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### Evaluation of functional and radiological outcome of tibial plateau fractures Schatzker type V and VI treated with dual plating

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#### Abstract

**Objective:** High-energy tibial plateau fractures remains a challenge to orthopaedics surgeons, with the bicondylar type (Schatzker type V) and the comminuted type (Schatzker type VI) fractures being the most difficult to treat. Treatment goals of high-energy tibial plateau fractures are to restore the joint stability, congruity, and alignment with minimal soft tissue dissection to allow early joint motion and weight bearing. However, these aims may be difficult to achieve because of the high complication rates and the poor outcomes associated with the surgical treatment in literature, there are multiple modalities of treatment for tibial plateau fractures and the literature has not definitively established a standard for the type of fixation. But there has been a growing support and evidence that dual plating is required in high energy bicondylar tibial plateau fractures.

In this study, we evaluated functional and radiological outcomes of 30 patients with high-energy tibial plateau fractures (Schatzker type V and type VI) treated with the double-buttress plate fixation through a medial and a lateral incisions using Rasmussen's functional & anatomical grading system.

**Material and methods:** 30 patients (26 males and 4 females) with type V and VI Schatzker tibial plateau fractures (10 case were type V and 20 case were type VI) were treated by double-buttress plate fixation through a medial and a lateral incisions between august 2013 to august 2016 at deen dayal upadhyay hospital, New Delhi. Functional and radiological outcomes evaluated by using Rasmussen's functional & anatomical grading system.

**Results:** according to Rasmussen's functional & anatomical grading system results were as follows; functional outcome were excellent in 10 patients(33.33%),good-18 patients (60%), fair-2 patients (6.7%) with mean score  $25.17 \pm 2.95$  and radiological outcome excellent in 19 patients(63.33%),good-11 patients (36.67%) with mean score of  $16.80 \pm 1.79$

**Conclusion:** double-buttress plate fixation through a medial and a lateral incisions is an excellent treatment option as it provides stable and rigid fixation and restore the joint stability, congruity, and alignment with minimal soft tissue dissection to allow early joint motion and weight bearing stable. These fractures are commonly associated with posteromedial fragment and fixation of fractured fragment during treatment of these fractures has a major role to play to resist rotational forces and prevention of varus deformity and malunion.

**Keywords:** dual plating, bicondylar, tibial plateau, Schatzker type V and VI

#### Introduction

Tibial plateau fractures constitute 1% of all fractures and 8% of fractures in the elderly. 10% to 30% of this are bicondylar lesions. Schatzker Types I to III are low-energy injuries whereas Types IV to VI are high-energy injuries.<sup>1</sup>High-energy tibial plateau fractures remains a challenge to orthopaedic surgeons, with the bicondylar type (Schatzker type V) and the comminuted type (Schatzker type VI) fractures being the most difficult to treat<sup>2</sup> because of the high complication rates. Treatment goals of high-energy tibial plateau fractures are to restore the joint stability, congruity, and alignment with minimal soft tissue dissection to allow early joint motion and weight bearing<sup>[3]</sup>.

Traditional open reduction and internal fixation with insertion of a single or double buttress plates through a single incision usually requires extensive stripping of the tenuous soft tissue envelope of the proximal tibia, leading to considerable DE vascularization of fracture fragments,

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thus delaying fracture healing and increasing the risks of infection and non-union [4]. In an attempt to improve the treatment of high-energy tibial plateau fractures, improved internal fixation with double buttress plates applied through a medial and a lateral incisions has been widely adopted. [5] This technique allows anatomic joint reduction with minimal iatrogenic soft tissue damage and its associated complications, provides adequate fixation of the fracture, and permits early functional range of motion.

In this study, we evaluated the postoperative functional and radiological outcomes of 30 patients with high-energy tibial plateau fractures (Schatzker type V and type VI) treated with the double-buttress plate fixation through a medial and a lateral incisions using Rasmussen's Functional & anatomical grading system.

