



International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2017; 3(3): 970-975
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www.orthopaper.com
Received: 11-05-2017
Accepted: 12-06-2017

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Comparison of outcome of unilateral plating and dual plating in treatment of bicondylar tibia plateau fractures

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DOI: <https://doi.org/10.22271/ortho.2017.v3.i3n.141>

Abstract

Introduction: Fractures of the proximal tibia, particularly those that extend into the knee joint are termed as tibial plateau or tibial condylar fractures. It results from indirect coronal or direct axial compressive forces. Overall worldwide, it comprises of 1% of all fractures & 8% of the fractures in elderly. In the past two decades, with improvements in surgical techniques and implants, there has been a growing trend towards surgical management of these injuries. Thus we have advanced from the conservative approach to internal fixation in fractures as an acceptable mode of treatment. No proven uniform successful method of treatment. Nevertheless, tibial plateau fractures remain challenging because of their number, variety and complexity.

Aim: To study the surgical management in terms of unilateral and dual plating for bicondylar intraarticular fractures of proximal tibia to obtain a stable, pain free, mobile joint, to prevent the development of osteoarthritis and to correlate the radiological findings with the type of fracture and the functional end result.

Materials and Methods: This was a prospective study of 44 cases. All patients included in this study sustained tibial plateau fracture grade V and VI according to Schatzker Classification. We used Rasmussen's functional and radiological scoring system for the comparison of outcome of plating. In the surgical group 20 patients were treated by unilateral plating and 24 patients were with dual plating. These patients were followed up for an average period of 13 months.

Results and discussion: In our study according to Rasmussens functional scoring⁴, we have achieved excellent outcome in 43%, good in 50%, fair in 7%, which is comparable to the standard studies. These studies suggest that while isolated lateral locked plating may offer a more biological approach to bicondylar fractures, and may provide a viable alternative for open fractures with a medial wound or fractures with tenous soft tissues, classical dual plating remains the most rigid construct.

Conclusion: The surgical management of tibial bicondylar fracture is challenging and dual plating gives excellent anatomical reduction and rigid fixation to restore articular congruity, facilitate early knee motion by reducing post-traumatic osteoarthritis and thus achieving optimal knee function.

Keywords: Unilateral plating, dual plating, bicondylar tibia plateau fractures

Introduction

In early civilization, treatment of fractures was guided by those who set themselves up as healers. Some were good observers and passed it on to the later generation. The management of fractures thus began. When it became possible to visualize the position of fractures by X-ray, major changes in treatment took place and led to the internal fixation and later-to rigid fixation of anatomically reduced fractures.

Fractures of the proximal tibia, particularly those that extend into the knee joint are termed as tibial plateau or tibial condylar fractures. It results from indirect coronal or direct axial compressive forces. Overall worldwide, it comprises of 1% of all fractures & 8% of the fractures in elderly^[1]. These fractures encompass many and varied fracture configurations that involve medial, lateral or both condyles with many degrees of articular depressions and displacements. Each fracture type has its own characteristic morphology and response to the treatment. It is essential to determine the force of injury since high energy trauma is associated with considerable soft tissue and neurovascular damage.

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High velocity injury in form of road traffic accidents as a whole is creating an ever-growing problem. Since man has taken to travelling at high speed in the sitting position, when the machine or in which the subject is travelling stops suddenly, most of the impact is taken at first upon the patella, then the tibia and femur in varying proportions and at various positions.

The stationary ;lower limb may be struck by a moving object; this is the common pedestrian injury, called "BUMPER FRACTURE" – compression fracture of lateral tibial plateau with avulsion of medial collateral ligament. The exposed ;knee joint maybe subjected to angulation, rotation or shearing strains and when the subject is upright, his body weight assists in the injury and he falls over.

