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Original Article

Importance of radiological studies by means of computed tomography for managing fractures of the tibial plateau ☆,☆☆



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ABSTRACT

Objectives: To evaluate the concordance among knee surgery specialists regarding the classification and surgical technique indicated in cases of tibial plateau fracture, using conventional radiographs and computed tomography.

Methods: Forty-four patients with fractures of the tibial plateau shown on radiographic and tomographic images were selected. These were evaluated by specialists at two different times, with an interval of seven days. On the first occasion, the specialists only had access to the radiographs, while on the second occasion they had access to both radiographs and computed tomography images. Their concordance was evaluated by means of the kappa coefficient.

Results: The interobserver reliability of the Schatzker classification on the first occasion was 0.36 and on the second occasion, 0.35. This was considered to present low reproducibility. In evaluating the intra-observer reproducibility of this classification, the mean kappa index was 0.42, which was classified as moderate. From evaluating the choice of surgical access, the inter-observer reliability was 0.55 on the first occasion and 0.50 on the second, which was considered to present moderate reproducibility. Evaluation on the implant chosen showed that the interobserver reliability was 0.01 on the first occasion and -0.06 on the second, which was considered to be poor and discordant. In evaluating the classification of the three columns, the inter-observer reproducibility was 0.47 ($p < 0.0001$), which was classified as moderate concordance.

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Conclusion: Use of computed tomography did not present any improvement in the inter-observer concordance, using the Schatzker classification, and did not produce any change in the preoperative planning.

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Importância do estudo radiológico por meio de tomografia computadorizada no manejo das fraturas do platô tibial

O B J E T I V O S

Palavras-chave:

Fraturas da tibia/classificação
Fraturas da tibia/radiografia
Tomografia computadorizada
Procedimentos cirúrgicos operatórios

Avaliar a concordância entre especialistas em cirurgia de joelho com relação à classificação e à técnica cirúrgica indicada nas fraturas do platô tibial com o uso das radiografias convencionais e da tomografia computadorizada.

Métodos: Foram selecionados 44 pacientes com fraturas de platô tibial com suas imagens radiográficas e tomográficas, as quais foram avaliadas por especialistas em dois momentos distintos, com intervalo de sete dias. No primeiro momento os especialistas tiveram acesso apenas às radiografias e no segundo às radiografias e às imagens de tomografia computadorizada. A concordância foi avaliada por meio do coeficiente *kappa*.

Resultados: A confiabilidade interobservador para a classificação de Schatzker no primeiro momento foi 0,36 e no segundo 0,35, consideradas de baixa reprodutibilidade. Na avaliação da reprodutibilidade intraobservador dessa classificação, a média do índice κ foi de 0,42, classificada como moderada. A avaliação da escolha do acesso cirúrgico teve uma confiabilidade interobservador de 0,55 num primeiro momento e 0,50 no segundo, consideradas de reprodutibilidade moderada. Quando avaliado o implante escolhido, a confiabilidade interobservador foi de 0,01 no primeiro momento e -0,06 no segundo, consideradas ruim e discordante. Na avaliação da classificação das três colunas, a reprodutibilidade interobservador foi de 0,47 ($p < 0,0001$), classificada como concordância moderada.

Conclusão: O uso da tomografia computadorizada não apresentou melhoria na concordância interobservador na classificação de Schatzker, bem como não promoveu mudança no planejamento pré-operatório.

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Introduction

Fractures of the tibial plateau present risks to knee functioning, since these are joint fractures of the proximal third of the tibia where load transmission takes place. They result from axial compressive forces that may or may not be combined with varus or valgus stress on the knee joint.¹ These fractures account for around 1.3% of all fractures and are more common among male patients. This type of injury mainly affects young or middle-aged patients who are subjected to high-energy trauma, and elderly people who are exposed to low-energy trauma.² The treatment for these fractures aims to achieve anatomical reduction of the joint surface and stable osteosynthesis in order to enable early mobilization, so as to prevent complications such as joint stiffness and post-traumatic arthrosis.³

For these fractures, preoperative planning is fundamental. The clinical history, trauma mechanism, age and associated comorbidities influence the treatment decisions. In the physical examination, the soft-tissue envelope, neurovascular functioning and associated lesions should be assessed so that the intervention will be appropriate.⁴

