

## Original Research Article

# Operative management of tibial plateau fractures: an assessment of functional and radiological outcomes with Rasmussens scoring system

Yeshwanth Subash, Ilavarasan M. Dhamu, Jagadeesh B., Preethi N.,  
Manoj Jayaram, Gunalan K. Naidu\*

Department of Orthopaedics, Saveetha Medical College and Hospital, Thandalam, Chennai, Tamilnadu, India

**Received:** 30 September 2017

**Revised:** 08 October 2017

**Accepted:** 10 October 2017

**\*Correspondence:**

Dr. Gunalan K. Naidu,

E-mail: [gunalan99@yahoo.com](mailto:gunalan99@yahoo.com)

**Copyright:** © the author(s), publisher and licensee Medip Academy. This is an open-access article distributed under the terms of the Creative Commons Attribution Non-Commercial License, which permits unrestricted non-commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

### ABSTRACT

**Background:** Fractures of the proximal tibia involve a major weight bearing joint and are intra-articular injuries which frequently result in functional impairment. They require an accurate reduction of the articular surface with stable internal fixation. If these fractures are not managed appropriately, they often result in high rates of morbidity in the form of knee stiffness and arthritis. This study was done to assess the functional and radiological outcomes following various surgical modalities and to compare them with other studies as available in literature.

**Methods:** 30 patients with tibial plateau fractures treated by various surgical modalities at Saveetha Medical College and Hospital were studied from January 2013 to February 2015 and were followed up for a minimum period of 6 months. Functional and radiological outcomes were assessed by the Rasmussens scoring system.

**Results:** All 30 patients fulfilling the inclusion criteria were thoroughly evaluated and were taken up for surgery with various modalities of fixation which included cannulated cancellous screws, T and L buttress plates and locking compression plates. Articular surface elevation with bone grafting was done in depressed fractures. Early knee mobilization was started and strict non-weight bearing walking was advocated. We had a 90% acceptable functional result which was comparable with other studies.

**Conclusions:** In our study, we conclude that accurate reduction of the articular surface with stable internal fixation and early mobilization with bone grafting in depressed fractures with protracted weight bearing till fracture union gives good functional results. Also radiological values often do not often correlate well with functional outcomes.

**Keywords:** Tibial plateau, Osteosynthesis, Schatzker, Rasmussen

### INTRODUCTION

Fractures of the proximal tibia involve a major weight bearing joint and are intra articular injuries which frequently result in functional impairment. Once considered uncommon, the incidence of these fractures has been on the rise due to the increasing number of road traffic accidents. These fractures result from strong valgus/varus forces with or without axial loading.<sup>1</sup> They

are high velocity injuries often associated with significant soft tissue damage.

The fractures of the tibial plateau make up 1% of all fractures and 8% of fractures in the elderly population.<sup>2</sup> Fractures of the lateral tibial condyle appear to be the most common (55-70%) followed by the medial condyle (10-23%), while bicondylar fractures account for 10-30% of cases.<sup>3</sup>

These fractures often pose considerable difficulties for the treating orthopaedic surgeon due to the fact that they are intra-articular fractures which require accurate reduction of the articular surface and its treatment if not done appropriately frequently result in high rates of morbidity in the form of knee stiffness in the early postoperative period and arthritis at a much later stage.<sup>4</sup> In the past these fractures were managed conservatively, but in the current scenario with advances in surgical techniques, better understanding of biomechanics and various fixation methods and implants available, surgical management is the mainstay of treatment.<sup>5</sup> In spite of all this the management of these fractures still remains challenging due to their complex nature.

## METHODS

This was a prospective study of 30 cases of proximal tibial fractures treated by surgical means in the department of orthopaedics, Saveetha Medical and Hospital, Thandalam during the period from January 2013 to February 2015. At the time of admission all patients were clinically and radiologically evaluated. Age, sex, mode of injury, side of involvement, associated injuries and other co morbid conditions were documented in the case record. All fractures were classified according to Schatzkers classification. Gustilo and Andersons classification was used for compound injuries. In case of a compound fracture, a wound swab was sent for culture and sensitivity, tetanus prophylaxis given and emergency wound debridement was done immediately and patients were started on broad spectrum antibiotic prophylaxis.

