

FUNCTIONAL OUTCOME OF COLUMN SPECIFIC FIXATION IN THE MANAGEMENT OF COMPLEX TIBIAL PLATEAU FRACTURES

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ABSTRACT

Introduction

Complex tibial plateau fractures usually have complicated intra-articular fracture pattern, often associated with severe soft tissue injury and high risk of wound complications. Single or dual column plating fixation principle based upon conventional x-ray for such fractures may not address multiplanar comminution that often has posterior shearing or coronal fractures. Computed tomography based evaluation of such fractures and column specific approach allow direct fracture visualization and anatomic reduction that results in satisfactory outcome.

Objectives

To assess the clinical and functional outcome and complications of complex tibial plateau fractures fixed with column specific fixation principle.

Methodology

This prospective study was carried out from September 2019 to August 2021 in Orthopaedic department of Nobel Medical College, Biratnagar. Consecutive sampling was used among patient with complex tibial plateau fractures meeting the inclusion criteria. Among 30 patients, with closed and Gustilo grade I or II Schatzker type V-VI fractures or AO type-C injuries to the proximal tibia were operated on column specific approach and followed up for clinico-radiological evaluation.

Result

In this study, most of the patients belonged to 31-40 years of age group with mean age of 40.47 years. Majority of patients were male (76.7%). Fracture was highly associated with road traffic accident which accounted for 83%. Fourteen patients underwent anteromedial and anterolateral plating (46.67%), 10 patients underwent anterolateral and posteromedial plating (33.33%) and remaining 6 patients underwent triple column plating (20%). The Rasmussen's functional score at final follow up was 27.17 ± 2.793 (range 21-30). 86.7% patients had acceptable clinical outcome. The mean Rasmussen's radiological score at final follow up was 8.97 ± 1.217 (range 6-10). Thus 93.4% patients had acceptable radiological outcome.

Conclusion

Column specific approach addresses all the fracture fragments of complex tibial plateau fractures to achieve acceptable clinical and radiological outcome.

KEYWORDS

Intra articular fractures, column specific fixation, three column classification, dual plating.



INTRODUCTION

Tibial plateau fractures involve the articular surface with adjacent metaphysis of the proximal tibia which range from simple injuries with predictably excellent outcome after operative treatment to complex fracture patterns that challenge even the most experienced orthopaedic surgeon. It represents approximately 1.2% of fractures in adults.¹ Fractures in men occur at younger age and tend to be the result of high energy trauma but women have increasing incidence with advancing age particularly the seventh decades, which indicates these fractures occur in osteoporotic bone.² These fractures are the result of axial compressive forces alone or combined with varus or valgus stress on the knee joint in various degree of knee flexion. The fracture geometry depends on the magnitude and direction of the force applied, the degree of knee flexion during the accident and finally, the bone quality.³ Bicondylar tibial plateau fractures usually have complicated intra-articular fracture pattern, often associated severe soft tissue injury and high risk of wound complication.⁴ Incidence of complex tibial plateau fracture is on rise due to high energy trauma as a result of increased numbers of road traffic accident.⁵ Residual articular incongruity and instability can result in posttraumatic osteoarthritis.⁶ The most commonly used methods for the classification of tibial plateau fractures are Schatzker classification and the AO/OTA classification system. These complex tibial plateau fractures include Schatzker type V and VI or AO type-c fractures of proximal tibia.⁷ Treatment options include screws, an external fixator, hybrid external fixation, limited internal fixation combined with a tensioned wire, classic dual buttress plates, a unilateral periarticular locking plate, and hybrid dual plates (combination of locking plate and buttress plate).⁸ Open reduction and internal fixation of these complex fractures is recommended to achieve the goals of anatomic articular congruity, mechanical alignment restoration and functional range of knee motion. Schatzker classification and others which rely solely on the plain radiographs may not account the coronal fracture pattern.^{9,10} Dual column plating fixation principle for such fractures may not address multiplanar comminution that very often has posterior shearing or a coronal fractures.^{11,12} Column classification based on CT scan has allowed for accurate assessment of this fracture pattern and, to some degree, can instruct the surgeon in preoperative planning.^{13,14} Posteromedial fragments are seen in 59% to 74% of bicondylar fractures which affect the surgical plan in terms of positioning, surgical approach and incision placement.¹⁵ Combination of anterolateral and posteromedial approach allow direct fracture visualization and anatomic reduction that results in satisfactory outcome.¹⁶ This study was conducted to evaluate the functional outcome after internal fixation of complex tibial plateau fractures based on the column specific approach.

METHODOLOGY

This is a prospective study that was carried out between September 2019 to August 2021 in the department of orthopaedics of Nobel medical college, Biratnagar. This study was started after the approval from the ethical

committee. The written informed consent was taken from all patients participating in the study. A total of 34 cases with closed and Gustilo grade I or II Schatzker type V-VI fractures or AO type-C injuries to the proximal tibia, who followed up for clinico-radiological evaluation, between age group 20-60 years were included in our study. Cases with a duration of fractures > 2 weeks, fracture with compartment syndrome and patient with comorbidities were excluded from the study. 4 patients were lost to follow up, hence, 30 patients were included in our study.

