Scholars Academic Journal of Biosciences (SAJB) **ISSN 2321-6883 (Online)**
Sch. Acad. J. Biosci., 2016; 4(10A):849-862 **ISSN 2347-9515 (Print)**

(An International Publisher for Academic and Scientific Resources)
www.saspublishers.com DOI : 10.36347/sajb.2016.v04i10.012

Original Research Article

A Prospective Study of the Functional Outcome of Locking Compression Plating for Closed Schatzker Type V and Type Vi Tibial Plateau Fractures

Dr. Pradyumna Sharma[1], Dr. Venkatachalam K[2], Dr. Pugazhendhi G[3], Dr. Madhukar[2]
[1]Final Year M.S. Ortho PG, [2]Associate Professor, [3]Assistant Professor, Department of Orthopaedics, Sree Balaji Medical College and Hospital, No. 7, Works Road, New Colony, Chromepet, Chennai- 600044, Tamilnadu, India

***Corresponding author**
Dr. Pradyumna Sharma
Email: sairam137@yahoo.co.in

Abstract: Fractures involving proximal tibia compromise the knee functionality, mobility and stability. Tibial plateau fractures are caused by high energy trauma and as much as 25% of these fractures involve both the tibial condyles. In this prospective study, 28 cases of closed type V and type VI Schatzker's tibial plateau fractures were treated with locking compression plate, either by MIPPO technique or ORIF and were studied for their functional outcome by Bostman score and their radiological outcome by modified Rasmussen score. This study was done over a period of 3 years from September 2013 to August 2016. Depending on the case requirement locking compression fixation was done, either by MIPPO or ORIF technique. In the present study, using the Bostmans' score, 28.6% of excellent, 57.2% of good and 14.2% of poor results were obtained. We conclude that locking compression plate offers excellent biological fixation in an otherwise complex fracture pattern as seen in tibial plateau skeletal injuries.
Keywords: Tibial Plateau Fractures, MIPPO, ORIF, Locking Compression Plate

INTRODUCTION

Knee joint is a major weight bearing joint of the lower limb. Hence fractures involving the proximal tibia, compromise the knee functionality and stability. They principally affect young adults or the 'third age' population. Albuquerque *et al* reported a male predominance (70%) in these fractures. Fractures occurring in the older women are due to low energy trauma and those occurring in men are due to high energy trauma. These fractures account for 1% of all skeletal fractures. Study done by Rasmus Elsoe had concluded an incidence of 10.3 per 100,000 annually for tibial plateau fractures. Tibial plateau fractures are frequently caused by high energy trauma and up to 3% of these fractures are open injuries, often associated with other complications [1]. Surprisingly women are injured primarily while bicycling, slipping while walking and by getting injured during indoor activity. Axial loading along with varus or valgus force are responsible for these fractures [2]. The predictors of fracture pattern are dictated by the knee anatomy. The medial plateau is broader and significantly sturdy, when compared to the lateral tibial plateau. The lower limb further has a natural valgus tendency at the knee. Thus isolated injuries to lateral condyle occur in 60%, 15% involve medial condyle, and 25% are bicondylar [1]. Although challenging, the aim of treatment of these fractures is to restore normal knee functionality by near normal anatomical restoration of the articulating surfaces, thereby maintaining the mechanical axis and restoring ligamentous stability. The locking screw technology was initiated by Carl Hansmann [3] and improvised by Paul Reinhold. But now locking plate technology has become the latest innovation, which is widely used in managing comminuted complex tibial plateau fractures.

MATERIALS AND METHODS

Patients presenting with closed schatzker type V and type VI fractures to the trauma center of SBMCH, Chromepet, Chennai, between September 2013 and August 2016 would be a part of this study. The mode of injury was determined and recorded. The age and sex of the patient was recorded.

Inclusion criteria

1. All patients in the age group 20-55 were included.
2. Only those tibial plateau fracture patterns conforming to Schatzker type V and VI were included.

Exclusion criteria

1. Open fractures were excluded.
2. Fractures with compartment syndrome or vascular compromise were excluded.

3. Patients older than 55 and younger than 20 years were excluded.
4. Fractures other than Schatzker's type V and VI were excluded.
5. Patients with IDK were excluded.

