Are all Schatzker Type-II tibial plateau fractures alike? A retrospective study

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Abstract

Introduction -

Lateral tibial plateau is the commonest area to encounter the malunion inspite of surgical intervention. Limitation in fracture understanding has role to play and currently available classifications are lacking information about the morphological description of the fracture and injury to the associated ligaments/meniscus.

Aims, Hypothesis and Methodology -

In an attempt to add the information to Schatzker's type-II fracture, we propose a technical tip for detailed injury characterization. Clinical and radiological records of 20 patients with Schatzker's-II fracture tibial plateau were evaluated to identify heterogeneity of fracture.

Results -

Four displacement patterns of depression were seen, with varying severity of comminution involving the depressed fragment. The cortical split was in multiple planes in 55% of cases and associated injury to meniscus and MCL were identified in 40% of cases.

Conclusion-

Tibial plateau fracture classified as Schatzker's Type II tibial plateau fractures are morphologically split and depression fracture of the lateral tibial plateau, with concealed fracture heterogeneity in displacement patterns, fracture configuration, and associated injury to menisci or ligaments.

Introduction

Schatzker [1] classified proximal tibial plateau fracture into 6 principal types and type II is being the most common variety. This entity consists of depression involving the articular surface into the soft cancellous bone and split in the cortical rim. In current practice, routine use of the computer tomography (CT) scan led to the development of multiple CT-based classifications, which has made it possible to identify the coronal plane fracture and localize the fracture with respect to the quadrants [2,3]. Yet, it is not very infrequent to encounter significant malunion after surgical management of split and depression lateral tibial plateau fracture, which mandates revision surgery or conversion to the arthroplasty [4,5]. Meulen Kemp et al [6] also reported that the lateral tibial plateau is the commonest area to encounter malunion and incidence may range 23 to 77%. A recent systematic review has also pointed out the limitations of tibial plateau fracture classification; as the CT scan-based classification is lacking information about the morphological description of the fracture and injury to the associated ligaments/meniscus [7].

We propose a predefined checklist, to further extend the understanding of the knee injuries classified as Schatzker's Type-II tibial plateau fracture. The primary objective of the current study was to reveal the heterogeneity of knee injuries classified as Schatzker's type-II tibial plateau fracture.

Materials And Methods

We identified 20 cases of Schatzker type II fractures operated from January 2014 - December 2019. Demographic data, mode of injury, operative details, and radiological records (pre-operative radiographs, multiplanar CT scan images) were collected. All records were evaluated based on a predefined checklist to describe the depression fragment, split, and associated injuries to meniscus/ligaments Table-1, which includes the following criteria-

Displacement pattern of Depression fragment –

The displacement defined by axial displacement of both edge of depression fragment in sagittal and coronal plane in relation to the intact articular surface.

1.1 Sagittal Plane-

- Angulation displacement
 1. Posterior tilt (Figure 1A) – Fragment is tilted posteriorly; hinge lies at the anterior end of the depressed fragment; articular surface of depressed fragment faces posteriorly and the metaphyseal cancellous bone on the posterior side is compressed. The posterior tibial slope is increased.
 2. Anterior tilt (Figure 1B) - Fragment is tilted anteriorly; hinge lies at the posterior end of the depressed fragment; the articular surface of depressed fragment faces in the anterior direction and cancellous metaphyseal bone on the anterior side is compressed. Tibial slope either decreased or reversed.
- Axial plane displacement (Pure Depression) (Figure 1C)- The fragment sinks in the sagittal plane into the metaphysis with hinge broken on both sides.
- Complex (Figure 1D)- Depressed bony fragment is multi fragmentary, displaced in multiple directions.

1.2 Coronal Plane -

- Angulation displacement type
 1. Medial tilt (Figure 2A) – Depressed fragment is tilted medially; hinge lies at the lateral end of the fragment. The cancellous metaphyseal bone on the medial end of the fragment is compressed.
 2. Lateral Tilt (Figure 2B) - Depressed fragment tilted laterally; hinge lies at the medial end of the fragment. The cancellous metaphyseal bone on the lateral end of the fragment is compressed.
- Pure axial depression (Figure 2C) – The fragment sinks in the coronal plane into the metaphysis with hinge broken on both sides.
- Complex (Figure 2D) – Depressed bony fragment is multi-fragmentary which are displaced in multiple directions.

2. **Instability/ internal derangement** - Injury to the meniscus and/ or ligaments on the preoperative MRI or operative records and type of injury (Figure 3).

3. **Configuration of depressed fragment** - It can either be a single large osteochondral chunk (Figure 1B, 1C, 2B, 2C) or it can have a multi-fragmentary configuration (Figure 1D & 2D).

4. **Exit point of cortical split** – A split fracture results in a break in the cortical rim at minimum of locations. The exit point is readily identifiable on the axial sections of the lateral tibial plateau. The exit points were categorised under the quadrant theory⁸ and further subcategorised in relation to local bony landmark -

- Anterolateral quadrant
 1. Zone A – Medial to Gerdy's tubercle
 2. Zone B – lateral to Gerdy's tubercle and anterior to the anterior edge of the fibula
- Posterior Quadrant
 1. Zone C – Part of Lateral tibial condyle covered by head of fibula
 2. Zone D – Posterior to the posterior edge of fibula

The presence of exit points in each location were documented and fractures were categorised based on the number and plane based on the combination of exit points (Figure 4A-F).

