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Functional outcome of tibial plateau fractures treated with locking and non locking plate fixation: A retrospective study

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Abstract

Tibial plateau fracture have been a challenge to treat as these fractures are associated with severe damage to the soft tissue envelope and significant comminution and bone loss. This may be due to high speed velocity accidents or fall from height. There exist no gold standard approach in treating these fractures, each case may vary in terms of soft tissue injury, comminution and association of neurovascular status. This study was conducted by department of orthopaedics at Government Medical College Ernakulam from February 2018 to January 2020, during this period 30 patients managed by internal fixation was evaluated for their functional outcome. The patients were assigned into two groups; those treated with locking plate and another being the Non locking group. Follow up range was 10-24 months, average being 17.4. This study revealed locking plates to be superior in terms of knee scores, radiological outcomes and post-operative pain.

Keywords: tibial plateau, comminution, locking plates, non-locking plate, modified Rasmussen's score, alignment, pain score, knee score, functional outcome

Introduction

This is a retrospective study to compare the functional outcomes tibial plateau fractures treated with fixation by locking plates and non-locking plates. These fractures are associated with severe damage to the soft tissue envelope and significant comminution and bone loss. This may be due to high speed velocity accidents or fall from height where fractures results from direct axial compression, usually with a valgus (more common) or Varus force and indirect shear forces. Depressed fractures are common in osteoporotic bones in elderly. There is high incidence of infection in patients with comorbidities. There exist no gold standard approach in treating these fractures, each case may vary in terms of soft tissue injury, comminution and association of neurovascular status.

Achieving a stable fixation and maintaining intra articular congruity and obtaining good range of motion at the earliest is the primary objective of treatment. Lower implant profile which are anatomically designed provide better angular stability. The biomechanical advantages of locking plate constructs are realized specially in complex fracture rather than relatively straightforward simple fracture patterns [3, 4]. Locking plates in treatment of complex tibial plateau fractures holds many potential advantages, like increased holding power in osteopenic bone, unicortical purchase in periarticular region and ability to successfully and stably bridge severely comminuted meta-diaphyseal shaft areas [5, 6]

Methodology

This study was conducted by department of orthopaedics at Government Medical College Ernakulam from February 2018 to January 2020, during this period 30 patients managed by internal fixation was evaluated for their functional outcome. The patients were assigned into two groups; those treated with locking plate and another being the Non locking group. The injured patients were initially stabilized haemodynamically in Emergency room and concomitant injuries ruled out. Patients radiography of the limb with full length

anteroposterior (AP) & Lateral views taken and fracture pattern assessed initially. A 3D reconstruction CT section of the fracture is taken and fractures were classified as per schatzker classification. Doppler study of the limb is done in high velocity suspected cases to rule out vascular compromise. Depending on severity either a long leg slab or lower tibial skeletal traction is applied followed by a course of antibiotics. The appearance of bleb sign or skin wrinkling/reduction of swelling is taken as an indication for surgery. The surgeries were performed under fluoroscopic control under anesthesia. The fracture patterns dictated the operative approach. The proximal end of tibia has an intense area composed of cancellous bone which having a great lineage towards axial deviation and bending by compressive or shearing forces hence buttress plates were used. The types of plates used were either a T shaped, L shaped, Hockey stick plate or locking compression plates in bicondylar fractures which were due to high velocity injury and was severely comminuted and in osteoporotic fractures. To aid the reduction of inter fragmentary screws were used according to fracture pattern. The approach was either an anterolateral or posteromedial or posterior or medial approach. MIPPO was done in few cases depending on the fracture pattern, comminution or articular step.

