Orthopedic & Muscular System: Current research

OPEN ACCESS Freely available online

Research Article

Use of Three-Column Classification System to Manage Tibial Plateau Fracture

Byanjankar S[1*], Shrestha R[2], Joshi RR[1], Dwivedi R[1], Sharma JR[3], Panthi S[3]

[1]Department of Orthopaedics and Traumatology, Lumbini Medical College and Teaching Hospital, Palpa, Nepal; [2]Devdaha Medical College and Teaching Hospital, Nepal; [3]Rapti Academy of Health Science, Nepal

ABSTRACT

Introduction: Complex tibia plateau fracture has been gradually increased, due to an increase in motor vehicle accidents. Clinical outcomes of tibia plateau fractures have been improved, due to the development of different concepts and techniques like staged surgery, combined approach, and fixation of posterior fragments. The purpose of this study was to evaluate clinical outcomes by using column-specific fixation techniques for tibia plateau fractures.

Methods: From June 2014 to May 2016, 19 cases of tibia plateau fractures were operated on in our institution. Single column fracture was fixed with a Cannulated Cancellous Screw (CCS) or single plate, two-column fractures were treated with dual plate fixation and tri-columnar fracture was fixed with three plates.

Results: The mean Rasmussen anatomic score was 16.11 (SD, 2.82; range 10 to 18). Anatomic outcome was excellent in 12 (63.3%), good in 5 (26.3%) and fair in 2 (10.5%) patients. The mean Rasmussen functional score was 26.05 (SD, 2.32; range 19 to 29). Functional outcome was excellent in 10 (52.6%), good in 8 (42.2%) and fair in 1 (5.2%) patients. Mean knee flexion at the end of treatment was 134° (SD, 8°; 120° to 140°), however, 3 patients had extension lag of 10°.

Conclusion: Managing tibial plateau fracture is a challenge to an orthopedic surgeon. The column-specific fixation techniques give good anatomical reduction to restore articular congruity, rigid fixation, facilitate early motion, and better functional outcomes.

Keywords: Tibial plateau; Three-column; Articular congruity; Rigid fixation

INTRODUCTION

Complex tibial plateau fracture has been gradually increased, due to an increase in motor vehicle accidents [1]. The tibial plateau fracture comprises approximately 1%-2% of all fractures. It has a bimodal distribution, first occurring in young adults as a result of high-velocity injury and in the elderly as a result of a low-velocity injury [2]. The management of these fractures remains challenging to an orthopedic surgeon. The objective of treatment is the anatomical reduction of the articular surface, soft tissue preservation, maintains the mechanical axis of the limb, rigid internal fixation to obtain a stable joint with normal functional motion [3-5].

The current treatment option includes Open Reduction and Internal Fixation (ORIF), mini-open reduction with percutaneous screw fixation and hybrid external fixation, and indirect reduction with a fine-wire circular external fixator. Every treatment has its advantages and disadvantages [6-10]. Currently, ORIF with plates and screws is considered the gold standard method of treatment. Conservative treatment is reserved for patients with undisplaced or minimally displaced fractures or minimally displaced fractures or for patients who are not fit for surgery.

Many classifications systems are available for tibial plateau fracture, among them, the commonly used are Schatzker classification and Arbeitsgemeinschaft fur Osteosynthesefragen (AO)/Orthopedic Trauma Association (OTA) classification [11-12]. These classifications were based on the appearance of the anteroposterior radiographs. It doesn't describe posterior shearing or coronal fractures. Luo et al introduced a CT-based three-column classification for the tibial plateau and divided the tibial plateau into three regions; lateral column, medial column, and posterior column [13]. The fractures are categorized with a single column fracture (lateral, medial, or posterior column) or different types

Correspondence to: Byanjankar Subin, Department of Orthopaedics and Traumatology, Lumbini Medical College and Teaching Hsopital, Tansen, Nepal. Tel: 00977-9841794788; Email: byanjankar1@hotmail.com

