ORIGINAL ARTICLE

A Comparative Study on the Functional Outcomes of Patients who Underwent Internal versus External Fixation for Tibial Plateau Fractures Two Years Post-surgery

Marianne Therese S. Feng, MD,[1] Kristia Jimmylou Akiatan-Rey, MD,[1]
Harem P. Deiparine, MD[1] and Rey P. Pendang, LPT, MS

[1]*Vicente Sotto Memorial Medical Center*

ABSTRACT

Introduction. Tibial plateau fractures are due to high energy trauma brought about by axial compression forces and associated varus or valgus component.

Objective. Patients diagnosed with tibial plateau fractures from January to December 2018 treated with internal vs external fixation will be described according to their Schatzker classification. The study further aims to compare the functional outcomes between the two groups in terms of surgery done.

Methods. A chart review determined the distribution of demographics. The Modified Rasmussen Score (MRS) was used to determine the clinical and radiographic parameters after taking a new knee radiograph and assessment from the rehabilitation department. The MRS determined the functional outcomes of the said patients. Ethical considerations and proper informed consent were upheld after being reviewed by the hospital's research committee.

Results. Out of 48 patients, 35 underwent internal fixation via open reduction using plates and/or screws, while 13 underwent external fixation using hybrid external fixator. The demographic profile showed mostly males between ages 20 to 49 years old. Most cases were due to vehicular accidents affecting the left lower extremity. In terms of Schatzker classification, the most common was type VI. The computed mean MRS of the internal fixation group was 30.43 while the external fixation group was 30.00, generally showing no significant difference.

Conclusion. Surgical intervention of tibial plateau fractures aims for anatomic reduction using internal or external fixation. There was no significant difference on the functional outcome of the two groups despite classifying the respondents according to Schatzker type, hence we can conclude that external fixation be chosen as the treatment of choice for tibial plateau fractures when properly indicated.

Keywords: functional outcome, tibial plateau fractures, fixation

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Corresponding author: Marianne Therese S. Feng, MD
Vicente Sotto Memorial Medical Center
B. Rodriguez Street, Cebu City, Cebu 6000, Philippines
Email: fengie423@gmail.com

INTRODUCTION

Tibial plateau fractures involve the articular surface of the proximal tibia which is considered as one of the major weight–bearing joints in the human body.[1] It is one of the most common intra-articular fractures resulting from indirect coronal or direct axial compressive forces as its mechanism of injury.[2] It constitutes about 1% of all fractures and 8% fractures in the elderly. In younger patients, men are frequently involved owing to their predisposition for high velocity trauma.[3] Most of the time, it requires surgery and recovery thereafter can take several months.[1] As an orthopedic surgeon,

one's goal is to regain anatomic reduction and a stable joint to permit early range of motion for cartilage preservation and nourishment hence faster recovery and return to a productive state of function in terms of being able to work again and do his or her usual activities of daily living. Treatment concepts based on restoring or preserving limb alignment led to a satisfactory outcome for most patients.[4]

The Schatzker classification is divided into six types. Type 1 is for split or cleavage fracture creating a marginal fracture across the lateral plateau. Type 2 is a split or cleavage depression fracture of the lateral plateau which is the most common type. Type 3 is local compression or pure central depression. Type 4 is a medial condyle fracture, while Type 5 is bicondylar involving the medial and lateral plateau with or without involvement of the intercondylar eminence. Lastly, Type 6 is a diaphyseal metaphyseal dissociation with varying degrees of comminution of the articular surface.[1,5] This classification does not take into account the major fracture lines in the coronal plane especially posterior column fragments since it is based mainly on an anteroposterior radiograph. Despite its shortcomings, the Schatzker classification is still widely used due to its familiarity and ease of use with generally good reliability.[4]