**Methods:** The Current prospective Study Was Conducted in Deen Dayal Upadhyay Hospital from August 2013 to August 2016. 30 Patients which satisfied the inclusion criteria were evaluated for functional outcome and fracture union according to standard protocol and were followed up periodically. The results were analyzed by appropriate statistical methods.

#### Inclusion Criteria

- Adult (>18 years of age)
- Both sexes
- Closed Fractures
- Compound grade I fractures
- Exclusion Criteria
- Compound Grade II & III fractures
- Chronic moribund conditions
- Pathological fractures
- Patient not willing to participate in study

**Initial Assessment Protocol-**All patients on admission were seen by the emergency room medical officer and assessed as per standard ATLS protocol. Injured extremity was examined to define the personality of fracture with particular attention to swelling, neurovascular injury, skin condition, joint effusion and shortening of limb. All fractures were then evaluated with antero-posterior and lateral radiograph of knee joint and full length tibia, Oblique view radiographs if needed were taken. In Case fracture geometry could not be adequately assessed then CT scan with 3-D reconstructions were done. All Tibial Plateau fractures were classified based on Schatzker classification of Tibial Plateau fractures. Schatzker Type V and Type VI fractures with tense knee joint effusion, knee aspiration was performed under aseptic condition followed by lower tibial or Calcaneal skeletal traction was applied and limb was kept elevated on Bohler Brown frame till the tissue edema settled (wrinkle sign appeared) and skin condition became good enough to post the patient for surgery.

After Pre-Anesthetic check-up all procedures were performed under regional anesthesia (spinal or combined spinal epidural anesthesia).

Surgery-Patients were operated in supine position and C-arm was used. Pneumatic tourniquet was applied in upper thigh. After exsanguination with Esmarch bandage or limb elevation for 3 minutes, tourniquet was inflated.

**Medial plating:** Fixation of the medial column was performed first.

The skin was incised 1 cm posterior to the posteromedial border of the proximal tibia, curving proximally along the line

of the pesanserinus tendons. The saphenous vein and nerve was identified and retracted anteriorly. The deep fascia was incised to expose the pesanserinus tendons and the medial head of the gastrocnemius. The pesanserinus tendons were retracted anteriorly and the medial head of the gastrocnemius was gently retracted laterally and cut meniscotibial ligament to expose the posteromedial aspect of the proximal tibia.

- If medial fragment was too much posterior than skin was incised 1 cm posterior to the posteromedial border of the proximal tibia, along the medial border of the medial head of gastrocnemius muscle, beginning at the level of joint line. The subcutaneous tissue and popliteal fascia were incised sharply, freed up the medial head of the gastrocnemius muscle without detaching it and was retracted laterally. The semimembranosus complex was bluntly dissected and retracted medially. The upper age of popliteal muscle was identify and detached subperiosteally, exposing the posteromedial tibial plateau. If more exposure was needed, the tibial insertion of semimembranosus muscle was incised in a sub periosteal fashion. The posteromedial fragment was reduced and fixed provisionally with Kirschner wires, the fragment was then stabilized with a posteromedial 3.5 mm T or L buttress plate.

#### Anterolateral Plating

- For anterolateral approach, a curvilinear longitudinal incision was made starting from the lateral femoral epicondyle and passing over the Gerdy's tubercle and running parallel to the shin and 1 cm lateral to it. The ilio tibial band was elevated from the Gerdy's tubercle and the underlying capsule. The tibialis anterior was elevated sub periosteally to expose the lateral surface of the lateral tibial condyle and shaft.

Articular surface depressions was elevated by lifting it through just beneath the depressed fragment using a bone liver and the resultant metaphyseal void filled with autogenous cancellous bone graft from iliac crest. An anatomical lateral tibial locking plate was used to fix the lateral column. Surgical site was washed thoroughly with normal saline. Suction drain was applied. Closure was done in layers. Sterile dressing was done and an above knee POP slab was applied. Wound inspection was done on 3<sup>rd</sup> postoperative day, suction drain was removed and sterile dressing was done. Wound inspection was again done on 7<sup>rd</sup> postoperative day and sterile dressing was done. After stitch removal on 14<sup>th</sup> postoperative day, above knee POP slab was removed and above knee ROM brace applied to operated limb and physiotherapy begin.



