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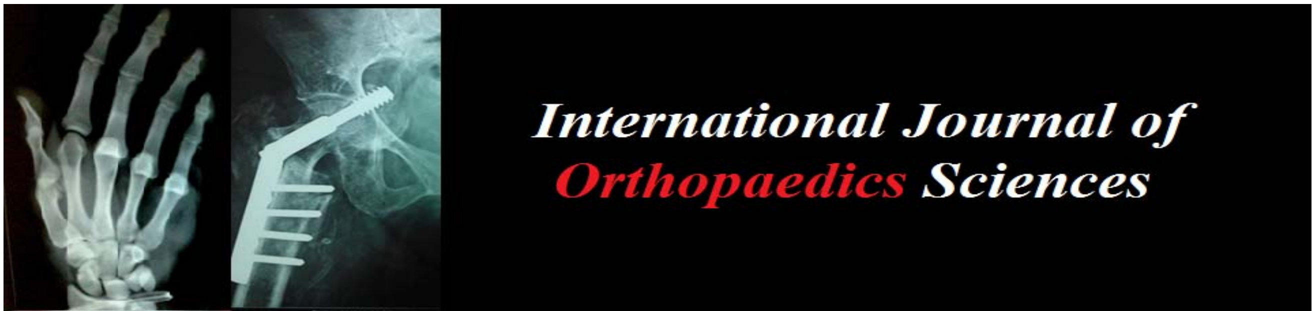

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The posterolateral corner of tibial plateau: When and how to fix?

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Abstract
Introduction: The posterolateral tibial plateau fractures remain a challenge and usually a tough nut to crack even for experienced surgeons. The proximity of the neurovascular structures and difficulty owing to the presence of the fibular head demands surgical skills and expertise. The purpose of this study is to understand the technical difficulties such as difficult exposure, limitation of distal extension of approach, limited implant choices.
Material and Methods: 14 consecutive cases of isolated posterior fractures of the posterolateral tibial plateau were operated with a modified posterolateral approach without exposing the CPN between September 2016 and September 2019. Articular reduction quality was assessed according to the intraoperative fluoroscopy and immediate postoperative radiographs. Patients were followed up at 2 weeks, 4 weeks, 2 months, 4 months and 6 months. International knee score was assessed online, at the end of 6 months.
Results: All patients were followed up, with a mean period of 8 months (range 25–40 weeks). Bony union was achieved in all patients. The average range of motion arc was 126° (range 110°–135°) and the mean postoperative IKS was 94.2 (range 81–97) at 6 months follow-up. None of the patients sustained neurovascular complications.
Conclusions: The modified posterolateral approach could help to expand the surgical options for optimal treatment of this kind of fracture, and plating of posterolateral tibial plateau fractures would result in restoration and maintenance of alignment. This approach demands precise knowledge of the anatomic structures of this region but the results are gratifying.

Keywords: posterolateral, fracture, tibial plateau

Introduction
The posterolateral tibial plateau fractures were once uncommonly encountered and rarely reported [1-4]. Recent data suggests that 15% of tibial plateau fractures involve the posterolateral quadrant however isolated posterolateral fractures account for almost 7% of all tibial plateau fractures [5]. When fractured, on average the posterolateral fragment is 10.5mm depressed [6, 7]. The presence of fibular head and popliteal ligament are an obstruction for the lateral or anterolateral approach to reach the fracture fragment adequately [8, 9]. Posterior approaches, allow direct fracture reduction [10, 11], but limited visualization makes the fixation difficult. These fractures remain to pose a challenge and usually a tough nut to crack even for experienced surgeon.
The proximity of the neurovascular structures, presence of the fibular head, and usually small size of the fragment demand surgical skills and expertise. The purpose of this study was to identify any specific pattern of such injuries on X-rays, study the technical and surgical difficulties in approaching these fractures, choice of hardware and evaluate the functional results and complications.

Material and Method
From September 2016 to September 2019, 14 patients with isolated posterolateral tibial plateau fractures operated at a large multi-disciplinary institute in central India and followed up for 6 months. The patients were treated on ATLS protocol in the emergency department. The diagnosis was made on the basis of clinical examination and X-rays. CT scan was done in all the cases for proper pre-operative planning to study the geometry of the fractured fragment, and the choice of hardware.