Radiography

Standard knee x-rays of AP, lateral, internal and external oblique and 15 degrees of caudal tilt were taken. Stress radiographs were taken to rule out instability. In comparison to the opposite uninjured side an opening up of 1mm or more of the joint space was taken as suggestive of the corresponding collateral ligament damage. CT scan with 2mm cuts and 3D reconstruction were sought. MRI scan was done routinely to identify associated IDK and to counsel the patient for staged surgeries. The Schatzker classification of tibial plateau fractures was used to classify fractures in this study. Only those cases that comprised the closed Schatzker type V and VI, without associated IDK or any other skeletal or organ injury, qualified for inclusion.

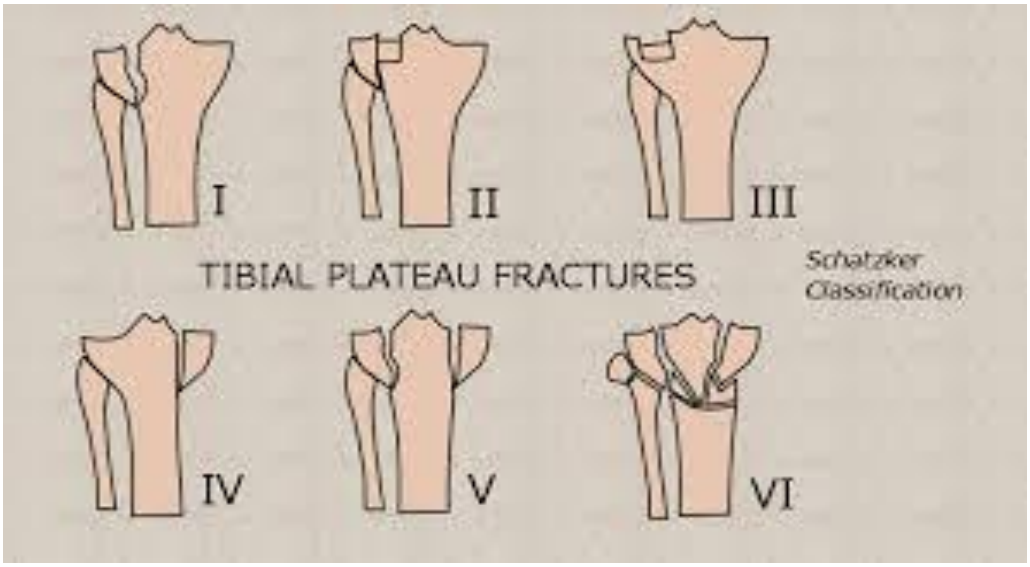

Fig-1: Schatzker classification of tibial plateau fractures

After anesthetic fitness, the cases were taken up for surgery, the patients were operated under suitable anesthesia, in the supine position on a radiolucent table. A sterile bolster was kept under the affected knee. The entire leg was prepped and draped. No tourniquet was used. Under image intensifier with sustained traction, the fracture geometry was analyzed and depending on the articular incongruity and depression, indirect reduction techniques were applied. If needed, through a metaphyseal window, the depressed articular fragment was elevated using a bone punch and K wires used to temporarily maintain the fracture reduction, to be later fixed by a large fragment cannulated cancellous screw. The gap left behind after elevation of the depressed fragment was packed with cortico-cancellous bone graft, obtained from the ipsilateral iliac crest. A single lateral compression locking plate would be the primary choice. The approach would be a transverse incision at the level just above the fibular head, cut deep down to the periosteum. Locking plate of adequate length would be selected and slid in the intermuscular plane along the lateral tibial surface, whilst maintaining traction and monitoring the reduction in the C-arm monitor. Locking screws would be applied to the tibial condyles, a maximum of 2 to 3. If in the lateral view, there be presence of a postero-medial fragment of the medial tibial condyle, then the fragments would be held using the screws from the lateral locking plate. If they are found displaced a separate medial plate would be used through a separate incision at the postero-medial aspect of the knee joint. Distally locking screws or cortical screws would be used based on the fracture pattern and the need for any compression or not. The distal screws would be applied only after ensuring perfect anatomical reduction, as the locking compression plate would not provide dynamic compression. The principles of bridge plating would be used and the fracture fragments would not be disturbed during any stage of the surgery. In cases which had fracture fragment displaced in an antero-posterior manner, a lag screw in the antero-posterior direction would be used to hold the fragments. Wounds would be closed by mattress skin sutures and then sterile dressings applied. Post operatively a long leg knee brace would be applied over RJ compression bandage. For the more geometrically complex and displaced fracture ORIF would be carried out. Here under tourniquet control, an inverted 'L' shaped incision would be made beginning at the level just above the head of the fibula, on the lateral tibial plateau and would be carried down to the lateral aspect of the shin of tibia or a lateral parapatellar incision would be used. Arthrotomy would be done to expose the joint and visualize the contour of articular reduction. In this approach submeniscal ligaments would need to be cut to expose the articular surface. The entire fracture would be exposed and reduction executed.