Anterolateral plating



Posteromedial plating

**Follow-up:** Standard AP and Lateral radiographs were taken again at 6 weeks and Partial weight bearing was allowed at 12 to 16 weeks, when the radiological signs of union start appearing, gradually progressing to full weight bearing over a month. Patient was subsequently called for follow-up at 18, 24, 36 & 48 weeks respectively. At each follow-up patient was assessed thoroughly for pain, disability, wound healing, range of movements of the knee progression of union, any

associated complications and was clinically assessed using the Rasmussen’s functional & anatomical grading system. Radiographs of the knee and leg were obtained to assess the articular congruity, the metaphyseal-diaphyseal alignment, and any evidence of new arthritic changes. The patients were also questioned regarding functional recovery and their responses noted. The tibial plateau angle (TPA), articular depression / step off, condylar widening and the medial posterior slope angle (PA) were measured by a radiographs.

**Observations and Results:** Descriptive statistics was analyzed with SPSS version 17.0 software. Continuous variables are presented as mean ± SD. Categorical variables are expressed as frequencies and percentages. The comparison of normally distributed continuous variables between the groups was performed using Student’s t test. Nominal categorical data between the groups were compared using Chi-squared test or Fisher’s exact test as appropriate. P<0.05 was considered statistically significant. The observation and results were analyzed with respect to the following variables:-

age	Mean=38.17	SD=8.23
sex	Male=86.7%	Female=13.3%
Mode of injury	RTA=86.7%	Fall=13.3%
Fracture Characteristics	Schatzker Type V Tibial Plateau fractures=10	Schatzker Type VI Tibial Plateau fractures=20

<b>Interval between injury and surgery in days</b>	<b>patients were operated between</b>	<b>mean 8.77±4.61 days</b>
	5 to 7 days=50%,	
	8 to 10 days=26.7%	
	≥10 days=23.3%	
<b>Skin condition</b>		
pre-operatively unhealthy skin	0	
unhealthy skin on 3 <sup>rd</sup> post-operative day	6	
At the time of stitch removal.	4	
<b>Range of Motion</b>		
	<b>Mean = 122.33 degree.</b>	<b>SD=15.58 degree.</b>
Time taken in full weight bearing in weeks	Mean=20.13week	SD=2.67 week
Time taken in radiological union in weeks	Mean=16.6 week	SD=2.3 week
<b>Squatting</b>		
1 can do	21	
2 cant do	9	
<b>cross legged sitting</b>		
1 can do	28	
2 cant do	2	

**Complications:**

Complications	Immediate	Early	Delayed
None	23	22	28
Deep infection	0	2	0
Superficial infection	7	2	0
Implant failure	0	0	0
Wound dehiscence	0	4	0
Hardware prominence	0	0	6
Secondary surgical procedure	0	0	2
Malunion	0	0	0
Nonunion	0	0	0

<b>Functional outcomes</b>	<b>Mean clinical outcome score=25.17 Corresponds to good outcome.</b>	<b>SD=2.95</b>
<b>Radiological out comes</b>	<b>Mean Radiological outcome score=16.80 corresponds to good outcome.</b>	<b>SD=1.79</b>
<b>Correlation Between Schatzker Fracture &amp; Functional outcomes</b>		
Type V	1 Excellent=30%	P value=1.000
	2 good=60%	
	3 fair=10%	
Type VI	1 Excellent=35%	
	2 good=60%	
	3 fair=5%	

Correlation between Schatzker fracture & radiological outcomes: p-value of 1.000, which is not significant statically

	Excellent + Good	Fair + Poor	P value
Functional outcome	28 (93.33%)	2 (6.67%)	0.492
Radiological outcome	30 (100%)	0	

Was excellent + good in 28 & 30 respectively and fair + poor in 2& 0 of the Schatzker Type V &VI Tibial Plateau fractures with p value of 0.492. P value was statically not significant and both group were statically comparable.