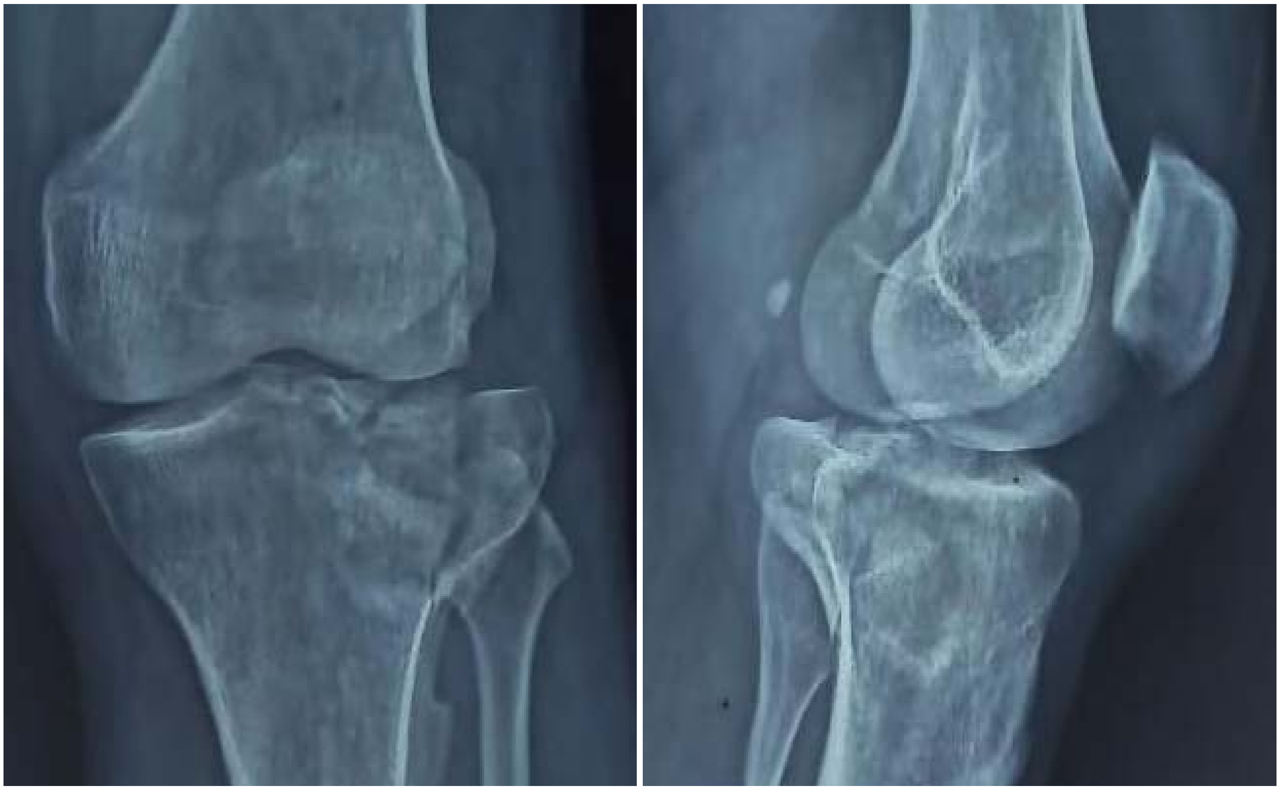

Fig 1: Anteroposterior and lateral x rays

The patient was taken in a prone position after proper anesthesia. A pillow was kept below the ankle to keep the knee in flexion which would relax the gastro-soleus. Fibular head and midline longitudinal line is marked. A longitudinal incision is made through a line passing medial one-third and lateral two-third between these markings. Subcutaneous dissection was done to reach the fascia. The common peroneal nerve lies laterally in this fascia. Fascia is incised in the same line of the skin incision i.e. more towards the midline. Fascia is retracted with the nerve and need not be dissected. The lateral head of Gastrocnemius was reflected medially from the lateral border below the fascia exposing the soleus. Soleus was stripped off from the fibular head exposing the fracture fragments. The anterior tibial vascular bundle consisting of an artery and two venae comitantes pass through the interosseous membrane, anteriorly, around 5-6 cm distal [12] to the tibial rim. The window of safety is small and is at a depth due to the bulk of the muscles.

Almost always these fractures were associated with a depressed fragment and a fractured peripheral rim. Fracture handling needs to be precise and demands expertise. The fractured rim was reflected keeping its attachment intact and the depression was elevated carefully with a dura retractor or bone elevator and temporarily held in place with multiple K wires. Posterolateral depressed fractures when elevated leave a definite void and these need to be augmented with bone grafts or substitutes. We used autogenous iliac crest bone grafts in 7 patients and bone substitutes in the rest of the 7 patients. The selection was done on an odd and even basis. The peripheral rim was reposited back and buttressed with a 3.5 mm distal end radius plate or a 3.5 mm reconstruction plate depending on the fracture geometry. The reconstruction plate however needs to be molded. The fascia and the skin were closed over suction drains. On table knee range of motion was assessed post-fixation.

Fig 2: Approach and implant in situ. Common peroneal nerve was not dissected.

Fig 3: Intraoperaive fluroscopic image showing the elevated fragment and fixation.

A long knee brace or above knee slab was applied post-operatively. Post-surgery, non-weight bearing mobilization, knee range of motion, and muscle strengthening exercises was prescribed. Sutures were removed at 2 weeks. Partial weight-bearing was permitted at 6 weeks with walker support and full weight bearing depending on the progress of the union.

Regular radiographic views were obtained postoperatively, every 4 weeks until the fracture healed. The fracture union was defined on the basis of a combination of clinical and radiographic criteria. Clinical criteria was the absence of pain or tenderness at the fracture site. Radiographic criteria was bridging callus at the fracture site on the antero-posterior and lateral radiographic views [13]. Fracture reduction was defined as satisfactory if the medial proximal tibial angle was 87°± 5°, and the posterior proximal tibial angle was 9° ± 5° [14]. At the final follow-up visit, measurements of the knee range of motion were done and all patients were evaluated using the International Knee Score.