Complex tibial plateau fractures with severe soft tissue injuries were initially stabilized with a spanning external fixator for 1 to 2 weeks, to allow for soft-tissue injury and swelling to subside. Preoperative planning included adequate AP and lateral knee radiographs of knee as well as CT scan with two-dimensional axial, coronal and sagittal cuts along with three dimensional reconstruction images. CT scan was done after application of external fixator which required staged treatment. Patients were classified under three column classification system and categorized as 1) medial and lateral column injury, 2) lateral and posterior column injury, and 3) medial, lateral and posterior column (triple column) injury.¹⁷ The location of anteromedial or posteromedial fracture spikes relative to the planned incision (apex of the fracture) was determined preoperatively. The patient was painted and draped in supine position on a radiolucent table. The conventional anterolateral approach for fixation of lateral column injury and posteromedial approach for fixation of posteromedial and/ or medial column injury. We started with the posteromedial approach, to provide a stable medial column to which the lateral plateau could be reduced and stabilized. The landmarks for the incisions were at the medial femoral epicondyle proximally, the joint line, and the posterior tibial border at level of the metaphyseal– diaphyseal junction distally. slight knee flexion (about 30 degrees) and external rotation of the ipsilateral hip allowed an easier access to the posteromedial edge of the proximal tibia. Care was taken to provide an adequate skin bridge (usually greater than 7–8 cm) posteromedial and anterolateral incision. The incision was planned about 4 to 6 cm proximal and distal to the fracture's apex (the overall incision length is around 8–10 cm). In cases where the joint line was to be exposed, the incision was extended proximally. After the skin incision and dissection of the subcutaneous layer, the fascia was incised between the medial gastrocnemius (posterior border of the dissection) and the pes anserinus anteriorly. To gain access more posteriorly, popliteus and medial hemi soleus muscles were elevated from tibial origin. Indirect reduction of the joint line was done by an accurate distal reduction of the fracture apex. Reduction of the fracture was achieved using both direct and indirect reduction technique. The apex of the fracture line was exposed, and it was irrigated and debrided. An anti-glide buttress plate (Ellis plate or a 3.5-mm reconstruction plate) was used for reduction and fixation. Additional plate was applied over anteromedial surface or posteromedial ridge whenever required. A properly placed "apical screw" with an under-contoured plate provided anti shearing stability and compression along



the joint line. An associated lateral plateau fracture, a separate, lateral approach was used concomitantly in the same supine position. Articular surface depression was elevated under direct vision through sub-meniscal arthrotomy with confirmation on image intensifier as well. The depressed fragment was elevated through a separate cortical window on the medial tibial wall using a bone punch and bone graft substitute was used to maintain the elevation. The wound was closed in a routine fashion over a suction drain. Postoperative care included early mobilization with active assisted and passive range-of-motion exercises starting on postoperative day 1. The goal of early mobilization was to achieve 90 degrees of flexion within the first postoperative days. The patients were discharged typically after 3 to 5 days, depending on the initial injury pattern, pain control, and attainable range of motion. A hinged knee brace was worn, and weight bearing was restricted to toe-touch (5–10 kg) during the first eight postoperative weeks. Thereafter, the brace was discarded, and weight-bearing status was progressively increased during an additional 4 weeks. Full weight bearing was not permitted before 12 weeks. The functional and radiological results were analyzed at the end of 1 year as per the Modified Rasmussen functional and radiological assessment scoring system.¹⁸ Results were classified as excellent, good, fair and poor as per scoring system. Those patients with excellent and good score were defined as having acceptable outcome. Post-operatively, patients were assessed with x-ray antero-posterior and lateral views at 6 weeks, 3 months, 6 months and 1 year (fig 2, fig 3). Statistical analysis was done by using SPSS (version 18). Quantitative variables were expressed as mean \pm SD whereas Categorical values were expressed as percentages and compared using the chi-square test. P value less than 0.05 was considered significant.

RESULTS

In this study, most of the patients belonged to 31-40 years of age group with mean age of 40.47 years. Majority of patients were male (76.7%). Fracture was highly associated with road traffic accident which accounted for 83%, fall from height and minor slip were also important mode of injury particularly in the old age. There was no significant difference in the side affected where 46.7% of the patients sustained injury in the left side and 53.3% on the right side. Out of 30 patients, 5 patients (16.67%) required staged treatment due to gross swelling and fracture blisters. Surgery was performed within 3-15 days (average 7.57 ± 3.05 days). Fourteen patients underwent anteromedial and anterolateral plating (46.67%), 10 patients underwent anterolateral and posteromedial plating (33.33%) and remaining 6 patients underwent triple column plating (20%). In this study, bone graft substitute was used in 3 patients (10%) to elevate lateral tibial plateau depression. All fracture united within expected time. There was no loss of reduction in any patients. There were 2 cases of wound infection (6.67%). One had superficial and the other had deep surgical site infection. They were managed with debridement and antibiotics and there was no residual osteomyelitis in any cases. One patient had post-operative CPN palsy which recovered with conservative management. The average ROM was $125.3 \pm 9.04^\circ$ (range $108^\circ - 138^\circ$). Eight patients (26.7%) had the knee ROM below 120° at final follow up but