### Discussion

The optimal treatment of tibial plateau fractures Schatzker type v and vi has been a matter of debate among orthopaedic surgeons since past. Despite presence of variety of treatment options like cast application, external fixation, limited internal fixation plus external fixation, MIPO and open reduction and plating, none of them has emerged as standard method of treatment. Each of these techniques has their own advantages and disadvantages. Recent reports have supported and recommended MIPO as the better method of treatment. But MIPO has its own limitations like it is a technically demanding procedure and indirect reduction of fractured fragments is always not possible. Keeping all of these facts in mind we studied Evaluation of Functional and Radiological Outcome of Tibial Plateau Fractures Schatzker Type V and VI Treated with Dual Plating. Most of open reduction techniques were associated with high wound complication rates due to mid line anterior approach or Mercedes-Benzes incision. Reaching the posteromedial fragment through a single incision causes wide periosteal stripping and extensive muscle dissection and may hamper reduction as well. Dual plating with two incisions is better than single incision. The posteromedial fragment which was present in 90.6 % of the cases, was one of the main indications for dual plating. The importance of reducing this fragment was stressed upon by Thomas Higgins *et al* [66] and Bareict *et al* [64] in their respective studies.

#### Age Distribution

Mean age of patients who sustained tibial plateau fractures Schatzker type V and VI was 38.17 years in our study with a standard deviation of 8.23 years. It was comparable with mean age of 37.7 years in study by Yonzz Hang *et al*. [4] mean age of 35 years in study by Ebrahim Ghayem Hassankhani *et al*. [5] and mean age of 40 years in study by G. Thiruvengita Prasad *et al*. [6]. Thus we can overemphasise the fact that the younger and economically productive segment of our society sustains these fractures.

**Sex Distribution** - Incidence of these fractures is higher in males, because males are more commonly involved in outdoor activities. In our study total 30 patients were studied, out of them 26 (86.7%) patients were male and rest 4 (13.3%) patients were females. There were 33 (82.5%) male patients and 7 (17.5%) female patients in study by g Thiruvengita Prasad *et al*. [6] there were 16 men and 6 women in study by Ebrahim Ghayem Hassan Khani *et al* [5]. in a series of 22 patients of proximal tibial fractures. Thus results of our study are comparable.

**Mode of injury**- Most common mode of injury is high energy trauma like road traffic accidents. Out of the 30 patients studied, 26 (86.7%) patients sustained fractures due to road traffic accidents, 4 (13.3%) patients were injured in simple falls or low energy trauma. While studying 46 cases of proximal tibial fractures G. Thiruvengita Prasad *et al*. [6]

and both group are comparable.

Correlation between functional & radiological outcomes:

recorded 46 (100%) cases of road traffic accidents, In study by Yonzz Hang *et al* [4]. 71 (89.9%) cases were of road traffic accidents, and 8 (10.1 %) cases were due to other causes.

**Fracture Characteristics**-Out of the 30 patients, 10 patients were of Schatzker Type V Tibial Plateau fractures while 20 of them were Schatzker Type VI Tibial Plateau fractures. Thus we can say that Schatzker Type VI Tibial Plateau fractures is more common than Schatzker Type V Tibial Plateau fractures Interval between Injury and surgery in days-During this study interval between injury and surgery was recorded. Out of 30 patients, 15 (50%) patients were operated between 5 to 7 days, 8 (26.7%) patients were operated between 8 to 10 days and 7 (23.3%) patients were operated more than 10 days after surgery. In our study mean time interval between injury and surgery was 8.8 days with a standard deviation of 4.6 days. We operated the patients only when the swelling settled and wrinkle sign appeared. So we can say that in majority of the patients (76.7 %) tissue oedema settles and wrinkle sign appears within 10 days of injury (5 to 7 days in 50% and 8 to 10 days in 26.7%). Injury surgery interval was 7.1 days in study of proximal diametaphyseal tibia fracture by Peter A. cole *et al* [7]. The average injury surgery interval was 8.5 days in study by cong-fenglou *et al* [8]. while single lateral locked screw plating of bicondylar tibial plateau fractures mean injury surgery interval was 7.5 days in study by T. Gosling *et al* [9]. Thus we can say that the results of our study are more or less comparable with other studies in literature.