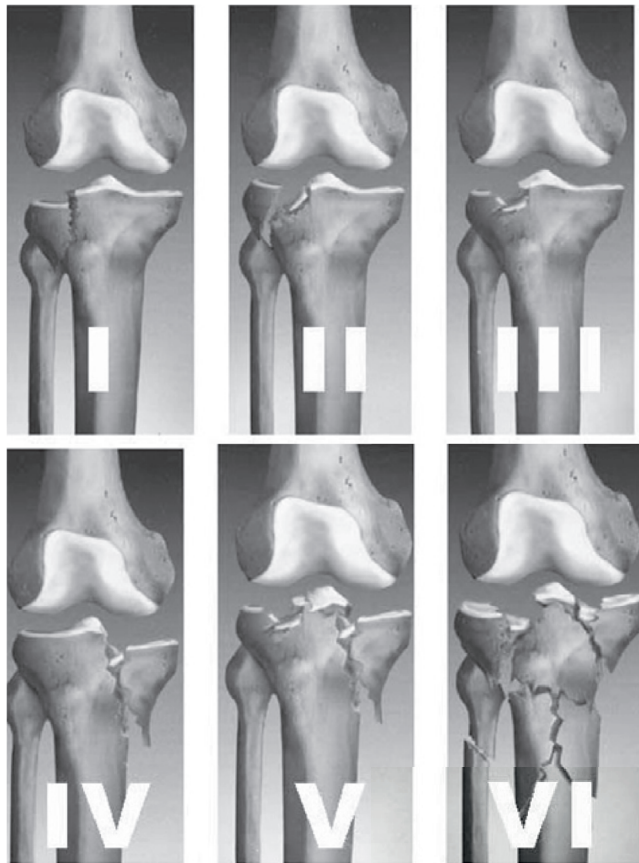
Radiographic evaluation on these fractures involves four views: anteroposterior, lateral, internal oblique and external oblique (Fig. 1). Computed tomography (CT) is of great value for determining the location and magnitude of the joint depression.¹

Management of these fractures consists of using comprehensive classification systems that are easily reproducible and have prognostic value, thereby making it conceptually easier to define tactics and surgical accesses.

In cases of tibial plateau fractures, one classification that is routinely used in clinical practice is the one created by Schatzker (Fig. 2). Another classification recently introduced by Luo et al.⁵ is based on a system of three columns that uses the axial tomographic view (Fig. 3). The tibial plateau is divided into three areas that are defined as the lateral, medial and posterior columns, which are separated by three lines named OA, OC and OD. Point O is the center of the knee (the midpoint between the two tibial spines); point A represents the anterior tuberosity of the tibia; point D is the posteromedial edge of the proximal tibia; and point C is the most anterior point of the head of the fibula. Point B is the posterior sulcus of the tibial plateau, which divides the posterior column into two parts:



Fig. 1 – Radiographic views for diagnosing tibial plateau fractures: (A) anteroposterior; (B) lateral; (C) internal oblique; (D) external oblique.¹



Schatzker

- _____
Type I Fracture with lateral shearing
- _____
Type II Shearing + lateral joint depression
- _____
Type III Pure joint depression
- _____
Type IV Fracture of the medial plateau
- _____
Type V Bicondylar fracture
- _____
Type VI Bicondylar fracture extending to metaphysis

Fig. 2 – Schatzker's classification.¹

medial and lateral (Fig. 1). In addition to using the axial view, the accuracy of the classification was obtained with the aid of the AP view with 3D reconstruction.

According to this classification, an independent joint depression with a cortical fracture of the column is defined as a fracture of the corresponding column. Pure joint depression (Schatzker III) is defined as a zero-column fracture. The majority of fractures due to simple lateral shearing or depression/shearing (Schatzker I and II) are fractures of one column (lateral column). However, when there is an anterolateral fracture and a separate posterolateral joint depression with a fracture of the posterior cortical bone, it is defined as a fracture of two columns (lateral and posterior columns). A joint depression in the posterior column with a fracture of the posterior cortical bone is also defined as a fracture of one

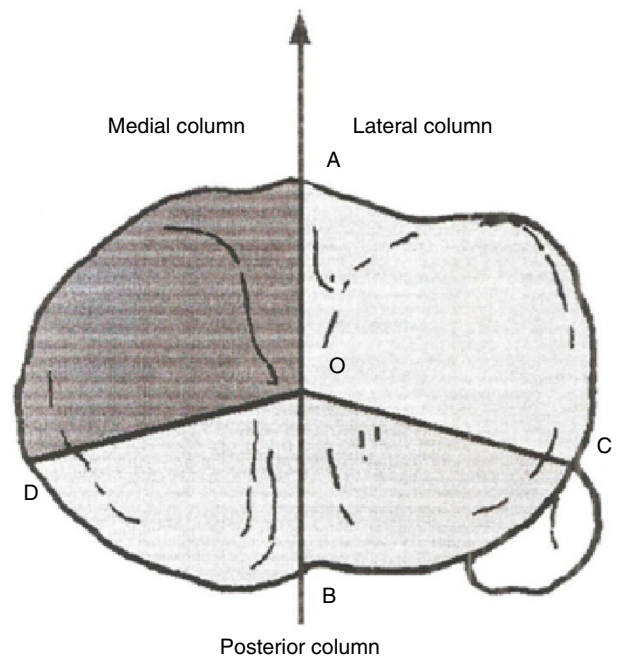


Fig. 3 – Three-column classification proposed by Luo et al.⁵: illustration of division of the tibial plateau into three columns, by means of an axial image, viewing from above.

Table 1 – Options relating to access route and type of implant for preoperative planning.