nobody had ROM below 90° and associated knee stiffness. Four patients (13.3%) had extensor lag of less than 10° . Three patients (10%) had valgus or varus deformity less than 10° . The mean Rasmussen's functional score at final follow up was 27.17 ± 2.793 (range 21-30). Out of 30 patients, 50% had excellent, 36.7% had good result and 13.3% had fair result. Excellent and good result can be taken as an acceptable clinical outcome. So, 86.7% patients had acceptable clinical outcome. The mean Rasmussen's radiological score at final follow-up was 8.97 ± 1.217 (range 6-10). 66.7% had excellent result, 26.7 had good result and 6.7% had fair result. Thus 93.4% patients had acceptable radiological outcome (table 1, fig 1).

Table 1: Modified Rasmussen's functional and radiological outcome.

Result	Functional outcome		Radiological outcome	
	Scoring (points)	Our study (30 cases)	Scoring (points)	Our study (30 cases)
excellent	28-30	15(50%)	9-10	20(66.7%)
good	24-27	11(36.7%)	7-8	8(26.7%)
fair	20-23	4(13.3%)	5-6	2(6.6%)
poor	<20	-	<6	-

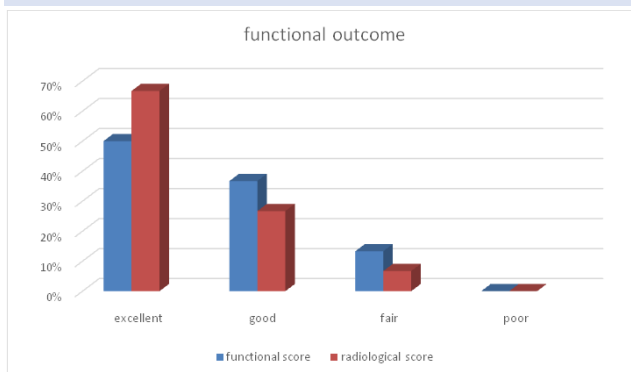


Figure 1: Modified Rasmussen's functional and radiological outcome



Figure 2 : Tibial plateau fracture fixed with triple plating.

a) pre-operative x-ray, b) immediate post-op x-ray, c) follow up x-ray with fracture union, d) patient with full range of motion.



Figure 3: Tibial plateau fracture fixed with dual plating. (a, b) pre-operative and post-operative x-ray of anterolateral and anteromedial plating, (c, d) pre-operative and post-operative x-ray of anterolateral and posteromedial plating.

DISCUSSION

Complex tibial plateau fracture requires anatomical reduction of articular surface to prevent secondary arthritis and need to achieve stable articular and metaphyseal fixation to facilitate the fracture healing.¹⁹ The optimal treatment of these fractures are still challenging and controversial despite the development of various new techniques, anatomical implant for fracture fixation and proper soft tissue handling.^{20,21} Any treatment protocol should aim at restoring articular congruity and the metaphyseal and diaphyseal dissociation, both of which are equally important for better functional outcome.²² Hence to improve the outcome and better understanding of the fracture anatomy, we used Luo three column classification based on multiplanar CT scans and column specific approach for treating two or more columns of tibial plateau fractures. Single lateral locking plate is not always sufficient to prevent varus collapse in complex tibial plateau fractures. Hence, dual plating is recommended by many authors.^{23, 24} Dual plating technique using a posteromedial approach along with anterolateral approach has been suggested by many authors for those bicondylar tibial plateau fractures with associated posteromedial fragment.²⁵ This posteromedial approach, in supine position, can't obtain articular elevation in the lateral part of posterior column for which reduction and buttressing can only be done in prone position.¹⁶ We observed these fractures more commonly in the active young males due to their exposure to high velocity motor vehicle accident which is similar to study done by Egli et

al.²⁶ In our study, postoperative complication was not significant. We had 86.7% patients with acceptable clinical outcome and 93.4% patients with acceptable radiological outcome when assessed using modified Rasmussen's scoring system which is comparable to study done by other authors.^{27,28} As we were able to obtain stable fixation with column specific plating, we could start early aggressive knee rehabilitation which helped us achieve excellent functional outcome in our study.

CONCLUSION

Based on this study, we would like to conclude that we were able to achieve acceptable clinical and radiological outcome while managing complex tibial plateau fractures with column specific approach.

LIMITATIONS OF THE STUDY

The limitations of our study were single center study, short-term follow-up, non randomized with no comparative or control group and posterolateral depressed fracture not included in our study.

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CONFLICT OF INTEREST

Authors have no conflict of interest.

FINANCIAL DISCLOSURE

None

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