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Computed tomography-based three-column classification aid in complex tibial plateau fractures schatzkers type V and VI fixation

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Abstract

Fractures of the tibial plateau usually result from high energy trauma. They change the knee kinematics, alter joint stability, and cause joint incongruity. These fractures range from simple lateral condyle fractures to severe comminuted metaphyseal fractures. Various surgical modalities like open reduction internal fixation with cannulated Screw fixation, Condylar plate with or without bone graft, AO/ASIF Buttress plate (T/L) with or without bone graft, Proximal tibial locking plate have been practiced. The aim of this Prospective Observational Cohort is to introduce a computed tomography-based “three-column fixation” concept; and evaluate the functional outcomes of treatment of internal fixation of tibial condylar fractures. 35 patients of age group 18-70 yrs who presented with X-ray based Schatzker Type V and VI proximal tibia fractures were selected for the study and a three column CT-based classification was done. All the patients underwent Open Reduction and Internal Fixation with locking compression plating. The opted surgical approach depended on the assessment of injury by CT-based reconstruction of the fracture. The functional outcomes were assessed using oxford knee score. Complications were observed and treated accordingly with an average follow-up of 12 months. It was observed that the mean duration of the union was 14-16 weeks. Most of the patients (19) showed excellent results with a good range of motion of 122°. The combination of posterior and antero-lateral approaches is a safe and effective way to have direct reduction and satisfactory fixation for complex tibial plateau fractures. The three-column classification seems to be an efficient method to characterize and classify fractures of tibial plateau, particularly multiplanar fractures involving the posterior column.

Keywords: Tibial plateau fracture, schatzkers, three column classification, dual plating, oxford knee score

Introduction

Fractures of the tibial plateau usually result from high energy trauma. Motor vehicle accidents seem to be the predominant cause worldwide. Tibial plateau fractures (TPFs) have a complicated intra-articular fracture pattern, representing approximately 1.2% of all fractures [1]. Fractures range from simple lateral condyle fracture to severe comminuted metaphyseal fractures [3]. These fractures are often associated with severe soft tissue compromise. Hence while treating these fractures, the surgeon takes into consideration many factors like the type of fractures, soft tissue, and ligamentous injury. 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 type of imaging is optimal. Management of complex tibial plateau fractures is technically demanding for an orthopedic surgeon for accurate articular reduction intraoperatively to avoid early post-traumatic osteoarthritis. Traditionally, the treatment for complex tibial plateau fractures type V and VI of Schatzkers or Type C of AO was based on two-dimensional classification systems. Several authors have agreed that a computed tomography (CT)-based three-dimensional consideration of the fracture pattern was important in the treatment of tibial plateau fractures [2]. In recent years, “three-column fixation” technique, which is predicated on three-dimensional understanding of the fractures, has been used to treat the multiplanar complex tibial plateau fractures.

Materials and Methods

Study Population – All the patients presenting to OPD or Emergency in KIMS, Bhubaneswar, with Proximal Tibia Fractures, admitted in Department of Orthopedics.

Inclusion Criteria: Age > 18 years, Displaced and undisplaced Schatzkers type V, VI closed fractures.

Exclusion criteria: open compound fractures, Pathological fractures, bilateral fractures, Compartment syndrome, Adjacent joint injuries, Non-consenting patients on admission, all the patients underwent a standard radiologic protocol of x-rays and CT scan and were classified as per the three column classification. They underwent relevant pre and post procedure investigations following which they were subjected to surgical management. Post-operative complications if any were look after meticulously and functional outcome was assessed by Oxford knee score. The cases were followed up at interval of 1 month, 3 months, 6 months and 12 months, for a maximum of 2 years.

Three Column Classification

Complex tibial plateau fractures V and VI were classified based on three column classification, on the transverse view, the tibial plateau is divided into three areas, which are defined as the lateral column, the medial column, and the posterior column. These three columns are separated by three connecting lines, namely OA, OC, and OD. Point O is the center of the knee (midpoint of two tibial spines); Point A

