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To study the functional outcome in proximal tibia fracture having a posteromedial fragment fixed with buttress plating

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Abstract
Objective: The main objective of the study is to emphasizes the importance of the postero-medial fragment in the management of the tibial plateau fractures and study the functional outcome in Proximal tibia fracture treated with buttress plating. So accurate reduction and buttressing the fragment is essential for excellent functional outcome.
Materials and Methods: It was a single center Retrospective and prospective study. 60 patients, with mean age 50.53 ± 13.47, presenting with traumatic fractures of proximal tibial having posteromedial fragment treated with buttress plating via posteromedial approach were included in the study and were followed up for the period of 1-year post-surgery. Anatomical and functional evaluation was done using the modified Rasmussen's clinical and radiological criteria.
Results: Mean Rasmussen's Clinical Outcome score was 26.63 ± 2.63 with 53.33% (32 patients) showed excellent clinical outcome and 30% (18 patients) showed good outcome. Mean Rasmussen's Radiological Outcome score was 8.3 ± 0.95 with 60% (36 patients) showed excellent radiological outcome and 33.33% (20 patients) showed good outcome. The correlation between Rasmussen's Clinical and Radiological Score was found to be strongly positive (R=0.76) which was a statistically significant finding ($p<0.05$). The correlation between Rasmussen's Clinical and Radiological Score with Age of patients was found to be negative (p=0.03). There was a significant difference in Mean Clinical and Radiological Scores of Patients between different classification groups, Highest score were seen in patients with One Column involvement followed by Two column ($p <0.05$).
Conclusion: The study emphasizes the importance of the postero-medial fragment in the management of the tibial plateau fractures. Accurate reduction and buttressing the fragment is essential for excellent functional outcome. The goal of treatment of these fractures aims at stability and perfect articular reduction, both of them are not possible without reduction and fixation of the posteromedial fragment.

Keywords: posteromedial fragment, proximal tibia, buttress plating, Rasmussen, posteromedial approach

Introduction

Proximal tibia being involved in body weight transmission through knee joint and leg, it plays a vital role in knee function and stability. Incidence of fractures of proximal tibia are increasing due to the increasing incidence of RTA [1, 2]. To preserve normal knee function, the surgeon must strive to restore joint congruity, maintain the normal mechanical axis, ensure joint stability, and restore a full range of motion.

Fracture involving the medial condyle of the proximal tibia represents highly unstable type of fracture, and require anatomical fixation for better postoperative results. Various modalities for treatment of proximal tibia have been proposed, earlier was mostly done by plaster cast. Later in an article by W. H Threthowan 1920 emphasised the importance of realigning the intra-articulation fractures by open reduction and fixation; he also mentioned the need for elevating the depressed fragment. Thus, we have advanced from conservative approach to internal fixation in fractures as acceptable mode of treatment.

Till recent years x-ray based Schatzger's and AO (Arbeitsgemeinschaft für Osteosynthesefragen) OTA (Orthopaedic Trauma Association) classifications have been used for assessment of fracture pattern and determining the treatment plan and prognosis in tibial

plateau fractures [3, 4]. But these classification systems give inadequate information regarding involvement of posterior part of tibial plateau i.e., the fracture lines in the coronal plane [5-8]. Schatzger's, AO/OTA and most of the other classifications are based on the findings of anteroposterior radiographs and therefore cannot identify posterior shear (coronal) fracture patterns and give inadequate information regarding involvement of posterior part of plateau fractures [5-8]. So, Luo *et al*. [9] in 2010 came up with three column concept (fig 1) based on axial CT (Computed Tomography) scans. Tibial plateau was divided into lateral, medial and posterior (posteromedial and posterolateral) column. As the posterior column fractures are also well addressed in this classification system, it appears to be a better system as compared to other x- ray based classification systems.