Received: March 18, 2020; **Accepted:** March 21, 2020; **Published:** July 30, 2021

Citation: Byanjankar S, Shrestha R, Sharma JR, Panthi S, Joshi RR, Dwivedi R (2021), Use of Three-column Classification System to Manage Tibial Plateau Fracture, Nepal, Orthop. Muscular Syst. 10:310

of combined column fractures (2 and 3 columns). These days this concept has become popular in orthopedic practice. Clinical outcomes of tibial plateau fractures have been improved, due to the development of different concepts and techniques like staged surgery, combined approach, and fixation of posterior fragments.

The purpose of this study was to evaluate clinical outcomes by using column-specific fixation techniques for tibial plateau fractures.

PATIENTS AND METHODS

The study was performed with the approval of our Institutional Review Board. We reviewed the medical records of 24 tibial plateau fractures from June 2014 to May 2016, at our institution. Patients of age more than 18 years with a tibial plateau fracture treated surgically were included. Patients with extra-articular fractures, pathological fractures, age <18 years, polytrauma with serious head/chest injury, Gustillo grade III open fracture, or with medically unfit for surgery were excluded. Out of 24 patients, three cases were treated nonoperatively and two cases had a vascular injury with compartment syndrome and had to refer and were excluded. Demographic data including the age of patients, gender, and mechanism of injury, closed or open fracture, and time to weight-bearing, clinical and radiological union, and complications of surgery were reviewed from patient charts.

There were 15 males and 4 females with an average age of 41.74 (Range 24 years to 78 years). The left knee was involved in 10 patients and right in 9 patients. All patients were followed till the fracture is completely united. The average follow-up is 19.5 months (range 16 months to 30 months).

The mechanism of injury was classified as

- Road traffic accidents
- Fall from a height and
- Sports-related injury The open fracture was classified according to Gustilo and Anderson classification

Plain X-rays and CT scans and 3-D reconstructions were evaluated for the size, location, and severity of articular depression and cortical split, which is useful for recognizing fragment features and pre-operative planning. The fracture was classified with Schatzker classification, AO classification, and also with a three-column concept. A three-column classification was used for decision-making. Use of primary treatment like bridging external fixation was also noted.

The patients were operated on using general or regional anesthesia. All patients were treated by open reduction and internal fixation with the same surgical team. The surgical approach was followed as proposed by Zhu et al. [14].

POST-OPERATIVE MANAGEMENT AND ASSESSMENT

Postoperatively, a check X-ray was taken. The limbs were protected by a knee brace for 2 weeks until the subsidence of swelling and removal of stitches. Intermittent active knee mobilization was started from day 3rd onwards depending on the type of fracture, adequacy of fixation, and the treating surgeon's judgment. The patient was discharged between 5 days-14 days after surgery, depending upon soft tissue and surgical wound condition. After two weeks, brace and suture were removed and active range of motion exercises was allowed to prevent knee stiffness and to strengthen the quadriceps.

Partial weight-bearing was allowed according to fracture healing and patient compliance. The amount of weight-bearing was self-evaluated by the patient according to the pain that it produces. Full weight-bearing was allowed after clinical and radiological evidence of healing. Weight-bearing was delayed in that patient who sustained depression fractures. Patients were reviewed at 6 weeks, 3 months, 6 months, and 1 year after the operation with a clinical and radiographic assessment of the progress of fracture healing and complications. During each visit, the patients were evaluated using the Rasmussen clinical criteria and radiological evaluation [15].

Fracture union was considered when the patient is full weight-bearing without pain and the fracture site is not tender on palpation. Full weight-bearing was defined as the time that patients could have painless walking without any aids. Malunion was considered when varus-valgus angulation was more than 5°, anterior-posterior was more than 10°, internal and external rotations of more than 10°, and shortening of more than 15 mm. Delayed union was defined as failure to heal after at least 4 months and no more than 9 months following surgical reduction. Non-union was defined as a failure of progressive radiographic healing over 3 months, at a minimum of 6 months from treatment [16-18].