Fixation techniques and principles of tibial plateau fractures can be divided into plates and screws for internal fixation while external fixators or ring fixators can be used when soft tissue injury is severe.[6,7] Indications for external fixation would include fractures with metaphyseal and subchondral comminution not amendable to routine plating and soft-tissue compromise that hinders open reduction internal fixation procedures.[4,5] External fixators can also be used for temporary stabilization of the knee joint. It can restore length and alignment to allow soft tissue recovery prior to definitive treatment using internal fixation.[1,4] Definitive external fixation still has a role in complex tibial plateau fractures in cases when severe soft tissue injury despite delay, internal fixation is not felt safe.[1] On the other hand, internal fixation is indicated in comminuted and depressed fractures that need elevation of the articular surface with bone grafting and shear component fractures.[5,8] Lag screws can be used to compress simple fracture lines and may be used alone or in conjunction with other fixation devices. Partially threaded screws and 6.5 mm screws work well for obtaining compression and may be used for major plateau fracture lines. Plates serve different functions, and one common application is anterolaterally where the plate acts as a buttress. Whereas posteromedial plates serve as an anti-glide device to resist shearing forces that act on the tibial plateau. Lateral plates used for bicondylar patterns resist axial, rotational, and bending forces with the help of bigger locking screws.[1,8]

Relevance of the Study

This study aims to compare the functional outcome of tibial plateau patients treated with either internal or external fixation two years post-surgery. The results can be a guide in choosing the appropriate method of fixation for tibial plateau fractures which will yield near excellent functional outcomes in the long run and may set a new standard for treating such specific Schatzker types as long as proper indications for treatment are met.

OBJECTIVES

To determine the functional outcome of tibial plateau patients who underwent internal vs external fixation two years post-surgery.

Specifically, the study aims:

1. To determine the demographic profile of patients according to age, sex, mechanism of injury, laterality of the tibial plateau fracture, fracture configuration according to the Schatzker classification, and operation performed.
2. To compare the distribution of patients according to the Modified Rasmussen Score (MRS) at two years post-surgery in terms of the following domains and their subclassifications:
   a. Clinical Assessment
      i. Pain
      ii. Walking Capacity
      iii. Knee Extension
      iv. Total Range of Motion
   b. Radiographic Assessment
      i. Articular Depression
      ii. Condylar Widening
      iii. Varus / Valgus
      iv. Osteoarthritis
3. To compare the functional outcome of tibial plateau fractures as measured by the mean MRS between external versus internal fixation at two years post-surgery.
4. To describe the functional outcome as measured by the mean MRS between external versus internal fixation according to Schatzker type two years post-surgery.

MATERIALS AND METHODS

Sampling Procedure and Sample Size

The study was conducted in the Out-patient, Radiology, and Rehabilitation Medicine Departments. The study population included all patients diagnosed with tibial plateau fractures surgically treated with internal or external fixation from January to December 2018, and excluded those who were treated non-operatively, refused surgery, or went home against medical advice. Purposive sampling was done due to the specific profile of patients and the limited number of patients in the said population.

Among the 54 patients who were radiographically diagnosed with a tibial plateau fracture and subsequently underwent internal or external fixation, only 48 were contacted successfully, responded, and gave consent hence were included in the study.

Research Instrument

In 1973, Rasmussen created a scoring system for a series of 260 patients with proximal tibial fractures with an average of 7.8 years follow up. The MRS is designed to assess the short- and long-term patient relevant outcomes following knee injury in tibial plateau fractures. It is composed of two parts namely the clinical and radiographic assessment.[9] The clinical assessment involves six domains namely: Pain, Walking Capacity, Knee extension, Total Range of Motion, Stability, and Power of Quadriceps. It has been cited in over 1,188 studies over the past 50 years.[9,10]

Data Collection

The protocol was reviewed by the Institutional Review Board and the Ethics Review Committee. The consent used was patterned from the World Health Organization format. A medical chart review determined the total number of patients with tibial plateau fractures who underwent either internal or external fixation as their surgical management admitted from January to December 2018. The charts were retrieved electronically and were reviewed for the following data: age, sex, mechanism of injury, laterality of the tibial plateau fracture, Schatzker classification, and operation performed. The gathered data was recorded and tabulated on an Excel spread sheet. The study and procedure were explained to the patients included who were contacted via phone call. With verbal consent, the researcher scheduled the respondents for face-to-face consultation where each respondent was asked to sign the informed consent form and answer the MRS questionnaire. New radiographs of the knee were taken, while some patients brought their own films. On the same day, they were assessed by the Department of Rehabilitation Medicine according to the clinical assessment portion of the MRS questionnaire. The Radiology Department was also asked to assess the knee radiographs taken at two years post-surgery and scored them according to the MRS radiographic assessment and compared it with their injury films and immediate post-operative films. Scores were added and the sum of all items was computed. The collected raw scores were tabulated in a new Excel spreadsheet and the parameters were coded accordingly. Statistical analysis was then done on the data collected. Clinical assessment scores were interpreted as follows: Excellent 28 – 30, Good 24 – 27, Fair 20 – 23 and Poor <20. While the radiographic assessment scores had the following interpretation: Excellent 9 – 10, Good 7 – 8, Fair 5 – 6, Poor <5. Summation of scores was done per patient and the numeric results were categorized as poor through excellent.

