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Evaluation of Functional Outcome in Patients with Tibial Plateau Factures using Minimally Invasive Techniques with or without Calcium Hydroxyapetite Blocks

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Abstract

Background: *The purpose of the present study is to evaluate the functional outcome in patients with tibial plateau factures using minimally invasive techniques with or without calcium hydroxyapetite blocks.* ***Material and Methods:*** *24 patients with displaced tibial plateau factures (>2mm) were treated using minimally invasive techniques from June 2015 to June 2017. All the patients were assessed clinically for functional outcome of knee using Rasmussen score and radiographically for degree of maximal joint depression using J. F Keating et al criteria.* ***Results:*** *The mean follow up was 10.9 month (8-16). At 8 month follow up the mean range of flexion was 127 degrees with no loss of extension. Modified Calcium Hydroxyapatite was used as bone void filler in 14 patients. Quality of reduction in depressed plateau factures was excellent in 50%, satisfactory in 43% and poor in 7% at 8 months follow up. Overall the functional result using Rasmussen's criteria were acceptable in 92% of cases. All the patients in our series showed union with average time for union being 14.7 weeks.* ***Conclusion:*** *Minimally invasive surgeries have the advantage in that is allows anatomic reduction, allows early knee mobilization while minimizing the soft tissue dissection thus preserving the vascularity of fracture bone. Modified calcium hydroxyapatite is a useful alternative to autologous bone graft for the fractures of tibial plateau.*

Keywords*: Tibial plateau factures, minimally invasive techniques, Schatzkers classification, Calcium Hydroxyapetite blocks*

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Introduction

Tibial plateau fractures are one of the most common types of intra-articular fractures resulting from indirect coronal or direct axial compressive forces. These factures makes about 1% of all fractures and 8% of the fractures in elderly. Most commonly involved are lateral tibial condyle factures (55 to 70%) and isolated medial condyle fractures (10 to 23%) whereas the involvement of bicondylar lesions is found in 10 to 30% cases [1]. Intra-articular fractures of upper end tibia have been considered a major problem in management because of associated long term complications with this type of injury, affecting the functional outcome. The frequent complications occur in form of mal-alignment, incongruity of joint surface, instability of joint, loss of range of motion and residual deformity which prevent smooth daily activities [2]. These disabilities are attributed not only to the severity of injury but also to the complications and side effects of surgical treatment used. In fracture of tibial plateau anatomic reduction of the articular surface with stable fixation restores the mechanical axis allowing early mobilization.

Open reduction and internal fixation has significant complication rate, which has encouraged interest in percutaneous and minimally invasive techniques [3, 4].

The evolution of locking implants has allowed the use of minimally invasive technique for tibial plateau factures with improvement in soft tissue handling. [5,6,7] The advantage of reduced morbidity and hospital stay are also well documented.The treatment of choice for displaced fracture of tibial plateau is considered to be internal fixation. The most common pattern includes depression and split depression types, both of which often require bone grafting in order to augment the internal fixation. Recently biomaterial have been developed which avoid the need of bone grafting. Modified hydroxyapatite blocks are made up of calcium hydroxyapatite in highly crystalline form are absorbed slowly in the body and carries no risk of transmission of any disease. It can be used to fill contained defect in cancellous bone. It has excellent osteoconductive properties and its ultimate strength after 6 months of implantation has found to be equal or surpass that of cancellous graft [8-10]. It has been approved by FDA as bone void filler in 1998.

The aim of our study is to evaluate the functional outcome in patients with tibial plateau factures using minimally invasive techniques with or without calcium hydroxyapetite blocks.

Materials and Methods

This study is a prospective study conducted in department of orthopaedics at a tertiary care center from June 2015 to June 2017. It includes 24 patients with tibial plateau fractures who were treated with minimally invasive surgery with internal fixation with or without calcium hydroxyapatite augmentation. Patients with undisplaced or minimally displaced/depressed (<2mm) fractures, patients with delayed presentation (>2 weeks), pathological fractures and compound fractures were excluded from the study. A detailed clinical history and thorough physical examination was performed for each patient. Diagnosis and assessment of fracture configuration was made on the basis of plain X-rays AP, lateral, oblique and 10° caudal plateau views. Amount of maximal joint depression was assessed in all depressed plateau fractures in lateral and 10° caudal view. All fractures were classified according to the Schatzker classification for Tibial Plateau factures. Patients were evaluated clinically and radiographically to assess for any other associated injuries. The amount and severity of osteoporosis was measured by assessing trabecular pattern in proximal femur in plain X-ray using Singh's Index. ASA classification was used to assess physical status and to quantify surgical risk. All operations were done as routine procedures after appropriate investigations required for anesthesia fitness. A single shot of intravenous antibiotic was given in all patients at night before surgery. Patients were operated under tourniquet in general or regional anesthesia. All the factures were fixed using minimally invasive techniques along with 6.5mm CCS screws/buttress plate/locking compression plate with or without calcium hydroxyapatite blocks. Postoperatively gentle active assisted knee bending exercises and non weight bearing crutch walking were started from 2nd POD. Partial weight bearing was allowed at 6 weeks and commenced to full weight bearing by 3 months if the radiographs show good union. Follow-up was scheduled at every month for 6 months and then at 2 month interval and radiographs were taken at each visit. Functional outcome parameters were measured according to scale given Rasmussen. [Table-1]

