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Effects of preoperative planning on the treatment of the tibial plateau fractures using 3-column classification on radiological results

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ABSTRACT

Tibial plateau fractures are common and difficult to manage. The purpose of the treatment of tibia plateau fractures is to obtain knee joint which is stable, painless and has functional range of motion. Schatzker's classification and AO classification are most commonly used for the categorisation and to guide the treatment of these fractures. The 3-column classification is a useful tool in the preoperative surgical planning of tibial plateau fractures, especially in fractures extending to the posterolateral corner. The purpose of this study is to evaluate the effect of planning the treatment of the tibial plateau fractures using 3-column classification prior to surgical treatment on radiological results. A retrospective examination was made of 43 patients (32 males, 11 females, mean age 48.91) patients with operatively treated plateau fractures at Muğla Sıtkı Koçman University Medical Faculty was obtained. Preoperative and postoperative 6th month and 1st year radiological images were collected. Radiological evaluation of 43 patients included in the study revealed that 22 had a posterior column fracture. 11 of these posterior column fractures were fixated by posterior plate except medial and-or lateral plate or screw fixation. In addition, only interfragmanter screws were used in fixation of four patients and only plate oriented posterior screws were used in three patients with posterior column fracture. On the other hand, in four patients with posterior column fracture, no fixation was found except medial and-or lateral fixation for the posterior fractured components. The average preoperative modified rasmussen score of 22 patients with posterior column fracture was 3.5. Postoperative Modified Rasmussen Scores were calculated as 7.54 and 6.09 in the 6th months postoperative and 1st year, respectively. At the postoperative 1st year time nine patients in Kellgren-Lawrence grade 1, 18 patients in grade 2-3 and 16 the patients had grade 4 osteoarthritis. Grade 4 OA patients were all patients without any extra fixation for posterior column fracture. Modified Rasmussen Scores of these patients were also lower than other patients. Eleven patients who had fixation with posterior plate had higher radiological scores and less osteoarthritis findings. It was observed that there was no significant difference in terms of radiological scoring and osteoarthritic changes between patients who received an interragmenter screw and those who had a posterior oriented screw over the plate. As it is well known that postoperative negative changes and degeneration in the joint result from non-anatomic fixation. We think that in patients with proximal tibia fracture, diagnosis of fractures and recognition of fracture patterns in the posterior column are important and the most accurate diagnosis will be possible with CT imaging. We believe that efforts should be made for the anatomical detection of the fracture diagnosed.

1. Introduction

Tibial plateau fractures account for approximately 1% of all fractures (Cole et al., 2009). Tibial plateau fractures are common and difficult to manage injuries that can be due to high-energy trauma in young adults or low-energy trauma in elderly patients. 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 and should be considered as complex injuries representing a wide fracture spectrum, soft-tissue compromise, neurovascular damage, compartment syndrome, and ligament and meniscus tears (Lansinger et al., 1986; Honkonen et al., 1995).

Conservative treatment is limited only to simple non-displaced fractures and elderly patients with co-morbidity. With the development of surgical techniques and imaging methods, tibial plateau fractures are treated with surgical methods more frequently. Anatomical reduction of the joint surface, absolute stability and minimal soft tissue dissection is extremely important in surgical treatment (Mahadeva et al., 2008).

There are various surgical techniques used in the surgical treatment of tibia plateau fractures. Open reduction of the joint and fixation with screws and/or plates, arthroscopy or scopy assisted percutaneous screw fixation, external fixation, plaster or traction application are the treatment options. Currently, open reduction internal fixation using locked plate systems is accepted as the gold standard treatment method (Biggi et al., 2010; Wang et al., 2013).

The purpose of the treatment of tibia plateau fractures is to obtain a knee joint which is stable, painless and has functional range of motion. Fragmented fracture and poor soft tissue make it difficult to treat these injuries and may result in high complications and morbidity. The risk of wound complications is very high in the surgical treatment of tibial plateau fractures caused by high-energy traumas. Surgical timing should be set according to the condition of the soft tissues, and if necessary soft tissues should be waited until they become able to allow surgical intervention (Moore et al., 1987; Katsenis et al., 2005).