The indications for non-operative versus operative treatment varies widely among surgeons as do the specific methods of treatment for many fracture configurations and concomitant lesions. The objectives of treatment of Tibial plateau fracture, is precise reconstruction of the articular surfaces, stable fragment fixation allowing early mobilization and repair of all concomitant ligamentous and other soft tissue lesions [2].

In the past two decades, with improvements in surgical techniques and implants, there has been a growing trend towards surgical management of these injuries. A better understanding of biomechanics, quality of implants, principles of internal fixation, soft tissue care, antibiotics and asepsis have all contributed to the radical change. Thus we have advanced from the conservative approach to internal fixation in fractures as an acceptable mode of treatment. No proven uniform successful method of treatment. Nevertheless, tibial plateau fractures remain challenging because of their number, variety and complexity. Despite a plethora of articles, written in the past 50 years that have addressed the problems of classification and results of various treatments the optimal method of management remains controversial [3].

Aim: To study the surgical management in terms of unilateral and dual plating for bicondylar intraarticular fractures of proximal tibia to obtain a stable, pain free, mobile joint, to prevent the development of osteoarthritis and to correlate the radiological findings with the type of fracture and the functional end result.

Material and Methods

A prospective study of 44 cases was conducted at the department of Orthopaedics, Civil Hospital, Ahmedabad a tertiary healthcare centre. All patients included in this study sustained tibial plateau fracture grade V and VI according to Schatzker Classification [5].

Inclusion Criteria

All patients with bicondylar tibia plateau fracture schatzker type V-VI, above 18 years, able to walk without assistance before injury, were included. Schatzker type I- IV were not included as these fractures efficiently can be treated by unilateral plating and therefore to avoid discrepancy of results. For functional evaluation, we had only included patients without any previous disabilities and deformities.

Exclusion Criteria: Age less than 18 years, Patients who are medically unfit for the surgery, Patients with Gustilo Anderson type III fractures, Injury severity score (ISS) >16, Unicondylar tibia plateau fractures were excluded from the study.

Classification system

The Schatzker's classification was used to classify these fractures. We used Rasmussen's functional and radiological scoring system for the comparison of outcome of plating.

Methods

Patients were first seen in the casualty. History was taken followed by general and local examination of the patient and concerned specialists undertook appropriate management of the associated injuries. Intensive care was given to those patients who presented with shock and bleeding wound, and immediate resuscitative measures were taken. Once the patient's general condition was fit, relevant X-rays were taken. Fractures were classified according to Schatzker's classification and temporary axial traction on bohler splint were applied. Patients with open grade II/ III (Gustilo Anderson classification) were managed by hybrid fixation and fasciotomy depending upon compartment status. Patients with open grade I (Gustilo Anderson classification) fracture managed primarily by debridement and sterile suture technique with appropriate antibiotics given and kept in planned surgery after 5-6 days when local site seem to be operative. Patients with severe swelling managed by axial traction by calcaneal steinmann pin on bohler splint with application of ice and glycerin and magnesium sulfate at local part and taken in operative procedure when swelling reduced or subsided. Patients with mild swelling were given axial traction by calcaneal steinmann pin on bohler splint and taken in operation next day. Higher investigations such as CT scan were done for tibial plateau fractures to plan appropriate surgical procedure. those patients having posteromedial fracture fragment were planned for bicondylar plating.

As soon as the operation was planned, certain routine procedures were regularly followed.

1. Informed and written consent.
2. Use of injectable antibiotics pre-operatively and continued for two days and followed by oral antibiotic for further 5 days.
3. NBM 8 hours prior to surgery.
4. Preparing the part for surgery.
5. In our series, we have used tourniquet for all the patients.
6. In our series, we have used image intensifier for all the patients.

A. During post-operative period following protocol was followed.

1. BP and TPR hourly till 6 hours/12 hours.
2. Postoperative analgesics.
3. To watch out for bleeding
4. Postoperative antibiotics for 5 days
5. Foot end elevation (as the surgeries are performed under spinal anesthesia).
6. Postoperative X-ray preferably the next day.
7. Patients who had stable rigid fixation were started mobilization of next day
8. Patients with unstable fixation were given cast or brace for 7-10 days for support and Range of motion exercises were done daily under careful supervision and splint reapplied.

