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Comparative Functional outcome of Tibial Plateau Fractures Using plating with bone substitute material, a Calcium Phosphate Cement, Versus plating with Autogenous Bone Graft

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Abstract

Background: Tibial plateau fractures comprise 1% of all lower extremity fractures affecting patients during the most productive years of their lives and can produce major disability

Methods: The present study was conducted in department of Orthopaedics, SMS Medical College and Hospital, Jaipur. A total of 60 patients(52 males and 8 females) with depressed tibial plateau fracture in which 30 patients were treated surgically by platting with bone graft and 30 patients by platting with bone substitute, calcium phosphate cement from January 2018 to May 2019 and record of them were traced and regular follow up was done for a minimum period of 6 months.

Results: 2-3 days after surgery patients started static quadriceps exercise and active toe movements. At around 2 weeks suture is removed and active knee bending & ankle movement started. Partial weight bearing started around 6 weeks in CPC group and around 8 weeks in BG group.Then full weight bearing started at around 11 weeks in CPC group and around 12 weeks in BG group, when radiograph revealed full bone union.

Conclusion: In conclusion, our study show the injectable calcium phosphate cement used here is a promising alternative for filling metaphyseal defects in

the treatment of displaced tibial plateau fractures and also avoid donar site morbidity due to pain & infection.It also decrease duration of surgery ,blood loss and in case of large void, bone graft has limitation.

Keywords: Tibial Plateau, Fractures, Bone substitute material

Introduction

Tibial plateau fractures comprise 1% of all lower extremity fractures affecting patients during the most productive years of their lives and can produce major disability[1].

Tibia is the major weight bearing bone of the leg. The proximal weight bearing surface of the tibia which forms the inferior articulating region of the knee joint is called the tibial plateau and any fracture involving this articular surface of tibia is included in tibial plateau fractures.

Tibial plateau fractures occurs as a result of combination of vertical thrust and bending leading to varying degrees of articular surface depression and compression of underlying metaphyseal bone[2]. The fracture can be caused by motor vehicle accidents or bumper strike injuries. However, sport injuries, falls, and other less violent trauma frequently produce them, especially in elderly patients with osteopenia.[2]

Moore et al. reporting on a population of 752 patients with tibial plateau fractures found an average age of 44 years with 62% of fractures occurring in men.[3]

Tibial plateau fractures can be managed by operative or nonoperative methods. Non-operative or conservative methods include cast immobilization, traction immobilization and cast bracing. Surgical methods include closed reduction and percutaneous internal fixation ,open reduction and internal fixation, arthroscopic assisted osteo synthesis and hybrid procedures including the use of external fixators.[4]

Hence, if rational treatment is to be instituted, the physician must have a sound knowledge of the personality of the injury and a clear understanding of the knee examination, have analyzed pertinent imaging studies, and be familiar with a variety of techniques for treating tibial plateau fractures. The challenge to the orthopaedic surgeon is to determine if treatment can be best be achieved by non-operative or surgical methods. It is well established that optimal knee function depends on a stable knee with a congruous and healthy articular surface that permits balanced load transmission across the joint.

Material and Methods

Source of Data: Patients in the department of Orthopaedics in teaching hospital attached to S.M.S Medical College and Hospital from January 2018 to May 2019.

Method of collection of data

Methodology and type of data collected

- After obtaining clearance and approval from the institutional ethical committee and patients fulfilling the inclusion / exclusion criteria will be included in the study after obtaining informed consent.
- Detailed history will be obtained using the study proforma with special attention to mechanism of injury
- Examination of other associated symptoms will be based on history and clinical examination.
- 30 cases suffering from depressed tibial plateau fracture
- Collection of the data is as follows
- History
- Clinical examination – systemic and local

- Radiological evaluation using- X-ray, Computerized tomography and other imaging modalities
- Investigations- baseline and others
- Diagnosis- clinical and radiological
- Surgery- open reduction internal fixation with buttress t plate
- Routine antibiotics and analgesic/anti-inflammatory drugs
- Post operative evaluation by clinical examination and X-ray
- Assessment of complications-
- Perioperative- difficulty in reduction, hypotension, neurovascular injury.
- Immediate Post operative - pulmonary embolism, fat embolism, infection, nerve palsy.
- Late post operative - infection, non union, malunion, failed fixation

Inclusion criteria

- Patients with depressed (>5mm) tibial plateau fracture.
- Patients of any sex in the age group of 18 to 65 years.
- Patients who are fit for surgery.
- Patients giving informed consent for the study.