RESULTS

From June 2014 to May 2016, 19 cases of tibial plateau fractures were operated on in our institution. Observation and analysis of the results were done concerning age, mode of injury, and fracture type (Table 1).

Table 1: Demographic data.

Age in years	24 to 78 (mean 41.74)					
Male	15					
Female	4					
Mechanism of injury	Road traffic accidents	11 (57.8%)				
	Fall	7 (36.8%)				
	sports	1 (5.2%)				
Type of fracture	Schatzker Type	n (%)	AO	n (%)	3 column concept	n (%)
	I	6 (31.5%)	B1	7 (36.8%)	Single Column	12 (63.1%)
	II	1 (5.2%)	B2	2 (10.5%)	Double Column	6 (31.5%)
	III	2 (10.5%)	B3	2 (10.5%)	Tri-columnar	1 (5.2%)
	IV	3 (15.7%)	C1	2 (10.5%)		
	V	3 (15.7%)	C2	3 (15.7%)		
	VI	3 (15.7%)	C3	3 (15.7%)		

The average duration of injury and surgery was 3 (range 1 to 9) days. During Surgery, column-specific fixation was done. We had 12 (63.1%) single column (medial or lateral) fractures, 6 (31.5%) two-column (medial and lateral or lateral and posterior) fractures and 1 (5.2%) tri-columnar fracture. In 3 patients (15.7%) iliac crest bone graft was used to fill the bone defect and in 4 patients (21%) local cancellous bone was elevated. In 4 patients (21%) only lag screws (cannulated cancellous screws) were used. In 15 patients (79%) locking compression plate was used. One patient had a superficial infection with implant exposed, which was resolved after debridement, implant removal (at 8 months), and IV antibiotics. One patient with open fracture (Gustillo type II) was managed with debridement and internal fixation at a single setting. Six patients had other associated fractures. Among them, two had spine fracture, one had calcaneus fracture, one had a subtrochanteric fracture, one had open tibia fracture and one had proximal humerus fracture. One patient had a sports-related injury.

With the follow-up of an average of 19.5 (range, 16 to 30) months, fracture union was observed within an average duration of 12.44 (range 10-16) weeks. There were no cases of nonunion and fixation failure. Because of implant-related local complaints, the implants were removed in 7(36.8%) patients, with a median of 1.5 years (range, 0.66 to 1.84 years).

Fifteen patients were employed at the time of injury. Eleven patients (57.8%) returned to work after a mean duration of 5.45 months (range 3 to 9 months). Four patients had to change the job due to injury.

The final assessment was done at 12 months using Rasmussen clinical criteria and radiological evaluation The mean Rasmussen anatomic score was 16.11 (SD, 2.82; range 10 to 18). Anatomic outcome was excellent in 12 (63.3%), good in 5 (26.3%) and fair in 2 (10.5%) patients. The mean Rasmussen functional score was 26.05 (SD, 2.32; range 19 to 29). Functional outcome was excellent in 10 (52.6%), good in 8 (42.2%) and fair in 1 (5.2%) patients. Mean knee flexion at the end of treatment was 134° (SD, 8°; 120 to 140), however, 3 patients had extension lag of 10 degree. No patient had a fixed flexion deformity. There were no poor anatomic and functional results (Figures 1-3).

DISCUSSION

With the increase in motor vehicle accidents, complex proximal tibial fractures have also been increased. Surgical intervention is indicated for these fractures to obtain a stable and functional knee joint. Fracture around the joint results in significant morbidity and highly affects the quality of life. Hence, the treatment of a proximal tibial intraarticular fracture is challenging to orthopedic surgeons. Patience is important for soft tissue management. Spanning external fixation should be considered in high-grade soft tissue injury. Low energy fracture is more common in elderly patients and high energy injury is seen in the younger group [19].