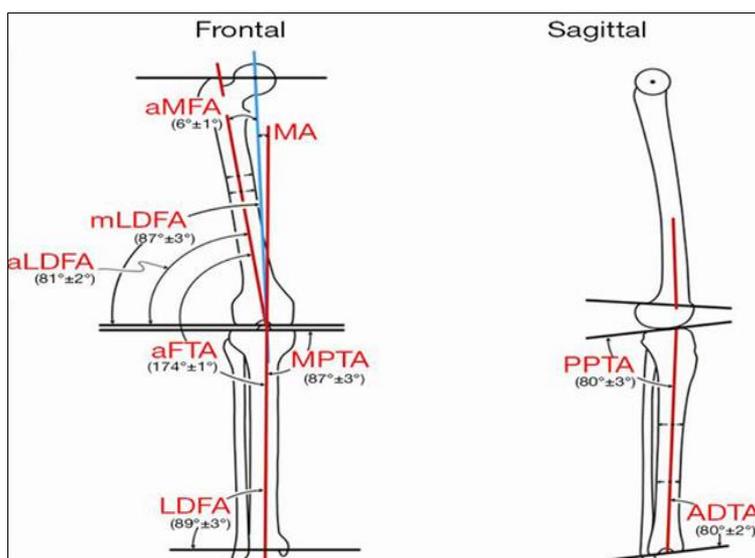
Inclusion criteria

- Age group between 18 to 60yrs
- Irrespective of sex and socio economic condition
- Tibial plateau with intra articular extension
- Tibial plateau fracture with any lower limb injury

Exclusion criteria

- Age group below 18 yrs and above 60 yrs
- knee fracture dislocation
- Associated Neurovascular injury
- Previous history of fracture around knee joint

Data from the OP records and old serial x-rays which were taken routinely at 2 weeks, 6 weeks, 12 weeks and 6 months were used to assess the radiological outcome assessment. Postoperative radiographic assessment for assessing the adequacy of articular reduction, metaphyseal-diaphyseal reduction, and alignment are taken. Wound inspected on 2nd, 4th and 6th post-operative day. Patients usually discharged on 9th post-operative day, prolonged hospital stay if any was associated with patients general condition, associated injuries, wound condition or other comorbidities were also looked upon. Suture removed after 15 days. Patients were taught quadriceps exercise and gentle rom advised from 3 weeks while maintaining non weight bearing. Full weight bearing is started after assessment clinically and radiologically after signs of healing. Patients are followed up in OPD at 2 weeks, 4 weeks, 6 weeks and 12 weeks and at end of 1 year, then at 2nd year follow up was done, where radiographs are taken and assessed clinically using according to Modified Rasmussen's Score. Radiological signs of union, alignment and joint congruity. Details such as infection or deformity along with implant failure or loss of reduction are noted. The Anteroposterior (AP) and lateral xrays of the limb was used for assessment of the articular congruity, the metaphyseal-diaphyseal alignment or early arthritic changes. Patient's functional outcome was also assessed at each follow-up]. The results were analysed according to the Oxford knee score criteria. The scores were graded as poor (<60), fair (60-69), good (70-79), and excellent (80-100). The radiological outcomes were determined by Modified Rasmussen Assessment criteria. Scores were graded as Excellent (28-30), Good (24-27), Fair (20-23), Poor (<20). The radiological signs for callus formation or healing, maintenance of reduction, any widening or depression of articular surfaces along with varus and valgus collapse were noted. Bony union was defined as union of at least 3 cortices in AP and Lateral views on follow-up radiographs. Nonunion was defined as absence of any signs of union at 6 months after surgery.



Alignment of the proximal tibia was determined by measuring the tibial plateau angle (the medial angle between the tangential line and anatomic axial of the tibia) on anteroposterior radiographs and the posterior slope angle (the angle between the tangential line of medial plateau and the perpendicular line of the anterior tibial cortex) on lateral radiographs; tibial plateau angle 90° or 80° or posterior slope

angle 15° or -5° was considered as malalignment. Any particular step off of 2 mm was defined as Malreduction. Secondary loss of reduction was defined as an increase of 2mm of intra-articular step-off, and secondary loss of alignment was defined as an increase of 3° malalignment when compared with the first postoperative radiograph.