Exclusion criteria

- Patients with open physis.
- Patients with pre existing arthritis compromising knee functuion.
- Patients with pathological fracture.
- Patients with associated polytrauma and same limb fracture.

Sample size: Sample size was calculated 30 subjects for each of two groups at Alpha error 0.05 and power 80% assuming minimum difference of means to be detected.

Study design: Hospital based Prospective randomized comparative interventional study.

Statistical / Outcome Analysis

- The collected data will be revised, coded, tabulated and introduced to a PC as master sheet.
- The data will be compiled using MS-Excel 2007 worksheet and analysed using primer and SPSS software(trial version). The data will be presenting in table and graphs wherever applicable.
- Quantitative variables will be expressed as expressed as mean and SD.
- Qualitative variables will be expressed as frequencies and percents.
- Appropriate statistical tests will be applied to obtain results.
- A significance level of $P<0.05$ will be used in all tests.

Results

In bone graft(BG) group, maximum (33.33%) patients are in 25-35 year age group and minimum (20%) patients in 45-55 & 55-65 year age group. In bone substitute(BS) group, maximum (40%) patients are in 35-45 year age group and minimum (10%) patients in 55-65 year age group. There was no significant difference(P value 0.826) between the age groups in the two groups. .In both groups, males are 86.67% and females are 13.33%(M>F). There was no significant difference (P value 0.704) between the two groups. In bone graft(BG) group, maximum (70%) patients are due to RTA and 30% patients due to FFH. In bone substitute(BS) group, maximum (70%) patients are due to RTA and minimum (6.67%) patients due to fall of object so most common mode of trauma is RTA. There was no significant difference (P value 0.325) between the two groups. In BG group 56.67% patients left side & 43.33% right side(L>R)

and in BS group 36.67% patients left side & 63.33% right side(R>L). There was no significant difference (P value 0.196) between the two groups.

Table No. 1: Distribution of the cases according to Schatzker Classification

Following table depicts the Schatzker Classification wise distribution of study subjects in both groups.In BG group 83.33% patients type 2 & 16.67% type 3 and in BS group 80% patients type 2 & 20% type 3. There was no significant difference (P value 1.000) between the two groups.

Schatzker Classification	BG (N=30)	BS (N=30)	P Value*	Sig.
2	25 (83.33)	24 (80.00)	1.000	NS
3	5 (16.67)	6 (20.00)		
Grand Total	30 (100)	30 (100)		

*Chi-square = 0.000 with 1 degree of freedom

Table No. 2. Distribution of the cases according to Duration (in weeks) of Partial Weight Bearing

Following table depicts according to Duration (in weeks) of Partial Weight Bearing distribution of study subjects in both groups.In BS group, maximum (93.33%) patients started partial weight bearing at 6 weeks and in BG group maximum (90%) patients started partial weight bearing at 8 weeks, so in BS group patients started early (6 weeks) partial weight bearing which showing significant difference(P value <0.001) between both groups.

Partial Weight Bearing (Weeks)	BG (N=30)	BS (N=30)	P Value*	Sig.
6 week	0 (0.00)	28 (93.33)	<0.001	HS
7 week	0 (0.00)	1 (3.33)		
8 week	27 (90.00)	1 (3.33)		
9 week	3 (10.00)	0 (0.00)		
Grand Total	30 (100)	30 (100)		

*Chi-square = 56.143 with 3 degrees of freedom

Table No. 3. Distribution of the cases according to Mean duration (in weeks) of Partial Weight Bearing

Following table depicts according to Mean duration (in weeks) of Partial Weight Bearing distribution of study subjects in both groups.In BG group mean duration of partial weight bearig is 8.10(±0.31) weeks and in BS group is 6.10(±0.40) weeks showing significant (P value <0.001) difference means early partial weight bearing in BS group.

