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Evaluation of role of fibula in functional outcome of tibial plateau fractures

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Abstract
Introduction: Tibial plateau fractures occur due to a combination of axial loading and varus/valgus applied forces leading to articular depression, malalignment and an increased risk of posttraumatic osteoarthritis (OA). Various treatment modalities have been used over the years, with mixed results. We present a study to report the functional results of tibial plateau fractures and to evaluate the association of proximal fibula fractures with respect to final outcome.
Methods: Patients diagnosed with tibial plateau fractures from July 2012 to March 2016 were included in the study. Patients with open injuries or neurovascular compromise were excluded. Patients were divided into subgroups on the basis of presence or absence of proximal fibula fracture. 124 patients were managed by either conservative or operative means and followed for an average of 19 months and clinically monitored for functional outcome using Knee Injury and Osteoarthritis Score.
Results: The study population consisted of 65 males and 59 females. Mean patient age was 46 years (range, 24-67 years). Mechanism of injury included road traffic accident (56), fall from height (14), and falls (54). Functional outcome as assessed by Knee Injury and Osteoarthritis Outcome Score was comparable to previous studies. Role of proximal fibula in supporting the lateral condyle was evident from better functional outcomes seen in patients with intact fibula and lateral condyle fracture.
Conclusion: An intact fibula contributes to the mechanical stability of the lateral tibial plateau. Therefore, the knee joint will be affected by injury of the bone or soft tissue that may occur in fibula fractures. A consideration to presence of proximal fibula fractures should be given while classifying tibial plateau fractures.

Keywords: tibial plateau, proximal fibula, fracture fixation, biomechanics, knee injuries

Introduction
Tibial plateau fractures are common and demanding injuries that can be due to high- or low-energy trauma and has a bimodal distribution affecting young adults or elderly patients. Frequent complications in the form of malalignment, incongruity of joint surface, instability, loss of range of motion and residual deformities affect activities of daily living [1-3]. The edema and inflammation associated with the trauma can lead to local venous compromise, dermal hypoxia, and additional soft-tissue injury [4]. This commonly leads to development of blisters over the skin and in some cases dermal and even muscle necrosis [5]. Compartment syndrome can be a devastating complication affecting proximal tibia fractures. Its incidence has been reported in up to 17% of closed and 18.7% of open complex pattern proximal tibia fractures [6]. Tibial plateau fractures are usually classified with the six-type Schatzker fracture classification [7]. But this system does not address the impact of a proximal fibula fracture on the management and final outcome.
The fibula has rich anatomical relations, some of which are important structures of the knee. These anatomical structures and the fibula provide stability of the knee joint and its functions as an important mechanical support to the knee joint [8]. Fibula by its position and various attachments exerts a buttress effect over the lateral condyle of tibia. The buttress effect assumes greater value probably when the condyles get fractured and collapse. On the lateral side fibula by its attachment provides support to lateral condyle and prevents collapse. Thus various fracture patterns behave differently with status of fibula, sometimes assisting and sometimes preventing development of deformity under weight-bearing conditions [9].

In polytrauma patients with ipsilateral tibial fracture, proximal tibiofibular dislocation may be easily missed. The anterior and posterior capsular ligaments and the lateral collateral ligament may get involved in the pathologies of the proximal tibiofibular joint, which may influence the biomechanics and thus the movements at the joint [10, 11].

The purpose of this article is to report the functional results of tibial plateau fractures and to evaluate the association of proximal fibula fractures with respect to final outcome.

Material and Methods

A prospective study was done including all patients diagnosed with intra-articular proximal tibia fracture presenting to us from July 2012 to March 2016. Patients with open injuries, extensive blistering, neurovascular injuries, compartment syndrome were excluded. Skeletally immature patients were not included in study. A written informed consent was obtained from all the patients for inclusion in the study. Patient demographics, injury mechanism were noted and clinical assessment was done. Radiographic evaluation was done with anteroposterior, lateral and oblique radiographs of knee. To keep the classification simple fractures were classified as follows.