Modified Rasmussen Criteria for Radiological Assessment

Criteria	Points
Articular Depression	
None	3
<5 mm	2
6-10	1
>10 mm	0
Condylar Widening	
None	3
<5 mm	2
6.10 nun	1
>10 mm	0
Varus/Valgus Angulation	
None	3
>10 ⁰	2
10 ⁰ - 20	1
>20*	0
Osteoarthritis	
None/no progression	1
Progression by 1 grade	0
Progression by >1 grade	
Maximum Score	
Excellent	9-10
Good	7.8
Fair	5-6
Poor	<5

Grade	Lack of extension (degrees)	Range of movement (degrees)	Varus or valgus instability (degrees)	Walking distance (meters)	Pain
Excellent (all of the following)	0	≥120	<5	≥3000	None
Good (not more than one of the following)	>0	<90	>5	<1000	Mild on activity
Fair (not more than two of the following)	≥10	<75	>5	<100	Moderate on activity or intermittent at rest
Poor (all results worse than fair)					

Functional Grading

Grading for the Oxford Knee Score	
Score 0 to 19	May indicate severe knee arthritis. It is highly likely that you may well require some form of surgical intervention, contact your family physician for a consult with an Orthopaedic Surgeon.
Score 20 to 29	May indicate moderate to severe knee arthritis. See your family physician for an assessment and x-ray. Consider a consult with an Orthopaedic Surgeon.
Score 30 to 39	May indicate mild to moderate knee arthritis. Consider seeing your family physician for an assessment and possible x-ray. You may benefit from non-surgical treatment, such as exercise, weight loss, and /or anti-inflammatory medication
Score 40 to 48	May indicate satisfactory joint function. May not require any formal treatment.



Pain severity was assessed using a Wong-Baker Faces pain rating scale.

Results

The study consisted of 30 patients of which 26 males and 4 females were selected based on the criteria. 15 patients were allocated for study from locking group & Non locking group respectively. There was right side limb predominance in our study. The youngest patient was 19 yrs and oldest being 57yrs. 9 patients underwent dual plating with anterolateral and posteromedial approach. The predominant cause of trauma was road traffic accident (90%), 16 cases were open fractures (I & II). Schatzker classification of fractures showed 2 cases of type I, 16 cases of type II, 4 cases of type III, 3 cases of type IV and 5 cases of type V and 4 cases of type VI

Schatzker classification of fractures showed

Type of fracture	Non locking	Locking
Type 1	2(13%)	0
Type 2	7(46.6%)	8(53.3%)
Type 3	2(13.3%)	2(13.3%)
Type 4	1(6.6%)	1(6.6%)
Type 5	2(13%)	1(6.6%)
Type 6	1(6.6%)	3(20%)

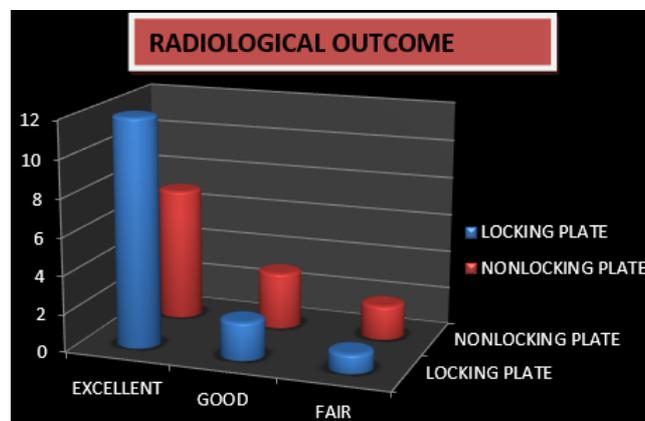
16 patients had associated injuries sustained during trauma which could have directly or indirectly influenced the functional outcome of the patients. Preference to MIPPO was given in deciding the surgical method of fixation with reference to fracture pattern or condition of soft tissue. 6 patients underwent MIPPO and 24 underwent open reduction for fracture fixation. 22 patients were operated within first week of trauma. 8 patients had associated comorbidities and soft tissue injury which required time to heal. The duration of hospital stay is not determined by type of surgical method used but decided by the patient’s general condition, associated injury, wound condition and other comorbidity if any. 60% fractures united between 16-24 weeks. Average time of union was 16 weeks. There was no delay in union time with open fractures, which was independent of the type of surgical procedure or implant used. There was no non unions noted. Follow up range was 10-24 months, average being 17.4. The intraoperative radiograph of all patients were confirmed by c arm and radiography and was found to be satisfactorily anatomic. Bone graft was used in bone defects in 10 cases (5 locking plate & 5 non locking plate). The follow up showed a step off of more than 2 mm in 2 cases of locking plates and in 6 cases of non-locking plates, articular widening of significance more than 2mm was noted in 9 cases 3 case of locking plates & 6 case of non-locking plates). In our study “The Pain severity “was significantly lower in locking plate group when compared to non-locking group which was at par with current literature.

