RESEARCH ARTICLE

Inter-observer variation of the Schatzker and Khan classification of Tibial plateau fractures: Cohort study

Mansoor Ali Khan, Sateesh Pal, Syed Kamran Ahmed, Muhammad Amin Chinoy

Abstract

Objective: To compare the inter-observer reliability of Shatzker classification and Khan Classification of Tibial plateau fractures.

Methods: This retrospective cohort study was conducted at The Indus Hospital, Karachi, Pakistan. Radiographs of 50 patients who presented with tibial plateau fractures from March 2015 to November 2016 were collected. Two observers classified these cases independently according to Shatzker and Khan Classification. Gwet's AC1 statistics applied to assess inter-observer reliability of both the classification systems.

Results: Moderate inter-observer agreement for Schatzker classification ($p<0.001$) and slight inter-observer agreement on Khan Classification ($p=0.738$) was observed.

Conclusion: Khan Classification is more comprehensive in classifying tibial plateau fractures and can be used for clinical research purpose, while Shatzker classification with better inter-observer reliability is applicable for routine clinical practice.

Keywords: Tibial plateau fractures, Reliability, Classification. (JPMA 71: S-51 [Suppl. 5]; 2021)

Introduction

Tibial plateau fractures constitute 1-2% of all fractures in the human body. As they are intra-articular fractures, they need to be reduced anatomically which is usually done by means of surgery. Different classification systems have been proposed for tibial plateau fractures for the ease of understanding and planning treatment. Ideal classification should be simple to memorize, guide in treatment planning, predict the prognosis of the fracture and help in clinical research.[1,2]

Schatzker and AO classification for tibial plateau fractures are the most frequently used classifications in clinical practice, but they both have significant drawbacks. They are based on anteroposterior radiographs only, not on lateral radiographs, so there is high chance of missing coronal split fractures that can lead to significant changes in knee joint biomechanics resulting in significant knee pain and early knee osteoarthritis.[3] Mandarino et al found that Schatzker classification has moderate inter-observer reproducibility.[4] Rafii et al. showed that computed tomography (CT) is superior to conventional X-rays in tibial plateau fractures.[5] Maripuri et al compared the Schatzker, AO, and Hohl and Moore classifications of tibial plateau fractures. They observed that Schatzker classification has better inter-observer reliability and intra-observer reproducibility than AO and the Hohl and Moore classification, but none of the classification system was ideal.[6] Mellema et al claimed that the Schatzker classification has better inter-observer reliability than the Luo classification.[7] Schatzker classification is the most reliable classification particularly when CT scan is used

Table-1: Tibial plateau fractures: Khan classification.[10]

S.No.	Topographic Features	Morphologic Features
1	Lateral tibial plateau fractures	L1-Wedge
		L2-Pure depression
		L3-Wedge and depression
		L4-Total condyle
		L5-Entire condyle
2	Medial tibial plateau fractures	MI –Wedge
		M2-Pure depression
		M3-Wedge and depression
		M4-Total condyle
		M5-Entire condyle
3	Posterior tibial plateau fractures	P1 -Posterolateral split
		P2-Posteromedial split
4	Anterior tibial plateau fracture	A1 -Anterolateral split
		A2-Anteromedial split
5	Rim fractures	R1-Rim avulsion fractures
		R2-Rim compression fractures
		R3-Rim combination fractures
6	Bicondylar fractures	B1 -Nonarticular bicondylar
		B2-Articular lateral
		B3-Articular medial
		B4-Articular lateral and medial
7	Subcondylar fractures	S1-Subcondylar lateral
		S2-Subcondylar medial
		S3-Subcondylar bicondylar
		S4-Su bcondylar bicondylar with split

Department of Orthopedics, The Indus Hospital, Karachi, Pakistan.
Correspondence: Mansoor Ali Khan. Email: makbonedoc65@gmail.com

to assess the tibial plateau fracture configuration. On the other hand, revised Duparc classification has a poor reliability due to its complexity and different morphological subtypes.[8]

Schatzker et al described classical and simple classification for tibial plateau fractures which included anatomical characteristics of fracture and its location, guided in treatment plan and provided some estimate of prognosis.[9] Khan et al introduced a more comprehensive classification for tibial plateau fractures, which included most of the fracture types, especially fractures in lateral radiographs to improve understanding of fracture configuration (Table-1).[10]

This study was performed to compare the inter-observer reliability of Shatzker classification and Khan Classification of tibial plateau fractures, to develop a still more reliable classification system.

