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To evaluate the fracture pattern and functional outcome of posterior tibial plateau fracture fixation

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Abstract
Objective: To study the posterior tibial plateau fractures patterns and assess the functional outcome of posterior tibial plateau fractures fixations. To define and evaluate the surgical approaches for fixation of these fractures.
Methods: 21 patients who were operated for posterior tibial plateau fractures were included in the study.
Result: 21 patients were subject to follow up for a period of 6 months. After 6 months follow up mean Rasmussen's knee function grading score was 24.76±3.16, with excellent result in 8 patients and good result present in 11 patients. Only 2 patients have fair score. No patient developed surgical site infection. 1 patient developed common peroneal nerve palsy, 2 patients developed medial laxity and 2 patients developed varus collapse.
Conclusion: Open reduction and internal fixation of posterior tibial plateau fracture gives excellent to good functional outcome. In our study we have 90.4% excellent to good functional outcome. Evaluation and recognition of the posterior tibial plateau fracture pattern is essential. Posterior or Posteromedial approach is required for addressing such fracture pattern.

Keywords: posterior tibial plateau, fracture patterns, posterior or posteromedial approach, rasmussen

Introduction
Proximal tibial articular surface is one of the critical load bearing areas of the human body. Fracture of this region occurs due to combination of axial loading and valgus or varus forces applied. Stability of the joint, alignment of the lower limb and motion of the knee joint are severely affected as a result of tibial plateau fracture [1]. These fractures are mostly caused by high-energy trauma and are sometimes associated with significant ligament and soft tissue injuries. This fracture pattern, however, is inherently unstable and difficult to adequately reduce and stabilize by conventional techniques and approaches [2-4].
Tibial plateau fracture accounts for 1% of all fractures [5]. Posterior tibial plateau fractures are not rare in clinical practice, but it is rarely found in isolation. A clinically significant posteromedial fragment has been observed in 30%-59% of bicondylar patterns [6, 7]. These fragments involve approximately a quarter of the total tibial plateau surface and are significantly displaced in half of the cases [6, 7]. It has been underappreciated previously, but with the popular application of 3D CT assessment of tibial plateau fracture, increasing attention has been paid to posterior tibial plateau fractures [8].
Posteromedial fractures, either isolated or associated with another fracture, was a challenge for observers to classify, because they are not described in the Schatzker [9]. Or AO classifications. These are only visible on lateral radiographs or computed tomography scans. If wrongly diagnosed, they may lead to the use of inappropriate fixation techniques that result in poor outcome [10].
Posterior tibial plateu fracture includes posteromedial fractures and posterolateral fractures. Posteromedial fractures are split type of fractures because of the concave surface of medial condyle. Posterolateral fractures are depressed fractures because of the convex surface of lateral condyle [11].
Displacement of the posteromedial fragment occurs during knee flexion at low angles without axial loading [12]. These data suggest that an even non-displaced posteromedial fragment are at

risk for displacement with early postoperative range of motion and supports the argument for stable fixation.

Material and Method

This descriptive study was hospital based, and was conducted in the department of Orthopaedics at Maharaja Agrasen Hospital, New Delhi. This was the time bound study (prospective as well as retrospective) from 1st June 2017 to 31st May 2018. A total 21 consecutive patients out of which 17 male and 4 female patients of age group 28 to 68 years were included in the study, including the retrospective data taken from 1st January 2015 to 31st May 2017. 19 patients sustained injury due to road traffic accident and 2 sustained due to self-fall. 11 patients were having Type VI Schatzker and 9 were having type V Schatzker fracture.

Inclusion criteria

1. Patients presenting with tibial plateau fracture with posterior fragment involvement.
2. Patients above 18 years of age (Skeletally mature)
3. Patients with closed fracture.
4. Patients who are fit for surgery and give consent to participate in study.

Exclusion criteria

1. Patients presenting with tibial plateau fracture without posterior fragment involvement.
2. Patients with age less than 18 years
3. Patients with pathological fractures.
4. Patients with open fractures.
5. Patients with late presentation.(>6weeks)
6. Patients who are unfit for surgery due to associated co-morbidity.

On admission thorough history and clinical examination was done. We assessed the neurovascular status and radiological assessments of the fractured limbs were performed. Further investigations were done depending on the general condition of the patient and the routine pre-operative protocol as per our hospital guidelines, radiological assessment in AP and lateral planes were done and preoperative 3D CT scans were done to evaluate the fracture pattern. As coronal plane fractures are easily missed in AP radiographs, so lateral plane X-rays and 3D CT scans helped us to evaluate the exact fracture pattern.

