

# An Observational Study of Clinical, Radiological, and Functional Outcome in Tibial Plateau Fractures Operated with Open Reduction Internal Fixation in Adults

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## Abstract

**Background:** Tibial plateau fractures are among some of the most challenging fractures to treat, associated with a high incidence of posttraumatic osteoarthritis later in life. The most commonly used surgical treatment is open reduction and fixation (ORIF) with plates and screws.

**Objectives:** This study was conducted to determine the radiological, clinical, and functional outcomes of patients with tibial plateau fractures treated by ORIF.

**Materials and Methods:** This retrospective observational study included adult patients operated on for tibial plateau fractures using ORIF. Functional outcome was assessed by patient-reported outcome measures using Short Musculoskeletal Function Assessment, Knee Injury and Osteoarthritis Outcome Score (KOOS), and Short Form-36 Quality of Life questionnaires. Clinical and radiological outcomes were assessed using Modified Rasmussen's clinical and radiological criteria.

**Results:** The majority of our patients had type 6 fractures (43.59%). We found a statistically significant negative correlation between the type of fracture and the KOOS total score. Clinical assessment using the Modified Rasmussen Criteria showed excellent results in 33.33% of patients, good results in 51.28% of patients, and fair and poor results in 7.69% of patients each, with an overall satisfactory clinical result in 84.61% of patients. The radiological assessment noted excellent results in 23.08% of patients, good results in 56.41% of patients, fair results in 12.82% of patients, and poor results in 7.69% of patients.

**Conclusions:** The preferred treatment of choice for tibial plateau fractures is open reduction internal fixation, with most patients demonstrating satisfactory (excellent to good) clinical and radiological outcomes. Operatively treated tibial plateau fractures result in improved functional outcomes, as it offers excellent anatomical reduction and rigid fixation to restore early movement and articular congruity, in addition to preventing stiffness of the knee.

**Keywords:** Proximal tibia fracture, ORIF, Quality of life, functional outcome, KOOS, SF-36, SMFA.

## Introduction

Tibial plateau fractures often occur after high-energy trauma affecting patients in the younger age groups. Nonetheless, this fracture type is also widespread among the elderly, wherein the trauma is more of a low-energy mechanism [1]. These fractures account for nearly 1% of overall and 2.5% of lower limb fractures [2]. Patients aged  $\geq 60$  account for nearly 23% of all patients with tibial plateau fractures, of which 60.86% were females [3]. Although a tibial plateau fracture can be diversely classified, the

most widely used is the Schatzker classification. The Schatzker system banks on anteroposterior radiographs to differentiate fracture classification [4]. An increase in the type number indicates increasing severity, symbolizing a gradually worse prognosis and an intensification in energy imparted to the bone at the time of injury. Type II is the most common type of tibial plateau fracture [5].

Fracture treatment by either surgical or other interventions aims to maintain the alignment of the bone and offer stability while the bone heals itself [6]. The most commonly used surgical intervention is open reduction and fixation (ORIF) with plates and screws [1]. The main target is to obtain a stable joint, allowing early range of motion for cartilage nourishment and preservation [7]. The objective of treatment of plateau fractures is a precise reconstruction of the articular surfaces,

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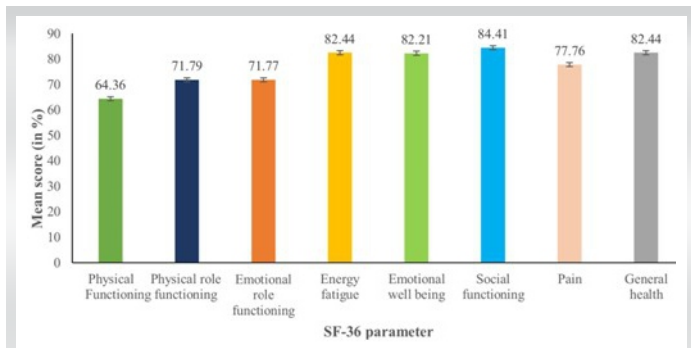


