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Functional Outcome of Patients Following Intra-articular Tibal Plateau Fractures

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Summary

Introduction. Tibial plateau fractures are injuries that often require surgical treatment due to their complexity. The management of these fractures can be challenging and may lead to complications and functional impairment, impacting daily activities significantly.

Aim of the study. The aim of this study was to evaluate of the functional outcome of patients with intra-articular tibial plateau fractures following surgical treatment and to compare the functional outcome between low-energy and high-energy trauma patients following surgical treatment of tibial plateau fractures.

Materials and methods. The study enrolled a total of 108 patients with proximal tibia fractures who were admitted to the Hospital of Traumatology and Orthopaedics between December of 2018 and December 2021. Among them, 88 patients (81.5%) underwent surgical treatment and were included in research groups. Fractures were evaluated using anteroposterior radiograph and computed tomography images and were categorized according to AO/OTA and Schatzker classifications. The patients were divided into two groups: Group A consisted of patients with low-energy trauma, and Group B included patients with high-energy trauma. Functional outcomes were assessed using the Lower Extremity Functional Scale (LEFS).

Results. The study assessed the functional outcome of 45 patients (51.1%) who underwent surgery between 11 and 43 months ago. Among them, Group A consisted of 30 patients with an average age of 54.4 years, and they achieved a mean LEFS score of 54.3 SD +/- 17. On the other hand, Group B included 15 patients with a mean age of 53.4 years, and their average LEFS score was 52 SD +/- 16.8. Statistical analysis using the Mann-Whitney test revealed no significant differences in the mean LEFS score between the two groups, U = 210.0, p = 0.718. When examining the individual activities covered within the LEFS assessment, there were no statistically significant differences observed between the two groups.

Conclusions. Our research findings suggest that, in patients with tibial plateau fractures resulting from low-energy and high-energy trauma, there is no significant difference in post-operative functional outcomes, as per the Schatzker classification of these fractures. This suggests that relying solely on the Schatzker classification may not be adequate for predicting functional outcomes. Factors beyond the appearance of the fracture on anteroposterior radiographs seem to wield substantial influence in determining functional outcomes.

Keywords: tibial plateau fracture, functional outcomes, Schatzker classification.

Introduction

The tibial plateau is a unique anatomical structure comprising two different articular surfaces - the medial larger and lateral smaller, partially covered by meniscus, articular cartilage and areas that are simply bone (2). Both low-energy or high-energy trauma mechanisms can lead to complex fractures. Every tibial plateau fracture must be carefully evaluated and managed. Open reduction and internal fixation (ORIF) remain the gold standard treatment for such fractures, aiming to restore coronal and sagittal alignment, mechanical alignment and to stabilize the knee joint. Other options include ring external fixators and minimally invasive osteosynthesis (10).

However, these fractures are often associated not only with extensive articulating surface damage but also with significant soft tissue damage which contributes to the difficulty of the surgery. Given the complexity of these fractures and the surgical challenges they pose, serious complications with long term functional impairment may arise. These complications include a reduced range of motion (ROM) in the knee joint, ankylosis, knee stiffness and others, which can interfere with various daily activities (9).

At least 38 classification systems have been developed to categorize tibial plateau fractures. In clinical practise AO Foundation/Orthopaedic Trauma Association (AO/OTA) classification and Schatzker classification are used. According to AO/OTA classification proximal tibia fractures includes extraarticular (type A), partially articular (type B) and complete articular (type C) fractures (4). Schatzker classification was published in 1974 by Joseph Schatzker (12). This classification divides fractures into six types, labeled from I to VI, in the ascending order of severity according to fractures complexity, age of patients, quality of bone and trauma mechanism, based on their appearance on anteroposterior radiograph and two-plane computed tomography (CT) images. Schatzker type V and VI fractures are most often caused by high-energy trauma (11). In 2018, Kfuri and Schatzker revisited the Schatzker classification, presenting the importance of the three-dimensional location of the split wedge fragment for the decision making for the surgical approach and placement of the plate (6).

Aim of the study

The aim of this study was to evaluate of the functional outcome of patients with intra-articular tibial plateau fractures following surgical treatment and to compare the functional outcome between low-energy and high-energy trauma patients following surgical treatment of tibial plateau fractures.