Operative procedure

The goals in treating articular fractures of the proximal tibia include restoring knee joint stability, limb mechanical axis, and articular congruity. These goals are achieved through direct anatomical reduction and fixation with inter fragmentary compression to gain absolute stability.

Posteromedial

The posteromedial approach affords access to the posterior medial and posterior portions of the medial condyle and is ideal for posteromedial shear and impaction injuries. It can be performed with the patient in the supine position and can be done in conjunction with a standard anterolateral approach for bicondylar patterns. It has also been described in combination with a posterolateral approach [13-15].

A longitudinal incision is of 2 cm is given posterior to the posteromedial border of the tibia. Care must be taken to identify and preserve the saphenous nerve and its branches. The pes anserinus tendons are identified, mobilized, and retracted as necessary. If these tendons continue to obstruct reduction and fixation efforts, they can be tenotomized and repaired at the end of the procedure. The fascia over the medial head of the gastrocnemius is incised and the muscle is retracted laterally so the sub periosteal dissection can then be carried across the back of the tibia. A bump under the heel is helpful at this stage. A medial submeniscal arthrotomy can be performed as necessary for direct visualization of the articular surface.

Direct posterior

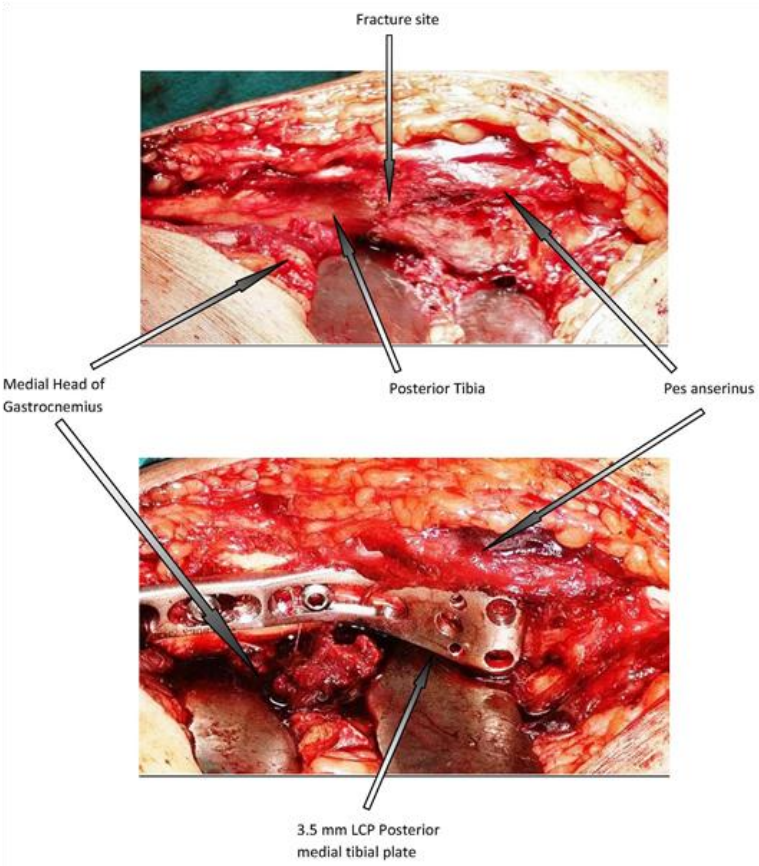
Many iterations of the direct posterior approach have been published [16-18]. The patient is positioned prone and an S-Shaped incision is made along the border of the medial head of gastrocnemius ending at the level of the joint line. After incising the popliteal fascia, the small saphenous vein is identified in the sulcus between the gastrocnemius heads. The medial gastrocnemius is retracted laterally while the semimembranosus complex is retracted medially without detaching its insertion on the posteromedial tibia. Alternatively, if additional exposure is necessary, the tendon of the medial head of the gastrocnemius can be divided sharply, proximal to the muscle's blood supply, leaving a cuff for repair. The medial gastrocnemius is then retracted laterally, protecting the neurovascular bundle [19]. The upper border of the popliteus muscle is detatched and dissected subperiostally, exposing the fracture. The tibial insertion of the semimembranosus complex can be incised in a subperiosteal fashion, if additional exposure is needed. If further distal exposure is needed, the soleus origin may be partially elevated.