Access	Implants
Double access (medial and anterolateral)	3.5 mm plate
Percutaneous	4.5 mm plate
Single access (medial or anterolateral or posterior)	7 mm cannulated screw

column (posterior column), which is not included in Schatzker's classification. The other typical two-column fracture is anteromedial with an isolated posteromedial fragment (fracture of the posterior and medial columns), which traditionally was in Schatzker's type IV (medial condylar fracture). Three-column fractures are defined as having at least one independent joint fragment in each column. The commonest three-column fracture is the traditional bicondylar type (Schatzker types V and VI), combined with an isolated posterolateral joint fragment.

The objective of the present study was to assess the importance of CT for managing fractures of the tibial plateau and compare the classification, surgical approach and type of implant used.

Materials and methods

Forty-four patients with tibial plateau fractures attended between April and August 2012 were selected in a non-probabilistic consecutive manner. They all came from the orthopedics and traumatology service of a state trauma referral hospital. Their radiological examinations (CT and simple radiographs) were analyzed by 10 orthopedists who were members of the Brazilian Society of Orthopedics and Traumatology with experience of knee surgery. These specialists were blinded and worked independently.

The equipment used to conduct the complementary examinations on the cases were the Siemens VMI compact plus 500 machine and the Vision Line LX2 processor for the simple radiographs and the GE 16-channel multislice tomograph for the CT scans.

Photographic images were obtained using a camera with a resolution of 5.0 megapixels (iPhone 4 smartphone), copied into digital media (.jpg format) and displayed for each observer separately by means of a PowerPoint presentation in Office 2007, on a tablet (iPad 2) with high-resolution images (1024 × 768).

All the specialists had access to the same images, without identification of the patients. These images were evaluated in two stages: time 1 and time 2, with a seven-day interval between the evaluations. At time 1, radiographic images of the affected knee were displayed in anteroposterior, lateral, internal oblique and external oblique views. The specialists answered a questionnaire regarding the Schatzker classification and the choice of access route and implant to be used (Table 1). At time 2, in addition to the radiographs, CT scans were shown. The questionnaire was applied again, with the addition of the classification of the columns. At time 2, the

order of the images was changes. All the data were recorded in files and questionnaires that were distributed in advance.

Before each presentation, a brief review of Schatzker's classification was made and the concept of the three-column classification was introduced (Figs. 2 and 3).

An annotated illustration showing the two types of classification in question was also handed to all the specialists.

Statistical analysis

The data gathered were processed in a database that was created using the SPSS 19.0 software for Windows, in which the universal variables and the variables analyzed were included. After this stage, the data were analyzed using the κ coefficient.

The κ coefficient evaluated the concordance between observers by means of paired analysis, in which the proportion of concordance between the observers was compared, taking into account the percentage concordance due to chance. The values ranged from -1 (absolute discordance to $+1$ (perfect concordance)).⁵⁻⁷

This project was approved by our institution's research ethics committee, in accordance with Resolution 196/96 of the National Health Council (Guidelines and Regulatory Rules for Research Involving Human Beings). Information about the study was given to each patient, and each patient was asked to sign free and informed consent statement. If the patient was considered to be incapable of signing the form, a close relative was asked to do so.

Results

During the study period, 44 patients were included: 28 males (64.0%) and 16 females (36.0%). Their mean age was 45.6 ± 16.7 years, with a minimum of 21 and a maximum of 77. However, since there was great variation of ages, we noted that the mode was in the fifth decade of life.

At evaluation time 1, the interobserver reliability of Schatzker's classification was 0.36, which was classified as low. In evaluating the choice of surgical access, the interobserver reliability was 0.55, which was moderately reproducible. In evaluating the choice of implants to be used, the interobserver reliability was 0.01, which was classified as poor (Table 2).

At evaluation time 2, the interobserver reliability relating to Schatzker's classification was 0.35, which was classified as low. In evaluating the surgical access, the interobserver reliability was 0.50, which was moderately reproducible. In evaluating the choice of implants, the interobserver reliability was -0.06 , which was classified as discordant (Table 3).

There was no statistically significant difference in relation to the means for interobserver reproducibility at times 1 and 2 of the evaluation of Schatzker's classification ($p = 0.658$) (Fig. 4).

The mean interobserver κ concordance at time 1 regarding the choice of implant was 0.05 (poor) and at time 2, it was -0.03 (discordant). There was no difference in the means regarding the choice of implant, in relation to the evaluation times ($p = 0.055$) (Fig. 5).

Table 4 and Fig. 6 show the degree of intraobserver concordance at the two evaluation times in relation to Schatzker's classification, the access route and the implant used.

Table 2 – Interobserver kappa index at time 1 in relation to Schatzker's classification, access route and implant.