Materials and methods

A retrospective study was done in the Hospital of Traumatology and Orthopaedics, Latvia. Ethical clearance was obtained from the Rīga Stradiņš University Research Ethics Committee and the Hospital of Traumatology and Orthopaedics Ethics Committee. A total of 108 cases with proximal tibia fractures, admitted to the Hospital of Traumatology and Orthopaedics in the period from December of 2018 to December of 2021, were studied. Eighty-eight patients (81.5%) with surgically treated proximal tibia fractures were included in the study. Trauma mechanism was classified as low-energy trauma or high-energy trauma according to the criteria derived from the Prehospital Trauma Life Support and Advanced Trauma Life Support guidelines (1).

After surgery, active and passive movements were started for the patients as soon as possible. Patients were advised not to put weight on the operated knee for the first three months after surgery and then started gradual weight-bearing activities.

Preoperative and postoperative anteroposterior radiograph and CT scan images were analysed, and each case was categorized using Schatzker classification. To reach the aim of

dividing of tibial plateau fractures in low-energy and high-energy caused injuries, we defined the groups of patients according the Schatzker classification concept. In group A low-energy injuries (Schatzker types I-IV) were included whereas group B comprised patients with high-energy injuries (Schatzker types V-VI). Classification was carried out by two independent researchers, who then came to a joint decision when the types differed.

The postoperative functional outcome was measured using Lower Extremity Functional Scale (LEFS) which was assessed through an interview. LEFS consists of 20 questions assessing a patient's ability to perform various daily activities. Each question is scored on a scale from 0 to 4, with 0 indicating extreme difficulty, 1 point – great difficulty, 2 points – moderate difficulty, 3 points – little difficulty and 4 points – no difficulty in performing the activity (3).

Patients whose fractures were not classifiable according to Schatzker's classification and patients who did not respond to two phone calls or refused to participate in the study were excluded. Detailed information about patient inclusion can be seen in flowchart (Fig. 1).

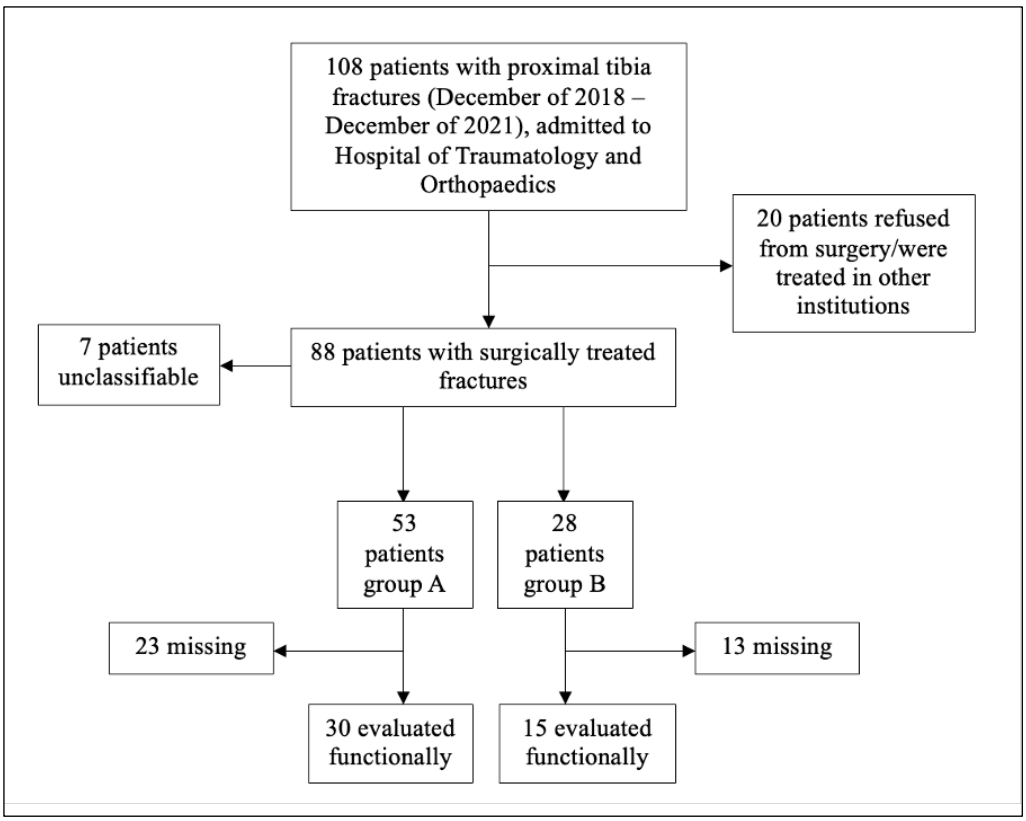

Figure 1. Flowchart for participant inclusion.