Chart 1: KOOS questionnaire

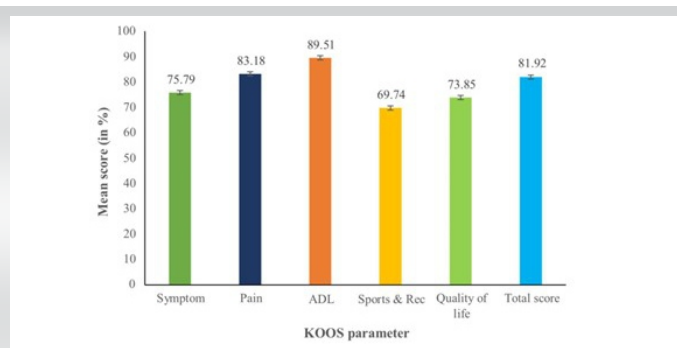


Chart 2: SMFA questionnaire

SF-36 parameter	Mean	SD	Range
Physical functioning	64.36	26.24	5 – 100
Physical role functioning	71.79	40.22	0 – 100
Emotional role functioning	71.77	42.27	0 – 100
Energy fatigue	82.44	11.05	50 – 100
Emotional well being	82.21	16.97	50 – 100
Social functioning	84.41	19.63	50 – 100
Pain	77.76	21.25	35 – 100
General Health	82.44	14.68	55 – 100

KOOS	Mean	SD	Range
Symptom	75.79	15.49	43 – 100
Pain	83.18	13.76	53 – 100
Function in daily living (ADL)	89.51	11.53	65 – 100
Sports and recreation	69.74	18.71	30 – 100
Quality of life	73.85	20.83	10 – 100
Total score	81.92	13.98	49 – 99

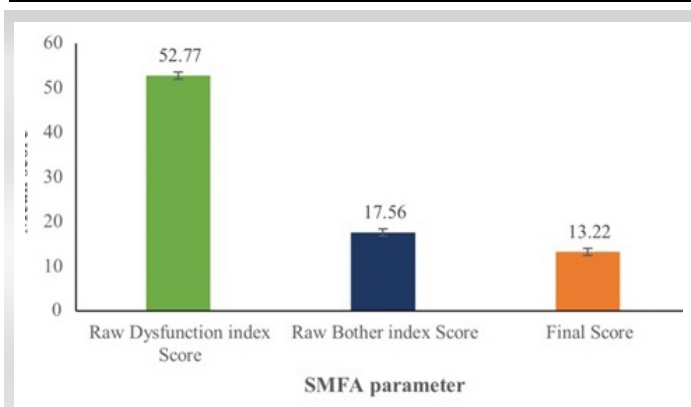


Chart 3: Modified Rasmussen Clinical Assessment

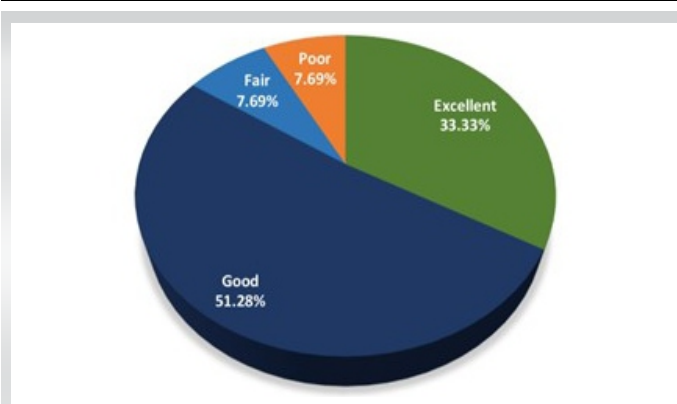


Chart 4: Modified Rasmussen Radiological Assessment

SMFA	Mean	SD	Range
Raw dysfunction index score	52.77	14.94	34 – 84
Raw bother index score	17.56	5.26	12 – 30
final score	13.22	10.9	0 – 35.32

Clinical Result (MRCA)	No. of patients	% of patients
Excellent	13	33.33
Good	20	51.28
Fair	3	7.69
Poor	3	7.69
<b>Total</b>	<b>39</b>	<b>100</b>

stable fragment fixation allowing early motion, and repair of all concomitant lesions [8]. While allowing early joint motion, ORIF of displaced plateau fractures permits accurate anatomical reduction of the joint surface of the tibia with rigid internal fixation to maintain the reduction [1].