The plating technique would be the same for the rest of the procedure. All wounds would be closed over a DT and sterile dressings applied. These patients would be immobilized in an above knee POP slab postoperatively.

All patients would be started on a broad spectrum intravenous antibiotics started preoperatively and continued for three days postoperatively. Suction drain would be removed 48 hours after surgery. Emphasis would be laid on starting early range of motion and static quadriceps exercises as suggested by Rasmussen [4]. Static exercises would be started on the second post-operative day as per patient's pain tolerance. Gentle hip and ankle mobilization exercises would be initiated. Continuous passive motion would be advised for select cases especially when ORIF had to be done. Non weight bearing crutch or walking with walker would be encouraged after removal of the DT.

Fig-2: Combi Holes

Locking Screw

Fig-3: Locking Compression Plate

Fig-4: Surgical Technique

Fig-5: Patient Positioning (Note that the high energy trauma has resulted in fracture blisters being formed on the medial aspect)

Fig-6: Skin Incision

Fig-7: Sliding The Plate

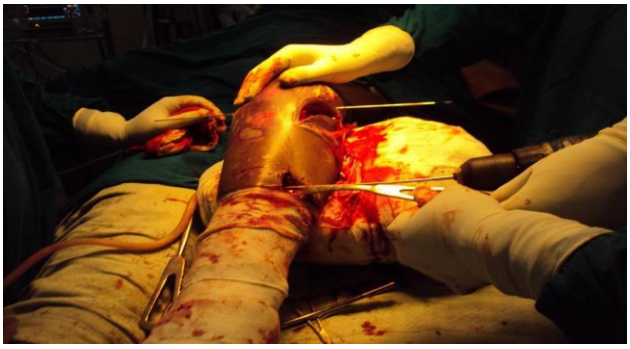

Fig-8: Delivering Plate In Distal Wound

Fig-9: Application Of Proximal Screws

Fig-10: Application Of Distal Screws

Fig-11: Skin Closure

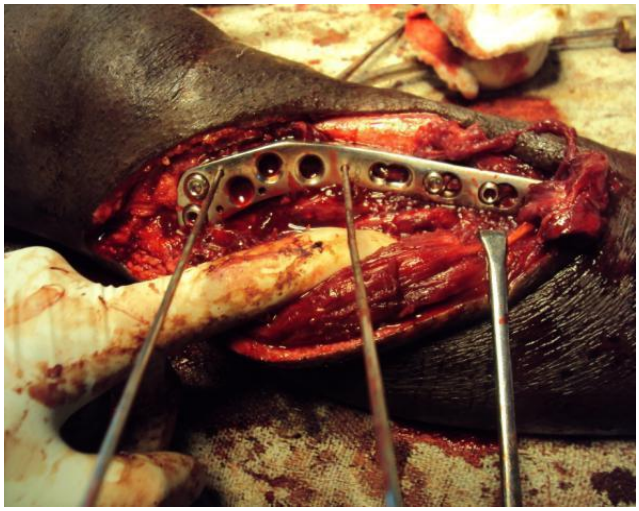

Fig-12: Open Reduction With implant In Situ

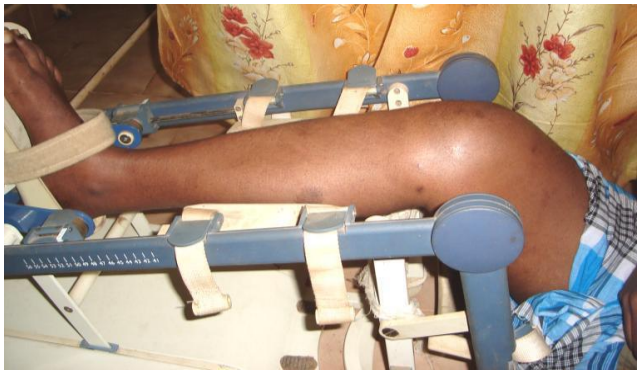

Fig-13: Patient On CPM

Follow up

All patients would be reviewed at 2 weeks, 4 weeks, 8 weeks and 12 weeks and then once in two months thereafter. They would be assessed for clinical and radiological signs of union. Clinical union would be defined as a painless fracture site during full weight bearing. Clinically patients would be observed for wound healing and fracture site tenderness. Weight bearing would be allowed only after clinical and radiological evidence of union. Radiologically the patients would be analyzed with x-rays at every post-operative visit for evaluation of maintenance of articular congruity and also to look for any condylar widening or malalignment.

Radiographic union would be defined as bridging trabeculation across the fracture line(s) on three of the four cortices. Functional outcome would be measured using Bostmans' knee score [5] and radiological outcome using Rasmussen radiological assessment [4] uniformly for all the patients at the 6th month follow up. Condylar depression would be measured from a reference line level with the uninjured plateau. Condylar widening would be obtained by measuring total width of the tibial plateau just below the joint line