The statistical significance of differences between research groups were determined with Mann-Whitney test. Categorical variables were reported as percentages and frequencies. Continuous variables were given as mean and standard deviation. The statistical analysis and data interpretation was carried out using IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp.

Results

Eighty-eight patients, 51 of whom were female and 37 male, with mean age of 54.3 (range 20 to 92) years, were classified according to Schatzker classification as follows: Schatzker – 9, Schatzker II – 27, Schatzker III – 7, Schatzker IV – 10, Schatzker V – 12, Schatzker VI – 16 and

7 patients could not be categorized according to Schatzker classification because the appearance of the fracture on anteroposterior radiograph and CT image did not correspond to any type covered by this classification and thus is labelled as “unclassifiable” (Fig. 2). According to these data, 53 (65.4%) patients are categorized in research group A and 28 (34.6%) in group B.

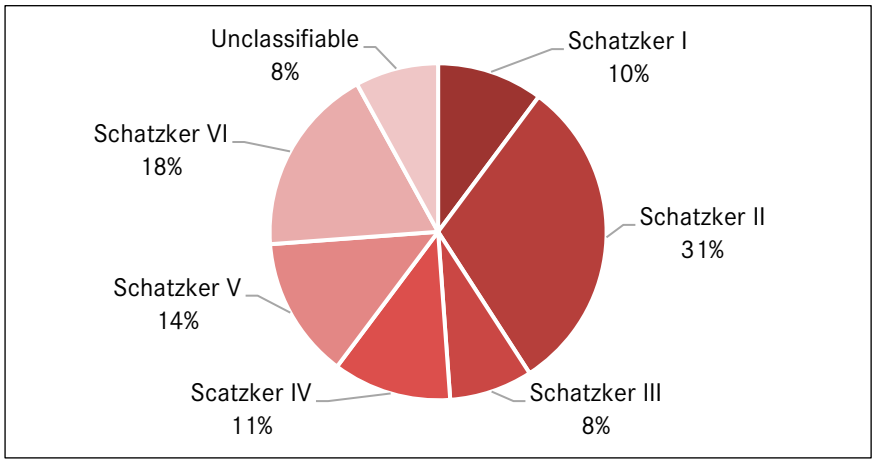

Figure 2. Distribution of surgically treated patients by Schatzker classification.

Functional outcome was assessed in 45 patients (51.1%) 11 – 43 months after surgery. The remaining 43 patients withdrew from the study or did not answer the phone call. Out of 45 patients 4 were categorized as Schatzker I, 13 as Schatzker II, 7 as Schatzker III, 6 as Schatzker IV, 5 as Schatzker V and 10 as Schatzker VI fractures (Fig. 3).

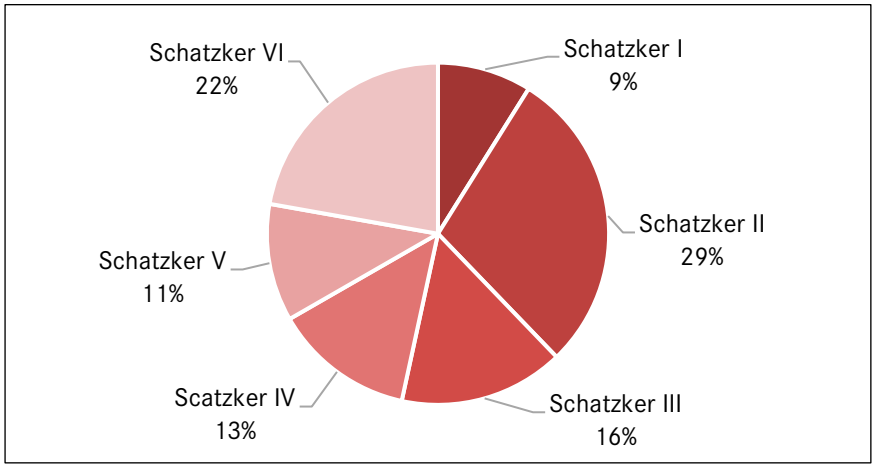

Figure 3. Distribution of included study participants by Schatzker classification.