Partial Weight Bearing (Weeks)	BG (N=30)	BS (N=30)	P Value*	Sig.
Mean	8.10	6.10	<0.001	HS
SD	0.31	0.40		

*Unpaired t-test (t = 6.980 with 58 degrees of freedom)

Table No. 4. Distribution of the cases according to Duration (in weeks) of Full Weight Bearing

Following table depicts according to Duration (in weeks) of Full Weight Bearing distribution of study subjects in both groups.In BS group, maximum (93.33%) patients started full weight bearing at 11 weeks and in BG group maximum (80%) patients started full weight bearing at 12 weeks, so in BS group patients started early (11 weeks) full weight bearing which showing significant difference(P value <0.001) between both groups.

Full Weight Bearing (Weeks)	BG (N=30)	BS (N=30)	P Value*	Sig.
11 week	0 (0.00)	28 (93.33)	<0.001	HS
12 week	24 (80.00)	1 (3.33)		
13 week	3 (10.00)	1 (3.33)		
14 week	3 (10.00)	0 (0.00)		
Grand Total	30 (100)	30 (100)		

*Chi-square = 53.160 with 3 degrees of freedom

Table No. 5. Distribution of the cases according to Mean duration (in weeks) of Full Weight Bearing

Following table depicts according to Mean duration (in weeks) of full Weight Bearing distribution of study subjects in both groups.In BG group mean duration offull weight bearig is 12.30(±0.65) weeks and in BS group is 11.10(±0.40) weeks showing significant (P value <0.001) difference means early full weight bearing in BS group.

Full Weight Bearing (Weeks)	BG (N=30)	BS (N=30)	P Value*	Sig.
Mean	12.30	11.10	<0.001	HS
SD	0.65	0.40		

*Unpaired t- test (t = 6.980 with 58 degrees of freedom)

Table No. 6. Distribution of the cases according to Lysholm Score (at 6 months)

Following table depicts according to LS Score (at 6 months) wise distribution of study subjects in both groups. In both group, maximum patients have 91 lysholm score. There was no significant difference (P value 0.203) between the two groups.

LS score (at 6 months)	BG (N=30)	BS (N=30)	P Value*	Sig.
81	3 (10.00)	0 (0.00)	0.203	NS
85	4 (13.33)	2 (6.67)		
90	7 (23.33)	9 (30.00)		
91	14 (46.67)	13 (43.33)		
95	2 (6.67)	6 (20.00)		
Grand Total	30 (100)	30 (100)		

*Chi-square = 5.954 with 4 degrees of freedom

Table No. 7. Distribution of the cases according to Lysholm Scale (at 6 months)

Following table depicts according to LS Scale (at 6 months) wise distribution of study subjects in both groups.In BG group, 53.33% patients & in BS group 63.33% patients have excellent grade and 36.67% patients in both group have good grade.In BG group 10% patients have fair grade. There was no significant difference (P value 0.196) between the two groups.

LS scale	BG (N=30)	BS (N=30)	P Value*	Sig.
Excellent	16 (53.33)	19 (63.33)	0.196	NS
Fair	3 (10.00)	0 (0.00)		
Good	11 (36.67)	11 (36.67)		
Grand Total	30 (100)	30 (100)		

*Chi-square = 3.257 with 2 degrees of freedom

Table No. 8. Distribution of the cases according to Complications

Following table depicts according to complications wise distribution of study subjects in both groups.In BG group 6.67% patients have redisplacement which not seen in BS group.In BG group, 20% patients and in BS group 6.67% patients have knee stiffness.10% patients have BG site pain till 6 months.Wound infection occurs

equally(3.33%) in both groups. There was no significant difference (P value 0.066) between the two groups.

Complications	BG (N=30)	BS (N=30)	P Value*	Sig.
Redisplacement	2 (6.67)	0 (0.00)	0.066	NS
Knee stiffness	6 (20.00)	2 (6.67)		
BG site pain	3 (10.00)	0 (0.00)		
Wound infection	1 (3.33)	1 (3.33)		

*Chi-square = 6.000 with 3 degrees of freedom

Discussion

In our study,Schatzker type II tibial plateau fracture is most common type. In a series by Stokel and Sadasivan[5,6], the most common fracture types to be type II.