and measuring the width of the femoral condyles just above the joint line. These two measurements should be normally equal [6]. Implant used in all the cases would be a stainless steel hockey stick shaped locking compression plate with combi holes. Whenever a posteromedial plate would be needed, a T shaped locking compression plate would be used. For the condyles a 6.5 mm cancellous locking screws and for the shaft 4.5 mm cortical locking screws would be used.

Table 1: Bostmans' Scoring System

	Variable	Points (Maximum 30)
1.	**Range of motion**	
	Full extension and range of motion > 120 degrees or	6
	< 10 degrees of normal	3
	Full extension, motion 90 to 120 degrees	0
	Flexion < 90 degrees	
2.	**Pain**	
	None or minimal on exertion	6
	Moderate on exertion	3
	In daily activities	0
3.	**Work**	
	Original job	4
	Different job	2
	Cannot work	0
4.	**Atrophy, difference of thigh circumference 10 cm proximal to patella**	
	< 12 mm	4
	12 – 25 mm	2
	> 25 mm	0
5.	**Ambulation assistance**	
	None	4
	Cane part time	2
	Cane full time	0
6.	**Effusion**	
	None	2
	Reported to be present	1
	Present	0
7.	**Giving away**	
	No	2
	Sometimes	1
	Daily life	0
8.	**Stair climbing**	
	Normal	2
	Disturbing	1
	Disabling	0
EXCELLENT: 28 – 30 POINTS, GOOD: 20 – 27 POINTS, POOR: < 20 POINTS		

Table 2: Rasmussens' Radiological Grading

	Points	Excellent	Good	Fair	Poor
1. Depression					
Not present	6	6	4	2	0
< 5 mm	4				
6 to 10 mm	2				
> 10 mm	0				
2. Condylar					
widening	6	6	4	2	0
Not present	4				
< 5 mm	2				
6 to 10 mm	0				
> 10 mm					
3. Angulation (varus/valgus)					
Not present	6	6	4	2	0
< 10 degrees	4				
10 to 20 degrees	2				
> 20 degrees	0				
Total		18	12	6	0

RESULTS

The cases were analyzed as per the following criteria:

Age distribution

The group varied from 20 to 55 years with the mean age of 36.5 years. Incidence of fracture was observed maximum (50%) between 30 to 39 years of age.

Table 3: Age distribution

Age Group	Number of cases	Percentage
20-39 years	7	25%
30-39 years	14	50%
40- 49 years	5	17.85%
50- 59 years	2	7.15%

Sex Distribution

The male to female sex ratio in our study was 23:5

Side Of Injury

Right side were more frequently involved in our study.

Table 4: Side Of Injury

Sex	Right	Left	Total
Male	14	9	23
Female	4	1	5
Percentage	64.28 %	35.72%	100%

Mode Of Injury

Road traffic accident was the commonest (71.42%) mode of injury, others included fall from height and wall collapse.

Time Of Union

The time of union varied from a minimum of 14 weeks to a maximum of 24 weeks, with the average being 16.5 weeks.

Type Of Fracture (Schatzker)

64.28% cases were of Schatzker type V and 35.72% cases were of Schatzker type VI.