Fixation

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 [24]. The clinical and biomechanical implications of poster lateral tibial plateau fracture fragments are not well understood and the indications for fixation are therefore controversial. Stabilization cannot be achieved with an anterolateral implant and strategies such as direct poster lateral plating, fibular strut placement, and anterior-to-posterior screws can be employed.

Implant details

The anatomical outline of posterior tibial plateau is not regular; whose transition area at metaphysis has great degree of curvature. Researchers have used 1/3rd tubular plate, anteroposterior lag screws, limited contact locking buttress plates, posteromedial proximal locking plate and reconstruction plate. In our study we used 3.5 mm limited contact locking plate and 3.5 mm posterior medial proximal tibial plate.

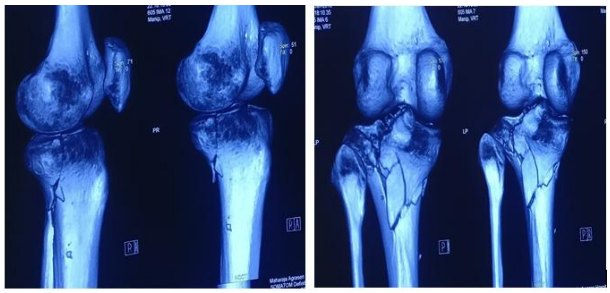


Result

The clinical outcomes were assessed according to the Rasmussen Knee Function grading score. Five parameters (Pain, walking capacity, lack of extension, range of motion and stability of the knee joint) were included for evaluation, each with a full score of 6 points. Based on the total score of each patients, the function were graded as Excellent (>27 points), good (20-26), fair (10-19) and poor (6-9).

According to Rasmussen knee function grading score, the mean of total score was 24.76 ± 3.16 (range 18-28) at 6 months follow up. The mean pain score was 4.95 ± 0.87, mean walking capacity score was 4.14± 1.49, mean range of motion score was 4.76 ± 0.83, mean lack of extension score was 5.05 ± 1.20 and mean stability of the knee joint score was 5.86 ± 0.48. Excellent result (≥27) occurred in 8 patients, good result (≥20-26) occurred in 11 patients and fair result (≥10-19) occurred in 2 patients.

No patient developed incision inflammation, wound dehiscence, wound infection, internal fixation loosening or breakage. 1 case of common peroneal nerve palsy and foot drop occurred, which was neuropraxia type of injury and patient recovered fully in 6 months follow up. 2 patients developed medial laxity of knee joint. Multifragmented fracture of the proximal tibia associated collateral ligament injury might be the reason for this complication. With proper physiotherapy, stability of knee joint significantly improved during this 6 months follow up period. 2 patients developed varus collapse at knee joint. Obesity and improper physiotherapy after surgery might be the reason for this complication. In these patients radiologically results were poor but functional outcome of these patients were good and fair. Both these patients were able to walk and perform their routine activity.

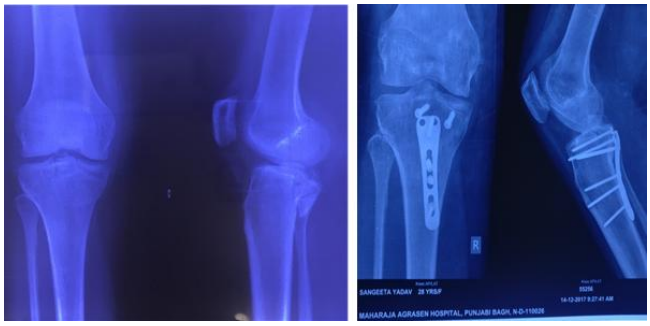


Pre-op CT scan

Pre-op X-ray 6 months Post-op X-ray

6 months Clinical picture

Pre-op CT scan



Pre-op X-ray **6 months Post-op X-ray**

6 Months Clinical picture

Discussion

Tibial plateau fractures are known since time immemorial. But posterior tibial plateau fractures were thought to be rare in occurrence. Sir Astley Cooper was the first to publish his method of treatment of tibial plateau fractures in 1825 [25]. Frassbend (1901) [26] was credited for performing first open reduction of tibial plateau fracture. Previously posterior tibial plateau fractures were treated with dual plates, similar to fixation of bicondylar tibial plateau fracture. But radiologically results have not been satisfactory. Some of the fracture fragments have not been attended too, while doing such fixation, leaving to poor functional outcome. This could be attributed to poor understanding of fracture geometry. Bendayan J, Noblin JD, Freeland AE (1996) [27] in a case series concluded that in patients with bicondylar tibial plateau fractures that include displaced posterior fragment, reduction by manipulation or through conventional anterior exposure often is not possible. A second posterior incision has been suggested and found to be efficacious.