### Inclusion criteria

Patients aged 18 to 60 years with tibial condyle fractures willing for surgery

### Exclusion criteria

Patients with immature skeletal system, pathological fractures, patients with severe co morbid conditions resulting in contra indication for surgery and neurovascular injuries

All 30 patients with tibial condyle fractures were taken up for surgery at the earliest possible depending on the medical status of the patient, condition of the skin and the amount of swelling present. Patients were given antibiotic prophylaxis with injection Cefazolin 1 gram and injection Amikacin 500 milligram at the time of induction of anaesthesia. The procedures were performed with tourniquet control under regional Anaesthesia and fluoroscopic control. Standard described surgical approaches were employed for the procedures.

Implants used in the procedures were 6.5 mm AO cannulated cancellous screws and locking and non-locking T and L buttress plates. In fractures with depression of the articular surface, a cortical window was

made to elevate the fragments using a periosteal elevator and the resulting defect was filled with bone graft harvested from the ipsilateral ileac crest. In 2 cases bone graft substitutes (tricalcium phosphate) was used<sup>6</sup> and in 1 case with a bicondylar fracture, a fibular head autograft was used to fill the defect.<sup>7</sup>

### Postoperative protocol

All patients were given intravenous antibiotics and analgesics 12<sup>th</sup> hourly for three days, post operatively. Drain tube removal was done after 48 hours. First wound inspection was done on the 3<sup>rd</sup> day and at three day intervals and sutures were removed on the 10<sup>th</sup> postoperative day. Patients were started on active knee mobilization and static quadriceps exercises from the first postoperative day subject to pain tolerance and patient compliance. They were mobilized with nonweight bearing with axillary crutches or with walking frame support depending on the age and general condition of the patient. Weight bearing was not permitted till 12-16 weeks or until definitive radiological and signs of fracture union. After discharge, the patients were followed up at 3, 6, 12 weeks, 6 months and 1 year later. Serial radiographs were taken and assessed and knee range of motion and was measured and recorded. The patients were evaluated clinically and radiologically using Rasmussens clinical (Table 1) and radiological grading system (Table 2) and the results were tabulated accordingly. The data collected was analyzed using IBM SPSS Version 22.0. Armonk, NY:IBM Corp. Chi square test was used in the comparison of categorical variables. A P value of less than 0.05 was considered to be statistically significant.

**Table 1: Rasmussens functional grading system.**

Parameters	Points
<b>Pain</b>	
None	6
Occasional	5
Stabbing pain in certain positions	3
Constant pain after activity	1
Significant rest pain	-3
<b>Walking capacity</b>	
Normal walking for age	6
Walking outdoors (>1 h)	5
Walking outdoors (15m-1h)	3
Walking outdoors (<15m)	1
Walking indoors only	0
Wheelchair/bedridden	-3
<b>Knee extension</b>	
normal	4
Lack of extension (<10 <sup>0</sup> )	2
Lack of extension (>10 <sup>0</sup> )	0
Lack of extension (>20 <sup>0</sup> )	-2
<b>Total range of movement</b>	
full	6

At least 120 <sup>0</sup>	5
At least 90 <sup>0</sup>	3
At least 60 <sup>0</sup>	1
<60 <sup>0</sup>	3
<b>Stability</b>	
Normal stability in extension and 20 <sup>0</sup> flexion	6
Abnormal stability in 20 <sup>0</sup> flexion	4
Instability in extension (<10 <sup>0</sup> )	2
Instability in extension (>10 <sup>0</sup> )	0
<b>Power of quadriceps</b>	
Grade 5	2
Grade 3-4	1
Grade <3	0
<b>Maximum score</b>	
Excellent	28-30
Good	24-27
Fair	20-23
Poor	<20