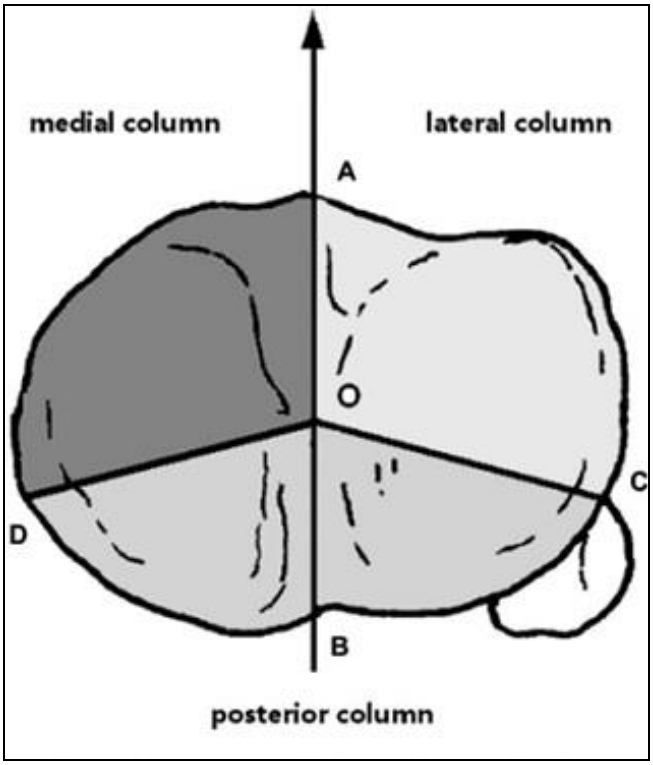

Fig 1: Three-Column Classification

With increasing use of CT scan for analysing tibial plateau fractures it was found that, in bicondylar fractures incidence of posteromedial fragment was very high (59-74%) [7]. These fragments, if not observed during pre-operative planning can lead to inadequate fixation, ultimately causing early arthritis, persistent pain and suboptimal functional outcome [10]. Many authors have reported that surgical plan made by analysing plain radiograph have been revised after CT scan in 6-60% cases [11, 12].

Materials and Methods

This descriptive study was single center, retrospective and prospective study. A total of 60 patients were included in the study (43 Male and 17 Female patients; 41 right and 19 left leg) with the mean age of 50.53±13.47 ranging from 23 to 65 years of age. Majority of the patients in this study suffered injury as a result of a road traffic accident (RTA) (42 patients, 70%). The other modes of injury reported in the study were fall (10 patients), fall from height (4 patients) or fall of heavy object (4 patients). The comorbidities reported in the enrolled patients were hypertension (HTN) reported in 18 patients (30%), diabetes mellitus (DM) seen in 8 patients and varicose veins in 4 patients. Mean duration of trauma before presentation which was noted in the study was 3.5 hours. The minimum duration noted was 1 hour while the maximum duration being 72 hours. The mean duration was found to be 8.53 hours.

Inclusion Criteria

1. Patients who have been diagnosed as closed proximal tibia fracture having posteromedial fragment fixed with posteromedial buttress plating.
2. Age group of 20 to 65 years of both sexes.

Exclusion criteria

1. Pathological fractures (like osteoporosis, tumour, infection)
2. Open Fractures [13]
3. Fractures associated with knee dislocation
4. Patients with ipsilateral femur and tibia fractures
5. Patient with multiple fractures

On admission thorough history and clinical examination was done. Patient also underwent routine AP and Lat X-ray of the proximal tibia. Additional views of Internal and External oblique views, traction and stress view are also included. Pre-op CT scan is essential in determining the extent of injury and classify the fracture. Fractures were classified on the basis of Schatzgers, AO and Three column Classification (Table 1 gives a graphical representation of patients in various classification systems).