	Schatzker kappa (p-value)	Access kappa (p-value)	Implant kappa (p-value)
Observers	0.36 (<0.0001) ^a	0.55 (<0.0001) ^a	0.01 (0.676)
Observer 1 vs. Observer 2	0.47 (0.004) ^a	0.64 (0.011) ^a	-0.08 (0.742)
Observer 1 vs. Observer 3	0.39 (0.008) ^a	0.84 (<0.0001) ^a	-0.10 (0.679)
Observer 1 vs. Observer 4	0.75 (<0.0001) ^a	0.68 (0.006) ^a	-0.01 (0.740)
Observer 1 vs. Observer 5	0.54 (<0.0001) ^a	0.52 (0.015) ^a	-0.10 (0.511)
Observer 1 vs. Observer 6	0.19 (0.029) ^a	0.69 (0.002) ^a	0.12 (0.434)
Observer 1 vs. Observer 7	0.16 (0.123)	0.41 (0.056)	-0.13 (0.300)
Observer 1 vs. Observer 8	0.11 (0.378)	0.35 (0.149)	-0.02 (0.914)
Observer 1 vs. Observer 9	0.36 (0.031) ^a	0.64 (0.010) ^a	-0.19 (0.193)
Observer 1 vs. Observer 10	0.64 (<0.0001) ^a	0.83 (0.002) ^a	0.24 (0.127)
Observer 2 vs. Observer 3	0.59 (0.001) ^a	0.50 (0.033) ^a	0.50 (0.033) ^a
Observer 2 vs. Observer 4	0.36 (0.027) ^a	0.64 (0.010) ^a	0.00 (1.000)
Observer 2 vs. Observer 5	0.50 (0.003) ^a	0.44 (0.041) ^a	-0.16 (0.214)
Observer 2 vs. Observer 6	0.37 (<0.0001) ^a	0.66 (0.003) ^a	-0.19 (0.125)
Observer 2 vs. Observer 7	0.27 (0.005) ^a	0.28 (0.143)	-0.02 (0.898)
Observer 2 vs. Observer 8	0.31 (0.0255) ^a	0.64 (0.010) ^a	-0.12 (0.338)
Observer 2 vs. Observer 9	0.73 (<0.0001) ^a	0.54 (0.072)	-0.12 (0.338)
Observer 2 vs. Observer 10	0.60 (<0.0001) ^a	0.79 (0.007) ^a	0.35 (0.019) ^a
Observer 3 vs. Observer 4	0.38 (0.015) ^a	0.69 (0.004) ^a	-0.01 (0.740)
Observer 3 vs. Observer 5	0.50 (0.003) ^a	0.55 (0.006) ^a	0.15 (0.251)
Observer 3 vs. Observer 6	0.26 (0.004) ^a	0.70 (0.001) ^a	0.06 (0.658)
Observer 3 vs. Observer 7	0.32 (0.012) ^a	0.37 (0.104)	0.09 (0.404)
Observer 3 vs. Observer 8	0.03 (0.822)	0.37 (0.124)	-0.04 (0.740)
Observer 3 vs. Observer 9	0.48 (0.008) ^a	0.50 (0.033) ^a	0.11 (0.376)
Observer 3 vs. Observer 10	0.47 (0.011) ^a	0.67 (0.009) ^a	0.23 (0.154)
Observer 4 vs. Observer 5	0.53 (<0.0001) ^a	0.52 (0.015) ^a	0.07 (0.087)
Observer 4 vs. Observer 6	0.16 (0.091)	0.69 (0.002) ^a	0.06 (0.165)
Observer 4 vs. Observer 7	0.04 (0.731)	0.55 (0.009) ^a	0.12 (0.026) ^a
Observer 4 vs. Observer 8	0.21 (0.128)	0.68 (0.006) ^a	0.08 (0.026) ^a
Observer 4 vs. Observer 9	0.25 (0.134)	0.64 (0.010) ^a	-0.02 (0.621)
Observer 4 vs. Observer 10	0.40 (0.011) ^a	0.83 (0.002) ^a	0.05 (0.428)
Observer 5 vs. Observer 6	0.54 (<0.0001) ^a	0.84 (<0.0001) ^a	0.38 (0.201)
Observer 5 vs. Observer 7	0.35 (0.003) ^a	0.35 (0.035) ^a	0.29 (0.091)
Observer 5 vs. Observer 8	0.29 (0.056)	0.52 (0.015) ^a	0.74 (0.011) ^a
Observer 5 vs. Observer 9	0.40 (0.007) ^a	0.44 (0.041) ^a	0.23 (0.425)
Observer 5 vs. Observer 10	0.88 (<0.0001) ^a	0.31 (0.145)	-0.13 (0.072)
Observer 6 vs. Observer 7	0.28 (0.002) ^a	0.45 (0.017) ^a	0.19 (0.258)
Observer 6 vs. Observer 8	0.31 (0.022) ^a	0.69 (0.002) ^a	0.12 (0.658)
Observer 6 vs. Observer 9	0.30 (<0.0001) ^a	0.31 (0.154)	0.12 (0.658)
Observer 6 vs. Observer 10	0.46 (<0.0001) ^a	0.51 (0.025) ^a	-0.10 (0.201)
Observer 7 vs. Observer 8	0.09 (0.493)	0.55 (0.009) ^a	0.21 (0.193)
Observer 7 vs. Observer 9	0.25 (0.023) ^b	0.28 (0.143)	0.02 (0.914)
Observer 7 vs. Observer 10	0.45 (<0.0001) ^a	0.39 (0.071)	-0.20 (0.125)
Observer 8 vs. Observer 9	0.21 (0.081)	0.28 (0.264)	-0.22 (0.461)
Observer 8 vs. Observer 10	0.17 (0.247)	0.48 (0.068)	-0.05 (0.425)
Observer 9 vs. Observer 10	0.49 (0.003) ^a	0.79 (0.007) ^a	-0.17 (0.011) ^a

^a Statistically significant.