represents the anterior tibial tuberosity; Point D is the posteromedial ridge of proximal tibia; and Point C is the most anterior point of the fibular head. Point B is the posterior sulcus of the tibial plateau, which intersects the posterior column into the medial and lateral parts. A “three-column classification” was used for decision making. According to this classification, one independent articular depression with a break of the column wall is defined as a fracture of the relevant column. Pure articular depression (Schatzker Type III) was defined as a “zero-column fracture.” Most of the simple lateral split and split depression fractures (Schatzker Types I and II) belong to a “one-column (lateral column) fracture.” However, when there is an anterolateral fracture and a separate posterior–lateral articular depression with a break of the posterior wall, the fracture is defined as a “two-column (lateral and posterior column) fracture.” Articular depression in the posterior column with a break of the posterior wall is also defined as a “one-column (posterior column) fracture” (not included in any type of the Schatzker classification). The other typical “two-column fracture” is the anteromedial fracture with a separate posteromedial fragment (medial and posterior column fracture), which traditionally belongs to Schatzker Type IV (medial condylar fracture). The “three-column fracture” is defined as at least one independent articular fragment in each column. The most common three column fracture is a traditional “bicondylar fracture” (Schatzker Type V or Type IV) combined with a separate posterolateral or posteromedial articular fragment.

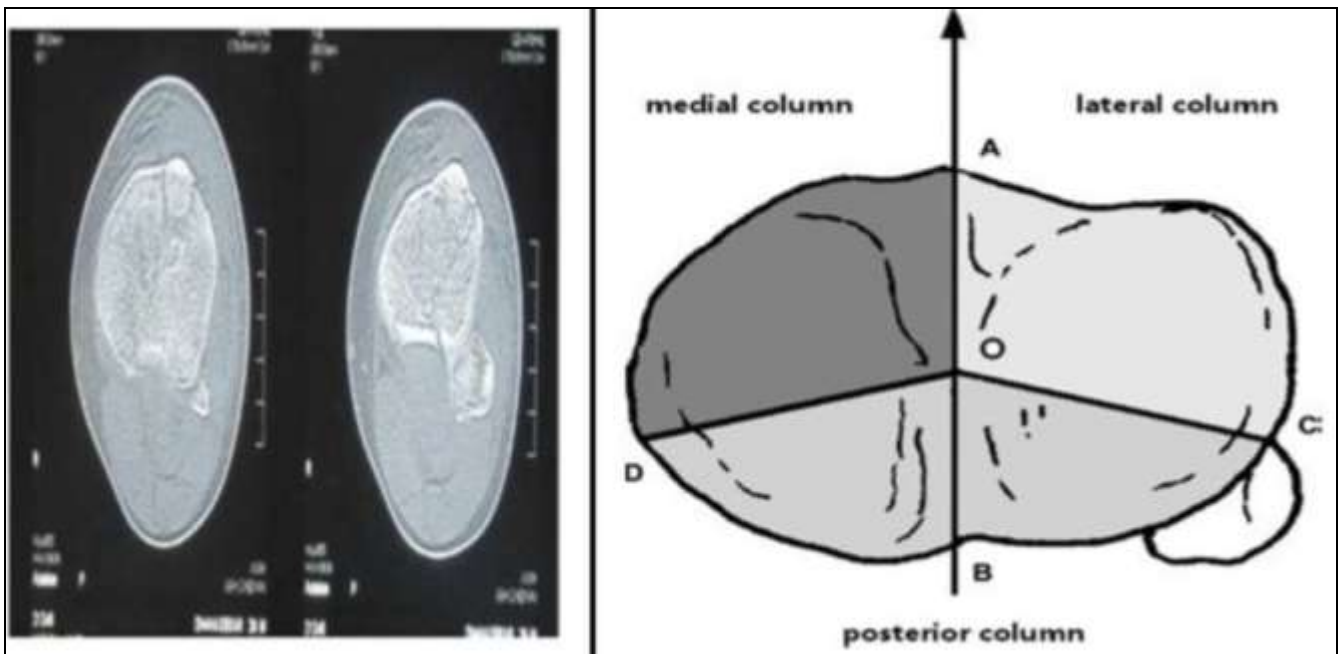


Fig 1A: Showing ct axial section of proximal tibia ,with fracture involving anteromedial ,anterolateral,posteromedial

Fig 1B: Showing ct based three column classification image

Surgical Procedure

Patients were thoroughly investigated, affected knee, and the iliac crest was prepared. Surgery was done under spinal anesthesia. All patients were given Inj.Cefotaxime 1g IV preoperatively as routine prophylaxis. The patient was placed in the supine position, with a folded pillow under the knee to allow knee flexion. A femoral distractor was used whenever needed.