Table 1: Distribution of patients according to fracture classification

A. AO Classification	
B1.2	14
B1.3	2
B3.2	10
B3.3	4
C1.1	8
C1.2	8
C2.2	6
C3.2	4
C3.3	4
B. Schatzger's Classification	
IV	32
V	28
C. Three-Column Classification	
One column	30
Two column	26
Three column	4

After understanding the fracture anatomy surgical plan was devised, 30 patients were treated with Posteromedial plate only while 26 patients were treated with Posteromedial and Anterolateral Plate and 4 cases were treated with Posteromedial plate and CC Screw. Patients were followed up for 1 year and final clinical assessment was done according to the Modified Rasmussen's Clinical and Radiological criteria. This study was approved by the ethical committee of the college under the Helsinki declaration.

Operative procedure and Implant

Posteromedial fragment was approached via posteromedial approach (fig 2) with patient in supine position. Position a sandbag beneath the contralateral hip to roll the patient approximately 20°. This will increase the external rotation of the affected limb, bringing the posteromedial corner of the tibia forward. Ease of access is also improved if the surgeon

stands on the opposite side of the table from the approach. Tourniquet was used in 83.33% of cases (50 patients).

Fig 2: Posteromedial Incision

Make a 6-cm longitudinal incision overlying the posteromedial border of the proximal tibia. The exact length of the incision will depend on the pathology to be treated. The long saphenous vein and the saphenous nerve will be just anterior to the surgical approach; these structures are identified and preserved. Pes anserinus expansion overlying the tibia is identified, to approach the tibia, either divide the pes anserinus longitudinally in the line of the skin incision or identify the anterior border of the pes and partially resect it from its insertion into the tibia, reflecting it posteriorly. Further deeper dissection is developed by an epi-periosteal plane between the pes anserinus and the medial head of the gastrocnemius at the posteromedial border of the tibia. The muscle is gently freed from the bone by blunt dissection. A medial sub-meniscal arthrotomy can be performed as necessary for direct visualization of the articular surface.

For the fractures of other columns appropriate incisions are taken for the adequate exposure of the fracture.

Multiple fixation methods have been used in the past to fix the posteromedial fragment. Researchers have used 1/3rd tubular plate, anteroposterior lag screws, reconstruction plate, anterolateral plates, limited contact locking buttress plates and posteromedial proximal locking plate. In our study we used 3.5 mm limited contact buttress plate for the posteromedial fragment and 4.5mm anterolateral plate and Canulated cancellous screw to address other fractures.

Posterior coronal plane fractures are vertically unstable making them optimal for buttress plating. A posteromedial buttress plate was confirmed superior in preventing fragment subsidence to anterior-to-posterior lag screws, limited-contact dynamic compression plate and an anterolateral locking plate [14].

Biomechanically, these plates are on the compression side of the bone. Plates applied to the posteromedial aspect of the tibia also prevent varus deformity, the most common deformity of the proximal tibia after fracture.

(Figure 3A to 3F depict a clinical case of proximal tibia fracture with posteromedial fragment fixed with buttress plating and with 1 year follow-up.)

Fig 3A: - Pre-Operative Radiograph

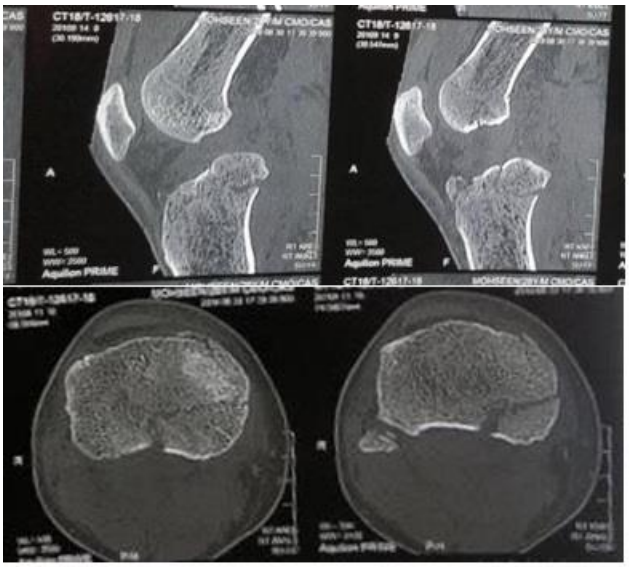

Fig 3B: Axial and Sagittal cut of CT scan.