In evaluating the three-column classification, the interobserver reproducibility was 0.47 ($p < 0.0001$), which was classified as moderate (Table 5 and Fig. 7).

The mean Schatzker concordance was 0.36 (low) and the three-column concordance was 0.48 (moderate). The mean κ concordance was greater in the three-column classification than in the Schatzker classification at time 2 ($p = 0.003$) (Fig. 8).

Discussion

Controversy regarding routine use of CT scans and the ideal classification method for tibial plateau fractures continues in

the literature. This aroused our interest in conducting this study.

The Brazilian National Health System (SUS) provides healthcare for a large percentage of this country's population. High-complexity examinations such as CT and magnetic resonance are not routinely available at some services. Their high cost, along with access difficulties, thus places value on conducting studies on the use of these examinations.

Intra- and interobserver reproducibility is a fundamental criterion for a classification system to become widely accepted and make it possible to compare series. Furthermore, this should guide treatment and determine the prognosis.^{1,8}

Table 3 – Interobserver kappa index at time 2 in relation to Schatzker's classification, access route and implant.

	Schatzker kappa (p-value)	Access kappa (p-value)	Implant kappa (p-value)
Observers	0.35 (<0.0001) ^a	0.50 (<0.0001) ^a	-0.06 (0.023) ^a
Observer 1 vs. Observer 2	0.55 (0.011) ^a	1.00 (<0.0001) ^a	-0.17 (0.258)
Observer 1 vs. Observer 3	0.28 (0.059)	0.21 (0.477)	-0.31 (0.303)
Observer 1 vs. Observer 4	0.13 (0.445)	0.49 (0.058)	0.06 (0.165)
Observer 1 vs. Observer 5	0.31 (0.108)	0.50 (0.049) ^a	0.05 (0.428)
Observer 1 vs. Observer 6	-0.01 (0.915)	0.53 (0.019) ^a	-0.04 (0.658)
Observer 1 vs. Observer 7	-0.11 (0.439)	0.38 (0.201)	0.02 (0.819)
Observer 1 vs. Observer 8	0.32 (0.014) ^a	0.49 (0.058)	0.00 (1.000)
Observer 1 vs. Observer 9	0.49 (<0.0001) ^a	0.49 (0.058)	-0.14 (0.462)
Observer 1 vs. Observer 10	0.22 (0.192)	0.61 (0.044) ^a	-0.21 (0.132)
Observer 2 vs. Observer 3	0.40 (0.004) ^a	0.21 (0.477)	-0.24 (0.111)
Observer 2 vs. Observer 4	0.48 (0.006) ^a	0.49 (0.058)	-0.01 (0.740)
Observer 2 vs. Observer 5	0.71 (<0.0001) ^a	0.50 (0.049) ^a	0.00 (0.740)
Observer 2 vs. Observer 6	0.19 (0.017) ^a	0.53 (0.019) ^a	0.02 (0.621)
Observer 2 vs. Observer 7	0.27 (0.046) ^a	0.38 (0.201)	0.05 (0.251)
Observer 2 vs. Observer 8	0.43 (<0.0001) ^a	0.49 (0.058)	0.00 (1.000)
Observer 2 vs. Observer 9	0.61 (<0.0001) ^a	0.49 (0.058)	-0.18 (0.120)
Observer 2 vs. Observer 10	0.60 (0.001) ^a	0.61 (0.044) ^a	0.58 (0.002) ^a
Observer 3 vs. Observer 4	0.42 (0.003) ^a	0.49 (0.058)	-0.04 (0.338)
Observer 3 vs. Observer 5	0.52 (<0.00001) ^a	0.50 (0.049) ^a	-0.08 (0.251)
Observer 3 vs. Observer 6	0.27 (0.016) ^a	0.37 (0.099)	-0.01 (0.887)
Observer 3 vs. Observer 7	0.38 (0.011) ^a	0.38 (0.201)	-0.03 (0.740)
Observer 3 vs. Observer 8	0.44 (0.001) ^a	0.49 (0.058)	0.00 (1.000)
Observer 3 vs. Observer 9	0.66 (<0.0001) ^a	0.49 (0.058)	0.43 (0.033) ^a
Observer 3 vs. Observer 10	0.52 (<0.0001) ^a	0.21 (0.477)	-0.15 (0.266)
Observer 4 vs. Observer 5	0.49 (0.005) ^a	0.67 (0.008) ^a	0.09 (0.064)
Observer 4 vs. Observer 6	0.26 (0.022) ^a	0.55 (0.011) ^a	-0.12 (0.073)
Observer 4 vs. Observer 7	0.28 (0.043) ^a	0.35 (0.125)	-0.13 (0.441)
Observer 4 vs. Observer 8	0.32 (0.019) ^a	1.00 (<0.0001) ^a	0.00 (1.000)
Observer 4 vs. Observer 9	0.29 (0.057)	1.00 (<0.0001) ^a	0.13 (0.137)
Observer 4 vs. Observer 10	0.50 (0.003) ^a	0.49 (0.058)	-0.06 (0.402)
Observer 5 vs. Observer 6	0.27 (0.005) ^a	0.41 (0.074)	-0.14 (0.621)
Observer 5 vs. Observer 7	0.36 (0.009) ^a	0.33 (0.156)	-0.08 (0.251)
Observer 5 vs. Observer 8	0.29 (0.049) ^a	0.67 (0.008) ^a	0.00 (1.000)
Observer 5 vs. Observer 9	0.63 (<0.0001) ^a	0.67 (0.008) ^a	-0.08 (0.165)
Observer 5 vs. Observer 10	0.59 (0.002) ^a	0.67 (0.008) ^a	0.01 (0.740)
Observer 6 vs. Observer 7	0.39 (<0.0001) ^a	0.20 (0.338)	0.13 (0.154)
Observer 6 vs. Observer 8	0.09 (0.480) ^a	0.55 (0.011) ^a	0.00 (1.000)
Observer 6 vs. Observer 9	0.27 (0.015) ^a	0.55 (0.011) ^a	-0.17 (0.038) ^a
Observer 6 vs. Observer 10	0.36 (0.001) ^a	0.53 (0.019) ^a	0.02 (0.621)
Observer 7 vs. Observer 8	0.10 (0.371)	0.35 (0.125)	0.00 (1.000)
Observer 7 vs. Observer 9	0.31 (0.020) ^a	0.35 (0.125)	-0.24 (0.106)
Observer 7 vs. Observer 10	0.37 (0.006) ^a	-0.04 (0.898)	0.15 (0.087)
Observer 8 vs. Observer 9	0.33 (0.015) ^a	1.00 (<0.0001) ^a	0.00 (1.000)
Observer 8 vs. Observer 10	0.40 (0.013) ^a	0.49 (0.058)	0.00 (1.000)
Observer 9 vs. Observer 10	0.28 (0.077)	0.49 (0.058)	-0.18 (0.183)