Anterolateral Approach ^[3]

Lateral plating is done using this approach. It is the workhorse

approach for split depression fractures. the incision is based on Gerdy's tubercle and extended distally over the anterior compartment. An L-shaped incision over the origin of the anterior compartment muscles provides access to the anterolateral surface of the tibia. With the knee flexed in a varus and internally rotated position, the intraarticular damage was evaluated through a submeniscal arthrotomy. The fracture was mobilized with a chisel and reduced directly under vision; the articular surface depression was elevated and the fracture was reduced. The resulting subchondral or

metaphyseal defect was then grafted with autograft. A large compression clamp was applied and the transverse diameter of the tibia was controlled under fluoroscopy. Finally, a lateral compression plate or buttress plate was used to stabilize the lateral compartment

Posteromedial Approach

The posteromedial approach is used for medial plating. The incision was placed approximately 2 cm posterior to the posteromedial edge of the tibial shaft. The fascia overlying gastrocnemius was incised and the pes anserinus was retracted anteriorly. The intra-articular fracture-dislocation was visualized with a submeniscal arthrotomy. The impacted fragment was then mobilized in flexion and external rotation, which offers the best view on the posterior aspect of the tibia, and is reduced. In this position, a 3.5-mm dynamic compression plate was contoured and fixed with screws in the distal fragment. The knee was then extended, and the posteromedial fragment is reduced with the 3.5-mm plate acting as a dorsal buttress and was finally fixed with

compression screws in a posteroanterior direction. The position of the screws was confirmed with an image intensifier before closing the wound

Postoperative Instructions: Proper postoperative rehabilitation plays a major role in the recovery of range of movement and power the quadriceps mechanism and functions of the joint. If fracture fixation is stable, then physiotherapy can be started early and the most useful range of motion can be achieved, in the first few weeks of the postoperative period. Postoperative . Early post-op (1-3 weeks): Dressings of the wound. Physiotherapy: Encouraging knee extension, improving knee range of motion exercise. Quadricep strengthening, hamstring stretching, ankle pumping exercise.

Follow up Protocol -All patients were advised to review for regular follow up in the regular interval. A clinical, radiographical evaluation was done to assess the fracture healing at 1, 3, 6 & 12 months.



Fig 2: anterolateral approach (fracture exposed, reduction done and finally a lateral compression plate was used to stabilise