Understanding the local anatomy, fracture patern and mechanism and preoperative planning are important in order to achieve good results. The surgeon should individualize operative treatment with respect to a variety of factors, such as the patient's age, pre-existing levels of activity, medical morbidity and expectations. Injury considerations should include the extent of fracture comminution and joint impaction, associated injuries, and most important, the condition of the soft tissues (Rasmussen et al., 1973; Lansinger et al., 1986).

Schatzker's classification and AO classification are the most commonly used for the categorisation and to guide the treatment of these fractures (Schatzker et al., 1979). Schatzker classification and AO Classification evaluate fractures according to the anterior posterior graphs. However, only anterior posterior radiographs and fractures in the coronal plane can be overlooked. Currently, with the widespread use of computed tomography, the detection of fractures in the coronal plan is made easier, and recent studies emphasize the importance of evaluations made with computed tomography in preop planning in the preoperative period (Hoekstra et al., 2017). Posterior shear fractures, which can be evaluated on side radiographs and computed tomography sections, are defined in 3-column classifications unlike other classifications (Piątkowski et al., 2015). The 3-column classification is a useful tool in the preoperative surgical planning of tibial plateau fractures, especially in fractures extending to the posterolateral corner. According to the Schatzker classification, the reliability among the observers is quite high (Hoekstra et al., 2017).

The purpose of this study is to evaluate the effects of planning the treatment of the tibial plateau fractures using 3-column classification prior to surgical treatment on radiological results.

2. Material and methods

Approval for the study was granted by the Local Ethics Committee. A retrospective examination was made of patients aged 18-80 years who were operated because of tibia plateau fracture at Muğla Sıtkı Koçman University Medical Faculty between January 2014 and November 2018. All data were abstracted from the electronic medical record, histories and physicals, operative notes, clinic visit notes, and radiographs. Variables such as fracture type, fixation method, timing of surgery were recorded.

An initial list of 55 patients with operatively treated plateau fractures was obtained. Twelve patients were excluded for lost to follow-up. Exclusion criteria included non-acute fractures (>4 weeks after the incident), open fractures and pediatric fractures (aged <18 years). 43 patients (32 males, 11 females, mean age 48.91 [range 20-76 years]) were included in the study. Preoperative and postoperative 6th month and 1st year radiological images were collected. Besides radiographs, all patients had computed tomography scans (CT) for accurate fracture evaluation and classification according to Schatzker et al., and 3-column classification (Schatzker et al., 1979; Luo et al., 2010).

All of the patients (43) were treated surgically. All patients were treated using the standard techniques of exposure, open reduction, and stable internal fixation.

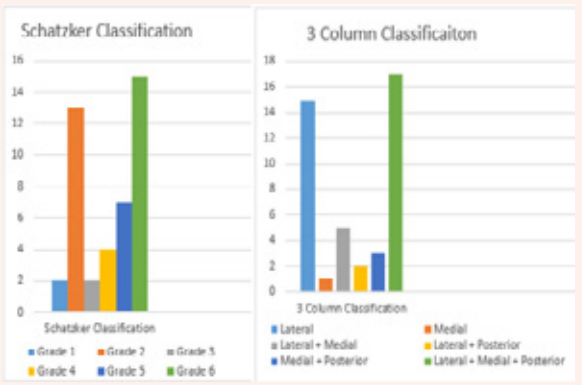
In general, fractures were stabilised by open reduction and internal plate fixation. The mean time to operation was 48 hours (range three hours to seven days). A midline incision or lateral and medial incision was used for open reduction and internal fixation. Joint surface depressions were elevated and stabilised by autograft or allogreft and a buttress plates were used in fixation. In fractures involving posterior column, a posterior butress plate was used for fixation in addition to other butress plates. If needed, additional cannulated screws were used to support the joint surface in order to avoid depression. The postoperative management protocol included early mobilization using a hinged knee brace. All patients were instructed to be non-weight bearing for the first six to ten weeks, followed by partial weight bearing for a further two to six weeks depending on the operating surgeon's intraoperative assessment of fracture comminution and stability.