Fig 3C: 3D CT scan image showing fracture anatomy

Fig 3D: Immediate Post-Operative Radiograph

Fig 3E: - 1 year Follow-up Radiograph

Fig 3F: Clinical picture showing full ROM at 1 year Follow-up

Result

Out of selected 60 cohort, 30 patients were treated with Posteromedial plate only while 26 patients were treated with Posteromedial and Anterolateral Plate and 4 cases were treated with Posteromedial plate and CC Screw. Mean duration of surgery was 133 ± 29.14 minutes (range 75 to 210 minutes) with mean blood loss being 261.67 ± 98.89ml. Post-Operatively in 52 patients (86.67%) antibiotics were given for 3 days, whereas for the rest of the patient antibiotics were continued till 5 days. 4 patients experienced post-operative complications; Two cases had superficial infection and one case had deep infection and another case had knee stiffness. Both the cases with superficial infection subsided without any consequences with intravenous antibiotics. Case of deep infection was treated with wound wash and antibiotic therapy according to culture sensitivity with I.V antibiotics given for 3weeks followed by oral course for 3weeks, infection subsided after the due treatment without any consequences. Another case of Knee stiffness was the result of inadequate mobilization of the patient due to poor follow up. Majority of the cases did not encounter any complication.

The clinical and radiological outcomes were assessed according to the Modified Rasmussen Clinical and Radiological outcome score. Six clinical parameters (Pain, walking capacity, lack of extension, range of motion, power of quadriceps and stability of the knee joint) were included for evaluation. Based on the total score of each patient, the function was graded as Excellent (>27 points), good (24-27), fair (20-23) and poor (<20). Four radiological parameters (Articular depression, Condylar widening, Valgus-Varus angulation, osteoarthrosis) were assessed for radiological outcome and were graded as Excellent (9-10 points), good (7-8), fair (5-6) and poor (<5).

Mean Rasmussen's Clinical Outcome score was 26.63 ± 2.63 (range 19 to 30) with 53.33% (32 patients) showed excellent clinical outcome, 30% (18 patients) showed good outcome, 9 patients showed fair and one showed poor outcome. Mean Rasmussen's Radiological Outcome score was 8.3 ± 0.95 (range 6 to 9) with 60% (36 patients) showed excellent radiological outcome, 33.33% (20 patients) showed good outcome and remaining 4 patient had fair outcome while none of the patient had poor radiological outcome. The correlation between Rasmussen's Clinical Score and Radiological Score was found to be strongly positive (R=0.76, CI: 0.55-0.87) which was a statistically significant finding ($p<0.05$).

The correlation between Rasmussen's Clinical Score and age of patients was found to be negative (R= -0.34, CI: -0.61 to -0.02) which was a statistically significant finding (p=0.03). The correlation between Rasmussen's Radiological Score and age of patients was found to be negative (R=-0.32, CI: -0.59 to -0.01) which was a statistically significant finding (p=0.04). This means that as the age of patient was higher, the outcome score was lower, and this was a statistically significant finding ($p<0.05$).

18 patients belonging to B class by AO classification had excellent clinical outcome (30%), while 14 of those belonging to class C had excellent outcome (23.33%). 20 patients belonging to B class by AO classification had excellent radiological outcome (33.33%), while 16 of those belonging to class C had excellent outcome (23.33%). There was significant difference in the mean Rasmussen's clinical as well as the radiological outcome scores between the various B and C subgroups by AO classification (Table 2 and 3).