Schatzker *et al*. (1979) [28] published their classification system, deriving it from the AP radiographs of a series of 94 patients. The most widely used Schatzker classification system is more than likely to miss posterior shear fractures, which are best visible in lateral than AP radiograph. With the increasing use of CT scan and 3-D reconstruction in patients with tibial plateau fractures, it was found that this kind of fracture was not rare [5, 11]. In a study of Barei *et al* [11], a posteromedial fragment was observed in nearly one third of the bicondylar plateau fractures evaluated. Higgins *et al* [5] studied 111 CT scans of bicondylar tibial plateau fractures, and they found that 65 cases involved posteromedial tibial plateau fragments, with an incidence of 59%,

In the past, tibial plateau fractures were treated mainly by anterior approaches. Even for single posterior condyle fractures, a plate-screw system or a lag screw was employed to fix the posterior fractures from anterior. This kind of osteosynthesis does not conform to the principle of biomechanics of the knee joint; by this method, it is hard to achieve the high standard of articular reduction, and in early post-operative period flexion of the knee joint is not permitted for fear of fragment re-displacement. Although Lobenhoffer [29], Fakler [30], Tao [31], and Chang [32] have illustrated different anatomic spaces in minor details to poster lateral and posteromedial condyles, the aim and essence is similar, that is, the expectation to expose, reduce, and fix the fragment. Compared with anterior approaches, the value of the Posteromedial and Poster lateral approaches is in accordance with biomechanics of the knee joint and easy anatomical reduction of articular surface, which could be stabilized with antiglide or buttress plate [33].

Bhattacharyya T (2005) described the posterior shearing tibial plateau fracture patterns and early results of treatment via a posterior approach in a retrospective case series [34]. Wang AQ *et al*. (2011) [35] conducted a prospective study in 10 patients and concluded that high energy fractures of the posterior tibial plateau could be well treated based on posterior approaches which can be combined with anterior approach if needed. Chiu CH, Cheng CQ (2013) [36] advised arthroscopic assisted reduction of posteromedial fragment. they found that it is associated with good functional and radiological outcome and low complication rates. Chen HW, Pan J, Yi XH, Huang YX (2016) [8] found that posteromedial approach is the best option to treat the posteromedial tibial plateau fractures because it can provide direct visualization of the fracture site and avoid dissection of neurovascular bundle in the popliteal fossa area with minimal soft tissue injury. In his study on 36 patients, rate of excellent and good result was 94.4%.

In our study, we have approached the posterior fragment by either posterior approach or posteromedial approach. Which provided a better view of fracture geometry, and proper fixation of such fracture was also possible. Post operatively functional outcome of this study was good to excellent in 90.5% patients, which is in accordance with other studies conducted in past for posterior tibial plateau fracture fixation.

The evaluation of articular surface and knee stability is carried out during operation. The restoration of knee stability is equally important as the reduction of articular surface. Several studies have proven that the knee instability is the important factor for a poor prognosis. The varus and valgus deformity could be well prevented with maintaining the tibia in alignment in both sagittal and coronal planes, through precise preoperative planning, careful reduction, and biomechanical fixation.

Conclusion

This descriptive study shows open reduction and internal fixation of posterior tibial plateau fracture gives excellent to

good functional outcome. Posterior tibial plateau fractures are mostly associated with high velocity injuries. Evaluation and recognition of the posterior tibial plateau fracture pattern is essential. Coronal plane fractures are difficult to identify in conventional anteroposterior and mediolateral X-rays of the knee joint. CT scan with 3-D reconstruction is required for proper appreciation of such fractures. There is need for better classification system for classifying coronal plane fractures, so that proper evaluation and pre-operative planning of posterior plateau fractures can become possible. Treatment should be oriented towards a congruent articular reduction with adequate knee stability, anatomical limb alignment and avoidance of complication with early physiotherapy. Posterior or Posteromedial approach is required for addressing such fracture pattern. Absolute fixation must be obtained in order to start early aggressive rehabilitation. Soft tissue problems should be kept in mind. Posterior fragment cannot be left alone, as even the no displaced fragments are at risk for displacement with early post-operative range of motion. Better functional outcome are correlated with high quality reduction.

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