	Type of Fracture	Associated fibula fracture
I	Isolated medial condyle fracture	A-Without fibula fracture
		B-With fibula fracture
II	Isolated lateral condyle fracture	A-Without fibula fracture
		B-With fibula fracture
III	Bicondylar fractures with or without metaphyseal extension	A-Without fibula fracture
		B-With fibula fracture

Fractures were managed by either conservative approach or operative fixation depending on fracture pattern and displacement. Conservative methods included close Reduction and application of an above knee cast. In operatively treated group, patients with fractures having isolated condyle involvement either medial or lateral, with no metaphyhseal extension were managed by fixation with cannulated screws. Fractures with metaphyseal involvement were managed by using locking contoured plates. Duration of immobilisation was 4 weeks for cases managed conservatively or with cannulated screws. Following this knee mobilization was started using a functional cast brace for another 6 weeks. Patients were gradually allowed full weight bearing at 3 months follow up. Patients were evaluated for functional outcome at 4months, 6 months and 1 year using the Knee Injury and Osteoarthritis Outcome Score (KOOS). Clinical Outcome was measured in terms of range of motion and alignment. Radiological outcome was assessed by radiographs.

Results

124 patients met our inclusion criteria. The study population consisted of 65 males and 59 females. Mean patient age was 46 years (range, 24-67 years). Mechanism of injury included road traffic accident (56), fall from height (14), and falls (54). Fracture classification and subsequent management are represented in table 1. Average time between injury to surgery was 5 days (range, 2-12 day/s). Mean clinical follow-up was 19 months (range, 12- 34 months). Demographic data is represented in Figure 1 and Figure 2. Functional outcome as assessed by Knee Injury and Osteoarthritis Outcome Score is represented in table 2.

Table 1: Fracture Classification and Management

Type of Fracture	Associated fibula fracture	Management	
		Conservative	Operative
Isolated medial condyle fracture	A-Without fibula fracture	20	16
	B-With fibula fracture	4	8
Isolated lateral condyle fracture	A-Without fibula fracture	15	11
	B-With fibula fracture	8	22
Bicondylar fractures with or without metaphyseal extension	A-Without fibula fracture	1	3
	B-With fibula fracture	2	14

Table 2: Outcome Analysis

Type of Fracture	Associated fibula fracture	Mean Knee Injury and Osteoarthritis Outcome Score
Isolated medial condyle fracture	A-Without fibula fracture	75.6
	B-With fibula fracture	78.2
Isolated lateral condyle fracture	A-Without fibula fracture	86.4
	B-With fibula fracture	79.2
Bicondylar fractures with or without metaphyseal extension	A-Without fibula fracture	70.2
	B-With fibula fracture	65.5