Table 2: Mean Rasmussen's Clinical Score by fracture classification

AO Grade	Mean Score	P value (ANNOVA test)
B1	27 ± 3.38	<0.001
B3	25.57 ± 3.3	
C1	24.5 ± 1.41	
C2	23 ± 2.64	
C3	21.75 ± 1.7	
Schatzger's Classification	**Mean Score**	**P value (ANNOVA test)**
IV	26.43 ± 3.22	=0.03
V	23.85 ± 1.83	
Three Column Classification	**Mean Score**	**P value (ANNOVA test)**
One column	27.31 ± 1.6	<0.001
Two Column	26.33 ± 3.31	
Three Column	24.5 ± 0.71	

Table 3: Mean Rasmussen's Radiological Score by fracture classification

AO Grade	Mean Score	P value (Annova test)
B1	8.6 ± 1.06	<0.001
B3	8.14 ± 0.89	
C1	7.95 ± 0.75	
C2	7.44 ± 0.57	
C3	7.12 ± 1.29	
Schatzger's Classification	**Mean Score**	**P value (Annova test)**
IV	8.37 ± 0.95	=0.04
V	8.01 ± 0.97	
Three Column Classification	**Mean Score**	**P value (Annova test)**
One column	8.53 ± 0.66	<0.001
Two Column	8.23 ± 0.97	
Three Column	6.5 ± 0.71	

18 patients belonging to category IV by Schatzger's classification had excellent clinical outcome (30%), while 14 of those belonging to category V had excellent outcome (23.33%). 20 of the patients belonging to category IV by Schatzger's classification had excellent radiological outcome (33.33%), while 16 of those belonging to category V had excellent outcome (26.67%). There was significant difference in the mean Rasmussen's clinical as well as the radiological outcome scores between the grade IV and V by Schatzger's classification.

18 of the patients belonging to Posteromedial category by Three columns classification had excellent clinical outcome (30%), while 14 of those belonging to posteromedial and lateral category had excellent outcome (23.33%). Both the patients in the medial lateral and posterior category had good clinical outcome. 20 of the patients belonging to Posteromedial category by Three columns classification had excellent clinical outcome (33.33%), while 16 of those belonging to posteromedial and lateral category had excellent outcome (26.67%). One patient in the medial lateral and posterior category had good clinical outcome while the other had fair outcome. There was significant difference in the mean Rasmussen's clinical as well as the radiological outcome scores between the posteromedial, posteromedial and lateral, as well as medial lateral and posterior groups, by Three-column classification.

The significant difference in the means of clinical and radiological outcome scores of different classification methods suggests that as the complexity of the fracture increases the outcome decreases ($p < 0.05$).

Discussion

The proximal tibial plateau fractures are associated with poor functional outcome if not treated successfully [7]. Proximal tibial plateau fractures account for about 2% of all the fractures. The management of these fractures have evolved significantly over the past decades. There are no clear-cut guidelines for non-operative treatment and across all patient ages and activity levels, many consider that articular step-off of less than 3mm or condylar widening of less than 5mm tends to have an acceptable low rate of adverse long-term effects if treated non-operatively. With varus or valgus tilt, the functional outcome deteriorates steadily. Age is never considered a criteria since older individuals do better when treated properly.