Parameters evaluated were walking capacity and pain perception in subjective evaluation category. In clinical examination ROM of knee, loss of extension and instability were measured. Points were assigned and grades were given in form of excellent, good, fair and poor outcomes. Radiographs were used to assess the degree of maximal joint depression. The reduction was graded as excellent if residual depression was 2mm or less, satisfactory if it is between 2-5mmm and poor if >5mm. (J. F Keating et al criteria).

Results

Our study included 27 patients with tibial plateau fractures treated by minimally invasive surgeries with internal fixation of which 3 patients did not come for minimum follow-up period of 6 months and hence were excluded.

Out of 24, 19 (79%) were male patients and 5 (21%) were female. Mean age of the patient was

38.16 years (17-64 years). The mean follow-up was 10.9 months (8-16 months). The average time of union was 14.7 weeks (12-20 weeks). Facture of fibula was the most commonly associated injury but no consideration was given to it while planning for fixation. Out of 24 patients, 2 patients belonged to type VI, 5 patients belonged to type V, 3 patients belonged to type IV, 1 patient belonged to type III and 9 patients belonged type II and 4 patients belonged to type 1 respectively. Most common fracture was Schatkers Type II fracture [Table-2].

Out of 24 patients, 14 had depression of tibial plateau in which calcium hydroxyapatite blocks was used as a bone graft substitute to fill the bone void. 12 patients had right tibial plateau fractures and remaining 12 patients had left tibial plateau fractures. RTA was the most common mode of injury secondly followed by fall from height. 20 patients belong to ASA class I, 3 patients to class II and 1 to class III [Table-3].Mean range of knee flexion at 32 weeks after surgery was 127° [Table -4]. Out of 14 patients having depressed plateau fracture, reduction was excellent or satisfactory in 13 (93%) patients at the end of 6 months.The functional results were excellent or good in 22 (92%) patients at the end of 6 months [Table-5].

Table-1 Rasmussen anatomical grading

		Points	Excellent	Good	Fair	Poor
A	**Depression**		6	4	2	0
	Not present	6				
	<5mm	4				
	6-10mm	2				
	>10mm	0				
B	**Condylar widening**		6	4	2	0
	Not present	6				
	<5mm	4				
	6-10mm	2				
	>10mm	0				
C	**Angulation (varus/valgus)**		6	4	2	0
	Not present	6				
	<10 degree	4				
	10-20 degee	2				
	>20 degree	0				

Table -2 Distribution of fracture types as per age

Type of fracture (Schatzker)	Number of patients	Average age
I	4 (16.66%)	26.25 Years
II	9 (37.5%)	41.11 Years
III	1 (4.1%)	40.00 Years
IV	3 (12.5%)	36.00 Years
V	5 (20.883%)	42.60 years
VI	2 (8.33%)	30.00 Years
Total	24	38.16 years

Table-3 Patients distribution according to ASA Classification

ASA Class	Number of patients
I	20 (83.5%)
II	3 (12.5%)
III	1 (4%)
IV	0
V	0
VI	0

Table-4 Mean range of Knee movement after surgery

Follow-up (weeks)	Mean loss of extension (degrees)	Mean range of flexion (degrees)
4 weeks	10	70
8 weeks	5	82
16 weeks	1	110
24 weeks	0	125
32 weeks	0	127

Table -5 Distribution of functional results as per fracture type

		Acceptable		Unacceptable	
Type	**Total**	**Excellent**	**Good**	**Fair**	**Poor**
I	4	2 (8.33%)	2 (8.33%)	0	0
II	9	4 (16.66%)	5 (20.83%)	0	0
III	1	0	1 (4.1%)	0	0
IV	3	1 (4.1%)	2 (8.33%)	0	0
V	5	1 (4.1%)	3 (12.5%)	1 (4.1%)	0
VI	2	0	1 (4.1%)	1 (4.1%)	0
Total	24	9	13	2	0

Figure 1: Preoperative Xray of patient with tibial plateau factures. Figure 2: Immediate postoperative X ray AP view treated with minimally invasive technique with calcium hydroxyappetite blocks. Figure 3: 6months postoperative Xray. Figure 4: Clinical picture of the patient in cross-leg position at 6 month follow-up. Figure 5: Clinical picture of the patient in squatting position at 6 month follow-up.