- B. Drain was removed after 48 hours, for 2-5 days the range of motion allowed was 0-30° from the 5th day the range of motion was gradually allowed to be increased to 90° or more. After suture removal, full range of movement was allowed.

C. Follow up after 15 days

1. Look for any infection- those patients having infection were investigated and antibiotics were given.
2. Any difficulty in mobilization- those patients having difficulty, proper active physiotherapy given and observed.

D. Follow up after 1 month

1. Radiograph for union, any malalignment, redepression, widening
2. Any complication : patients were managed properly depending on their complications
3. Those patients having difficulty in full range of motion – further active physiotherapy advised.
4. Partial weight bearing were allowed

E. Follow up after 3 months

1. Those patients having not proper union on radiograph – bone marrow injections were given
2. Full weight bearing have started according to their fixation and radiographic finding

F. Follow up after 6 months

1. Evaluate for the gait and those having improper gait – proper gait training were done
2. Radiograph taken to look for Rasmussen’s scoring system
3. Functional evaluation done according to Rasmussen’s scoring system

G. Further follow up were done depending on patient’s radiological and functional outcome.

Bone grafts were used in some of the patients on requirement basis.

Functional Assessment

For functional and radiological evaluation of outcome of treatment modalities, we have used Rasmussen’s scoring system [4].

Observation and Analysis

Table 1: Incident of age

Age	20-40	41-60	>60
Incidence	39%	54%	7%
Number	17	24	3

Table 2: Incidence of sex

Sex	Number of Cases	Percentage
Male	41	93%
Female	3	7%

Males were commonly involved as they go out for job, drive the vehicles and other activities while females are mostly housewives.

Table 3: Incidence of Mode of injury in occurrence of tibial plateau fractures.

Mode of Trauma	Number of Cases	Percentage
RTA	34	77%
Fall down	10	23%

Table 4: Incidence of side in relation to tibia plateau fractures.

Laterality of Fractures	Number of Cases	Percentage
Left	27	61%
Right	17	39%

Table 5: Incidence of severity of fracture as per Schatzker’s classification

Schatzker’s Classification	Number of Cases	Percentage
TYPE V	40	91%
TYPE VI	4	9%

Table 6: Incidence of type of fracture.

Type of Fracture	Number of Cases	Percentage
Close	42	95%
Open	2	5%

Table 7: Incidence of treatment modality in tibial plateau fractures.

Method of Treatment	Number of Cases	Percentage
Orif With Unilateral Plating Fixation	20	45%
Orif With Dual Plating Fixation	24	55%

Table 8: Mean delay between day of injury and day of surgery

	Mean delay b/w injury and Surgery(Days)	Range (Days)
Our study	2.4	1-10

Table 9: Duration of surgery in tibial plateau fractures

Duration of Surgery	Number of Cases	Percentage
Up to 1 hour	13	30%
Up to 2 hour	26	50%
Up to 3 hour	4	4%
More than 3 hour	1	2%

Table 10: Period of immobilization in tibial plateau fractures

Period of Immobilization	Number of Cases	Percentage
<10 days	36	82%
Up to 3 weeks	8	18%

Table 11: Average duration of follow up

	N	Mean	Std. Deviation	Minimum	Maximum
Follow up (Months)	44	13.34	5.92	6	28

Table 12: Average time of fracture union

	N	Mean (months)	Std. Deviation	Minimum (months)	Maximum (months)
ORIF with unilateral plating	20	3	0.2293	2	4
ORIF with dual plating	24	3	0.2083	2	4

Table 13: Results of outcome (radiological) in type of plating

Results	Unilateral Plating	Dual Plating	Total
Excellent	7 35%	15 62%	22 50%
Good	11 55%	8 33%	19 43%
Fair	2 10%	1 4.1%	3 7%
Poor	-	-	-
Total	20 100%	24 100%	44 100%