In our study, 52 patients(86.67%) are males showing injury more common in males than females and 28 patients(46.67%) had left side & remaining had right side involvement.

39 patients(65%) are in young age group (25-45 year) which is productive life and 42 patients(70%) had mode of injury road traffic accidents(RTA). Recently Lasun O. Oladeji,documented that tibial plateau fracture is more common in young age group due to motor vehicle collision.[7]

Autogenous iliac bone graft has been considered the standard for management of subarticular osseous defects associated with depressed tibial plateau fractures because it has advantages of availability, low cost, and structural support with bone inductive biologic capacity[8]. But, iliac bone-graft requires a second surgical procedure, causes pain at a previously uninjured site, and risks the possibility of iatrogenic infection[9,10]. Younger and Chapman[11] documented a 9% rate of major complications and a 21% rate of minor complications after 243 autogenous bone-graft harvest procedures, 215 of which were from the iliac crest. Goulet et al.[12] reported that thirty-three (38%) of their eighty-seven patients had pain at six months after the harvest of autogenous iliac bone, and eleven patients (13%) had difficulty walking. In a more recent study of bone-grafting of humeral shaft nonunions, Hierholzer et al.[13] reported complications in twenty (44%) of forty-five patients who had autologous bone grafts.

In our study all patients with autogenous iliac bone grafts had pain postoperatively at donor site, it had typically resolved by six to eight weeks after surgery,but 3 patients(10%) had pain at donor site at 6 month post operatively,for which taking pain killer medicine and no patient had an infection develop at the graft harvest site.

In our study,one (3.33%) patient in bone graft group and one(3.33%) patient in CPC group had surgical site infection which is managed by appropriate antibiotics and alternate day dressing.

Biomechanical studies have shown that alpha-BSM provides more support of the articular surface than does cancellous bone graft. Landry et al. and Trenholm et al.[14] found that, at a load of 1000 N applied to the plateaus of cadaveric tibiae with Schatzker type-II fractures, the rate of displacement was 68% lower for subchondral defects filled with alpha-BSM than for those filled with cancellous bone graft.

In their study, collapse and resorption of the autogenous graft material occurred almost immediately in the postoperative period, resulting in the collapse of the articular segment and a residual subsidence defect.

This collapse was significantly less with alpha-BSM than with bone graft ($p < 0.05$).

In our study, 2 patients(6.67%) with bone graft group had articular redisplacement which was less significant(≤4mm),require no revision surgery and managed conservatively.

In our study, knee stiffness present in 6 patients(20%) in bone graft group and 2 patients(6.67%) in CPC group.This difference may be due to early partial and full weight bearing in CPC group.

Yusuf OZTURKMEN et al, in 2010 study on 28 patients [19 males and 9 females; mean age, 41.2 years (range 22-72 years)] who had open reduction and internal fixation combined with CPC augmentation in tibial plateau fracture with a mean follow-up of 22.2 months (range 6-36 months).. According to the Lysholm knee score, functional results were excellent in 16 patients (57%), good in 8 patients (29%), and fair in 4 patients (14%).So augmenting the open reduction and internal fixation of depressed tibial plateau fractures, including elimination of morbidity associated with bone graft harvesting, the unlimited supply of bone substitute, the optimum filling of irregular bone defects, and shortening of the postoperative full weight-bearing time.[15]

In our study, functional outcome is measured by grading of Lysholm score,which is comparable in both groups and not showing any significant (P value 0.196) difference.It showing that calcium phosphate cement(CPC) can be used alternative of bone graft.By using bone substitutes, we can decrease operative time, blood loss, early weight bearing with less chance of articular subsidence, no donor site morbidity, less knee stiffness due to early mobilization and large amount can be used to fill large void etc.

Conclusion

In conclusion, our study show the injectable calcium phosphate cement used here is a promising alternative for filling metaphyseal defects in the treatment of displaced tibial plateau fractures and also avoid donar site morbidity due to pain & infection.It also decrease duration of surgery ,blood loss and in case of large void, bone graft has limitation.

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