Methods

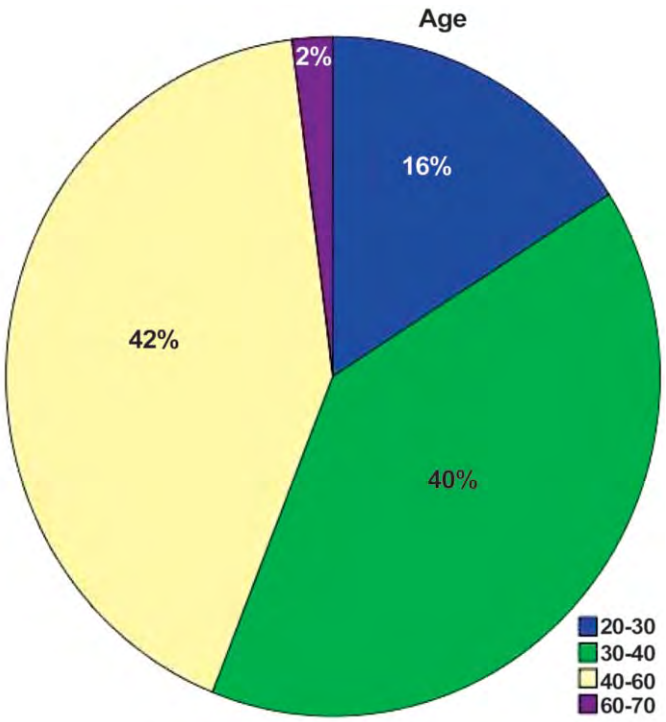
This was a retrospective cohort study conducted at The Indus Hospital, Karachi, Pakistan. Patients who were skeletally mature and presented with tibial plateau fracture, had good quality anteroposterior (AP) and lateral radiographs of proximal tibia with knee joint were included in the study. Data was collected from March 2015 to November 2016. The estimated sample size was derived from the online Raosoft sample size calculator.[11] Sample size was calculated based on a response rate of 50%, a confidence interval of 90%, and a margin of error of 5%.

All the cases were arranged on a proforma and numbered randomly. Two observers who were orthopaedic residents at different levels of training (Observer I: Orthopaedic resident year 3, Observer II: Orthopaedic resident year 2) classified these cases independently according to Shatzker[9] and Khan Classification.[10] Before the start of study, each observer completed a training session on both classification systems. Both observers were given adequate time for assessing the radiographs. Clinical details of patients including their presentation or management were not provided to observers. Classifications choices were made at the first viewing and no feedback was given to observers.

Data included age and gender of patients, Shatzker and Khan classification of all tibial plateau fractures by 2 different observers. Data from both observers was entered on Microsoft excel sheets. Data was then transferred to SPSS version 21.0 for analysis. Mean ± SD computed for age. Frequency and percentage computed for gender. Gwet's AC1 statistics[12] was applied to assess inter-rater reliability of both the classification systems.

Results

Total of 50 patients with tibial plateau fractures who met the inclusion criteria and had good quality



20 to 30 years: 8 (16%); 30 to 40 years: 20 (40%)
40 to 60 years: 21 (42%); 60 to 70 years: 1 (2%)

Figure-1: Age of the patients.

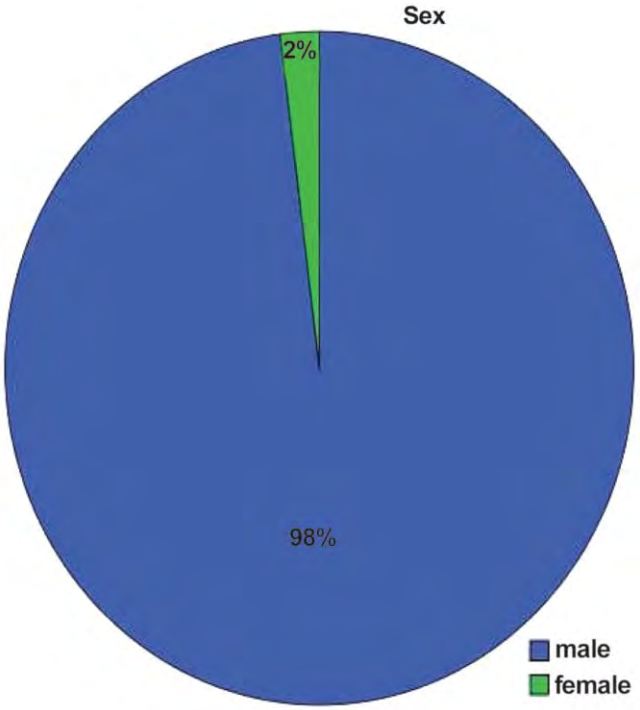
Table-2: Inter-observer variation of Shatzker classification (Observer I in rows and Observer II in columns).