**Range of Motion**-Out of 30 patients, Range of motion in 3 (10%) was of at least 140 degree, in 19 (63.33%) was of at least 120 degree, in 6 (20%) was of at least 90 degree, in 2 (6.67%) was of at least 60 degree and none of patients had below 60 degree. In our study mean Range of motion was 122.33 degree. Mean Range of motion was 121.2 degree in a study of treatment of complicated tibial plateau fractures with dual plating via a 2 incision technique by Yong zhang *et al* [4]. Mean Range of motion was 115 degree in a study on functional outcomes of bicondylar tibial plateau fractures treated with dual buttress plates and risk factors, by Yunfeng Yao, *et al* [10].

#### Complications

Surgeon should wait for tissue oedema to settle and wrinkle sign to appear before operating these fractures. On an average wrinkle sign appears within a week. Skin condition was assessed pre-operatively, on 3<sup>rd</sup> & 7<sup>th</sup> post-operative day and at stitch removal. 7 patients had unhealthy skin on 3<sup>rd</sup> post-operative day, which reduced to 4 patients at the time of stitch removal. Out of 4 patients, 2 patients had superficial infection, which was subsided with antibiotics and daily dressing and 2 patients had deep infection, among whom, in one patient secondary surgical procedure in form of implant removal was done, after the radiological union was seen and the infection subsided and the second patient was treated with antiseptic dressing and surgical procedure in the form of SSG. No malunion and non-union recorded. Hardware prominence was seen in six patients. Ebrahim Ghayem Hassan Khani *et al* [5] in their study of treatment of complex proximal tibial fractures by double plate fixation with single anterior incision;



recorded skin infection in 2 out of 22 patients. As study by Yong Zhang *et al* [4]. In their study recorded superficial infection in 4&2 in buttress plate group and combination group respectively and deep infection in 2 & in 1 patients. Kumar and Whittle reported a 7% deep infection rate in 57 Schatzker VI tibial plateau fractures treated with circular wire external fixation. Barei *et al* [11] studied the complications in 83 patients treated with dual plating and found a deep infection rate of 8.4 %. Our series in comparison had a significantly lower rate of deep infection of 3.1 %. Steven N. Shah, M.D., and Madhav A. Karunakar [12] in 2007 have reported on the wound complications in their series of 29 patients and found a overall infection rate of 17 % with deep infection being 13%.

#### Time taken for Radiological Union in weeks

In our study of 30 patients, fracture united in 14 to 15 weeks in 8 (26.7%) patients, in 16 to 17 weeks in 13 (43.3%) patients, in 18 to 20 weeks in 7 (23.3%) patients and in more than 20 weeks in 2 (6.7%) patients. Mean radiological union was 16.6 weeks. We can interpret from our results that most of the fractures 28 (93.7%) patients] united between 16 to 20 weeks. The average duration of union was 14.1 weeks in study of treatment of these fractures by Yong Zhang *et al* [4]. Ebrahim Ghayem Hassan Khani *et al* [5]. And reported a mean duration of radiological union to be 15 weeks (range: 12–23 weeks) in types V and VI Schatzker classification of tibial plateau fracture by double plate fixation. Kye Youl Cho *et al*. [13] while using a midline longitudinal incision and dual plating recorded average union times of 16 weeks (range: 12–24 weeks) While cong- fengluo *et al*. [8] recorded mean union time as 13.1 weeks with range of 11 to 16 weeks. Similarly James P Stannard *et al* [14] recorded mean union time of 15.6 weeks (range: 6–28 weeks) Thus we can say that the results of our study are more or less comparable with other studies in literature.