Radiological assessment were performed regularly for all patients. Preoperative fracture classification according to Schatzker and 3-column classification, degree of joint depression, reduction quality, the presence of osteoarthritis, union time were reviewed by the senior author. Preoperative, immediate postoperative and postoperative one year modified Rasmussen score were calculated by the senior author.

Radiological features of osteoarthritis included the presence of joint space narrowing, articular margin osteophytes, as well as subchondral cysts and sclerosis. Union was defined as evidence of bone healing by direct or indirect means in at least two radiographic planes.

Descriptive statistics were calculated to examine the characteristics of the sample. T-tests were conducted for comparisons between the two groups on continuous variables and x2 tests for comparisons between the two groups on unranked categorical variables, and Fisher exact test where appropriate. For all analyses, significance was set at the $p<0.05$ level.

Table 1. Schatzker and 3 column classifications made by direct x-ray and computed tomography images taken before the operation are summarized.



3. Results

43 patients (32 men, 11 women) were included in the study. The mean age was 48.91 [20-76 years]. Schatzker and 3-column classifications made by direct x-ray and computed tomography images taken before the operation are summarized in Table 1. All patients could be grouped according to Schatzker and 3-column classifications. The degrees of articular depression, condylar widening, varus/valgus angulation, and osteoarthritis were measured and recorded from the preoperative and postoperative radiological images. In addition to this, all patients had Modified Rasmussen Scores preoperatively and postoperatively.

Radiological evaluation of 43 patients included in the study revealed that 22 had a posterior column (17 had 3-column fractures, five had two column fractures). In the postoperative radiological evaluation of 22 patients with posterior column fracture; 11 of these posterior column fractures were fixated by posterior plate except medial and-or lateral plate or screw fixation (Fig.1). In four patients with posterior column fracture;

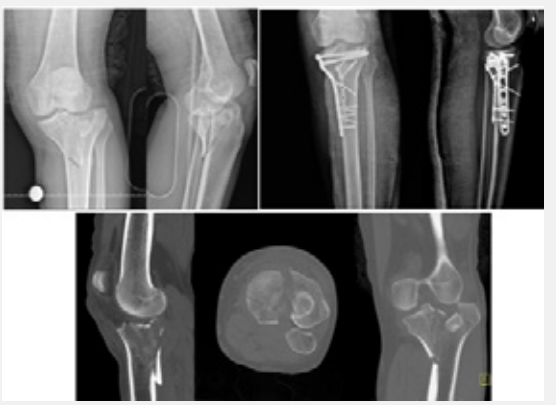


Fig. 1. Preoperative and postoperative images of a 42-year-old patient with a tibial plateau fracture after a traffic accident.

interfragmanter screw were used in fixation and plate oriented posterior screws were used in three patients with posterior column fracture. On the other hand, in four patients with posterior column fracture, no fixation was found except medial and-or lateral fixation for the posterior fractured components.

The average preoperative modified rasmussen score of 22 patients with posterior column fracture was 3.5. Postoperative Modified Rasmussen Scores were calculated as 7.54 and 6.09 in the 6th months postoperative and 1st year, respectively. Postoperative Modified Rasmussen Scores were worse and osteoarthritis findings were higher in four patients without any fixation to the posterior column. When these four patients were not statistically analyzed, it was seen that the average Modified Rasmussen Score

was calculated as 7.77 and 6.66 in the 6th month and 1st year, and the radiological score was improved. In particular, 11 patients who had fixation with posterior plate had higher radiological scores and less osteoarthritis findings. It was observed that there was no significant difference in terms of radiological scoring and osteoarthritic changes between patients who received an interfragmenter screw and those who had a posterior oriented screw over the plate.

4. Discussion

The aim of our study is to evaluate the effect of preoperative planning of surgical treatment of the tibial plateau fractures using 3-column classification on radiological results and to examine the postoperative radiological results of patients with posterior column fracture in the tibial plateau. We believe that the selected fixation method and the achieved reduction success are the most important factors in preventing the development of osteoarthritis. In the literature, it has been shown that a joint line displaced more than 2 mm may be associated with poor clinical outcomes, and traumatic osteoarthritis develops in approximately 20-44% of patients after a proximal tibial fracture (Rasmussen et al., 1973; Volpin et al., 1990; Giannoudis et al., 2010).