In 19th century, it was believed that posteromedial tibial plateau fracture was rare and difficult to treat. Advent of CT scan and 3-D reconstruction unveiled the posteromedial fragment in many cases of tibial plateau fractures. The incidence of this posteromedial fragment was found to be 33% in all cases of bicondylar proximal tibial fractures by a study done by Barei *et al*. [8] In a study by Higgins *et al* [7] he analyzed the CT scans of bicondylar tibial plateau fractures (111 cases) and found the incidence of posteromedial fragment to be 59% (65 cases). It is believed that the posteromedial fragment occurs as a consequence of avulsion of semi-membranosus tendon attachment of the proximal tibia due to hyperextension force. It may also occur as a result of the varus force on a flexed knee causing the femoral condyle to impact on the tibial plateau resulting in split fracture. The unique feature of the posteromedial fragment is that it has a relatively large surface area forming almost half of the surface area on the medial condyle. In a study by Barie *et al* [8], it contributed for about 58% (range 9%-98%) of the surface area of medial condyle of proximal tibia. Higgins *et al*., confirmed the fact and showed that the fragment occupied 25% of the total tibial articular surface. Usually, it is a split fracture with more than 5mm displacement rather than a depression even in osteoporotic bones. As a result, there have poor outcome after conservative treatment. It is often associated with injury to anterior cruciate ligament. Open reduction and internal fixation with buttress plating is the recent recommendation for these fractures. Since the fragment is posteromedial, the direct posterior approach placed the neurovascular structures at risk. Approaching the fragment anteriorly also posed risks in the form of extensive dissection of the medial capsular structures and needed tibial tubercle osteotomy for better exposure. In a study by Hsieh *et al*. [15], they used anteromedial approach and advocated it since there is no risk of neurovascular injury or flexion contracture of the knee [16]. This approach involved erasure of semi-membranous and semi-tendinosus tendons. The medial collateral ligament was also easily injured. Since the major blood supply of knee is from the medial side there is increased risk of soft tissue devitalization in already compromised soft tissue from high velocity injury. In 1960s, posterior approach to knee involving dissection of the neurovascular bundle was introduced by Trickey [17]. Since it was a highly demanding procedure, many had complications.

Bendayan *et al* described a posteromedial second incision to reduce and stabilize a displaced posterior fragment [18]. Direct visualization and satisfactory reduction were achieved. Injury of the medial head of gastrocnemius was an unavoidable complication. Anteroposterior lag screws were applied to hold the fracture fragment. Hsieh *et al*., in their study involving 8 cases treated using anteroposterior lag screws showed satisfactory results. But the stabilization of the large fragment with anteroposterior screws showed to be biomechanically unstable. Some suggested long screws in the lateral locking plates to hold the fragment in place. But the direction of the screws was parallel to the fracture plane rendering them biomechanically inferior to posteromedial locking plates. Moreover, the direction of screws in the locking plates were fixed. The incidence of varus collapse and the subsequent poor functional outcome was associated with lateral locking plates used for this type of fracture.

Yoo *et al* [18] in his study found that the 3.5 mm nonlocking lateral tibial plate combined with a 1/3rd tubular plate in the posteromedial aspect was biomechanically superior.

In our study, fractures involving the medial condyle of the proximal tibia especially with the posteromedial fragment were treated with 3.5 mm system posteromedial limited contact buttress plate. Functional outcome was measured

using Modified Rasmussen's Criteria for Clinical and Radiological Outcome score. The combined score is taken with maximum score of 30 for Clinical Outcome and maximum score of 10 for Radiological Outcome. Outcome graded into excellent, good fair and poor based on the scores. In this study 32 patients had excellent clinical outcome and 20 having good outcome. Fair outcome was seen in 7 patients and Poor outcome in 1 patient. Also, 36 out of 60 patients had Excellent Radiological outcome with Good and Fair outcome seen in 20 and 4 patients respectively.

Mean Clinical Outcome Score in patients treated with Posteromedial plate only was 27.06 as compare to 26.18 in patients treated with dual plating. 53% patient had Excellent Outcome in patients with only PM plating while 46% had Excellent outcome in patients with dual plating. Mean Radiological Outcome Score was 8.47 in patients treated with only PM plating while 7.52 was the score in patients treated with PM and AL plating. 74% patient had excellent outcome in patients treated with only PM plate while in Patients treated with Posteromedial and Anterolateral plating only 54% patients had excellent outcome.

The result of our study was in accordance with previous literatures regarding the management of posteromedial proximal tibia fracture. Articular reduction is of primary importance for the future outcomes. Proper preoperative planning is the key for successful surgery.

Conclusion

The study emphasizes the importance of posteromedial fragment in the management of tibial plateau fractures. Posteromedial approach is the safe approach to such fragments. Posterior fractures are difficult to identify in routine radiographs of knee joint, thus emphasizes the requirement of CT scan for diagnosis and understanding the fracture anatomy for better fixation of the fracture. Outcome of a patient is directly proportional to the quality of reduction achieved and soft tissue.

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