Results

Peri-Operative

The study included 2 female and 12 male patients, having a mean age of 39 years (range 21–56 years) The fractures involved 5 left knees and 9 right knees. Twelve patients sustained injury due to road traffic accidents (85.7%), two were injured by a fall from height. The mean time from injury to surgery was 4.8 days (range, 2–7 days) and the average duration of follow-up was 7.5 months (range, 4–12 months). Bone grafting was done in 7 patients, rest 7 patients had a bone substitute implantation to cover the bone impaction defect. 1 patient managed with substitute, developed brownish discharge which was sterile on culture and responded well to antihistamine drugs under antibiotic cover

Radiographic

Bony union was achieved in all the patients. Bony union occurred at a mean of 13.1 weeks (range, 10–16 weeks) after surgery. The mean medial proximal tibial angle was 87.45°(range 87-90) and the mean posterior proximal tibial angle was 8.95 (range 7-12). There was no case of implant failure.

Fig 4: Follow-up X ray done at 6 months.

Fig 5: post operative range of motion at 6 months.

Functional Outcomes

The average international knee score (IKS) was 94.2 (range, 84–97). At the final follow-up, the average flexion was 132° (range 120-140). Extension lag was not noted in any of the patients. No patients complained of instability or chronic pain post-surgery.

Complications

All wounds healed well eventually without infection. No neurovascular deficit was noted in any of the patients. There were no cases of nonunion, malunion.

Discussion

These fractures portray a deceptive benign picture and can usually end up being misdiagnosed. The AP view has a characteristic fractured peripheral rim with a depressed fragment as shown in fig 1. Misdiagnosing, might result in faulty planning and difficult execution during surgery. A posterior fragment misidentified as a lateral one would be difficult to be fixed appropriately with a lateral approach

A perfect surgical approach should have enough visualization with minimal damage to the anatomy[3] and such an approach could not be discovered for posterolateral corner injuries. The conventional Anterolateral approach do not help visualize and buttress the fragment[3], and in the struggle to do so might land up injuring neurovascular structures. Lack or communition of posterior bone column makes it difficult to elevate the depressed fragment through anterior windows[22]. Different surgical approaches have been tried over decades to approach these fractures in supine, prone and lateral positions, each having their own pros and cons.

H Tscherne *et al* [15] used fibular osteotomy in supine position in early 1993. It had chances of nerve injury and also the fibula needed to be fixed after the procedure made it tedious. Lobenhoffer *et al.* [16] used a trans-fibular approach between the fibular head and the tibial tuberosity. This method had extensive soft tissue handling. Approximately half of the patients lost articular reduction which was thought due to soft tissue imbalance. Yu *et al.* [17] in 2010 advocated splitting of iliotibial band which might require fibular osteotomy. Injury to the fibular collateral ligament was common. Solomon *et al.* [18] tried the supine position with the knee flexed to 60 degrees. This approach also utilized a fibular head osteotomy. All these approaches needed dissection of common peroneal nerve.

Several lateral approaches have been utilized as well. Chang *et al.* [19] described a supra-fibular approach in lateral decubitus. The incision was planned from gerdy's tubercle to postero-superior joint line crossing over fibular head. The approach was through the interval between fibular collateral ligament and lateral condyle. The common peroneal nerve was not dissected. Frosch *et al.* [20] used an incision tracing over posterolateral border of fibula. It used two planes in the deeper layers. The posterolateral ligament complex was least injured and hence had better knee stability in terms of clinical outcome. Wang *et al.* [21] described a "Modified Frosch approach" utilizing only one deep incision. Frosch and Modified Frosch approach, both can be used to fix lateral condyle and posterolateral quadrant with a single skin incision.

Carlson *et al.* [22] and Bhattacharya *et al* [9] used a curvilinear "S" incision in the prone position. The lateral head of gastrocnemius was retracted medially with the soleus being elevated. J Tao *et al.* [2] tried a L shaped incision above joint crease. The nerve had to be dissected in these approached and the exposure was difficult. Posterior approaches are preferred for direct visualization and buttressing the fracture fragment appropriately [23, 24], bus have their own shortcomings. The surgical field is usually at a depth and handling the fragment is difficult [25].

The modified posterolateral approach in the study doesn't improve visualization. However given the fact that the nerve was not dissected out and there were no cases of nerve injury in the follow up, this appears to be a feasible choice. The choice of hardware remains limited, the 3.5mm distal radius volar plate serves to buttress the fragments and to accommodate the tibial metaphyseal slope. Care should be taken not to pierce the anterior cortex with screws to avoid impingement.

Our study had a smaller cohort of patients and there is a definite learning curve. The same has to be further evaluated.

Conclusion

The modified posterolateral approach, is satisfactory for dealing posterolateral tibial plateau fractures within 5 cm from the joint line. It provides adequate field for fixation with no need for dissection of neurovascular bundle and has rare chances of neurovascular compromise. This approach is promising and needs further studies comprising larger patient groups.

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