66.7% of patients (n=30) were included in group A as they were categorized into one of the Schatzker types I-IV and 33.3% of participants (n=15) were included in group B as their tibial plateau fractures belonged to one of the Schatzker types V-VI (Fig. 4).

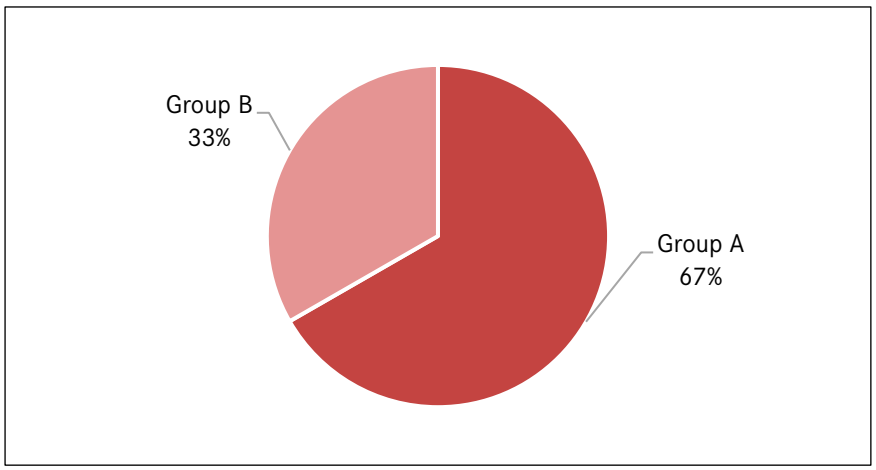

Figure 4. Distribution of study participants by research groups.

The mean age of patients in group A was 54.4 years, of whom the youngest patient was 27 years old and the oldest 81 years old, and in group B 53.4 years, with the youngest patient being 36 years old and the oldest 79 years old (Fig. 5).

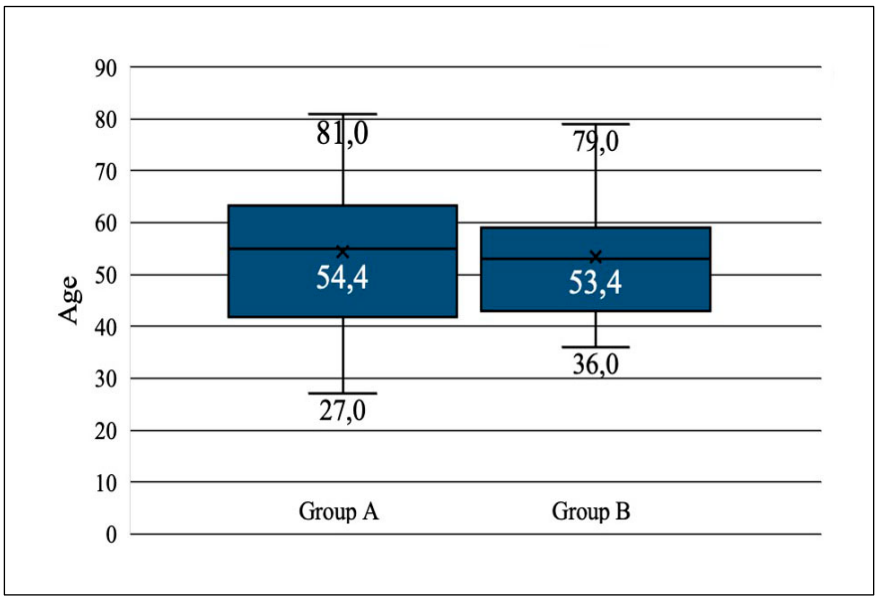

Figure 5. The mean age of participants by research groups.

Group A had mean LEFS score 54.3 SD ± 17 points and group B had mean LEFS score 52 SD ± 16.8 points. There were no statistically significant differences in the mean LEFS score between both study groups, Mann-Whitney test, U = 210.0, p = 0.718.