^a Statistically significant.

In the results from our study, Schatzker's classification presented a low rate of general interobserver reproducibility, both at time 1, when only radiographs were analyzed, and at time 2, when radiographs and CT scans were analyzed. In evaluating the intraobserver reproducibility, the result found comprised moderate mean concordance.

In a study involving 50 cases of tibial plateau fracture, Charalambous et al.⁹ observed that Schatzker's classification presented highly variable intra- and interobserver reproducibility. They concluded that these results should be taken into consideration, so that surgeons would use this classification for guiding treatments and determining prognoses.

Walton et al.¹⁰ compared the Schatzker and AO Group classifications and concluded that the AO was more reproducible. They also observed that the two classifications were originally based on radiographic studies. This factor may have interfered with the results from our study, given that we also used CT images.

According to Brunner et al.,¹¹ Schatzker's classification presented good intra- and interobserver reproducibility when performed with the aid of CT.

Raffii et al.¹² demonstrated that CT was superior to conventional radiography for managing tibial plateau fractures and that it was a reliable method for evaluating and classifying these fractures.

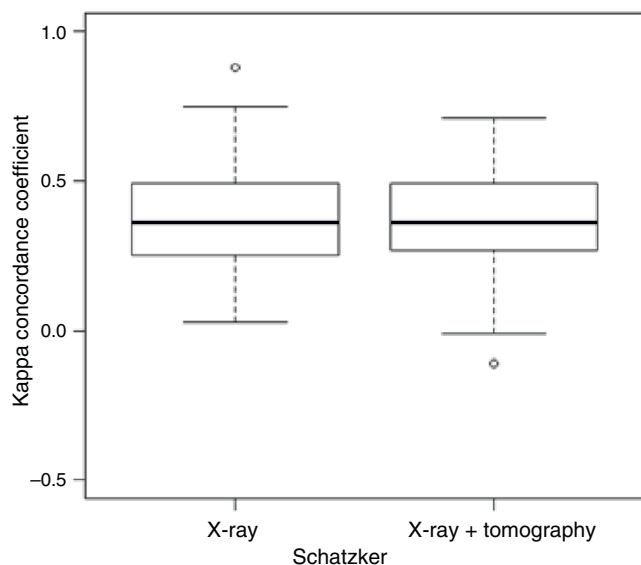


Fig. 4 – Boxplot of interobserver reproducibility of Schatzker's classification in relation to the two evaluation times.