The functional outcome depends mainly on the range of knee motion, joint stability, and pain [9]. The outcome is determined more by the knee's stability than the fracture reduction itself. There is limited evidence assessing the functional outcome of a tibial plateau fracture after ORIF. Even though an increase in the severity of fracture was strongly associated with worse functional outcomes, there was a significant association

between improved (lower) Musculoskeletal Function Assessment (MFA) scores and the ability to achieve a satisfactory articular reduction [10]. Although ORIF is widely used to treat tibial plateau fractures, there needs to be more data regarding the effectiveness and complications associated with its use in such fractures in Western India. Hence, this study was planned to determine the radiological, clinical, and functional outcomes of patients with tibial plateau fractures treated by

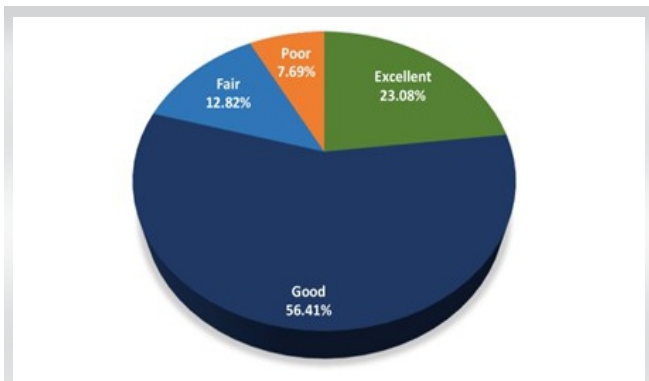


Chart 5: Modified Rasmussen's Clinical Subclass Assessment

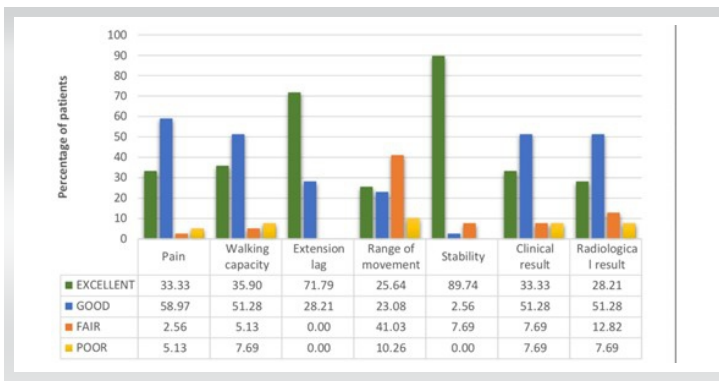


Chart 6: Correlation between Type of Fracture and KOOS Total Score

Radiological Result (MRA)	No. of patients	% of patients
Excellent	9	23.08
Good	22	56.41
Fair	5	12.82
Poor	3	7.69
<b>Total</b>	<b>39</b>	<b>100</b>

Parameters	Excellent		Good		Fair		Poor	
	No.	%	No.	%	No.	%	No.	%
Pain	13	33.33	23	58.97	1	2.56	2	5.13
Walking capacity	14	35.9	20	51.28	2	5.13	3	7.69
Extension lag	28	71.79	11	28.21	0	0	0	0
Range of movement	10	25.64	9	23.08	16	41.03	4	10.26
Stability	35	89.74	1	2.56	3	7.69	0	0

open reduction internal fixation.

**Materials and Method**

**Study site**

Department of Orthopaedics, Jupiter Lifeline Hospital, Thane.

**Study population**

This study was conducted on patients operated for tibial plateau fractures at the study site and those who fulfilled the enrolment criteria of the study.

**Study design**

This was a retro-prospective observational study.

**Study duration**

The data were collected for patients operated on between May 2016 and May 2019 and analyzed over 12 months, from June 2019 to May 2020.

**Sample size**

Considering the annual trend of the number of patients with tibial plateau fractures operated on in Jupiter Lifeline Hospital, we found approximately 10 patients per year in our hospital's medical records department. 39 patients fulfilled the inclusion criteria and were included in the study.

**Inclusion criteria**

Patients satisfying all the following criteria were enrolled in the study:

1. Patients of either sex (males/females)
2. Patients aged >18 years and <70 years
3. Patients diagnosed and operated for tibial plateau fracture
4. Patients willing to give written informed consent for the study.

**Exclusion criteria**

The patients fulfilling any of the following criteria were excluded from the study:

1. Patients aged <18 years and >70 years
2. Patients with tibial plateau fractures treated with any other modality and not ORIF
3. Patients with pathological fractures including tumors
4. Patients with infection

Table 7: Correlation between type of fracture and KOOS total score

	r	P-value
KOOS Total score	-0.3347	0.037

\*Calculated using the Spearman's correlation test

$r_s$  = Spearman's correlation coefficient;

$r_s = 1$  means a perfect positive correlation, and

$r_s = -1$  means a perfect negative correlation

$p < 0.05$  is considered statistically significant.