The mean scores for the activities included in the LEFS in both patient groups can be seen in Table 1. There were no statistically significant differences for individual activities between both groups.

Table 1. The mean scores and p values of differences between Lower Extremity Functional Scale activities in the research groups.

Activities	Group A (Schatzker I-IV) (n=30) Mean±SD	Group B (Schatzker V-VI) (n=15) Mean±SD	P value
Any of your usual work in the house or school	3.43 ± 0.86	3.27 ± 0.88	0.493
Usual hobbies or sporting activities	2.43 ± 1.30	2.40 ± 0.91	0.931
Getting into or out of the bath	3.03 ± 1.25	2.60 ± 1.64	0.443
Walking between rooms	3.63 ± 0.72	3.60 ± 0.74	0.926
Putting on shoes or socks	3.67 ± 0.80	3.60 ± 0.63	0.386
Squatting	2.40 ± 1.63	1.87 ± 1.60	0.253
Lifting an object like groceries or a bag	3.67 ± 1.03	3.53 ± 1.06	0.576
Doing light activities around the house	3.60 ± 0.67	3.20 ± 1.01	0.188
Doing heavy activities around the house	2.63 ± 1.45	2.33 ± 1.40	0.444
Getting into a car	3.20 ± 1.13	3.27 ± 1.28	0.719
Walking two blocks	2.93 ± 1.17	3.20 ± 0.94	0.548
Walking one and a half kilometer	2.70 ± 1.32	2.87 ± 1.19	0.752
Going up and down the stairs (about a flight)	2.93 ± 1.17	2.87 ± 1.30	0.959
Standing for one hour	2.60 ± 1.30	2.67 ± 1.40	0.851
Sitting for one hour	3.57 ± 0.77	3.53 ± 0.99	0.675
Running on even ground	1.10 ± 1.49	1.00 ± 1.20	0.873
Running on uneven ground	0.97 ± 1.38	0.73 ± 0.80	0.958
Making sharp turns while running fast	0.97 ± 1.38	0.73 ± 0.80	0.905
Hopping	1.33 ± 1.54	1.47 ± 1.50	0.649
Rolling out of bed	3.87 ± 0.35	3.47 ± 0.99	0.193

Representative case of Schatzker II right tibia plateau fracture, belonging to research group A, is shown in Fig 6. The control radiograph 8 weeks after osteosynthesis with a plate is also depicted.

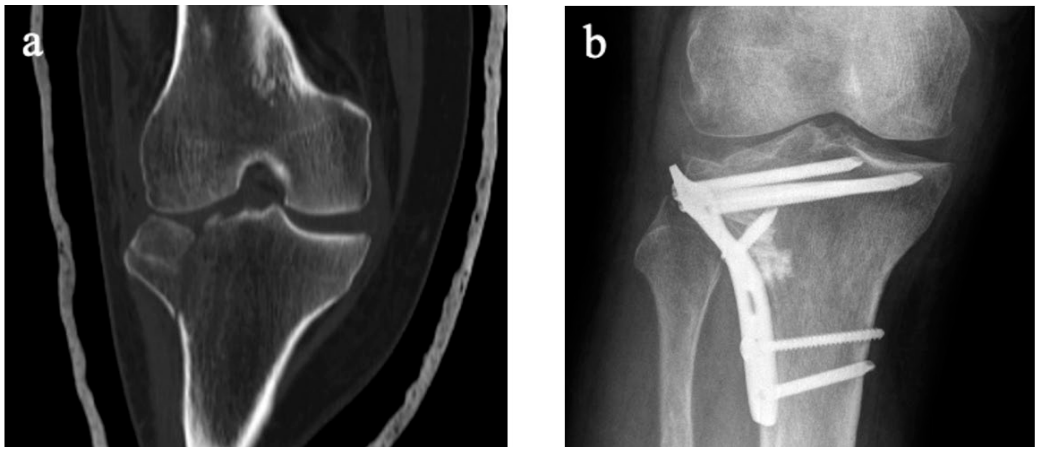

Figure 6. Representative case of group A right tibia plateau fracture (Schatzker II) in CT before surgery (a) and control a radiograph 8 weeks after osteosynthesis with a plate (b).