Schatzker classification by Obsever I	Schatzker classification by Obsever II					Total	P-value Gwet's AC1 (95% CI)
	I n (%)	III n (%)	IV n (%)	V n (%)	VI n (%)	n (%)	
I	1 (2)	0 (0)	0 (0)	0 (0)	1 (2)	2 (4)	
II	0 (0)	8 (16)	0 (0)	0 (0)	0 (0)	8 (16)	
III	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	1 (2)	
IV	1 (2)	0 (0)	9 (18)	3 (6)	0 (0)	13 (26)	p<0.001**†
V	0 (0)	1 (2)	0 (0)	4 (8)	7 (14)	12 (24)	0.50 (0.34-0.67)
VI	0 (0)	0 (0)	0 (0)	0 (0)	14 (28)	14 (28)	
Total	2 (4)	10 (20)	9 (18)	7 (14)	22 (44)	50 (100)	

Table-3: Inter-observer variation of Khan Classification (Observer I in rows and Observer II in columns).

Khan classification by Observer I	Khan classification by Obsever II													
	B2 n (%)	B4 n (%)	L1 n (%)	L2 n (%)	L3 n (%)	L5 n (%)	M3 n (%)	M4 n (%)	M5 n (%)	S1 n (%)	S2 n (%)	S4 n (%)	Total n (%)	P-Value Gwet's AC1 (95%CI)
B4	1 (2)	4 (8)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (4)	1 (2)	0 (0)	8 (16)	
L2	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	
L3	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	
L4	1 (2)	0 (0)	1 (2)	0 (0)	5 (10)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	7 (14)	
L5	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	
M3	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	
M4	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0.738†
M5	0 (0)	2 (4)	1 (2)	0 (0)	0 (0)	0 (0)	1 (2)	2 (4)	4 (8)	0 (0)	0 (0)	0 (0)	10 (20)	0.26 (0.12-0.39)
P1	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	
P2	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	0 (0)	1 (2)	
S1	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (4)	0 (0)	0 (0)	2 (4)	
S3	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	2 (4)	2 (4)	
S4	1 (2)	2 (4)	0 (0)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	0 (0)	4 (8)	3 (6)	3 (6)	14 (28)	
Total	3 (6)	9 (18)	2 (4)	1 (2)	8 (16)	1 (2)	2 (4)	3 (6)	4 (8)	8 (16)	4 (8)	5 (10)	50 (100)	

B2-Articular lateral, B4-Articular lateral and medial, L2-Pure depression, L3-Wedge and depression, L4-Total condyle, L5-Entire condyle, M3-Wedge and depression, M4-Total condyle, M5-Entire condyle, P1 -Posterolateral split P2-Posteromedial split, S1-Subcondylar lateral, S2-Subcondylar medial, S3-Subcondylar bicondylar, S4-Su bcondylar bicondylar with split.



Males: 49 (98%); Females: 1 (2%)

Figure-2: Sex of patients.

anteroposterior (AP) and lateral radiographs of proximal tibia with knee joint were enrolled in the study. Mean age of patients was 40 ± 9.45 years. Eight (16%) patients were between 20 to 30 years, 20 (40%) between 30 to 40 years, 21 (42%) between 40 to 60 years and 1 (2%) patient was between 60 to 70 years (Figure-1). There were 49 (98%) males and only 1 (2%) female (Figure-2).

Regarding inter-observer variation, moderate inter-observer agreement for Schatzker classification was observed (p<0.001) (Table-2). Both the observers agreed on 29 (58%) cases while disagreed on 21(42%) cases.

Slight inter-observer agreement on Khan Classification (p=0.738) was observed (Table-3). Both the observers agreed on 15 (30%) cases only while disagreed on 35 (70%) cases. Many subtypes of Khan classifications were not found in provided radiographs by both the observers.

Discussion

A useful classification in orthopaedic surgery which reliably categorizes fracture type, helps in communication in clinical practice, guides in treatment and is an aid in clinical research. Most frequently used classifications in tibial plateau fractures include Schatzker and AO classifications. There are multiple modifications and new proposals of classifications systems but they need to be reliable in terms of intra and inter-observer variation. There are many comparisons among the current classifications of tibial plateau fractures.[13]

Fractures of tibial plateau are common and difficult to treat and optimum treatment is matter of controversy. The anatomic differences between medial and lateral tibial plateau should be considered when planning to fix these injuries. Apparently, dividing tibial plateau fractures into

unicondylar or Bicondylar fractures and those with a pure split or articular depression with or without split can be a more reliable approach. Recently, several studies concluded that a multi-planar CT scan increases the reliability in classifying tibial plateau fractures but depends on its availability in hospitals and the cost of investigation. The major drawback of Schatzker and AO classification is that they do not include a coronal fracture which occurs as a result of varus or valgus forces combined with axial loading leading to postero-medial or anterior coronal splits. These coronal fractures are burning issues and they are getting more and more attention by trauma surgeons across the world. They are prevalent in most complex bicondylar tibial plateau fractures as a result of high energy trauma. Resulting comminution, especially with fractures involving the posterior aspect of the tibial plateau, makes the interpretation of fracture patterns difficult and prone to misconception. Among 111 bicondylar tibial plateau fractures evaluated by plain radiographs, Higgins et al found postero-medial fragment in 59% cases. Failure to recognize and fix the postero-medial fragment may lead to rotation of medial femoral condyle and early knee osteoarthritis.[14]