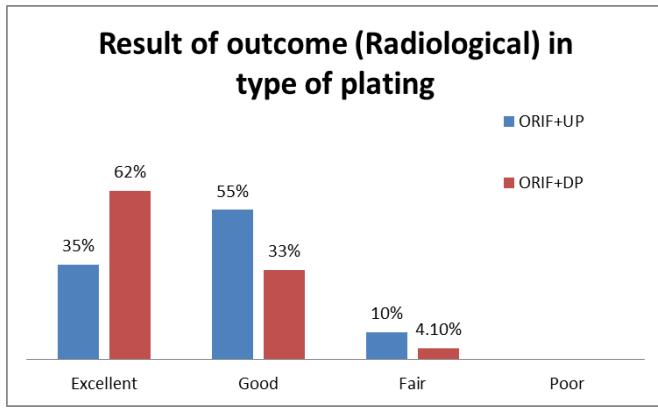


Table 14

Radiological Results (Rasmussen's Scoring)	No. of Cases	Percentage
Excellent	12	50%
Good	19	43%
Fair	3	7%
Poor	-	-

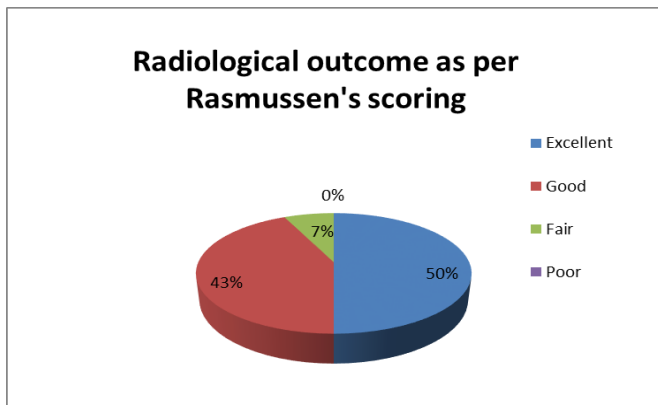


Table 15: Incidence of complication

Complication	No. of Cases	Unilateral Plating	Dual Plating
Redepression	15	10 (50%)	5 (21%)
Malunion	11	7 (35%)	4 (17%)
Superficial inf.	6	1 (5%)	5 (21%)
Deep inf.	4	1 (5%)	3 (13%)
Extensor lag	10	4 (2%)	6 (25%)
Knee stiffness	6	2 (1%)	4 (17%)
Knee instability	5	4 (2%)	1 (4%)

Discussion

In the search of perfection, any treatment modality that has a varied opinion is a subject for research and study. High energy intra-articular fractures of tibial plateau cause ongoing management problems and remains challenging for orthopaedic surgeons even to date [8].

In the operative treatment of fractures of the tibial plateau emphasis has been placed on the strict adherence to the principles of anatomical reduction, rigid fixation and early movement [9]. During operation direct reduction requires periosteal stripping and stable internal fixation necessitates considerable dissection, thereby sacrificing the vascular

supply. These techniques are associated with high rates of complication, non-union, the frequent requirement for secondary bone grafts and loss of reduction being of particular concern [10].

Most investigators would agree that four primary factors can ultimately determine the prognosis of proximal plateau injuries:

1. The degree of articular depression.
2. The extent and separation of the condylar fracture lines.
3. The degree of diaphyseal-metaphyseal comminution and dissociation [11, 6, 7, 12]
4. The integrity of the soft tissue envelope [6, 13, 14, 15]

When considering operative treatment, all four of these factors must be evaluated to determine the best course of treatment.

This study group comprises of 44 patients of whom all were treated by surgical methods. In the surgical group 20 patients were treated by unilateral plating and 24 patients were with dual plating. These patients were followed up for an average period of 13 months.