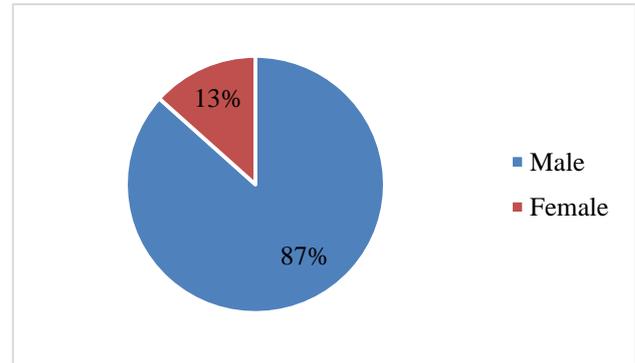
**Table 2: Rasmussens radiological grading system.**

Parameters	Points
<b>Articular depression</b>	
None	3
<5 mm	2
6-10 mm	1
>10 mm	0
<b>Condylar widening</b>	
None	3
<5 mm	2
6-10 mm	1
>10 mm	0
<b>Varus/valgus angulation</b>	
None	3
<10 <sup>0</sup>	2
10-20 <sup>0</sup>	1
>20 <sup>0</sup>	0
<b>Osteoarthritis</b>	
None/no progression	1
Progression by 1 grade	0
Progression by >1 grade	-1
<b>Maximum score</b>	
Excellent	9-10
Good	7-8
Fair	5-6
Poor	<5

**RESULTS**

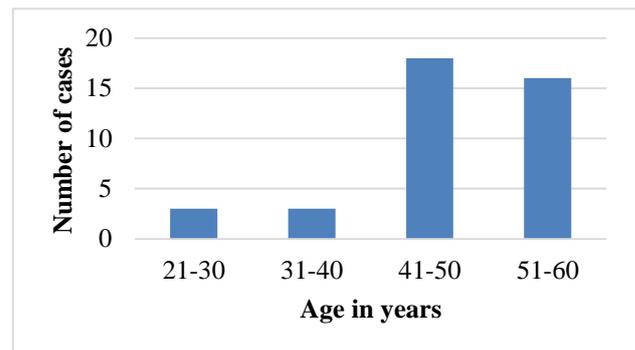
In our study 86.6% of the patients were male while 13.4% were female. The male to female ratio was 6.5:1 showing a male preponderance (Figure 1).

Regarding the side of injury there was a left side preponderance with 19 patients having a left side fracture while 11 had fractures on the right side.



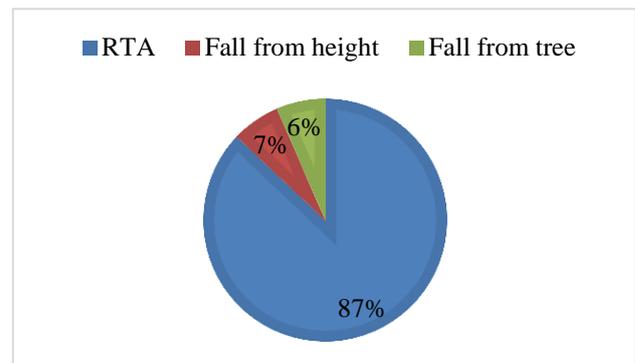
**Figure 1: Sex incidence.**

The age incidence of the patients ranged from 28-59 years. The average age was 43.5 years. The peak incidence was in the 41-50 age group. From this data, we can infer that most tibial plateau fractures occur in an active age group rather than at extremes of age (Figure 2).



**Figure 2: Age incidence.**

27 patients (90%) in our study sustained a road traffic accident making it the most common mode of injury. Road traffic accidents are more commonly associated with males due to the handling of vehicles as compared with females and co relates well with the male preponderance seen in our study (Figure 3).



**Figure 3: Mode of injury.**

Most of the patients in our study presented within 24 hours of injury while a few of them presented a little late. The variations seen in the time of presentation could be due to delay in referrals from other centers where the patients could have reported initially for treatment or due to native treatment opted by the patient initially which was the case with 2 patients seen in our study (Table 3).