5. Location of the depressed Fragment

The depressed fragments were localised based peak depression in the quadrant two quadrants of lateral tibial plateau [8]. The depressed fragments can be present either in:

- Anterolateral (AL) quadrant (Figure-4A),
- Posterolateral (PL) quadrant (Figure-4C)
- Both the quadrants (Figure 4B & 4F).

Information obtained as per checklist to describe the details of fracture character were recorded in Excel sheet and variation were analysed in percentages.

Results

Radiological and surgical records of the 20 patients were evaluated. Following the fracture characterization checklist. The Angulation type of displacement were most encountered; sagittal plane 60% (12/20) and coronal plane depression 55% (11/20). Pure axial depression was seen in 4 and 3 cases on coronal plane and sagittal axis, respectively. Complex pattern of displacement was seen in 4 cases on sagittal plane and 6 cases on coronal plane. The angulation displacement on the coronal plane was lateral tilt type in 9 cases versus 1 case had medial angulation. Whereas angulation displacement on the sagittal plane was anterior type in 9 cases and posterior in 4 cases.

Configuration of the depressed articular fragment was noted to be, either a single osteochondral chunk in 9 cases or multifragmentary in 11 cases. In 54% of the case with multifragmentary osteochondral fragment had complex displacement pattern in both sagittal and coronal plane (36%) or in one of the planes (18%). 9 cases were having single split 4 in sagittal plane and 5 in the coronal plane. However, all single-coronal-plane fracture was involving the anterolateral quadrant. 7 patients were having dual plane split fracture [9] and 4 were having multiple plane split.

Injury to meniscus or ligament were seen in 8 cases; 4 cases had grade 3 medial collateral ligament (MCL) injury which was diagnosed on the clinical examination combined with stress radiography (Figure 3) and the other 4 cases had a longitudinal tear of the lateral meniscus injury which was diagnosed during open reduction in 2 cases and on arthroscopic examination in 2 cases (Table-2).

Discussion

In our case series of split and depression type of tibial plateau fractures, we were able to identify the wide heterogeneity under various subheadings. Therefore, with the available information, it would not be wrong to say that the knee injuries classified as Schatzker type-II fracture are a group of morphologically split and depression types of lateral tibial plateau fracture with variation in the pattern of displacement, fracture location, and associated injuries. Millar et al [7] in their recent systematic review proposed that it is imperative to evaluate the tibial plateau fracture morphologically, topographically, the pattern of displacement, and associated injury to ligaments for comprehensive understanding.

Morphologically all the Schatzker-II fractures are having a cortical split of the lateral tibial plateau and depression of the articular surface. McGonangle et al [10] using the fracture mapping identified that 72% of the lateral tibial plateau fracture has a fracture in the sagittal plane ($\pm 22^\circ$), amenable to fixation with lateral angle stable plate. On the contrary, looking in our series, the classical sagittal plane cortical split was seen in only 20% (n=4) of the cases. However, the other 5 cases having anterolateral quadrant split fracture were also amenable to anterolateral fixation. 55% of the cases were having a dual plane or multiplane split. Having multiple cortical splits involving the anterolateral and posterolateral quadrant, indicate the frequent need for multicolumn fixation or the need for a Hoop plate to stabilize such fracture [11,12, 13].

The possible reason could be explained by the higher velocity of injury in our series. As, classically split and depression fracture is a type of low-velocity trauma [14], whereas all our cases sustained this fracture as a consequence of road traffic accident (RTA) of varying severity, which explains a higher amount of comminution involving the depression fragment and frequent encounter of multiple cortical splits. However, with increasing road traffic accidents, it is a need for time to understand the multiple dimensions of the fracture. Similarly, 40% of the patients were having an injury to either lateral meniscus or grade III injury of the MCL also corroborative to higher velocity of injury [15].

Identification of injuries to meniscus and ligament can be missed in the fracture setting and having a checklist will draw obvious attention. Moreover, this could be helpful to overcome the limitations of the available classifications [7]. In the current study, we were having the intraoperative data to identify the injury to the ligament or meniscus. In the future wherever possible having a preoperative MRI would be more appropriate for detailed and pre-emptive surgical planning [15].

Moreover, the Depression of articular fracture was heterogeneous in regard to the pattern of displacement in the sagittal and coronal plane, comminution, and location in relation to the quadrants. The angular displacement of the articular surface in a sagittal plane not only identifies the varying pattern but also hints at the varying positions of the knee flexion in combination with valgus force leading to lateral tibial plateau fracture [3].

Our study has some limitations because of the retrospective study design and a lesser number of cases. However, our primary objective was limited to identify the heterogeneity of Schatzker type-II fracture. Our findings are very much corroborative to observations of Sun et al [13] they stated that careful study of multiplanar CT images is impeccable, and it would be inappropriate to generalize one scenario for all Schatzker type II fractures. However, to establish the clinical relevance of the fracture heterogeneity would be needing a prospective trial.