Mechanism of Injury

There were 2 groups based on the mechanism of injury. 77% of the cases were due to road traffic accidents and 23% of the cases were due to domestic fall.

Nikolaos *et al.* [17] in 2010 reported the most common cause of trauma was RTA in 69%, Radheshyam *et al.* [18] in 2012 found out to be 89%, Ebraheim *et al.* [8, 5] in 2004 also reported the same in 56%. Rasmussen [11] reported most common cause was by RTA that is 45% of the cases.

Incidence of Mode of Trauma

Series	RTA	Fall	Other	Total
Our series	34(77%)	10(23%)	0	44
Nikolaos <i>et al.</i> [17]	86(69%)	37(30%)	2(1%)	125
Radheshyam <i>et al.</i> [18]	50(89%)	6(11%)	0	56

Surgical Treatment and Results

Following treatment modalities were used in our study.

- ORIF with Unilateral locking plate
- ORIF with Dual plate

Out of 44 patients in our study 45% were treated with unilateral plating and 55% were by dual plating.

We have not formulated the stringent criteria as to particular method of fixation for particular type of fracture. So each case was individualized and treated according to its merit.

In our study the mean delay between (b/w) day of injury and day of surgery was 2.4 days (Range 1-10 days) which is comparable to Radheshyam *et al.* [18] in 2012 of 2 days (range 1-5 days), 9.2 days by Barei *et al.* [23] in 2010 and 10.4 days by Z.Yu *et al.* [22] in 2009.

Study	Mean delay b/w injury and surgery (Days)	Range (Days)
Our study	2.4	1-10
Radheshyam <i>et al.</i> [18]	2	1-5
Barei <i>et al.</i> [23]	9.2	0-40

The patients were taken for surgery at the earliest possible time depending on their medical condition, skin condition and the amount of swelling.

The mean duration of surgery in our series was 100 min which was comparable to 113 min by Hasnain *et al.* [20] in 2012.

In our series 82% of the patients were mobilized within 10 days of surgery and remaining 18% were kept protected until 3 weeks and gradual mobilization was started.

The period of immobilization was again individualized depending on the security of rigid fixation and other circumstances demand. The benefit of early knee motion include – lesser knee stiffness and improved cartilage healing (regeneration). However, these benefits are to be cautiously balanced by risks, including loss of fracture reduction, failure of internal fixation and compromised ligament and soft tissue healing. Schatzker, Robert McBroom in 1978, Magonhobi, Steven and Gauswitz in 1984 stated that the prognosis is given by the degree of displacement, type of fracture, method of treatment and quality of postoperative care [12]

All the patients were followed up for the mean duration of 13 months (Range 6-28 months) which is less in our series as compared to 35.78 months (Range 24-68 months) by Mathur *et al.* [8, 2] in 2005, 32 months (Range 12-48 months) by Radheshyam *et al.* [18] in 2012 and 29 months (Range 12-84 months) by Ebraheim *et al.* [19] in 2004.

In our study according to Rasmussen's radiological scoring [11], we have achieved excellent outcome in 50%, good in 43% and fair in 7%, which is comparable to the standard studies as shown in the following table. The mean Rasmussen's radiological score was 15.20 (Range 4-18)

On further analyzing the radiological results according to the treatment modality. Out of 22 excellent results; 32% were achieved in unilateral plating and 68% in dual plating. Out of 19 good results; 58% were achieved in unilateral plating and 42% in dual plating. Out of 3 fair results; 66% were achieved in unilateral plating and 34% in dual plating.