Luo CF et al. introduced the "three-column concept" as a new classification system for tibial plateau fractures. They also mentioned that "Three-column fixation" is an effective and safe way for the treatment of multiplanar complex tibial plateau fractures [13]. We formulated the specific criteria for a particular method of treatment for a particular type of fracture. Single column fracture was fixed with a Cannulated Cancellous Screw (CCS) or single plate, two-column fractures were treated with dual plate fixation and tri-columnar fracture was fixed with three plates.

These fractures are commonly seen in the young, active, and productive group especially in male patients, as they are more engaged in outdoor activities. In the present study males (78.9%) were more affected than females which were also reported by Lee

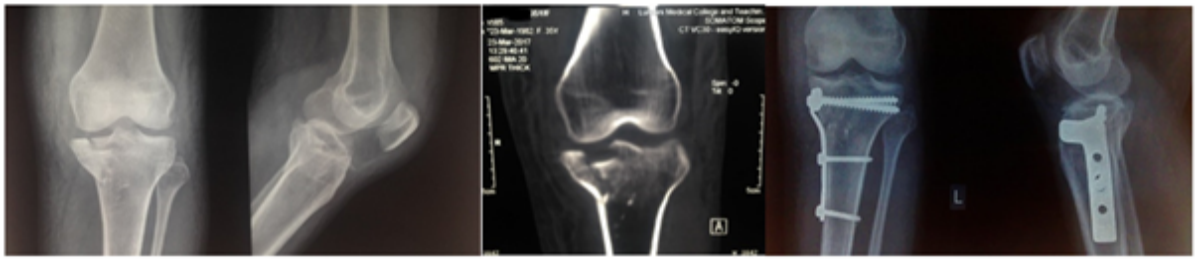

Figure 1: Medial Column fracture (single column).

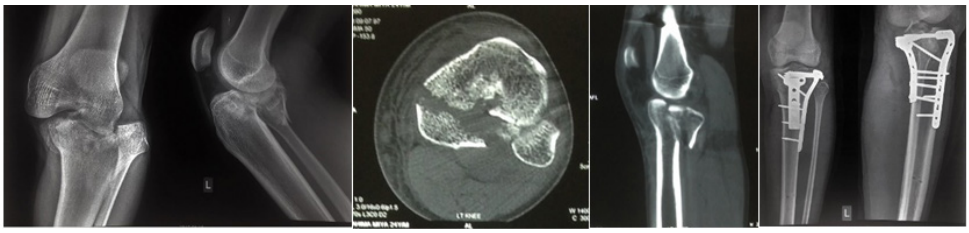

Figure 2: Two Column fracture.

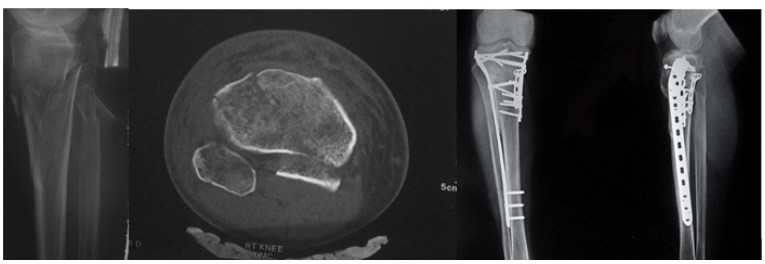

Figure 3: Three Column fracture.

et al [(65.71%), Manidakis et al. (58.4%), Mehin et al. (56%), and Albuquerque et al. (70.3%) [20-23].

In our study, the majority of fractures occurred between the age of 21 and 50 years (78.9%) with the maximum incidence in the age group of 41-50 years (36.8%). We found that 78.9% (15 patients) of injuries occurred in the productive age group of 21 and 50 years which correlates with Honkonen SE et al. (20-60 years), Albuquerque et al. (71%, between 30-60 years). Lee et al. reported that the average age of tibial plateau fractures in patients was 42 years which correlates with the present study (41.74 years) [20,23,24].