Follow up

The follow up period ranged from a minimum of 12 months to a maximum of 33 months. Average being 18.8 months.

Table 5: Case Distribution According To Bostmans'[5] Functional Outcome

	No of cases	Percentage
Excellent	8	28.58
Good	16	57.14
Poor	4	14.28

Table 6: Case Distribution According To Rasmussens'[4] Radiological Outcome

	No of cases	Percentage
Excellent	8	28.58
Good	10	35.72
Fair	6	21.42
Poor	4	14.28

Table 7:Comparison Between Operative Techniques According To Time Of Union

	MIPPO	ORIF	Overall
AVERAGE TIME FOR UNION IN WEEKS	15	20	17.5

Table 8: According To Bostmans'[5] Functional Outcome

	MIPPO	ORIF	Overall
AVERAGE SCORE	26	14.75	24.46

Table 9: According To Post Op Knee Movements

	MIPPO	ORIF	Average
AVERAGE RANGE OF MOTION IN DEGREES	123	98	110.5

Table 10: Comparison Of Bostmans'[4] Functional Outcome Between MIPPO and ORIF

	MIPPO	MIPPO
TOTAL (28)	16	12
EXCELLENT	10	2
GOOD	6	6
POOR	0	4

Table 11: Comparison Of Rasmussens'[5] Radiological Outcome Between MIPPO AND ORIF

	MIPPO	ORIF
EXCELLENT	10	2
GOOD	4	6
FAIR	2	2
POOR	0	2

Maximum Rasmussen radiological assessment score was 18 and the minimum was 6, with an average of 12.

COMPLICATIONS

Infection

3 cases developed wound infection, of which 2 were superficial infection controlled by appropriate antibiotics and regular dressings. One case developed wound necrosis which needed regular dressings and debridement and healed after split skin grafting.

Knee stiffness

3 of our cases developed knee stiffness with the range of motion being less than 90 degrees at the end of twelve months of follow up.

Malunion

In one case, there was more than 20 degrees of varus angulation.

Limb length discrepancy

Shortening of around 1.8 cm was observed in one case.