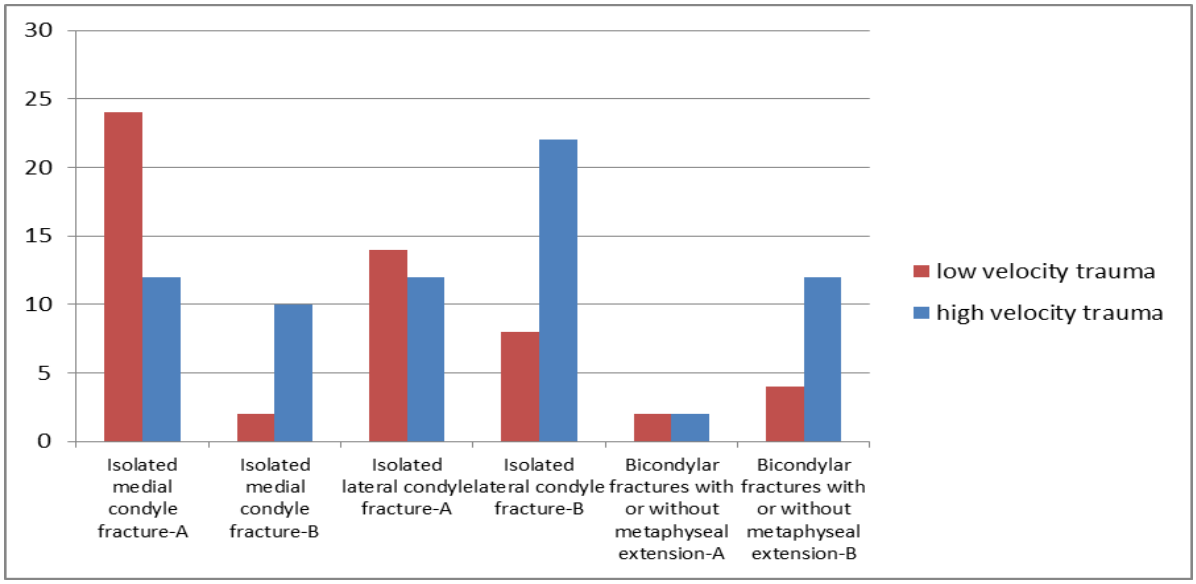


Fig 1

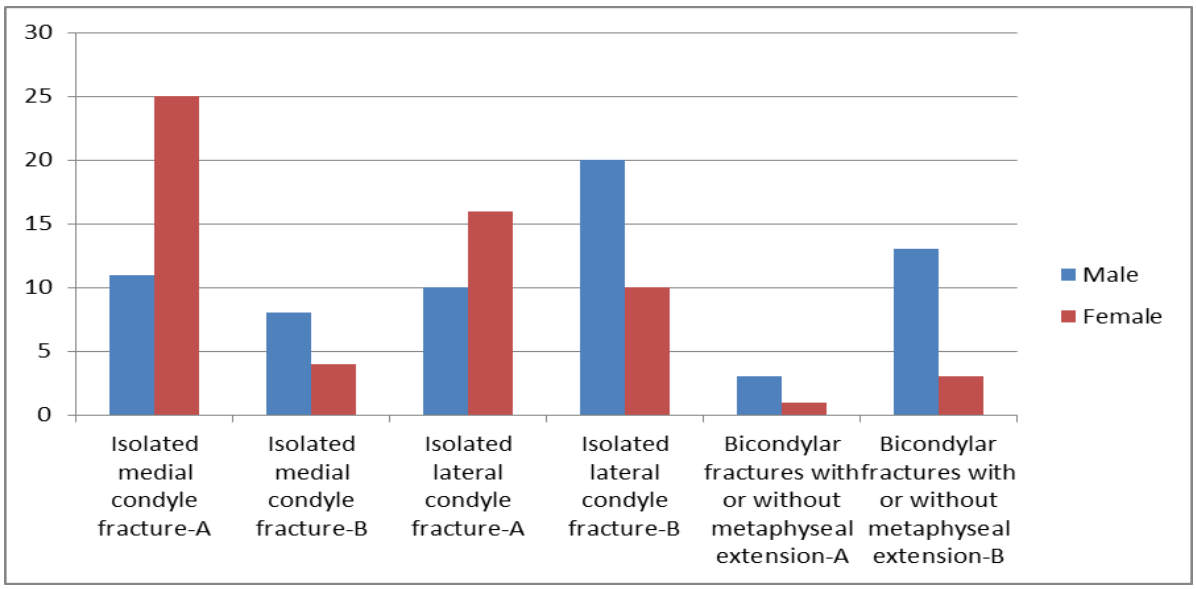
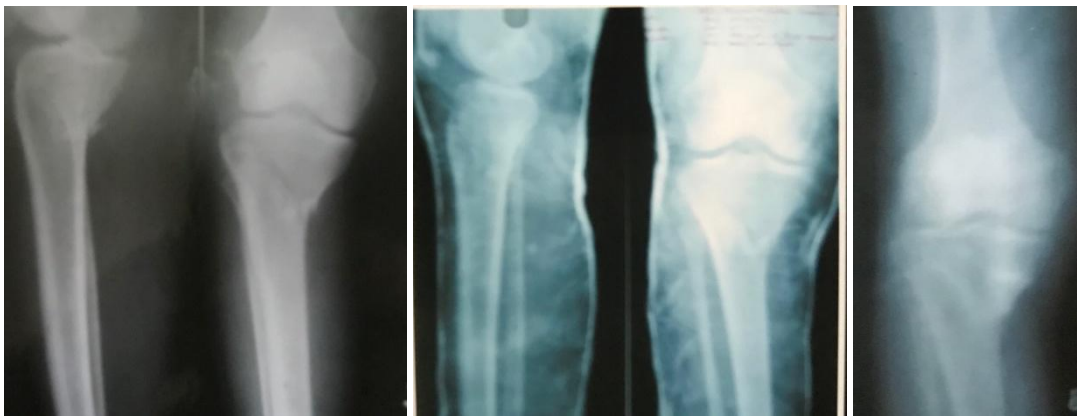