Using Spearman's correlation test, we observed a statistically significant negative correlation ( $r, -0.3347; P = 0.037$ ) between the type of fracture and KOOS total score.

5. Patients not willing to give written informed consent.

### Informed consent and ethical aspect

The study participants enrolled after giving written informed consent. The protocol was submitted and approved by an ethical and scientific committee.

### Study procedure

The study was initiated only after obtaining approval from the institutional ethics committee. Data of all patients operated on for tibial plateau fractures were collected from the patient's case record and radiographs from the hospital database. The patients' data were screened according to the study's inclusion and exclusion criteria. Those satisfying the criteria were selected for the study. Data were recorded in the case record form for each patient. Functional outcome was assessed by patient-reported outcome measures using the SF-36 Quality of Life questionnaire, KOOS questionnaire, and SMFA questionnaire. Clinical and radiological outcomes were assessed using Modified Rasmussen's clinical and radiological criteria, and final scores were recorded as excellent, good, fair, and poor.

### Data collection method

Patient details were collected from the case records, radiographs, and investigation reports.

### Statistical analysis

Qualitative data were presented using frequency and percentage, while the quantitative data were presented using descriptive statistics, i.e., Mean  $\pm$  SD. Shapiro Wilk's test was used to test whether the data followed a normal distribution.  $P < 0.05$  was considered statically significant. Data were represented graphically wherever possible. Descriptive statistics were used for parameters that did not need statistical analysis. MS Excel and GraphPad software (SPSS Inc., Chicago, IL, USA) were used for data entry and analysis.

### Results

- 1) The mean SF-36 dimension score (Table 1, Chart 1) for physical function was  $64.36 \pm 26.24$  (range: 5–100), physical role functioning was  $71.79 \pm 40.22$  (range: 0–100), emotional role functioning was  $71.77 \pm 42.27$  (range: 0–100), energy fatigue was  $82.44 \pm 11.05$  (range: 50–100), emotional well-being was  $82.21 \pm 16.97$  (range: 50–100), social functioning was  $84.41 \pm 19.63$  (range: 50–100), pain was  $77.76 \pm 21.25$  (range: 35–100), and general health was  $82.44 \pm 14.68$  (range: 55–100). The mean total score for KOOS was  $81.92 \pm 13.98$  (range: 49–99).
- 2) There was a statistically significant negative correlation between the type of fracture (injury severity) and KOOS total

score (patient satisfaction). (Table 2-7)

3) The mean SMFA Raw Dysfunction Index Score (Table 3, Chart 3) was  $52.77 \pm 14.94$  (range: 34–84), and the mean Raw Bother Index Score was  $17.56 \pm 5.26$  (range: 12–30). The mean final SMFA score was  $13.22 \pm 10.90$  (range: 0–35.32).

4) Clinical assessment using the Modified Rasmussen's Criteria (Table 4, Chart 4) showed excellent results in 33.33% of patients, good results in 51.28% of patients, and fair and poor results in 7.69% of patients each, with an overall satisfactory clinical result in 84.61% of patients.

5) Radiological assessment using Modified Rasmussen's Criteria (Table 5, Chart 5) noted excellent results in 23.08% of patients, good results in 56.41% of patients, fair results in 12.82% of patients, and poor results in 7.69% of patients.

6) No patient lost to follow-up.

### Discussion

The primary goal in the treatment of tibial plateau fractures embraces axial alignment, restoration of articular congruity, joint stability, and knee motion. In addition to allowing early joint motion, ORIF of displaced plateau fractures provides precise anatomical reduction of the joint tibia surface with rigid internal fixation to maintain the reduction [1]. An individual's functional outcome is largely dependent on the range of knee motion, joint stability, and pain [11]. Studies evaluating functional outcomes of such fractures have shown surgical treatment to result in excellent functional as well as radiological results, with most patients having returned to their daily activities as before the trauma and regained just about full flexion and extension of the knee joint after 1 year of treatment [12-15].

This study was thus planned to evaluate the radiological, clinical, and functional outcomes of patients with tibial plateau fractures treated by ORIF.

In the present study, we included a total of 39 patients. Rademakers et al. evaluated the long-term (5–27 years) functional and radiologic results of 202 surgically treated tibial plateau fractures [12]. Dattani et al. conducted a prospective study to assess the utility and responsiveness of the generic SF-36 and the disease-specific SMFA questionnaires in 55 patients treated operatively for tibial plateau fractures [13]. van Dreumel et al. evaluated the mid-to-long-term functional outcome of 71 patients surgically treated for tibial plateau fractures [14].