The average union time in our study was 12.44 weeks in which 14 weeks by Vasanad GH et al., 20.2 weeks by Chang SM et al. [25-26]. Only closed bicondylar four-quadrant tibial plateau fractures were included in the study by Chang SM et al. This may be the reason for longer union time.

Modern anatomic pre-contoured locking plate provides better stability, allows early knee motion thus preventing knee stiffness, and improves articular cartilage nutrition and healing [27]. Although we have low-profile locking plates, about 37% of patients presented with implant-related complaints, and implants were removed in all these cases with a median of 1.5 years.

It is interesting to see that 4 patients couldn't return to previous work and had to change their job after a tibial plateau fracture. This indicates that tibial plateau fracture can give long-term complications to the healthy individual.

Eighteen patients (94%) achieved an acceptable functional outcome, which was comparable to other studies 90% to 91% [28-29]. Seventeen patients (89.47) achieved an acceptable anatomic outcome which was comparable to other studies reporting 91% [25%] to 93% [28]. The better functional outcome may be due to rigid fixation and early fracture union leading to an early return to activities.

In our study, we also looked for if any association between anatomic outcome and functional outcome. We found that anatomic and functional outcomes correlate with each other, except in two patients who achieved good functional outcomes despite the fair anatomic outcome. Cross leg sitting is an important part of our culture. Most of the patients (15 in count) were able to sit cross leg during the last follow-up. Long-term follow-up is required to study late-onset secondary arthritis in this kind of injury. The limited number of patients and short follow-up period are the limitations of our study.

CONCLUSION

Managing tibial plateau fracture is a challenge to an orthopedic surgeon. The column-specific fixation techniques provide good anatomical reduction to restore articular congruity, rigid fixation, facilitate early knee motion, and gives a better functional outcome.