Tibial plateau fractures are a group of injuries with differences in topographic features, morphological features, pathomechanics and prognosis. The Khan's classification is comprehensive because it includes all fracture types reported in literature. A new fracture (subcondylar and bicondylar with coronal split) has been classified for the first time. An alphanumeric system has been developed that has made nomenclature easy to remember and use.[10] Although in our study we found that Inter-observer reliability of Khan's classification is less than Schatzker's classification, the reason may be widespread applicability of Shatzker classification in routine practice, but we need to combine all types of tibial plateau fractures under one umbrella which needs its routine use and applicability in routine practice. The Khan classification for tibial plateau fractures is more comprehensive and can classify all types of tibial plateau fractures but due to its complexity, it is difficult to use in daily clinical practice while Shatzker classification is simple and easy to remember for routine clinical use but fails to address all types of tibial plateau fractures.

Conclusion

Although Inter-observer reliability of Khan classification is less than Schatzker classification, the reason may be widespread applicability of Shatzker classification in routine practice, but Khan classification is more comprehensive in classifying tibial plateau fractures and can be used for clinical research purpose while Shatzker classification is easy to remember and applicable for routine clinical practice.

Disclaimer: Abstract was presented as oral presentation at 31st Pakorthocon 2017 in Peshawar, Pakistan.

Conflict of Interest: None.

Funding Disclosure: None.

References

1. Albuquerque RP, Giordano V, Pallottino A, Sassine T, Canedo R, Pina J, Amaral NP. Analysis of the reproducibility of tibial plateau fractures' classification.Rev Bras Ortop. 2009;44:225-9
2. Gradl G, Neuhaus V, Fuchsberger T, Guitton TG, Prommersberger KG, Ring D. Radiographic diagnosis of scapholunate dissociation among intra-articular fractures of the distal radius: interobserver reliability. J Hand Surg Am 2013;38:1685-90
3. Zhu Y, Hu CF, Yang G, Cheng D, Luo CF. Inter-observer reliability assessment of the Schatzker, AO/OTA and three-column classification of tibial plateau fractures. J Trauma Manag Outcomes 2013;7:7.
4. Mandarino EM, Person A, Guimarães JAM. Evaluation of the reproducibility of the Schatzker classification for tibial plateau fractures. INTO 2004; 2:11-8.
5. Rafii M, Lamont JG, Firooznia H. Tibial plateau fractures: CT evaluation and classification. Crit Rev Diagn Imaging. 1987; 27:91-112.
6. Maripuri SN, Rao P, Manoj-Thomas A, Mohanty K. The classification systems for tibial plateau fractures: how reliable are they? Injury. 2008;39:1216-21
7. Mellema JJ, Doornberg JN, Molenaars RJ, Ring D, Kloen P.Interobserver reliability of the Schatzker and Luo classification systems for tibial plateau fractures. Injury. 2016;47:944-9.
8. Taskesen A, Demirkale I, Okkaoglu MC, Özdemir M, Bilgili MG, Altay M. Intraobserver and interobserver reliability assessment of tibial plateau fracture classification systems. Jt Dis Relat Surg. 2017;28:177-81.
9. Schatzker J, McBroom R, Bruce D: The tibial plateau fractures: The Toronto experience 1968-1 979. Clin Orthop 138:94-104, 1979.
10. Khan RM, Khan SH, Ahmad AJ, Umar M. Tibia1 Plateau Fractures A New Classification Scheme. Clin Orthop Relat Res. 2000; 375:231-42.
11. http://www.raosoft.com/samplesize.html. Cited on 27. June, 2021
12. Gwet K. Computing inter-rater reliability and its variance in the presence of high agreement. Br J Math Stat Psychol. 2008; 61:29-48.
13. Charalambous CP, Tryfonidis M, Alvi F, Moran M, Fang C, Samarji R, Hirst P. Inter- and intra-observer variation of the Schatzker and AO/OTA classifications of tibial plateau fractures and a proposal of a new classification system. Ann R Coll Surg Engl 2007; 89: 400-404
14. Higgins TF, Kemper D, Klatt J. Incidence and morphology of the posteromedial fragment in bicondylar tibial plateau fractures. J. Orthop. Trauma. 2009;23:45-51.