#### Time taken in Full Weight Bearing in Weeks

In our study of 30 patients, 1 (3.3%) patients started full weight bearing in 16 to 17 weeks, 10 (33.3%) patients took 18 to 19 weeks, 11 (36.7%) patients took 20 to 21 weeks and 8 (26.7%) patients took more than 21 weeks. Mean time taken in full weight bearing was 20.1 weeks. During our study we allowed full weight bearing only after complete radiological union, because of that results of duration of radiological union are nearly similar to results of time taken in full weight bearing.

#### Squatting and cross legged sitting after union

Out of 30 patients, squatting exercises can do by 21, cross legged exercises can do by 28. Review of literature doesn't yield much about Squatting and cross legged exercises in tibial plateau fractures

#### Functional outcomes

Final functional outcome was 'excellent' in 10 (33.33%) patients, 'good' in 18 (60%) patients, 'fair' in 2 (6.7) patients and 'poor' in 0 (0%) patients. Mean clinical outcome score was 25.17 with standard deviation of 2.95 which corresponds to 'good' outcome. (Rasmussen grading).

#### Radiological out comes

Final Radiological outcome was 'excellent' in 19 (63.33%) patients, 'good' in 11 (36.67%) patients, 'fair' in 0 (0%) patients and 'poor' in 0 (0%) patients. Mean clinical outcome score was 16.80 with standard deviation of 1.79 which corresponds to good outcome (Rasmussen grading).

There was a correlation found between the radiological and the functional score thereby showing the importance of achieving a good articular reduction to have good function (p

value =0.492) Younger patients were found to score higher functionally.

Though Schatzker type 6 is supposed to be prognostically bad compared to type 5, there was no significant association between the type of fracture and functional and radiological outcomes (p =1.000).

Degenerative changes are usually seen 6-8 years after initial injury. The main factors in preventing early degenerative changes after intra articular fractures of the knee include the anatomical restoration of joint congruity restoring the normal alignment, joint stability and early rehabilitation. There is an increased incidence of degenerative changes in patients of higher age at the time of injury. Our follow up patients were mainly in the third decade which could be one of the reasons we had no incidence of osteoarthritic changes.

Hence our results demonstrate a substantially lower deep infection rate and a much better outcome as compared with previous studies reporting results of open reduction and plate fixation. The use of 2 incisions and avoidance of extensive soft-tissue dissection may have contributed to the lower infection and wound complication rates observed in this study.

We acknowledge that our study has its limitations in that limited study population. Duration of study was short to analyze the onset of secondary' osteoarthritis. Not all Schatzker Type V and VI fractures in this period were treated with dual plating. It was left to surgeon's decision to decide which patient to operate with which method. -All observations were made by a single unblinded observer. None of the parameters were randomized. However, we hope that continued study of these fractures will lead to a better understanding of these fractures in general and help us in maintaining a high standard of results.

## Conclusion

These fractures are commonly associated with posteromedial fragment and fixation of fractured fregment during treatment of these fractures has a major role to play to resist rotational forces and prevention of varus deformity and malunion.

- To avoid complications full weight bearing should only be allowed after radiological union which on an average takes 18 to 22 weeks with mean of 20.1 week.
- Early aggressive knee mobilisation has been one of the key factors in achieving excellent functional outcome in our series.
- Superficial infection is the commonly encountered complication in these fractures after surgery, but by respecting and gently handling the tissue envelope, this complication can be avoided.
- Thus we can conclude with the message that tibial plateau fractures schatzkar type V and VI treated with Dual plating (medial plating and anterolateral plating) yields good functional and radiological outcome with lower complication rate.

## Case

41 yr old gentle man with a history of RTA, schatzkar type V tibial plateau fracture with no neurovascular deficit. Surgical fixation with T buttress non-locking plate on medial side and lateral proximal locking plate on lateral side. At the last follow up, patient was symptom free with normal walking capacity, no extension lag, no instability and ROM were 0 to 120 degree.



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