COMPLICATIONS

Fig-14: Knee Stiffness

Secondary Loss Of Reduction

Fig-15: Skin Necrosis

Fig-16: Malunion

ILLUSTRATED CASES
CASE 1

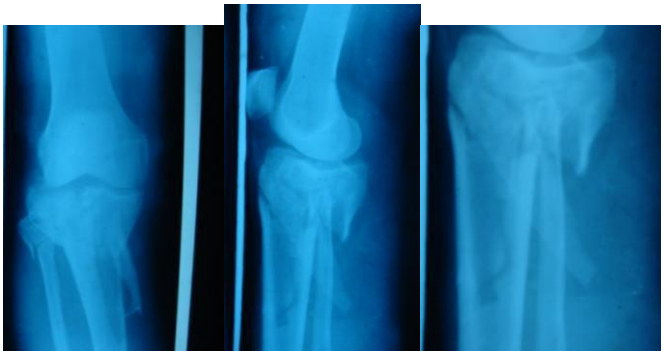

Fig-17: Pre Operative X Rays

Fig-18: Immediate Post OP **6 Months Post OP**

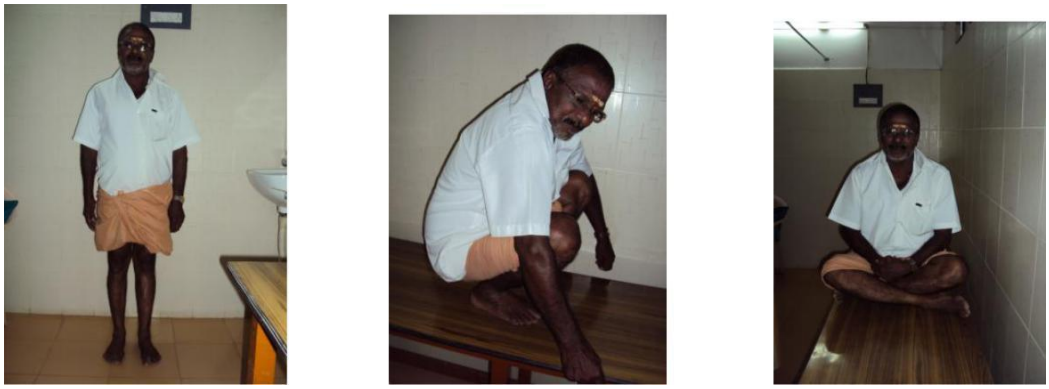

Fig-19: Fair Functional Outcome

CASE 2

Fig-20: Pre Operative X Rays **CT Scan**

Fig-21: immediate post OP **6 month post OP**

Fig-22: Excellent functional outcome

CASE 3

Fig-23: pre OP x rays

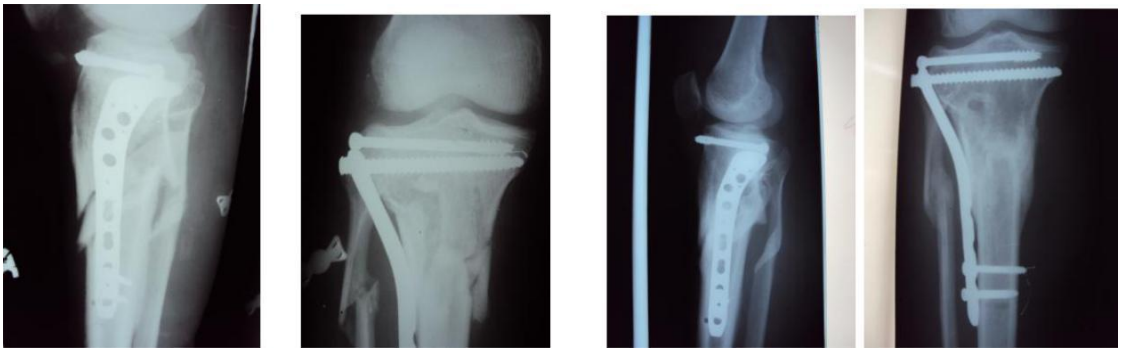

Fig-24: Immediate post OP **6 months post OP**

Fig-25: Good functional outcome

DISCUSSION

This prospective study done on twenty-eight patients with high energy tibial plateau fractures gives us an insight into the epidemiological pattern of these injuries. In our series the patients were predominantly in the fourth decade. Among our patients 82.15% were males, 17.85% females. Also 64.28% were right sided and 35.72% cases were left sided knee injuries. 64.28% of cases were of Schatzker type V and 35.72% of cases were of Schatzker type VI.

Average waiting period for surgery was 2-7 days (mean 3.8). There was significant association between lag period and the functional outcome (p 0.007) with cases operated early having a better functional outcome.

In our series 16 patients were operated using MIPPO technique and 12 with open reduction and internal fixation. Late cases which underwent open reduction internal fixation in an attempt to achieve joint congruity, went in for complications like knee stiffness, wound necrosis and poor functional outcomes. But there was no significant association between the operative technique used and the complications (p 0.428). In cases operated by minimally invasive technique, there was no use of tourniquet and hence blood loss was minimal varying from 30 to 50 ml. Whereas in the open reduction method, tourniquet time varied from 50 minutes to 75 minutes and the average blood loss was around 150ml, which reiterates the

advantages of minimally invasive approach over open reduction, with regard to blood loss.

Most of the good range of movements came from the minimally invasive methods. However, two cases of ORIF had poor range of movements, first taken up for surgery after 7 days and the other where there was a secondary loss of reduction needing prolonged immobilization.