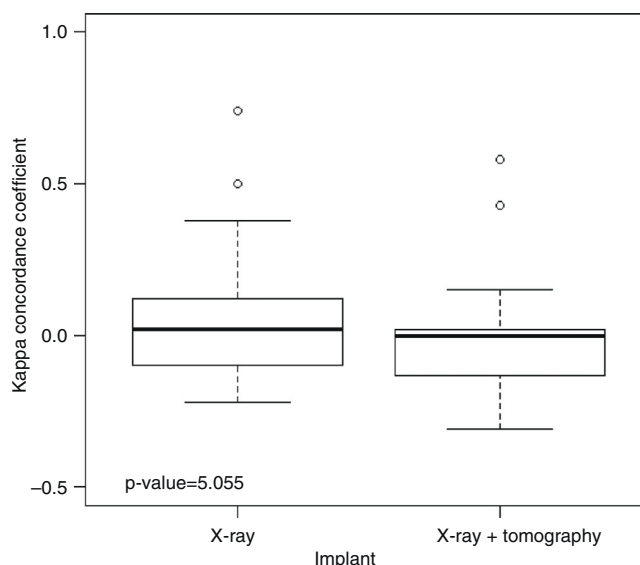


Fig. 5 – Boxplot of the interobserver kappa concordance relating to choice of implant.

The studies in the literature on the concordance and reproducibility of Schatzker's classification still present very divergent results but, as also observed in our study, most of them have characterized this classification system as having poor to moderate reproducibility.^{9,13-15}

In some studies, CT has not changed the reproducibility of Schatzker's classification in relation to conventional radiographs,¹⁴ as also shown in our results. In other studies, this examination has become important for this evaluation.^{11,12}

Martijn et al.¹³ evaluated the impact of CT on inter and intraobserver concordance, in comparison with plain radiographs, for operative planning and for Schatzker's classification of tibial plateau fractures. They concluded that using CT in addition to plain radiographs did not improve the

Table 4 – Interobserver kappa index at both times in relation to Schatzker's classification, access route and implant.

Time 1 vs. Time 2	Schatzker kappa (p-value)	Access kappa (p-value)	Implant kappa (p-value)
Observer 1	0.35 (0.044) ^a	0.36 (0.128)	0.36 (0.128)
Observer 2	0.85 (<0.0001) ^a	0.35 (0.125)	-0.04 (0.707)
Observer 3	0.39 (0.012) ^a	0.50 (0.049) ^a	0.67 (0.011) ^a
Observer 4	0.28 (0.075)	0.83 (0.002) ^a	0.15 (0.464)
Observer 5	0.49 (0.005) ^a	0.26 (0.202)	-0.16 (0.521)
Observer 6	0.28 (0.043) ^a	0.44 (0.037) ^a	0.12 (0.658)
Observer 7	0.28 (0.071)	0.02 (0.944)	0.11 (0.573)
Observer 8	0.31 (0.037) ^a	0.48 (0.067)	0.00 (1.000)
Observer 9	0.38 (0.017) ^a	0.79 (0.007) ^a	-0.04 (0.658)
Observer 10	0.62 (<0.0001) ^a	0.49 (0.058)	-0.10 (0.512)

^a Statistically significant.

Table 5 – Interobserver reproducibility in relation to three-column classification.

Observers	kappa (p-value)	Observers	kappa (p-value)	Observers	kappa (p-value)
1 × 2	0.29 (0.118)	2 × 9	0.52 (0.022) ^a	5 × 6	0.32 (0.131)
1 × 3	0.21 (0.249)	2 × 10	0.53 (0.011) ^a	5 × 7	1.00 (<0.0001) ^a
1 × 4	0.58 (0.003) ^a	3 × 4	0.55 (0.011) ^a	5 × 8	0.57 (0.023) ^a
1 × 5	0.26 (0.145)	3 × 5	0.53 (0.009) ^a	5 × 9	0.66 (0.002) ^a
1 × 6	0.17 (0.394)	3 × 6	0.41 (0.064)	5 × 10	0.67 (0.001) ^a
1 × 7	0.26 (0.145)	3 × 7	0.53 (0.009) ^a	6 × 7	0.32 (0.131)
1 × 8	0.12 (0.460)	3 × 8	0.17 (0.478)	6 × 8	0.31 (0.154)
1 × 9	0.58 (0.003) ^a	3 × 9	0.55 (0.011) ^a	6 × 9	0.39 (0.079)
1 × 10	0.44 (0.028) ^a	3 × 10	0.30 (0.129)	6 × 10	0.40 (0.064)
2 × 3	0.37 (0.104)	4 × 5	0.66 (0.002) ^a	7 × 8	0.57 (0.023) ^a
2 × 4	0.52 (0.022) ^a	4 × 6	0.39 (0.079)	7 × 9	0.66 (0.001) ^a
2 × 5	0.43 (0.064)	4 × 7	0.66 (0.002) ^a	7 × 10	0.67 (0.001) ^a
2 × 6	0.84 (<0.0001) ^a	4 × 8	0.31 (0.154)	8 × 9	0.31 (0.154)
2 × 7	0.43 (0.064)	4 × 9	1.00 (<0.0001) ^a	8 × 10	0.34 (0.066)
2 × 8	0.41 (0.108)	4 × 10	0.70 (0.001) ^a	9 × 10	0.70 (0.001) ^a

^a Statistically significant.