CONFLICT OF INTEREST

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

REFERENCES

1. Yao Y, Lv H, Zan J, Zhang J, Zhu N, Ning R, et al. A comparison of lateral fixation versus dual plating for simple bicondylar fractures. Knee. 2015;22:225-229.
2. Carlson DA. Posterior bicondylar tibial plateau fractures. J Orthop Trauma. 2005;19:73-78.
3. Society COT. Open reduction and internal fixation compared with circular fixator application for bicondylar tibial plateau fractures. Results of a multicenter, prospective, randomized clinical trial. J Bone Joint Surg Am, 2006;88:2613-2623.
4. Eggli S, Hartel MJ, Kohl S, Haupt U, Exadaktylos AK, Röder C. Unstable bicondylar tibial plateau fractures: a clinical investigation. J Orthop Trauma. 2008;22:673-679.
5. Weaver MJ, Harris MB, Strom AC, Smith RA, Lhowe D, Zurakowski D, et al. Fracture pattern and fixation type related to loss of reduction in bicondylar tibial plateau fractures. Injury. 2012;43:864-869.
6. Ricci WM, Rudzki JR, Borrelli J Jr. Treatment of complex proximal tibia fractures with the less invasive skeletal stabilization system. J Orthop Trauma. 2004;18:521-527.
7. Chin TY, Bardana D, Bailey M, Williamson OD, Miller R, Edwards ER, et al. Functional outcome of tibial plateau fractures treated with the fine-wire fixator. Injury. 2005;36:1467-1475.
8. Uhl RL, Gainor J, Horning J. Treatment of bicondylar tibial plateau fractures with lateral locking plates. Orthopedics. 2008;31:473-477.
9. Krupp RJ, Malkani AL, Roberts CS, Seligson D, Crawford CH III, Smith L. Treatment of bicondylar tibia plateau fractures using locked plating versus external fixation. Orthopedics. 2009;32:559.
10. Zhang Y, Fan DG, Ma BA, Sun SG. Treatment of complicated tibial plateau fractures with dual plating via a 2-incision technique. Orthopedics. 2012;35:359-364.
11. Schatzker J, McBroom R, Bruce D. The tibial plateau fracture. The Toronto experience 1968-1975. Clin Orthop Relat Res. 1979;138:94-104.
12. Marsh JL, Slongo TF, Agel J, Broderick JS, Creevey W, DeCoster TA et al. Fracture and dislocation classification compendium 2007: orthopedic trauma association classification, database, and outcomes committee. J Orthop Trauma. 2007;21:S1-S133.
13. Luo CF, Sun H, Zhang B, Zeng BF. Three-column fixation for complex tibial plateau fractures. J Orthop Trauma. 2010;24:683-692.
14. Zhu Y, Yang G, Luo CF, Smith WR, Hu CF, Gao H, et al. Computed tomography-based three-column classification in tibial plateau fractures: the introduction of its utility and assessment of its reproducibility. J Trauma Acute Care Surg. 2012;73:731-737.
15. Rasmussen PS. Tibial condylar fractures. Impairment of knee joint stability as an indication for surgical treatment. J Bone Joint Surg Am. 1973;55:1331-1350.
16. Hogel F, Gerber C, Buhren V, Augat P. Reamed intramedullary nailing of diaphyseal tibial fractures: comparison of compression and non-compression nailing. Eur J Trauma Emerg Surg. 2013;39:73-77.
17. Gosling T, Schandelmaier P, Muller M, Hankemeier S, Wagner M, Krettek C. Single lateral locked screw plating of bicondylar tibial plateau fractures. Clin Orthop Relat Res. 2005;439:207-214.
18. Jiang R, Luo CF, Wang MC, Yang TY, Zeng BF. A comparative study of Less Invasive Stabilization System (LISS) fixation and two-incision double plating for the treatment of bicondylar tibial plateau fractures. Knee. 2008;15:139-143.
19. Zeltser DW, Leopold SS. Classifications in brief: Schatzker classification of tibial plateau fractures. Clin Orthop Relat Res. 2013;471:371-374.
20. Lee JA, Papadakis SA, Moon C, Zalavras CG. Tibial plateau fractures treated with the less invasive stabilization system. Int Orthop. 2007;31:415-418.
21. 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;34:565-570.

22. Mehin R, O'Brien P, Broekhuyse H, Blachut P, Guy P. End-stage arthritis following tibia plateau fractures: average 10-year follow-up. Can J Surg. 2012;55:87-94.

23. Albuquerque RP, Hara R, Prado J, Schiavo L, Giordano V, Amaral NP. Epidemiological study on tibial plateau fractures at a level I trauma center. Acta Ortopédica Brasileira. 2013;21:109-115.

24. Honkonen SE. Indications for surgical treatment of tibial condyle fractures. Clin Orthop Relat Res. 1994;302:199-205.

25. Vasand GH, AntinSM, Akkimaradi RC, Prasad P, Naikawadi. Surgical management of tibial plateau fracture-a clinical study. J Clin and Diag Res. 2013;7:3128-3130.

26. Chang SM, Hu SJ, Y Zhang YQ, Yao MW, Wang ZM, Dargel J, et al. A surgical protocol for bicondylar four-quadrant tibial plateau fractures. Int Orthop. 2014;38:2559-2564.

27. Gausewitz S, Hohl M. The significance of early motion in the treatment of tibial plateau fractures. Clin Orthop Relat Res. 1986;202:135-138.

28. H Raza, Hashmi P, Abbas K, Hafeez K. Minimally invasive plate osteosynthesis for tibial plateau fractures. J Orthop Surg. 2012;20:42-47.

29. Oh CW, Oh JK, Kyung HS, Jeon IH, Park BC, Min WK, et al. Double plating of unstable proximal tibial fractures using minimally invasive percutaneous osteosynthesis technique. Acta Orthop. 2006;77:524-530.