Malalignment was noted in 3 cases in locking group and 6 cases in non-locking group in terms of MPTA, 7 cases were malaligned with reference to PPTA, 2 cases from locking group and 5 cases from non-locking group. Our observation of knee scores were better for locking plate group as compared with non-locking plate.

The locking plate group was better as for results obtained; Out of 10 (66.6%) patients had range of 100- 130 degrees of flexion, 3(20%) had a range of 90-100 degrees and in 2 (13.3%) patient had a flexion range between 90- 80 degrees 13 patients (86.6%) had excellent and 2 patients (13.3%) had good objective knee society score in locking group as compared to 8 (53.3%) and 7(46.6%) respectively.

11 patients (73.3%) had excellent, 4 patients (26.6%) had well and 1 patient (6.6%) had a fair functional knee society score

in locking group. In non-locking group 8 patients (53.3%) had excellent, 3 patients (20%) had good and 4 patient (26.6%) had a fair functional knee society score 12 patients (80%) had excellent, 2 patients (13.3%) had good and 1 patients (6.6%) had fair radiological outcome in locking group. 8 patients (53.3%) had excellent, 3 patients (20%) had good and 4 patients (26.6%) had fair radiological outcome in non-locking group



Radiological Outcome

The functional outcome using Oxford knee score was 12 cases had scored between 40 and 48, 2 cases had scored between 30 and 39, 1 case had scored between 20 and 29 in locking group. 7 scored between 40 and 48, 3 cases between 30 and 39, 5 cases had scored between 20 and 29 in non-locking group.

The functional outcome using Oxford knee score

Functional Outcome	Locking Plate	Non-locking Plate
40-48	12	7
30-39	2	3
20-29	1	5

Superficial wound infection was seen in 4 (13.3%) patients and was treated with oral antibiotics. No wound dehiscence seen. One patient who had deep wound infection opted for implant removal after one year of surgery though there was no sign of infection at that time.

Discussion

Fractures of the tibial plateau are majority due RTA or high velocity trauma, fall from height or sometimes due trivial trauma in osteoporotic bones, rarely pathological fractures. They account for about 1.2% of all fractures. These intra articular fractures are quiet challenging especially in high velocity injuries where comminution and bone loss along with injury to soft tissues or loss of soft tissue makes it more complex. The mode of injury and its presentation can affect the quality of life and significant morbidity. The choice of the implant or approach are not always definitive in outcome, which rely solely on maintaining the articular congruity or reduction. The respect for soft tissues during surgery is to be the hallmark in all these cases since they are already harmed by initial injury. The need for biological fixation based on the foundation of preserving blood supply and a traumatic surgical techniques has proved to improve healing and bone union rates. Aim of study is to evaluate functional outcome in operatively treated tibial plateau fractures in 30 cases which were included based on criteria set. The study focused on mode of injury, sex and age distribution and side and type of

injury sustained along with complications and the functional outcome evaluated in them. Younger age group patients sustained injury due to RTA or high velocity injury. The second category being fall from height or stairs or being hit by vehicle while crossing the road.