X-ray imaging is still the gold standard in controlling the progression of post-traumatic osteoarthritis (Lizaur-Utrilla et al., 2015). In our study, we used X-ray imaging in radiological follow-up. Based on x-ray imaging, traditional classification systems (Hohl and Moore, Schatzker, OTA / AO 2007) play an important role in guiding surgical treatment (Schatzker et al., 1979). With the advent of computed tomography, more different classifications have emerged and facilitated the understanding of fracture morphology. In 2016, Wang et al. made a prospective cohort study involving 287 patients and proposed the concept of three columns (medial, lateral and posterior columns) (Wang et al., 2016).

3-column classification approach is a valuable addition to the Schatzker classification in the current form. Although the 3-column classification approach of tibial plateau fractures has already shown to be very helpful to understand the fracture pattern and determine the surgical strategy preoperatively, 3-column classification approach allows both lateral buttressing and posterolateral support of lateral tibial plateau fractures extending into the posterolateral complex. According to Zhu et al. the inter-observer reliability of the 3-column classifications is higher than the Schatzker classification (Zhu et al., 2012). On the other hand, several studies have compared reliability and reproducibility among commonly used classification systems, but no consensus has been reached on the best choice (Gicquel et al., 2013).

The medial part of the knee is concave to the tibial side and the femoral condyle is highly mobile in the tibial space. During the axial loading of the femur, it creates an explosive effect on the tibia. Since the tibial plateau charge is directed posteriorly, the resulting force vector is directed to the posterior, thereby leading to a posterior division. Therefore, it is important to keep in mind the possibility of developing a posteromedial fracture (Eggli et al., 2008). We suggest that the posterior fracture detection is very important in treatment success. In this regard, we think that conventional X-ray imaging may not be sufficient and CT imaging should be routinely performed in every patient with a proximal tibia fracture.

In our department, we routinely use CT scans in tibia plateau fractures to determine the fracture pattern preoperatively and X-ray imaging in follow-up period postoperatively. Preoperative CT images were collected from our patients' records. By classifying 3-columns on CT records, we detected patients with posterior colon fracture. In our study, 22 of 43 patients had posterior column fracture. Modified Rasmussen Scores were calculated on X-ray imaging in the preoperative, postoperative 6th months and 1st year time. Radiological evaluation was also performed for posttraumatic arthritis examination. At the postoperative 1st year time nine patients in Kellgren-Lawrence grade 1, 18 patients in grade 2-3 and 16 the patients had grade 4 osteoarthritis. Grade 4 OA patients were all patients without any extra fixation for posterior column fracture. Modified Rasmussen Scores of these patients were also lower than other patients. On the other hand, in our study, 79% of the patients that operated because of tibia plateau fracture had mild or severe osteoarthritis, osteoarthritis findings may also develop regardless of the type of fixation like other intraarticular fractures. Articular incongruities in the tibial plateau are well tolerated, with little evidence that anatomical reduction of the more common fracture patterns improves patient outcome or prevents arthritis. Factors other than articular congruity, such as joint stability, retention of menisci, and coronal alignment, play a more important role in determining outcome. Despite anatomical joint reconstruction, development of osteoarthritis may still occur secondary to the initial articular cartilage and meniscal injury (Honkonen et al., 1995; Marsh et al., 2002). Limitations of this study; the number of patients was low and the follow-up was short. Meniscus repair was not performed in any patient. This may have affected the results.

As it is well known that postoperative negative changes and degeneration in the joint result from non-anatomic fixation. Articular step-off and widening of the lateral condyle correlate strongly with the clinical outcome of tibial plateau fracture treatment. We think that in patients with proximal tibia fracture, diagnosis

of fractures and recogniation of fracture patterns in the posterior column is important and the most accurate diagnosis will be possible with CT imaging. We believe that efforts should be made for the anatomical detection of the fracture diagnosed.

Declaration of conflicting interests

The author declares that there is no conflict of interest.

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