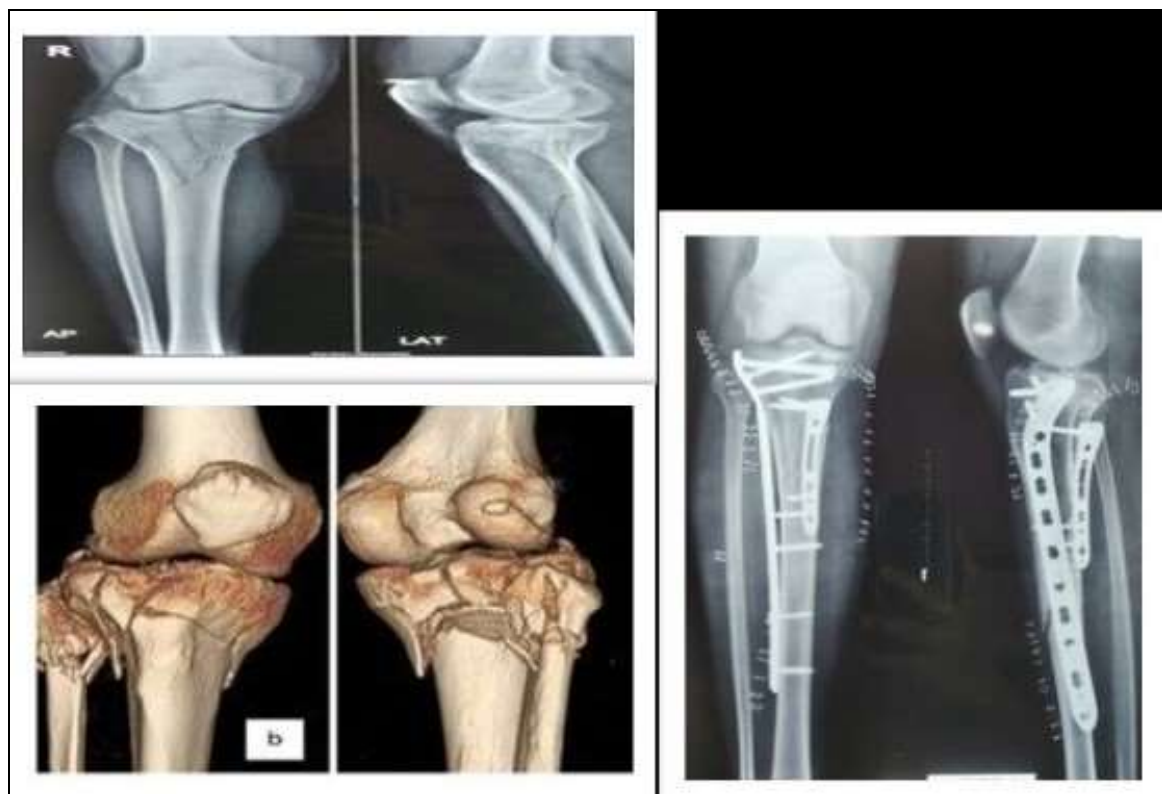


Fig 3: pic (a) pre op xray (b) ct image (C) post op xray

Table 1: Showing fracture pattern and modality of treatment given based on type

	3 column	Type of plating	type	No of pts
1	Anterolateral, posterolateral, anteromedial	Lateral plating only	V	13
			VI	1
2	Anterolateral, anteromedial	Lateral plating and Medial plating(dual)	V	3
			VI	9
3	Anterolateral, anteromedial, posteromedial	The lateral condyle and posteromedial plating(dual)	V	3
			VI	4
4	Anterolateral, anteromedial	The lateral condyle and medial cc screws	V	2
			VI	

Results and Analysis

In our study, 35 patients were assessed between September 1st 2018 to august 31st 2020, they were classified based on three column classification

In our study, the tibial plateau fractures were most commonly due to RTA and between the mean age group 48.7 years .Out of 35 patients, 22 (62.8%) were males and 13(37.2%) were females. Type V were 22 (62.8%) and type VI were 13 (37.2%) There was a slight right-sided predominance 21(60%), compared to the left side`14 (40%). All associated skeletal injuries were attended and given due care appropriately. 5 patients had Hypertension and 6 patients had Diabetes. Duration of hospitalisation of the patient was an average of 8.5 days. 14 patients (40%) required bone grafting, and all were treated with autografting harvested from iliac crest. Single plating was done in 14 patients (40%) dual plating was done in 19 patients (54.2%) and single plating with CC screws was done in Two patient (5%). All fractures united within expected time with an average time of 14.2 weeks. Average range of motion -122.9 degree .Not a single case of non-union was noted in our series.

Table 2: Showing oxford knee society score in post op pts

S. no	OKS	No. of PTS	%
1	Excellent (40-48)	19	54.2
2	good (30-39)	11	31.4
3	Moderate (20-29)	3	8.57
4	Poor (0-19)	2	5.71

The functional outcome of the post op patients scoring based on oxford knee score was done. The Average knee score was 41. Out of 35 cases, we found varus collapse in 3 cases which continued throughout follow up. Two cases had a superficial infection at 6 months, out of which one resolved by antibiotics and the other re-quired debridement and then resolved

Discussion

Tibial plateau fractures especially type V and type VI pose a challenge to orthopaedic surgeons for being very complex, as they are associated with significant amount of comminution, compartment syndrome, severe soft tissue compromise, ligament injuries, and associated other bony injuries. Good surgical techniques and implants are essential for accurate articular reduction. Most of the present classification systems for tibial plateau fractures use two-dimensional images, which usually direct surgeons to concentrate 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, some surgeons have realized the importance of considering posterior fixation in tibial plateau fractures, especially for the posteromedial fragment. So the aim towards treatment of these fracture are ‘ Good

preoperative visualization and planning under 3DCT scannin, followed by good Anatomical reduction under visual and fluoroscopy, stable fixation and early mobilization for a painless, mobile joint

35 cases of Schatzkers type V and type VI were studied and end results of this study are discussed below, taking into consideration of following parameters

In our study, individuals in between 20-49 years are the ones who have maximum incidence of these high energy fractures, with average age group of 48.7years. which correlates with study done by Vasand *et al.* (2013) ^[4] found 75% patient were in age group 30-50 years, In our study 62.8% of the patients were males. This correlates well with the study done by Vasand *et al* (2013) ^[4] who found 90% of the patients were male and Wu at al. (2015) ^[5] found 75% male prevalence in their studies