Data Analysis

The study used the following statistical tools: Chi – square test of independence determined the relationship of categorical variables under the demographic data; Mann – Whitney U test was done on the functional outcome between the internal fixation and external fixation group classified by Schatzker classification; finally, the mean MRS of both fixation groups were computed and compared. Additional cross tabulation was done to describe the data according to the mean MRS score of external and internal fixation groups under each Schatzker type.

Scope and Limitation

The study was limited to the data retrieved from the charts such as the preoperative and postoperative diagnoses and procedures done. It did not aim to delineate or classify patients according to soft tissue status at the time of admission or surgery. The study only utilized the Schatzker classification which was the main classification used in the institution during the study period.

RESULTS

A total of 51 patients underwent surgical treatment by means of internal or external fixation. Forty-eight patients were successfully contacted and included in the study. Most patients belonged to the age range of 30 to 39 years old at 18.8% for the internal fixation group (Table 1A) with a mean age of 36.57 (Table 1B). On the other hand, the age groups with the greatest number of patients for the external fixation group were from 20 to 29 and 40 to 49 years old both at 8.3% (Table 1A) with a mean age of 42.62 (Table 1B). Ages were well spread out among the different age groups.

The demographic profile of the respondents in terms of gender for both fixation groups were predominantly male at 45.8% and 20.8%, respectively. In terms of the mechanism of injury, most cases were due to motor vehicular accidents

Table 1A. Age Distribution of the Study Population

Age Group	Internal Fixation	External Fixation	Total
<20	6 (12.5%)	0 (0.0%)	6 (12.5%)
20 – 29	6 (12.5%)	4 (8.3%)	10 (20.8%)
30 – 39	9 (18.8%)	1 (2.1%)	10 (20.8%)
40 – 49	7 (14.6%)	4 (8.3%)	11 (22.9%)
50 – 59	4 (8.3%)	3 (6.3%)	7 (14.6%)
>59	3 (6.3%)	1 (2.1%)	4 (8.3%)
Total	35 (72.9%)	13 (27.1%)	48 (100%)
p Value		0.314	

Table 1B. Mean Age according to Surgery Done

Mean Age by Surgery Done	Number	Mean ± SD
Internal Fixation	35	36.57 ± 14.27
External Fixation	13	42.62 ± 13.58
p Value		0.193

Table 2. Gender Distribution of the Study Population

Study Variables		Internal Fixation	External Fixation	p Value
Gender / Sex	Male	22 (45.8%)	10 (20.8%)	0.566
	Female	13 (27.1%)	3 (6.3%)	
Mechanism of Injury	Motor vehicular accident	34 (70.8%)	11 (22.9%)	0.184
	Fall	0 (0.0%)	1 (2.1%)	
	Sports-related	1 (2.1%)	1 (2.1%)	
Laterality	Left	25 (52.1%)	10 (20.8%)	0.988
	Right	10 (20.8%)	3 (6.3%)	
	Bilateral	0 (0.0%)	0 (0.0%)	
Schatzker Classification	Type I	4 (8.3%)	5 (10.4%)	0.111
	Type II	7 (14.6%)	0 (0.0%)	
	Type IV	3 (6.3%)	3 (6.3%)	
	Type V	5 (10.4%)	2 (4.2%)	
	Type VI	16 (33.3%)	3 (6.3%)	

at 93.7% combined. The most involved laterality was left lower extremity at 72.9% combined. Under the Schatzker classification of tibial plateau fractures, most patients were classified with a Schatzker Type VI at 39.6% followed by Schatzker Types 2 and 5 (Table 2).

The radiographic assessment mostly showed articular depression of less than 5 mm in 37.5% of the internal fixation group, while the external fixation group had 14.6%. Condylar widening was similar between the two fixation groups at about less than 5 mm. Varus and valgus were less than 10 degrees for both groups. In terms of osteoarthritis assessment, both groups noted a progression of 1 grade at 56.3% for the internal fixation group and 22.9% in the external fixation group (Table 3).