Radiological Results as per Rasmussen's Scoring

Series	Excellent	Good	Fair	Poor
Our series	50%	43%	7%	0%
Mathur <i>et al.</i> [16]	8%	81%	11%	0%
Y-S. Chan <i>et al.</i> [21]	28%	61%	11%	0%

In our study according to Rasmussen's functional scoring [11], we have achieved excellent outcome in 43%, good in 50%, fair in 7%, which is comparable to the standard studies as shown in the following table. The Rasmussen's functional score was 24.86 (Range 8-29)

On further analyzing the functional results according to the treatment modality: out of 19 excellent results; 32% were achieved in unilateral plating and 68% in dual plating. Out of 22 good results; 55% were achieved in unilateral plating and 45% in dual plating. Out of 3 fair results; 66% were achieved in unilateral plating and 34% in dual plating.

Functional Results as per Rasmussen's Scoring

Series	Excellent	Good	Fair	Poor
Our series	43%	50%	7%	0%
Mathur <i>et al.</i> [16]	37%	51%	11%	0%
Radheshyam <i>et al.</i> [18]	32%	52%	11%	0%

A recent biomechanical study showed that dual-plate fixation allowed significantly less subsidence than isolated lateral locked plates after cyclical loading in a cadaver mode. [27] These studies suggest that while isolated lateral locked plating

may offer a more biological approach to bicondylar fractures, and may provide a viable alternative for open fractures with a medial wound or fractures with tenous soft tissues, classical dual plating remains the most rigid construct.

Complications

Overall incidence of deep infection was in 4 of 44 patients with 3 cases of dual plating, requiring serial debridement and ultimately implant removal after radiological union.

Both superficial and deep infection rate were comparable with the standard study of Mathur *et al.* [16] in 2005, Ebraheim *et al.* [19] in 2004 and Nikolaos *et al.* [17] in 2010.

	Our series	Mathur <i>et al.</i> [16]	Ebraheim <i>et al.</i> [19]	Nikolaos <i>et al.</i> [17]	Ppawar <i>et al.</i> [26]
Superficial infection	14%	11.6%	2.4%	15.2%	8%
Deep infection	10%	7%	1%	9.6%	0%

Incidence of redepression was very high in our study, in 15 cases (34%) out of which 10 cases in unilateral plating as compared to 18.4% with Nikolaos *et al.* [17] in 2010, 19.4% with J. Siegler *et al.* [25] in 2011.

Malunion in the form of varus or valgus were observed in 11 cases (25%, 9-varus and 1-valgus) as compared with 0% by of Mathur *et al.* [16] in 2005, 2% by Ebraheim *et al.* [19] in 2004, 9.6% by Nikolaos *et al.* [17] in 2010, 2% by F. Biggi *et al.* [24] in 2010.

There was no incidence of nonunion in our series as compared with 0% by of Mathur *et al.* [16] in 2005, 2% by Ebraheim *et al.* [19] in 2004, 5% by F. Biggi *et al.* [24] in 2010.

The incidence of knee instability in our study was 11% as compared with 12% by Pawar *et al.* [26] in 2012.

The incidence of restricted knee motion in the form of extensor lag and knee stiffness in our study was 23% and 13% respectively as compared with 16% and 12% by Pawar *et al.* [26] in 2012, 0% and 5% by F. Biggi *et al.* [24] in 2010, 0% and 10% by J. Siegler *et al.* [25] in 2011.

There was no incidence of compartment syndrome, deep vein thrombosis or nerve palsy observed in our study.

Conclusion

In the present case study of 44 patients after evaluation of functional and radiological outcomes of various modalities of treatment by Rasmussen's score, we have arrived at the following conclusions:-

- The correct method of management of bicondylar fractures of the proximal tibia depends on good clinical judgement.
- Operative management showed excellent radiological alignment and functional outcome in most patients with dual plating with earliest return to pre injury activity level.
- Whatever may be the modality of treatment early active adequate physiotherapy and maintenance of rehabilitation protocols proved to be the independent factor influencing functional results.

Hence, to conclude, the surgical management of tibial bicondylar fracture is challenging and dual plating gives excellent anatomical reduction and rigid fixation to restore articular congruity, facilitate early knee motion by reducing post-traumatic osteoarthritis and thus achieving optimal knee function.

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