**Table 3: Time of presentation.**

S.no.	Time of presentation (in hours)	Number of cases	Percentage (%)
1	0-6	7	23.3
2	6-12	3	10
3	12-24	18	60
4	>24	2	6.6

**Table 4: Type of fracture according to Schatzkers classification.**

Type of fracture	Number of cases	Percentage (%)
1	7	23.3
2	8	26.6
3	2	6.6
4	4	13.3
5	6	20
6	2	6.6

In our series Schatzkers type 2 was the most common type of fracture seen followed by type 1 (Table 4).

15 patients in our study were taken up for surgery between 1-3 days while 1 patient was operated on the day of injury itself. Surgery was delayed in 6 patients due to gross knee swelling and the presence of fracture blisters. Time was given for the swelling to subside in order to prevent problems with wound healing. Also, some patients had co morbid conditions which required a more detailed and thorough workup before they could be taken up for surgery. We believe that a gross delay in surgery may influence the overall functional outcome (Table 5).

**Table 5: Showing timing of surgery.**

Timing of surgery	Number of cases	Percentage (%)
<24 hours	1	3.3
1-3 days	20	66.6
3-10 days	6	20
>10 days	3	10

Most of the fractures in our study were fixed with locking and non-locking T and L buttress plating while supplementary bone grafting in case of depressed

fractures was used to fill up bony defects in 10 cases (Table 6).

**Table 6: Methods of fixation.**

Methods of fixation	Number of cases	Percentage (%)
AO cannulated cancellous screws	4	13.33
Buttress plates	16	53.33
Buttress plate with bone graft	10	33.34

There were 10 patients in our study who had associated bony injuries which were treated accordingly (Table 7). Our series had 6 patients who had associated ligament and meniscal injuries with 2 medial meniscus injuries, 1 anterior cruciate ligament with medial collateral ligament injury, 1 lateral meniscus incarceration at the fracture site and 2 medial collateral ligament sprains (Table 8).

**Table 7: Associated fractures.**

Type of fractures	Number of cases
Clavicle	3
Neck of fibula	4
Shaft of femur	1
Distal radius	2
Patella	1

**Table 8: Showing associated meniscal and ligamentous injuries.**

Type of injury	Number of cases
Medial meniscus	2
ACL with MCL	1
MCL sprain	2

The average period of follow up was 17 months ranging from 14 to 24 months. None of the patients in our study were lost to follow up. The mean time to fracture union was 14 weeks ranging from 12 to 18 weeks. The mean time to full weight bearing walking was 12 weeks ranging from 10 to 16 weeks. The average range of motion of the knee was 104 degrees ranging from 70 to 111 degrees. The patients were assessed as per Rasmussens functional and radiological criteria.

**Table 9: Rasmussens radiological grading.**

Radiological grading	Number of cases	Percentage (%)
Excellent	3	10
Good	21	70
Fair	4	13.33
Poor	2	6.67

According to Rasmussens radiological criteria 70% of patients had a good result while 10% had excellent results with poor results seen in 6% of patients (Table 9). In the functional grading 56.6% of patients had a good result while 30% had an excellent result. Poor results were seen in 3 cases (Table 10).

**Table 10: Rasmussens functional grading.**

Functional grading	Number of cases	Percentage (%)
<b>Excellent</b>	9	30
<b>Good</b>	17	56.6
<b>Fair</b>	1	3.4
<b>Poor</b>	3	10

In our series, we had 8 patients who had postoperative complications in the form of superficial skin infection, skin necrosis, knee stiffness and malunion which were addressed accordingly. There were no cases of malunion or implant failure encountered in our series. None of the patient required metal exit at the time of the last follow up (Table 11).