Clinical assessment based on the physical examination and objective perspective to the respondents, most patients of both fixation groups noted occasional pain and had good walking capacity being able to walk outdoors more than an hour. Though a few had normal knee extension, majority had an extension lag of less than 10 degrees. In terms of total range of motion of the knee, at least 120 degrees of knee range of motion was achieved by 43.8% and 14.6% of the patients in the internal fixation and external fixation groups, respectively. The stability of the knee joint showed remarkable results in both groups with normal extension and 20 degrees of flexion. Lastly, majority of patients had motor strength of 5 in the power of quadriceps (Table 4).

After subjecting all data to different statistical tests, the computed mean Modified Rasmussen Score for the internal fixation group was 30.43 while the external fixation

Table 3. Distribution according to Radiographic Assessment

Parameter	Internal Fixation	External Fixation	p Value
Articular Depression			
None	12 (25.0%)	3 (6.3%)	
<5 mm	18 (37.5%)	7 (14.6%)	0.66
6 – 10 mm	5 (10.4%)	3 (6.3%)	
Condylar Widening			
None	10 (20.8%)	4 (8.3%)	
<5 mm	15 (31.3%)	7 (14.6%)	0.63
6 – 10 mm	10 (20.8%)	2 (4.2%)	
Varus / Valgus			
None	5 (10.4%)	2 (4.2%)	
<10°	22 (45.8%)	8 (16.7%)	0.99
10° – 20°	8 (16.7%)	3 (6.3%)	
Osteoarthritis			
None / no progress	3 (6.3%)	2 (4.2%)	
Progression 1 grade	27 (56.3%)	11 (22.9%)	0.30
Progression >1 grade	5 (10.4%)	0 (0.0%)	

Table 4. Distribution according to Clinical Assessment

Parameter	Internal Fixation	External Fixation	p Value
Pain			
Occasional	30 (62.5%)	10 (20.8%)	0.77
Stabbing pain in certain positions	5 (10.4%)	3 (6.3%)	
Walking Capacity			
Normal for age	5 (10.4%)	2 (4.2%)	1.0
Outdoor >1 hour	30 (62.5%)	11 (22.9%)	
Knee Extension			
Normal	4 (8.3%)	1 (2.1%)	
Lack of extension (<10°)	26 (54.2%)	12 (25.0%)	0.30
Lack of extension (>10°)	5 (10.4%)	0 (0.0%)	
Total Range of Motion			
Full	10 (20.8%)	3 (6.3%)	
At least 120°	21 (43.8%)	7 (14.6%)	0.59
At least 90°	4 (8.3%)	3 (6.3%)	
Stability			
Normal in extension and 20° flexion	31 (64.6%)	10 (20.8%)	0.162
Abnormal stability in 20° flexion	2 (4.2%)	3 (6.3%)	
Instability in extension (<10°)	2 (4.2%)	0 (0.0%)	
Power of Quadriceps			
Grade 5	27 (56.3%)	9 (18.8%)	0.85
Garde 3 – 4	8 (16.7%)	4 (8.3%)	

Table 5. Functional Outcome according to the Mean Modified Rasmussen Score

Functional Outcome	Number	Mean ± SD	p Value
Internal Fixation	35	30.43 ± 2.12	0.417
External Fixation	13	30.00 ± 1.99	
Total	48	30.31 ± 2.06	

Table 6. Functional Outcome according to the Mean Modified Rasmussen Score by Schatzker Type

Schatzker Type	Surgery Done			
	Internal Fixation		External Fixation	
	Number	Mean ± SD	Number	Mean ± SD
Type 1	4	29.00 ± 2.71	5	30.60 ± 1.34
Type 2	7	29.43 ± 2.44	0	-
Type 4	3	31.00 ± 1.00	3	30.00 ± 1.73
Type 5	5	30.60 ± 2.30	2	31.00 ± 2.83
Type 6	16	31.06 ± 1.81	3	28.33 ± 2.52
Total Number	35	30.43 ± 2.12	13	30.00 ± 1.99

group was 30.00 (Table 5). Regardless of the Schatzker classification, both groups had good knee functional outcomes (Table 6). Since the study was only limited to 48 respondents, data tabulated was not enough to draw a comparison for each type (Table 7).