Fig. 7 represents an exemplary case of Schatzker VI right tibia plateau fracture in a CT image, along with the control radiograph taken 9 weeks after osteosynthesis with two plates. This case belongs to research group B.

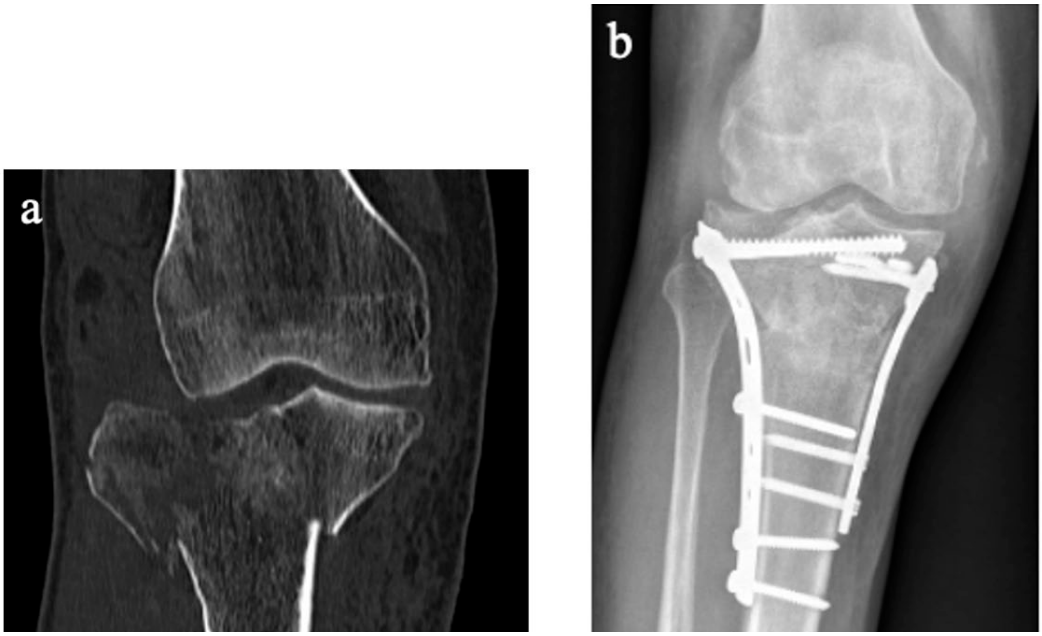

Figure 7. Representative case of group B right tibia plateau fracture (Schatzker VI) in CT before surgery (a) and a control radiograph 9 weeks after osteosynthesis with two plates (b).

Discussion

In this study, the functional outcomes of surgical treatment for tibial plateau fractures were compared between Schatzker groups I-IV, corresponding to low-energy injuries, and Schatzker groups V-VI, corresponding to high-energy trauma, using a valid patient-rated outcome measure. Research groups were determined based on Schatzker classification, because it assesses the level of energy of the fracture and the mechanism of trauma (6) (14).

High-energy tibial plateau fractures of Schatzker V and VI are complex fractures often associated with severe soft tissue injury which poses high risk for post-operative complications (13).

Meiser et al. used LEFS to determine 10-year functional outcome after surgically treated tibial plateau fractures using bone allograft. The median LEFS score was 57.5 ± 19.0 (range 33–79) (8). In our study group A and group B had mean LEFS score 54.3 SD ± 17 and 52 SD ± 16.8 respectively. The most difficult in both groups were intense activities such as running on uneven ground and making sharp turns while running fast.

Although high-energy trauma seemed to yield worse results, in our research LEFS did not show a statistically significant difference between both study groups. Additionally, when considering specific activities included in the LEFS, both groups exhibited statistically similar scores. Based on this study, the Schatzker classification alone may not be sufficient for predicting mid-term postoperative outcomes.

The current literature does not provide the clear picture regarding the functional results after surgically treated tibial plateau fractures due to different functional outcomes evaluation scales. Jagdev et al. reported the higher grade of osteoarthritis in Schatzker type V and VI fractures and the role of the early rehabilitation to prevent severe degenerative changes after these fractures (5).

The study encountered several cases that were not possible to categorize according to two-dimensional Schatzker classification. These cases involved fractures in coronal plane, compromising the posterior rim of the tibial plateau, and isolated intercondyloid eminence fractures. In the literature several authors have emphasized the importance of using three-

dimensional CT to classify these fractures. For instance, Luo et al. introduced the three-column concept, which divides the tibial plateau into three columns (7).