**Table 11: Complications.**

Complications	Number of cases
<b>Superficial skin infection</b>	2
<b>Skin necrosis</b>	1
<b>Knee stiffness</b>	4
<b>Malunion</b>	1



**Figure 4: X-rays. A. Preoperative X-ray of a type 5 fracture, B. Immediate postoperative X-ray, C. X-ray at third month follow up showing complete fracture union with good alignment of the articular surface.**

## DISCUSSION

Fractures of the proximal tibia account for 1% of all fractures and are complex injuries which require considerable expertise in surgical management. Since they involve a major weight bearing joint, they require a good anatomic reduction, stable internal fixation with preservation of the blood supply to the tissues and early mobilization with protracted weight bearing in order to restore a good function of the joint and to prevent

complications from occurring. Good handling of the soft tissues is an important component of the procedure in order to prevent problems with wound healing.

30 patients with tibial plateau fractures were managed surgically and analyzed in terms of age, sex, mode of injury, type of fracture, time of presentation and surgery and method of fixation used. All patients were assessed at periodical intervals for a period of two years and the results were graded according to Rasmussens functional and radiological scoring system.

Most of the fractures in our series were managed with open reduction and internal fixation with T and L locking and non-locking buttress plates along with supplemental bone grafting in 10 patients to fill up bony defects. In our series, we observed that for simple split fractures with divergence and without any articular depression, a good fixation could be achieved with the use of AO 6.5 millimeter cannulated cancellous screws by percutaneous means. For fractures associated with articular depression, elevation of the depressed fragment by creating a cortical window and filling up the defect with either ileac crest bone graft or bone graft substitutes and stabilization with a buttress plate was done. In one patient who had a comminuted fracture with a large metaphyseal defect, fibula head was used as a graft without any complications at the donor site. All fractures in our series united well at the end of 3 months with one case going in for a varus malunion. There were no cases of nonunion or implant failure in our series.

Keating in his study of tibial plateau fractures reported a 92% acceptable functional result.<sup>6</sup> Rasmussen PS had 67% of acceptable functional results in open reduction and internal fixation of these fractures.<sup>7</sup> Rombold had 93% acceptable results while Lansinger reported 81% acceptable functional results.<sup>8,9</sup> In Schatzkers study 84% acceptable results were obtained and Blocker et al reported 75% satisfactory results.<sup>10,11</sup> In later studies Dwelius reported an 87% successful outcome.<sup>12</sup> In our series, there was a 90% acceptable functional result (Table 10).

There have been a number of studies which have evaluated the role of good anatomical reduction in obtaining a good functional result. Rasmussen PS in his study noted that out of 183 fractures treated with open reduction and internal fixation, 40 fractures which had an articular depression of more than 5 millimeters at the time of follow up had no difference with respect to clinical outcome as compared to those which had a depression of less than 5 millimeters. Lucht and Pilgaard reviewed 109 fractures and found that most fractures with joint depression of 3-10 millimeters and even majority of fractures with more than 10 millimeters of joint depression had an acceptable functional result.<sup>13</sup> In our Study, we observed that an articular surface depression of 5-10 millimeters was well tolerated and did not affect the functional outcome on a short term follow up. The

radiological values often do not correlate well with clinical outcomes. The limitation of our study was a small study group and a relatively short period of follow up. A longer follow up would be necessary to evaluate the effect of articular surface depression as a factor in the development of osteoarthritis of the knee joint.

In our series, we had 2 patients with medial meniscus injuries, one patient with lateral meniscus interposition at the fracture site and 1 anterior cruciate ligament injury with mcl laxity. The fracture with the interposed lateral meniscus injury was visualized arthroscopically and the interposition was cleared followed by closed reduction and fracture fixation. As a rule, primary ligament repair or reconstruction was not done primarily. In a study by Honkonen, he concluded that medial or lateral meniscectomy at the time of surgical treatment of the tibial plateau is strongly associated with a poor outcome and a high prevalence of osteoarthritis.<sup>14</sup> After fracture union if they were any signs of knee instability, then they were treated accordingly. The patient who had the anterior cruciate ligament injury had symptomatic instability at the end of 6 months. The bony union of the fracture was satisfactory. He underwent a reconstruction with satisfactory results. Out of the 2 patients with medial meniscus injury one had an arthroscopic repair done and the other underwent a partial meniscectomy. We also had 2 patients with medial collateral ligament sprains which were treated conservatively and were asymptomatic at later follow up.