Fig 2



(a) Pre-op (b) Post-Cast (c) Final follow-up

Varus collapse seen in a patient with medial condyle fracture with intact fibula

Discussion

Condition of fibula, whether fractured or intact, determines angulatory behavior of tibial plateau fractures under weight-bearing and functional conditions. Overall there was no significant inclination towards male or female sex as almost equal number of cases were seen in both subtypes (M=65, F=59). But a closer look at data reveals male predominance for fractures involving high velocity trauma, with most of the females sustaining fractures as a result of trivial falls. Another important observation is that the mean age for female subgroup was significantly higher than male subgroup (M=38years, F= 54 years). Also fibula fracture was associated

with high velocity trauma. It was less common in female subgroup. In elderly females with osteoporotic bones, a trivial trauma even can result in tibial plateau fracture. These are low energy trauma and less commonly have an associated proximal fibula fracture.

Fifty patients in our series were treated non-operatively, with consideration to fracture pattern and age of patients. The majority of patients were treated operatively. Fifty seven cases were treated with cancellous screws. Seventeen cases were managed by using a locking contoured plate for proximal tibia. Techniques for elevation of depressed fragments, ORIF and bone grafting were used in patients with depressed or displaced articular fragments. Decision for operative versus conservative treatment was taken on the basis of intraarticular or meta-diaphyseal displacement and surgery was aimed to achieve anatomical joint reconstruction. Most of the patients who underwent operative treatment had proximal fibula fractures suggesting greater displacement with presence of proximal fibula fracture. An intact proximal fibula supports the lateral condyle and prevents displacement.

A number of studies support the view that articular incongruity predisposes to early OA. [12, 13] We achieved excellent joint reduction in 98 cases at the time of initial surgery or application of above knee cast. This number was reduced to 76 at the final visit. Loss of reduction was more in following groups; conservatively treated, associated fibula fracture, elderly patients, isolated medial condyle fracture with intact fibula. Alteration of joint biomechanics due to fibula fracture predisposes to loss of reduction as the patient starts weight bearing. The rate of nonunion in this series was 2.4 % which is comparable to other studies.[14, 15] This was seen in patients with high velocity trauma and having comminution. There was 12.4% incidence of residual varus deformity. Gaudinez *et al*. reported 19% of varus deformity in his series of 18 complex (types V and VI) fractures [16]. Varus collapse was more common in patients with intact fibula. Eleven of our patients developed valgus and this was contrastingly more common in patients with a proximal fibular fracture.

Infection can further complicate the management of tibial plateau fractures. Its incidence can be decreased by careful surgical timing and soft tissue handling. Indirect reduction techniques and minimally invasive surgery also decrease the likelihood of further devascularisation. In our series the incidence of superficial and deep infection was (17.2%) and (6.6%), respectively. Various studies report infection rates between 0-87.5 percent [14, 15, 17-20]

Different scoring systems have been used to evaluate functional outcome of tibial plateau fractures. We used the KOOS which is graded between 0 and 100. A score of <60 was graded as poor, 60–70 as fair, 70–85 as good and 85–100 as excellent. The outcome was excellent in 25 cases (20%) good in 71 cases (57%), fair in 19 (15%) and poor in nine (7%). Others have reported good/excellent scores in 65–89% of subjects [14, 20-23]. Overall better outcomes were observed in patients with intact fibula; though a small subgroup of medial condyle fractures with intact fibula collapsed in varus as weight bearing was initiated and resulted in inferior scores. On long term evaluation a subset of patients with proximal fibula fractures had lateral knee pain which was lees commonly seen in patients with intact fibula. This suggests altered biomechanics of proximal tibiofibular joint and increased loading of the lateral compartment of knee resulting in pain.

We are aware that this study has a number of limitations including a follow-up period of less than ten years and use of different methods of fracture fixation. Despite these limitations, we believe that it provides useful information with regard to the impact of fibula fracture on intermediate functional outcome following these injuries.

Conclusion

Fibula supports the lateral condyle and prevents its collapse. Coronal plane malalignment may develop if this role of fibula is not considered while managing tibial plateau fractures. Therefore, it is prudent to include fibula in the classification, assessment and management of tibial plateau fractures for reducing the incidence of deformity and improving functional outcome.

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