The SF-36 questionnaire revealed the following results. The mean SF-36 dimension score (Table 1, Chart 1) for physical function was  $64.36 \pm 26.24$  (range: 5–100), physical role functioning was  $71.79 \pm 40.22$  (range: 0–100), emotional role functioning was  $71.77 \pm 42.27$  (range: 0–100), energy fatigue was  $82.44 \pm 11.05$  (range: 50–100), emotional well-being was  $82.21 \pm 16.97$  (range: 50–100), social functioning was  $84.41 \pm$



19.63 (range: 50–100), pain was  $77.76 \pm 21.25$  (range: 35–100), and general health was  $82.44 \pm 14.68$  (range: 55–100). The mean SF-36 physical composite scores recorded by Dattani et al. at baseline, at 6 months, and after 12 months after surgery were  $56.75 \pm 6.87$ ,  $42.29 \pm 10.11$ , and  $46.63 \pm 9.23$ , respectively [13].

Observations recorded on the KOOS questionnaire were as follows: (Table 2, Chart 2) The mean score for the symptom subscale was  $75.79 \pm 15.49$  (range: 43–100), pain subscale was  $83.18 \pm 13.76$  (range: 53–100), function in daily living (ADL) subscale was  $89.51 \pm 11.53$  (range: 65–100), sports and recreation subscale was  $69.74 \pm 18.71$  (range: 30–100), and quality of life subscale was  $73.85 \pm 20.83$  (range: 10–100). The mean total score was  $81.92 \pm 13.98$  (range: 49–99). There was a statistically significant negative correlation ( $r$ ,  $-0.3347$ ;  $P = 0.037$ ) between the type of fracture and KOOS total score (Table 7). The median KOOS scores reported by van Dreumel et al. were 89.8% for pain, 91.1% for “other symptoms,” 89.7% for daily function, 72.5% for sports and recreation, and 75.0% for quality of life, while the overall score was 83.0% [14].

Results of the SMFA questionnaire demonstrated (Table 3, Chart 3) a mean Raw Dysfunction Index Score of  $52.77 \pm 14.94$  (range: 34–84) and a mean Raw Bother Index Score of  $17.56 \pm 5.26$  (range: 12–30). The mean final score was  $13.22 \pm 10.90$  (range: 0–35.32). Dattani et al. recorded that the mean SMFA dysfunction index at baseline, at 6 months, and after 12 months after surgery were  $44.33 \pm 3.65$ ,  $54.04 \pm 8.84$ , and  $50.40 \pm 7.54$ , respectively [13].

The Modified Rasmussen Criteria was used to categorize the various parameters such as pain, walking capacity, extension lag, ROM, stability, and clinical and radiological outcomes after ORIF in our study population. Pain was evaluated to be excellent by 33.33% of patients, good by 58.97% of patients, fair by 2.56% of patients, and poor by 5.13% of patients. Walking capacity was evaluated to be excellent by 35.90% of patients, good by 51.28% of patients, fair by 5.13% of patients, and poor by 7.69% of patients. Extension lag was evaluated to be excellent by 71.79% of patients and good by 28.21% of patients. Range of movement was evaluated to be excellent by 25.64% of patients, good by 23.08% of patients, fair by 41.03% of patients, and poor by 10.26% of patients. Stability was evaluated to be excellent by 89.74% of patients, good by 2.56% of patients, and fair by 7.69% of patients. (Table 6, Chart 6)

Clinical assessment using the Modified Rasmussen Criteria (Table 4, Chart 4) demonstrated excellent results in 33.33% of patients, good results in 51.28% of patients, and fair and poor results in 7.69% of patients. Radiological assessment using the Modified Rasmussen Criteria (Table 5, Chart 5) demonstrated excellent results in 23.08% of patients, good results in 56.41% of patients, fair results in 12.82% of patients, and poor results in 7.69% of patients. In the study by Ebraheim et al., based on the Rasmussen functional score, 68% of cases had an excellent result, 13% had good result, 11% had a fair result, and 9% had a poor result [11].

In the present study, the average follow-up duration of our patients was  $20.69 \pm 11.53$  (range: 8–39) months. The mean duration of follow-up noted by Ebraheim et al. was 29 (range: 12–84) months [21]. In the study by Rademakers et al., the average follow-up of 109 patients (54% eligible patients) was 14 (range: 5–27) years [12].