DISCUSSION

Patients sustaining tibial plateau fractures are subjected to high energy trauma with a combination of axial loading and varus or valgus applied forces leading to articular depression of the knee joint.

In this study, 93.7% were due to motor vehicular accidents which explains a high energy entity causing these fracture configurations seen in the Schatzker classification. Most cases seen at the emergency room were due to trauma and accidents. Among the respondents of the study, there were also 35 patients who injured their left knee. The most common age group were those in the 4th decade of life at 22.8% and the second most common age groups were from the 2nd to 3rd decade of life at 20.8%. A large portion of the study population belonged to the working age group which could play an impact with regard to their functional outcome after surgery in relation to their capacity to work again.

The data in this study showed one grade progression to osteoarthritis brought about by the articular nature of tibial plateau fractures (79.2%). It is inevitable to have posttraumatic arthritis in tibial plateau patients, with the presence of implants internally applied, which may also loosen or protrude into the joint as a complication of internal fixation in the long run. As compared to external fixators, they are removed as out-patient basis once fracture healing is already present.

Table 7. Cross Tabulation of Schatzker Type and Surgery Done

Schatzker Type		Surgery Done		Total
		Internal Fixation	External Fixation	
Type 1	Count	4	5	9
	% within Schatzker Type	44.4%	55.6%	100.0%
	% within Surgery Done	11.4%	38.5%	18.8%
	% of Total	8.3%	10.4%	18.8%
Type 2	Count	7	0	7
	% within Schatzker Type	100.0%	0.0%	100.0%
	% within Surgery Done	20.0%	0.0%	14.6%
	% of Total	14.6%	0.0%	14.6%
Type 4	Count	3	3	6
	% within Schatzker Type	50.0%	50.0%	100.0%
	% within Surgery Done	20.0%	0.0%	12.5%
	% of Total	14.6%	0.0%	12.5%
Type 5	Count	5	2	7
	% within Schatzker Type	71.4%	28.6%	100.0%
	% within Surgery Done	14.3%	15.4%	14.6%
	% of Total	10.4%	4.2%	14.6%
Type 6	Count	16	3	19
	% within Schatzker Type	84.2%	15.8%	100.0%
	% within Surgery Done	45.7%	23.1%	39.6%
	% of Total	33.3%	6.3%	39.6%
Total	Count	35	13	48
	% within Schatzker Type	72.9%	27.1%	100.0%
	% within Surgery Done	100.0%	100.0%	100.0%
	% of Total	72.9%	27.1%	100.0%

A total of 45 patients were included in the study, 35 of which underwent internal fixation using single or dual plating and use of screws while 13 underwent external fixation with the use of hybrid external fixators. The study showed 85.4% of patients had normal to 120 degrees range of motion of the involved knee joint. Generally, clinical outcomes of this study showed no pain to occasional pain for both groups two years post-surgery. Patients also reported walking capacity mostly lasting more than an hour outdoors. Most patients were able to go back to work, though a few stayed home due to the pandemic. With regard to knee stability and muscle strength, all patients in the study showed near normal results - 85.4% stability in extension and 20 degrees of flexion. For the quadriceps muscle strength, 75% had a grade of 5. In terms of articular depression, condylar widening and varus or valgus alignment after 2 years from surgery, all patients regardless of fixation type showed at most less than 5 mm widening and depression and at most 10 degrees of varus valgus malalignment which is generally near normal or near excellent in terms of radiographic functional outcome.

By classifying the respondents according to the Schatzker classification, the study showed similar mean functional outcomes as computed using the MRS which had a mean of the following: 29.89 for Type I, 29.43 for Type II, 30.50 for Type IV, 30.71 for Type V and 30.60 for Type VI. Despite the similar mean functional outcome, it is vital to take note that most injuries in the study were comprised of Schatzker Type VI which would imply very high energy trauma and more difficult fracture patterns hence leading to difficulty in surgery as well.

On that note, this study showed a relatively good functional outcome even in the more severe fracture pattern or type which is a good thing despite the severity of the injury upon presentation. After comparing the mean MRS scores between the internal and external fixation group, it showed a p value of 0.417 which has no significant difference and both study groups showing good functional outcome based on their scores. Lastly, when taking into account the Schatzker type and surgery done, it lacked the strength in numbers to be able to make a solid comparison for each which is included in the study's limitations.