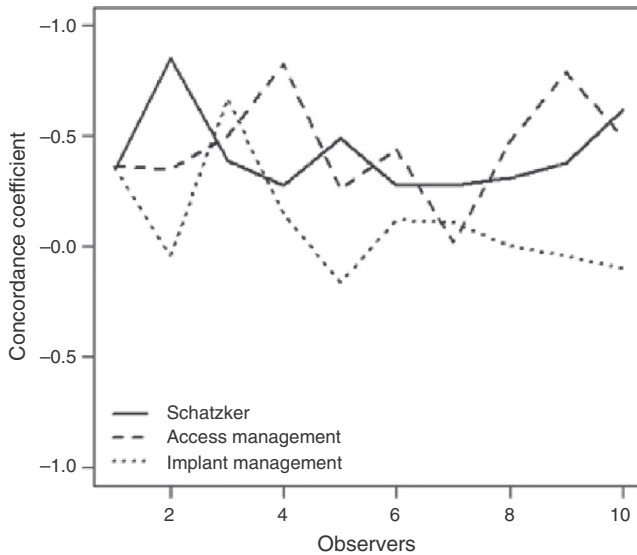


Fig. 6 – Interobserver concordance coefficient relating to Schatzker's classification and the choice of access route and implant.

intra- and interobserver reproducibility of Schatzker's classification, and that its routine application was questionable.

In contrast to Wicky et al.¹⁶ and Markhardt et al.,¹⁷ whose studies confirmed that CT showed tibial plateau fractures more accurately and enabled greater precision of preoperative planning, there was no statistically significant change in relation to operative planning in the present study after viewing the CT.

Luo et al.⁵ proposed using a three-column classification for tibial plateau fractures that encompassed lesion patterns that would be difficult to classify with the methods currently used. Fractures with posterior fragments are not envisaged in Schatzker's classification, which may make it difficult to

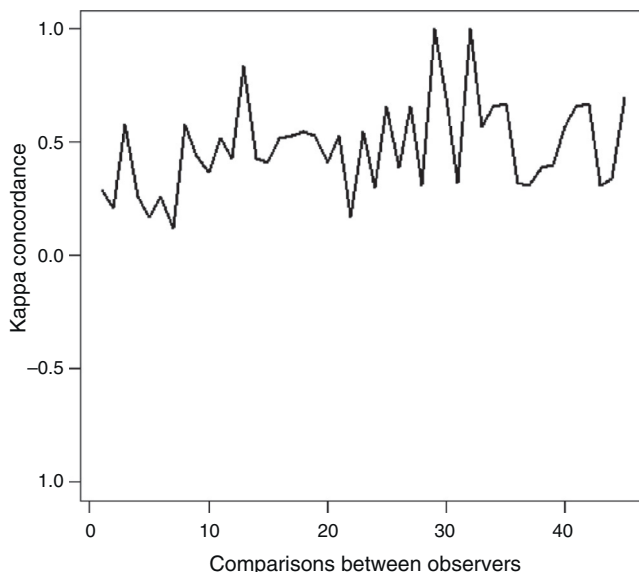


Fig. 7 – Interobserver kappa concordance of the three-column classification.

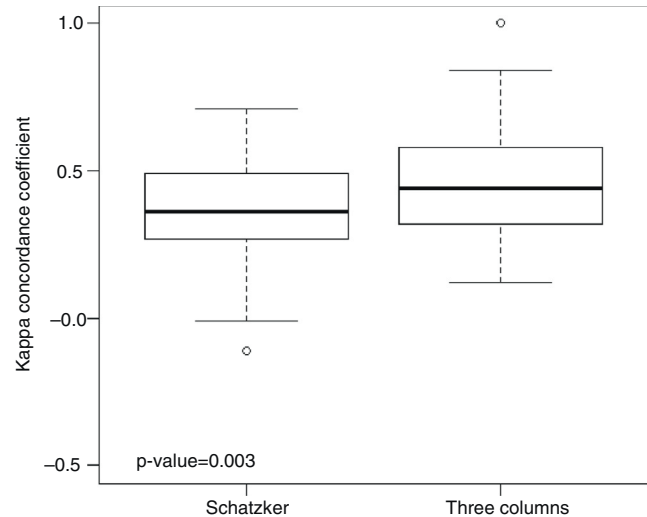


Fig. 8 – Boxplot of interobserver kappa concordance of the Schatzker and three-column classifications.

diagnose them and plan operations. In our analysis, we found that there was moderate interobserver concordance in the three-column classification. This classification may be a useful option in managing tibial plateau fractures.

Because CT is unavailable in some services and because of the high cost of this examination and the high exposure to radiation that is involved, there is a need for new studies to clarify the real value of CT in classifying and managing tibial plateau fractures.

Studies with larger samples and broader approaches need to be developed so that routine use of CT and the present classification systems for managing tibial plateau fractures can be judged more meaningfully.

Conclusion

Use of CT did not give rise to greater concordance between the evaluators regarding Schatzker's classification. Nor did it contribute towards changes in preoperative planning in comparison with radiographs.

The three-column classification presented moderate interobserver concordance and might be a useful option in approaches towards tibial plateau fractures.

Conflicts of interest

The authors declare no conflicts of interest.

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