In our study, the indications for the surgery were Condylar widening of >5mm, Lateral condyle step off >3mm, All medial condylar fractures requiring surgical fixation.

The development of locking implants has allowed the use of minimally invasive technique for unilateral plating^[11-12] with improvement in handling the soft tissue^[11-12]. In our study 6 patients underwent MIPPO technique.

In his study Lee *et al.*^[20] of 35 cases described that there were no loss of reduction, nonunion, and infection developing in only two. Krupp *et al.* compared the outcomes of open reduction and locked plating versus fine-wire external fixation of 58 cases of bicondylar tibial plateau fractures and found that locked plating was associated with a decrease in the time to union and in incidence of articular malunion, the overall complications and knee stiffness was showed to be minimal.

Biggi *et al.* study regarding use of MIPPO with locking plates proved to show good clinical outcome in terms of fracture healing and wound healing and union rates. Outcome. Little child *et al.* observed that no definite advantage was associated with the use of locked plating for high-energy tibial plateau fractures.

The study by Mohammad Ali Tahririan *et al.* showed superiority of locking plate to non-locking plate methods with regard to knee scores and VAS pain scores indicating more improvement in knee functional score and minimizing postoperative pain using the locking plate method. Chang-Wug Oh *et al.* in their study on double plating of (twenty three) type V and type VI proximal tibial fractures using minimally invasive percutaneous osteosynthesis found Eighteen patients with excellent, three patients with good and two patients with fair results. In our study, 7 patients belonged to type V & VI fractures; 4 patients had better result

In their study of ten patients Kye-Youl Cho *et al.*, used a single midline longitudinal incision and dual plating for the treatment of type V and type VI schatzker fractures and the mean range of motion was 125 degrees. They had only one case with delayed wound healing as postoperative complication. But the functional outcome was not significantly altered when compared with others. Dual plate gives better biomechanical strength and rigid construct thereby better control of both columns thus avoiding late collapse. There were no major wound problems in any of these studies.

Though there exist no advantage in using locking plate in high velocity injury as described by Little child *et al.* in his study, internal fixation with locking plates and using MIPPO techniques have proved to give good results.

An anatomical reduction and rigid fixation of both medial and lateral columns is of prime importance for stability of complex bicondylar fractures of tibia. Maintenance of articular congruity should be the goal. The elevation of the fragments, raft screws and bone grafting techniques are all techniques proved for good reduction and outcome. Dual plating with minimal invasive technique has proved to provide a good stability by acting as buttress plate of both columns with low rate of reported complications. Steven N., *et al.* reported wound dehiscence and infection in proximal Tibial fractures treated with double plate fixation.⁽³³⁾ In our study superficial wound infection was seen in 4 (13.3%) patients and was treated with oral antibiotics. No wound

dehiscence seen. One patient who had deep wound infection opted for implant removal after one year of surgery though there was no sign of infection at that time. The apprehension being faced is with the small sample size being employed; similar studies had proved superiority of locking plates with smaller sample sizes as observed in current literature. The present study has shown better results with locking plates in terms of knee scores, radiological outcomes and post-operative pain which was at par with current literature.

Conclusion

The management of complex tibial plateau fractures is an ever remaining challenge. Choice of the procedure/implant should be based on the fracture pattern, bone quality and intraoperative fracture reduction. The development of locking implants and biological fixation with minimally invasive technique and proper handling the soft tissues influences the final outcome. Our results in minimally invasive percutaneous plate osteosynthesis (MIPPO) technique is in par with the literature. The present study has shown excellent results in terms of knee score, post-operative pain and better knee functional score with locking plates. Our conclusion regarding functional outcome being decided by nature of trauma, bone quality, degree of comminution and bone loss, type of fracture, vascularity of the limb, whether open or closed fracture and soft tissue status, comorbidities and associated injuries also play a vital part in final outcome.

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