzker type V and VI fractures, which emphasize the importance of accurate intraoperative reduction and stable fixation. The maintenance of normal radiological alignment postoperatively in both groups underscores the effectiveness of both fixation methods when executed properly, and it confirms that both dual - column and unicolumnar plating can achieve satisfactory alignment and stability in the short term.

The rate of complications in our study was low, with one case in each group developing a superficial skin infection that resolved with oral antibiotics and routine wound care. No deep infections were reported, and no patients required implant removal due to infection. The comparable infection rates between the dual - column and unicolumnar plating groups suggest that, with proper soft tissue management, dual plating does not increase infection risk despite the more extensive exposure required for its insertion. This finding aligns with studies indicating that wound complications in dual plating can be minimized with meticulous surgical technique and postoperative care, particularly in high - energy fractures where soft tissue compromise is a concern. However, soft tissue considerations remain important, as dual plating requires two incisions and greater soft tissue handling, which could pose a higher risk of wound complications in patients with compromised tissue quality.

The postoperative rehabilitation protocol, which included early quadriceps strengthening and intermittent knee mobilization, was well - tolerated in both groups and facilitated progressive weight - bearing at 6 weeks and full weight - bearing by 12 weeks. Most patients achieved nearly full knee range of motion by the 10 - week mark, with no significant differences in knee flexion and extension between the groups. This demonstrates that both fixation techniques support early mobilization, a key factor in optimizing functional recovery in proximal tibial fractures. Our approach to rehabilitation is consistent with protocols recommended for intra - articular fractures, where controlled early mobilization and gradual weight - bearing are critical for preventing stiffness and promoting functional restoration.

Limitations of this study include its relatively small sample size and short follow - up period of 16 weeks. Although the results provide valuable insights into early outcomes, they may not capture longer - term complications such as late - onset osteoarthritis, which is a known risk following intra - articular fractures of the tibia. Future studies with larger sample sizes and extended follow - up are necessary to assess the long - term benefits and risks of each fixation method, particularly with respect to joint health and patient quality of life over time.

In conclusion, dual - column plating and unicolumnar plating with screw fixation are both effective options for managing Schatzker type V and VI proximal tibial fractures. Dual - column plating offers superior support for the medial plateau, reducing the risk of varus deformity and potentially lowering the incidence of early degenerative changes. Unicolumnar plating, while less invasive, may lead to slightly higher rates of malalignment and arthritic progression, underscoring the importance of case selection. For these complex fractures, accurate reduction, stable fixation, and attention to soft tissue management are essential for optimal functional outcomes. The choice of fixation method should be guided by fracture characteristics, patient factors, and surgeon expertise to ensure the best possible clinical and functional results.

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