CONCLUSION

In this two – year follow up among patients who were diagnosed with tibial plateau fractures, the most common mechanism of injury was due to motor vehicular accident and there was a preponderance of the left side being affected. With regard to age distribution, patients belonged to the 2nd to 4th decade of life. The most common Schatzker classification among the respondents was type VI which coincides with high energy axial loading and varus or valgus directed force on the knee during the moment of impact. As for the operative treatment, majority underwent internal fixation and almost half underwent external fixation. All variables were based on the surgery done. However, there was no significant difference in terms of the functional outcome between the two groups based on the mean MRS score. The mean scores among the different Schatzker types also showed no significant difference in functional outcome. Though the study population was relatively small, based on the results, external fixation can be chosen as the surgical treatment of choice for patients with tibial plateau fractures when properly indicated. Based on literature, it has lower infection rates compared to open reduction internal fixation and less prominent hardware.

Recommendations

Further research specifically a prospective type of study should be done in a larger population and a longer follow-up period. It is also important to have an adequate representation for each Schatzker type in the population of future studies to have more targeted results.

It is also recommended to have a similar study in a setting where normal face to face follow-ups at the out-patient department following a standard schedule for radiographic assessment and to have rehabilitation services made readily available to foster holistic return to function. In our institution, the procurement of implants such as plates and screws will take a longer period to be approved as compared to the fast-moving implants such as the external fixators which are being purchased in advance to have it stored in the Central Supply Department for the end users to have access to. Based on the results of this study, operational protocols or treatment guidelines for tibial plateau fractures which can promote the use of external fixation in the definitive treatment of such would yield a good functional outcome with lesser chances of peri-implant infection, surgical site infection, symptomatic implants, and discomfort.

Statement of Authorship

MTSF contributed in the conceptualization of work, acquisition and collection of data, and drafting and revising of version to be published. KJAK and HPD contributed in the conceptualization of work, checking and revising of protocol and final version of manuscript. RPP contributed in the statistical analysis of data and interpretation of numbers.

Author Disclosure

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REFERENCES

1. Marsh JL, Karam MD. Tibial plateau fractures. In: Court-Brown CM, Heckman JD, McQueen MM, Ricci WM, Tornetta P III, McKee MD, editors. Rockwood and Green's Fractures in Adults, 8th ed. Philadelphia, PA: Wolters Kluwer Health/ Lippincott Williams & Wilkins; 2015. pp. 2303 – 2368.
2. Schneidmueller D, Gercek E, Lehnert M, Walcher F, Marzi I. Proximal tibial fractures. Am J Sports Med, 2011;31:404–7.
3. Jacofsky DJ, Haidukerwych GJ. Tibia plateau fractures. In: Scott WN. Insall & Scott Surgery of the knee. Philadelphia: Churchill Livingstone; 2006. pp. 1133–46.
4. Hall JA, Beuerlein MJ, McKee MD, Canadian Orthopaedic Trauma Society. Open reduction and internal fixation compared with circular fixator application for bicondylar tibial plateau fractures. Surgical technique. J Bone Joint Surg Am. 2009 Mar;91 Suppl 2 Pt 1:74-88. doi: 10.2106/JBJS.G.01165.
5. Schatzker J. Fractures of the tibial plateau. In: Schatzker JT, ed. Rationale of operative fracture care. Berlin: Springer-Verlag; 1987. pp. 279-295.
6. Smith ST, Marsh JL, Nepola JV, Found EM. Tibial plateau fractures treated with external fixation and minimal internal fixation. Iowa Orthop J. 1991;11:69–77.
7. Young MJ, Barrack RL. Complications of internal fixation of tibial plateau fractures. Orthop Rev. 1994 Feb;23(2):149–54.
8. Prat-Fabregat S, Camacho-Carrasco P. Treatment strategy for tibial plateau fractures: an update. EFORT Open Rev. 2017 Mar;1(5): 225–32. doi: 10.1302/2058-5241.1.000031.
9. Jakinapally SR, Konuganti SR, Rao VP, Rapur S. Functional and radiological evaluation of surgical management in tibial plateau fractures: a prospective study. Int J Res Orthop. 2018 Mar-Apr;4(2): 261–5. doi:10.18203/issn.2455-4510.IntJResOrthop20180511
10. Rasmussen PS. Tibial condylar fractures: impairment of knee joint stability as an indication for surgical treatment. J Bone Joint Surg Am. 1973 Oct;55(7):1331–50.