Figures: 1 2 3 4 5

Discussion

Management of displaced tibial plateau fracture by plaster cast immobilization often leads to fracture displacement and eventually unsatisfactory result. On the other hand traditional form of open reduction and internal fixation has high incidence of soft tissue problems. Minimally invasive techniques for treating tibial plateau fractures are superior to both the methods of management and have gain the popularity over recent years. 24 patients with tibial plateau fracture were treated operatively by minimally invasive surgeries with aim to preserve biology of the fractures. In addition calcium hydroxyapatite was used as a substitute to autogenous cancellous bone graft to augment fixation in fractures associated with articular depression. After fractures of tibial plateau, there is alteration in the contact relationship between the distal femur and proximal tibia. Beyond a critical threshold, depression or displacement of tibial plateau leads to significant rise in joint "stress". If the degree of stress in a joint exceeds the ability of the articular cartilage for self-repair then accelerated osteoarthrosis is likely to occur [11]. Unicondylar fractures were fixed by percutaneously place two 6.5 mm CCS. A buttress plate was used to support the condyles with comminution at inferior apex. Of 11 patients fixed by percutaneously placed CCS 64% had excellent result and 36% had good

functional results. Our finding was comparable to Koval KJ *et al*; [12] who reported good to excellent result in all of 20 patients with unicondylar tibial plateau fracture fixed with percutaneously placed 6.5mm CCS. Keogh *et al*; [13] reported similar results in their series of 13 patients.

Modified calcium hydroxyapatite blocks were used as a bone graft substitute to fill the metaphyseal defect in depressed fractures (14 out of 24). Robert D et al[14] compared the effect of a calcium hydroxyapatite with that of impacted cancellous autograft for maintaining an anatomical reduction in an experimental model of tibial plateau fracture. There was no difference in fracture stiffness between the two treatments at any of the time-points examined. There were no intraoperative complications. There were 2 superficial wound infection which responded to antibiotic treatment and local dressings. 2 patients developed persistent serous discharge from the cortical window site. Repeated cultures were reported to be sterile and both the discharging wounds healed within 3 weeks.

The mean range of flexion in our study was 127° at 8 months follow-up. There was no loss of extension. 1 patient developed knee stiffness with knee flexion <90°. J.F Keating *et al;* [15] reported comparative results (129° knee flexion) at 1 year follow-up. Paul F et al[16] reported 120 mean range of motion at knee in a study of 43 patients of tibial plateau fracture.

After fixation, under anaesthesia patients were tested clinically for associated ligamentous injury. Medial collateral ligament injury was suspected in 2 and lateral collateral in 2 patients and 1 patient had combined ACL and medial collateral ligament injury. Overall, the incidence of ligament injuries in our series was 21%. All injuries were treated conservatively. At 8 months follow-up none had symptomatic residual instability. Similar incidence was reported by Dela Marter et al 23% and Hohl M *et a*l; 20%[17]. Also Caldwell E H et al, Cave EF *et al;* and several others from their study concluded that ligamentous injury associated with tibial plateau fracture is not significant and need not to be repaired as long as bone injury is reduced. [18]

Union was achieved in all cases. It was assesses clinically by stability without pain, under stress without support and radiographically by evidence of bridging callus. The average time of union was 14.7 weeks. Raikin and froimson also reported similar duration of union (around 15 weeks) in tibial plateau fractures[19]. 3.8 months (average) period for union was reported by Alexandros ST et al in their study of 49 tibial plateau fractures.[20]

Using Rasmussen's functional criteria 38% patients had excellent, 54% had good and 8 % had fair outcome. The median Rasmussen score was 24 at 6 months. J F Keating et al reported similar result with good and excellent in 92% of cases at 6 months and 95% at 1 year. Alaxendros S T et al reported 84% acceptable results with open reduction and internal fixation in 49 tibial plateau fractures [20]. Schatzker et al reported 78% and 58% result in those treated operatively and non operatively respectively [21].

Findings of our study suggest that stabilizing tibial plateau fractures using minimally invasive techniques is definitely advantageous over conservative or conventional open techniques. We have used indirect method of reduction for achieving biological fixation to conserve the vascularity of bone. Stable anatomic reduction can be achieved allowing early mobilization, which is the pre-requisite for optimal results. Calcium hydroxyapatite block is a useful alternative to bone grafting in depressed tibial plateau fractures. Its ability to maintain articular reduction in response to an axial load is comparable to cancellous bone graft. It exhibits the proper porosity to allow for osteoblastic in growth and to achieve effective bone healing (osteoconductive). It is gradually incorporated in the surrounding bone.

Conclusion

Tibial Plateau fractures need optimum treatment in order to return to early productive life. Minimally invasive surgeries have the advantage of open reduction and internal fixation in that is allows anatomic restoration of the articular surface and allows early knee mobilization while minimizing the soft tissue dissection thus preserving the vascularity of fracture bone. Postoperative complications are reduced as fixation is done through minimal invasion. Modified calcium hydroxyapatite is a useful alternative to autologous bone graft for the fractures of tibial plateau. It is biocompatible

and has the ability to maintain articular reduction in response to axial loading. The pain and morbidity associated with using graft from iliac crest are avoided.

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