**Table 12: Comparison of results with other studies.**

Authors	Number of cases	Acceptable functional results
Keating <sup>6</sup>	151	92%
Rasmussen <sup>7</sup>	132	67%
Rambold <sup>8</sup>	102	93%
Lansinger <sup>9</sup>	240	81%
Schatzker <sup>10</sup>	320	84%
Blokker <sup>11</sup>	60	75%
Dwelius <sup>12</sup>	75	87%
<b>Our series</b>	30	90%

The cardinal rules to be followed in the management of fractures of the tibial plateau are restoration of the articular surface, stable internal fixation, filling metaphyseal defects with bone grafts, preservation of blood supply by meticulous soft tissue handling, early and active mobilization and protracted weight bearing. The same principles were followed in our series and the results were encouraging. We had complications like superficial infection, skin necrosis, knee stiffness and a case of malunion. In our study, there were no complications like deep infection, neurovascular injury, loss of fixation or nonunions. It is presumed that the lesser number of complications in the present study is due to the smaller study group and short follow up. Implant removal was not done as a routine and none of the

patients required a metal exit at the time of the last follow up.

## CONCLUSION

In our study, we conclude that surgical management of tibial plateau fractures following the principles of articular surface restoration, stable internal fixation, meticulous soft tissue dissection and bone grafting to fill defects in depressed fractures followed by early active knee mobilization and protracted weight bearing gives good functional results. Radiological values often do not correlate well with functional outcomes. The effect of articular incongruity and instability on the functional outcome as a predictor for the development of knee osteoarthritis can only be assessed by a long term follow up.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the institutional ethics committee*

## REFERENCES

1. Rockwood and Green fractures in Adults. Vol 2. 5th Edition. 2001: 1802-1838.
2. Hohl M. Tibial condylar fractures. JBJS. 1967;49:1455-97.
3. Bucholz RW, Heckman JD. Tibial plateau fractures. Rockwood and Greens fractures in Adults. 7th Edition. Vol 2: Philadelphia: Lippincott Williams and Wilkins; 2010: 1700-1831.
4. Bagley CE, O Connor SJ. Conservative Treatment of fractures of the Tibial plateau. JBJS. 1952;64:506-15.
5. Neil EG. General principles in the management of Joints. Surgical clinics of North America. 1961;41:1607-18.
6. Keating JF, Hadjucka CL, Harper J. Minimal internal fixation and calcium phosphate cement in the treatment of fractures of the tibial plateau: A Pilot study. JBJS. 2003;85:68-73.
7. Rasmussen PS. Tibial Condylar Fractures Impairment of knee stability as an indication for surgical treatment. JBJS. 1973;55:1331-50.
8. Charles R. Depressed fractures of the tibial plateau. J Trauma. 1962;2:337-52.
9. Lansinger O, Bergment B, Körner L, Andersson GB. Tibial condylar fractures-A 20 year follow up. JBJS. 1986;68:13.
10. Schatzker J, MC Brown R, Bruce D. Tibial plateau fractures: The Toronto experience. Clin Orthop. 1979;138:94-104.
11. Blokker CP, Rorabec CH, Bourne RB. Tibial plateau fractures: An analysis of results in 60 patients. Clin Orthop. 1984;(192):193-9.
12. Dwelius PJ, Colville MR, Woll TS. Treatment of tibial plateau fractures with internal fixation. Clin Orthop. 1997;(339):47-57.

13. Lucht U, Pilgaard S. Fractures of the tibial condyles. *Acta Orthop Scand.* 1971;42:366-76.
14. Honkonen SE. Indications for surgical management of Tibial condyle fractures. *Clin Orthop.* 1994;302:199-205.

**Cite this article as:** Subash Y, Dhamu IM, Jagadeesh B, Preethi N, Jayaram M, Naidu GK. Operative management of tibial plateau fractures: an assessment of functional and radiological outcomes with Rasmussens scoring system. *Int J Res Orthop* 2017;3:1092-8.