In our studies, type V fractures were 62.8% and type VI were 37.2%. Wu *et al* (2015) ^[5] found 55% prevalence of type V fractures. Road traffic accident which are high velocity injuries was the commonest mode of injury (65.2%) in my study. In our study, there were 40% patients treated with use of bone graft (auto grafts) while 60% without use of the primary bone graft. Use of bone graft is necessary in such fractures as they involve significant amount of comminution and depression which need to be elevated to achieve articular congruous reduction. Use of bone grafting in form of autograft or allograft improve the outcome in treated fractures ^[57]

With careful review and application of the CT scan for the evaluation for these fractures ^[4]. According to study by cong feng lou ^[6] have realized the importance of considering posterior fixation in tibial plateau fractures, especially for the posteromedial fragment ^[6] as inadequate fixation leads to varus collapse of the fragment. Multiplanar complex tibial plateau fractures, especially those involving the posterior column, are quite difficult to manage clinically. With this technique, posterior column fixation is stressed when the fractures involve the posterior aspect of the plateau. Instead of classic bilateral (medial and lateral) approaches, a new combination of posterior and anterolateral approaches using careful patient positioning (the “floating position”) is introduced to treat such a fracture. Both the Schatzker and AO/ Orthopaedic Trauma Association systems classify fractures according to the appearance on anteroposterior radiographs. Maccarini *et al.* ^[7] studied 25 cases of tibial plateau fractures. After CT scan, only 48% of the cases had the same classification as before the CT scan and 60% of the cases had changes in the operative plan. Most authors agree that CT scanning adds valuable information to the treatment of tibial plateau fractures ^[7]. In our study, We think the CT-based “three-column concept” can help surgeons analyze these fractures three dimensionally providing a better approach and fixation methods when fracture segment

involves posterior column.

Barei DP, Nork SE, Mills WJ, Coles⁸ in their clinical study found most of the open reduction techniques were associated with high wound complication rates due to midline anterior approach or Mercedes-Benz incision. Reaching the posteromedial fragment through a single incision causes wide periosteal stripping and extensive muscle dissection and should hamper reduction as well. Dual incisions are better than single incision. In our study, dual incision with anterolateral and posteromedial approach was done for dual plating, the mean oxford knee society score was found to be 41. Average knee range of motion was 122.9 degree with no deep infection wound complication in any cases

In a biomechanical study by Mueller *et al.* ^[9], stability in a tibial plateau fracture model was compared between the unilateral locking plate fixation and the dual locking plate fixation. The results were similar to those in the study of Yao *et al.* ^[10], who suggested that the shape of the medial condyle fracture plays a key role in single or double plate application. The posteromedial fracture fragment has been reported to have a frequency of 33% in bicondylar tibial plateau fractures. They reported there was no significant difference in the incidence of early postoperative malalignment and malreduction between dual plates and lateral locking plates used to treat bicondylar tibial plateau fractures in patients with a relatively intact medial condyle. Our study also had similar frequency with unilateral plating fixation for intact medial condyle and dual locking for comminuted or displaced medial and posteromedial fracture segment. Overall dual plate fixation followed commonly for complex tibial plateau fractures. Different scoring systems have been recommended to evaluate functional results of tibial plateau fractures. We used OKS in this study. Our results are comparable with those of other published studies with 54% excellent rates.

Ricci *et al* and cole ^[11] *et al* reported about 9% varus malalignment due to fixation and weight bearing and 4% Surgical Site infection. Varus complication is a rare and grave complication on long term outcome as it leads to early OA knee. Our study had three patients with varus, about 8.5% of the people. Of which 2 due to early weight bearing and one due to inadequate fixation. Our study had two cases of knee stiffness, one case due to inadequate fixation of posteromedial fragment and non compliant to physiotherapy in one case. Weight-bearing was started only at 8-12 weeks which was similar to our study. Since our study group is small we were not able to statistically conclude which procedure is better. Choice of the procedure/implant should be supported on the fracture pattern, bone quality, and intraoperative reduction

Conclusion

Schatzkers type V and VI Tibial plateau fractures are complex high energy injuries usually present with different and difficult configurations. The type of management with every fracture pattern changes, As no fracture is the same and should be managed on fracture to fracture basis. with incorporation of recent 3D CT guided three column classification, it gives a proper idea about the fracture pattern so helping in pre op planning and surgical approach and fixation. so it a useful tool in surgical planning strategy.

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