There are several limitations in this study. Firstly, it is a retrospective study. The trauma mechanism was derived from the medical documentation descriptions according to patients' and ambulance personal on admission and might be inexact. The patients' different functional demands and ability to recall information might affect anamnesis and the interpretation of their complaints during the use of the assessment scale. Secondly, there were different age groups, types of implants and rehabilitation were used in these patients. Patients were operated by a several surgeons. Thirdly, due to the relatively small number of patients, our results should be taken cautiously.

Conclusions

The results of our research suggest that post-operative functional outcome in patients with tibial plateau fractures caused by low-energy trauma does not differ from fractures due to high-energy trauma, according to Schatzker classification of the fractures. It appears that the Schatzker classification alone does not seem to be sufficient to predict functional outcomes, and factors other than fracture appearance on anteroposterior radiograph play a significant role in determining the functional outcome. The most difficult in both groups were intense activities.

References

1. American College of Surgeons: Advanced Trauma Life Support, 10th ed. Chicago, 2018: 4-5.
2. Ariffin HM, Mahdi NM, Rhani SA, Baharudin A, Shukur MH. Modified hybrid fixator for high-energy Schatzker V and VI tibial plateau fractures. Strategies Trauma Limb Reconstr. 2011;6(1):21–6. doi:10.1007/s11751-011-0105-4
3. Binkley JM, Stratford PW, Lott SA, Riddle DL. The Lower Extremity Functional Scale (LEFS): scale development, measurement properties, and clinical application. North American Orthopaedic Rehabilitation Research Network. Phys Ther. 1999;79(4):371-83. doi:10.1093/ptj/79.4.371
4. Buckley RE, Moran CG, Apivatthakakul T. AO principles of fracture management. Davos Platz, Switzerland: AO Foundation, Stuttgart, Germany; New York, Ny; 2017
5. Jagdev SS, Pathak S, Kanani H, Salunke A. Functional outcome and incidence of osteoarthritis in operated tibial plateau fractures. Arch Bone Jt Surg. 2018;6(6):508-16. doi:10.22038/ABJS.2017.21582.1555
6. Kfuri M, Schatzker J. Revisiting the Schatzker classification of tibial plateau fractures. Injury. 2018;49(12):2252–63. doi:10.1016/j.injury.2018.11.010
7. Luo CF, Sun H, Zhang B, Zeng BF. Three-column fixation for complex tibial plateau fractures. J Orthop Trauma. 2010;24(11):683–92. doi:10.1097/BOT.0b013e3181d436f3
8. Meiser S, Arora R, Petersen J, Keiler A, Liebensteiner MC, Pallua JD, Wurm A. Radiographic and clinical outcome of tibial plateau fractures treated with bone allograft. Arch Orthop Trauma Surg. 2023;143(5):2447–54. doi:10.1007/s00402-022-04461-x
9. Papagelopoulos PJ, Partsinevelos AA, Themistocleous GS, Mavrogenis AF, Korres DS, Soucacos PN. Complications after tibia plateau fracture surgery. Injury. 2006;37(6):475–84. doi:10.1016/j.injury.2005.06.035
10. Prat-Fabregat S, Camacho-Carrasco P. Treatment strategy for tibial plateau fractures: an update. EFORT Open Rev. 2017;1(5):225–32. doi:10.1302/2058-5241.1.000031
11. Rohra N. Functional and radiological outcome of Schatzker type V and VI tibial Plateau fracture treatment with dual plates with minimum 3 years follow-up: A prospective study. J Clin Diagn Res. 2016;10(5):RC05-10. doi:10.7860/JCDR/2016/18732.7855
12. Schatzker J. Compression in the surgical treatment of fractures of the tibia. Clin Orthop Relat Res. 1974;(105):220-39.
13. Schatzker J, Kfuri M. Revisiting the management of tibial plateau fractures. Injury. 2022;53(6):2207–18. doi:10.1016/j.injury.2022.04.006
14. Zeltser DW, Leopold SS. Classifications in brief: Schatzker classification of tibial plateau fractures. Clin Orthop Relat Res. 2013;471(2):371–4. doi:10.1007/s11999-012-2451-z