Due to the small study population of 39 patients, it was difficult to assess the statistical significance between the clinical and radiological parameters and that of injury severity.

### Conclusion

The preferred treatment of choice for tibial plateau fractures is open reduction internal fixation, with most patients demonstrating satisfactory (excellent to good) clinical and radiological outcomes. Good clinical judgment is a requisite to manage the different types of tibial plateau fractures. There is a need for a sound knowledge of the nature of the injury along with a clear understanding of the knee evaluation and imaging studies by the surgeon.

Operatively treated tibial plateau fractures result in improved functional outcomes, as it offers excellent anatomical reduction and rigid fixation to restore early movement and articular congruity, in addition to preventing stiffness of the knee.

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**Declaration of patient consent:** The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

**Conflict of Interest:** NIL; **Source of Support:** NIL

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## References

1. Stevens DG, Beharry R, McKee MD, Waddell JP, Schemitsch EH. The long-term functional outcome of operatively treated tibial plateau fractures. *J Orthop Trauma* 2001;15:312-20.
2. Wood AM, Aitken SA, Hipps D, Heil K, Court-Brown C. The epidemiology and changing face of tibial plateau fractures and other intra-articular proximal tibial fractures: The Edinburgh experience. *Orthop Proc* 2015;97:23.
3. He QF, Sun H, Shu LY, Zhan Y, He CY, Zhu Y, et al. Tibial plateau fractures in elderly people: An institutional retrospective study. *J Orthop Surg Res* 2018;13:276.
4. Millar SC, Arnold JB, Thewlis D, Fraysse F, Solomon LB. A systematic literature review of tibial plateau fractures: What classifications are used and how reliable and useful are they? *Injury* 2018;49:473-90.
5. Roberts D, Bryanton M, et al. Radiopaedia. Schatzker Classification of Tibial Plateau Fractures. Available from: <https://radiopaedia.org/articles/schatzker-classification-of-tibial-plateau-fractures-1> [Last accessed on 2020 Jun 18].
6. Rüedi TP, Murphy WM. *AO Principles of Fracture Management*. 1st ed. Stuttgart: Thieme; 2007.
7. Manidakis N, Dosani A, Dimitriou R, Stengel D, Matthews S, Giannoudis P. Tibial plateau fractures: Functional outcome and incidence of osteoarthritis in 125 cases. *Int Orthop* 2010;34:565-70.
8. Timmers TK, van der Ven DJ, de Vries LS, van Olden GD. Functional outcome after tibial plateau fracture osteosynthesis: A mean follow-up of 6 years. *Knee* 2014;21:1210-5.
9. Raza H, Hashmi P, Abbas K, Hafeez K. Minimally invasive plate osteosynthesis for tibial plateau fractures. *J Orthop Surg (Hong Kong)* 2012;20:42-7.
10. Barei DP, Nork SE, Mills WJ, Coles CP, Henley MB, Benirschke SK. Functional outcomes of severe bicondylar tibial plateau fractures treated with dual incisions and medial and lateral plates. *J Bone Joint Surg Am* 2006;88:1713-21.
11. Ebraheim NA, Sabry FF, Haman SP. Open reduction and internal fixation of 117 tibial plateau fractures. *Orthopedics* 2004;27:1281-7.
12. Rademakers MV, Kerkhoffs GM, Sierevelt IN, Raaymakers EL, Marti RK. Operative treatment of 109 tibial plateau fractures: Five- to 27-year follow-up results. *J Orthop Trauma* 2007;21:5-10.
13. Dattani R, Slobogean GP, O'Brien PJ, Broekhuysen HM, Blachut PA, Guy P, et al. Psychometric analysis of measuring functional outcomes in tibial plateau fractures using the Short Form 36 (SF-36), Short Musculoskeletal Function Assessment (SMFA) and the Western Ontario McMaster Osteoarthritis (WOMAC) questionnaires. *Injury* 2013;44:825-9.
14. Van Dreumel RL, Van Wunnik BP, Janssen L, Simons PC, Janzing HM. Mid-to long term functional outcome after open reduction and internal fixation of tibial plateau fractures. *Injury* 2015;46:1608-12.
15. Luo CF, Sun H, Zhang B, Zeng BF. Three-column fixation for complex tibial plateau fractures. *J Orthop Trauma* 2010;24:683-92.

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