During the follow up period which ranged from minimum of 12 months to 33 months, average being 18.8 months, the cases were assessed for functional outcome using Bostmans' [5] knee score which took cognition of the activities of daily living with clinical findings like pain, effusion, instability, range of movements and we had 8 excellent, 16 good and 4 poor cases. The patients in whom Minimally Invasive Plate Osteosynthesis was used showed better results when compared to Open Reduction Internal Fixation with the average functional score being 26 in the earlier and 14.75 in the latter. Thus cases operated by minimally invasive techniques had better functional outcomes compared to those treated by open reduction (p value 0.001). All the 4 patients with poor results belonged to the Open Reduction Internal Fixation group. Patients were radiologically assessed using Rasmussen scoring system and we had 8 excellent, 10 good, 6 fair and 4 poor outcomes with an average Rasmussen score being 12, which is comparable to the results obtained by Mathur *et al* [7] (average score 15.3). With respect to the analysis of radiological outcome there is no association of it with the operative technique (p 0.714). And reiterating the fact that radiological outcomes do not match the functional outcomes, it has been found out that there is no association between the two (p 0.188). Though Schatzker type 6 is supposed to be prognostically bad compared to type 5, there was no significant association between the type of fracture and functional or radiological outcomes (p 0.875, p 0.306). More than the type, early surgery and minimal invasive surgery held the key to good results. In spite of the often feared complication of non-union in locking compression plates, in our study all the cases ended in sound bony union. This probably is because we had preventively bone grafted the bad cases. Statistical analysis has proved that there is significant difference in duration of fracture union between minimally invasive groups and open reduction groups with the former showing union earlier (p value 0.019). Malunion occurred in a one case which had poor functional outcome primarily due to poor patient compliance which was in the form of early weight bearing. In a series by Mathur *et al* [7] on 27 operatively treated tibial plateau fractures, functional outcome was analyzed using Rasmussen scoring and they obtained 37% excellent and 51.85% good results with only 3 patients having unacceptable results. Whereas in our study the average functional score was 24.46 with 42.86% having excellent, 42.86 % having good and 14.28% having poor functional outcomes. The mean Rasmussens' [4] radiological score at final follow up was 15.33, in our study the average radiological score was 12. We had also observed that the clinical evaluation did not correlate with the follow up radiography. Though Mathur *et al* [7] in their series had used the open reduction techniques advocated be AO/ASIF, from our results we see that minimally invasive methods also achieve equally good results.

In another study by Kienast *et al* [8] on the use of unilateral lateral locking plates in bicondylar tibial plateau fractures in twenty-six patients, he had achieved 65% good, 23% moderate and 11% poor results, which is comparable to our study. The average postoperative knee movements in our study were 110.5 degrees with three patients having movements less than 100 degrees similar to Kienast *et al* [8]. In our series the infection rate was less, limited to superficial wound infection in one case and wound necrosis in another, all of which settled by regular dressings and antibiotics, and later split skin grafting. Historically the rate of infection following dual incision techniques for tibial plateau fractures has been high sometimes going up to 50% in some studies [9], but in our study the rate of infection was only 7.14%. As far as the complications are concerned they did not alter the functional and radiological outcomes (p 0.374, p 0.498).

Our study confines to a group of 28 patients followed up for a mean period of 18.8 months.

CONCLUSION

Early stable fixations of the bicondylar fractures of tibial plateau by biological methods using locking compression plates achieves predictably good results.

The minimally invasive approach is a boon in the treatment of such complex fractures as it achieves early union, good functional outcome and minimal complication, as the vascularity of the fracture is not grossly disturbed.

Emphasis is now therefore shifting from perfect reduction and rigid fixation to a biological means of fixation by minimally invasive approaches.

To achieve the above goals, we need an implant which provides stability at the same time respects biology, for which locking compression plate is an apt solution.

REFERENCES

1. Koval KJ, Zuckerman JD. Handbook of fractures, 3rd edition, 382.
2. Farouk O, Krettek C, Miclau T, Schandelmaier P, Guy P. Minimally invasive plate osteosynthesis. J Orthop Trauma. 1999;13(6):401-6.

3. Hansmanns' plate Verh Dtsch Ges Chir. 1886;15:134–137.
4. Rasmussen PS. Tibial condylar fractures. Impairment of knee joint stability as an indication for surgical treatment. J Bone Joint Surg Am. 1973;55-7:1331-50.
5. Bostman O, Kiviluoto O, Nirhamo J, Comminuted displaced fractures of the patella, injury. 1981;13:199.
6. Stokel EA. Tibial Plateau Fractures-Standardized evaluation of operative results. Orthopaedics. 1991;14(3):263-270.
7. Mathur H, Acharya S, Nijhawan VK, Mandal SP. Operative results of closed tibial plateau fractures. Indian J Orthop. 2005;39:108-112
8. Kienast B, Paech A, Queitsch C, Schümann U, Oheim R, Jürgens C, Schulz A. Complex tibial head fractures: Is there an advantage in locked implants. Int J Orthop Surg. 2008;8(1).
9. Blokker CP, Rorabeck CH, Bourne RB. Tibial Plateau Fractures An Analysis of the Results of Treatment in 60 Patients. Clinical orthopaedics and related research. 1984 Jan 1;182:193-9.