Conclusion

the Schatzker Type II proximal tibia fracture comprises a group of grossly similar-looking split and depression type fracture. Having a checklist for evaluation will allow detailed evaluation of knee injury, pertaining to the description of fracture topographical, morphologically, the patterns of fracture displacement, and associate injury to the ligament/meniscus.

Abbreviations

CT- Computed tomography

MCL – Medial collateral ligament

RTA – Road traffic accident

Declarations

Ethics approval and Consent to participate:

Ethical approval was taken from the institutional review board (IRB) of the institute (Postgraduate institute of medical education, Chandigarh, India) with IRB number: NK/6398/STUDY/478. Written and informed consent was taken from all the patients included in the study.

Consent for Publication:

Institute ethics committee given permission for publication and all author agree to consent for publication of this manuscript.

Availability of data and material:

This is to declare that the corresponding author has the possession of all the relevant data and material which was required for the formulation and assessment of this manuscript

Competing Interests:

The authors have no competing interests

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Author's Contribution

First and corresponding author designed the study protocol and has written the manuscript.

Second author has done the independent documentation of the radiological record.

Third Author has scrutinized and provided the radiological records.

Fourth author has helped in study protocol design, guided the manuscript writing and data analysis.

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Tables

Table-1 Predefined checklist to evaluate a case with Schatzker-II fracture

Subheadings to define Depression			Subheading to define Split	Soft tissue injury
Displacement pattern	Configuration	Quadrant specific location	Location of split in relation to bony landmarks	Meniscus/ligament injury
Angulation	Single fragment	Anterolateral quadrant	Plane of split	Present
Axial plane	Multifragmentary	Posterolateral	Numbers of split	Absent
Complex		Both		

Table-2 – case wise details of morphological variations in Schatzker-II tibial plateau fracture

S.No	Depression		Exit points of Split					Meniscus/ligament injury	
	Displacement pattern		Configuration	Quadrant	Location	Number	Plane	Meniscus	Ligament
	Coronal	Sagittal							
1.	Lateral	Anterior	Comminuted	AL	ABD	3	Dual	-	-
2.	Pure	Anterior	Single	AL	ABD	3	Dual	-	-
3.	Pure	Anterior	Comminuted	AL	AB	2	Coronal	-	-
4.	Lateral	Anterior	Comminuted	AL	AD	2	Sagittal	-	-
5.	Lateral	Anterior	Comminuted	AL	ABC	3	Dual	-	Grade 3
6.	Complex	Complex	Comminuted	AL	ACD	2	Dual	-	-
7.	Lateral	Anterior	Single	AL	AB	2	Ant coronal	-	-
8.	Lateral	Anterior	Comminuted	AL	AB	2	Ant coronal	-	-
9.	Lateral	Anterior	Comminuted	Both	AD	2	Sagittal	Present	-
10.	Pure	Anterior	Single	Both	AB	2	Ant coronal	-	-
11.	Complex	Complex	Single	Both	ABCD	4	Multi	-	Grade 3
12.	Complex	Complex	Single	Both	ACD	3	Dual	-	-
13.	Pure	Pure	Comminuted	Both	ABCD	4	Multi	Present	-
14.	Lateral	Pure	Single	Both	ABCD	4	Multi	-	Grade 3
15.	Complex	Complex	Single	Both	AD	2	Sagittal	-	-
16.	Lateral	Posterior	Comminuted	Both	ACD	3	Dual	-	-
17.	Lateral	Pure	Single	PL	ACD	3	Dual	-	Grade 3
18.	Lateral	Posterior	Single	PL	BCD	3	Post coronal	Present	-
19.	Complex	Posterior	Comminuted	Both	AD	2	Sagittal	Present	-
20.	Complex	Posterior	Comminuted	Both	AB	2	Ant coronal	-	-

Figures

Figure 1

A: Sagittal section of CT scan demonstrating posterior tilt and single depression fragment. B: Sagittal section of CT scan demonstrating anterior tilt. C: Sagittal section of CT scan demonstrating pure depression and single depression fragment. D: Sagittal section of CT scan demonstrating complex tilt and multiple depression fragments.

Figure 2

A: Coronal section of CT scan demonstrating medial tilt. B: Coronal section of CT scan demonstrating lateral tilt and single depression fragment. C: Coronal section of CT scan demonstrating pure depression and single depression fragment. D: Coronal section of CT scan demonstrating complex tilt and multiple depression fragments.

Figure 3

Intraoperative fluoroscopic image revealing valgus opening after osteosynthesis suggestive of grade III MCL injury

Figure 4

A: Axial CT scan revealing two exit zones of split and depression in anterolateral quadrant (Zones A+B) B: Axial CT scan revealing two exit zones of split and depression involving the anterolateral and posterolateral quadrant (Zones A+C+D) C: Axial CT scan revealing two exit zones of split and depression involving the posterolateral quadrant (Zones C + D) E: Axial CT scan revealing three exit zones of split (Zones A + B +D) F: Axial CT scan revealing four exit zones of split and depression involving both quadrants (Zones A + B +C +D)