International Journal of Research in Orthopaedics
Arumugam S et al. Int J Res Orthop. 2017 Nov;3(6):1205-1210
http://www.ijoro.org

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20174715

Original Research Article

To analyze the functional outcome of proximal tibial fractures treated with minimally invasive percutaneous plate osteosynthesis technique

Sivakumar Arumugam[1]*, Venkateshwara Arumugam[2], V. Raviraman[1]

[1]Department of Orthopaedics, Velammal Institute of Medical Sciences, Madurai, Tamil Nadu, India
[2]Meenakshi Medical College and Research Institute, Kanchipuram, Tamil Nadu, India

Received: 02 September 2017
Revised: 28 September 2017
Accepted: 29 September 2017

***Correspondence:**
Dr. Sivakumar Arumugam,
E-mail: dr_sivakumar_a@yahoo.co.in

ABSTRACT

Background: Tibial plateau fractures constitute about 1% of all fractures and complex bicondylar fractures constitute 30% of all Tibial plateau fractures. Minimally Invasive Percutaneous Plate Osteosynthesis [MIPPO] is a method of biological fixation in which a plate is percutaneously inserted and fixed at a distance proximally and distally from the fracture site. By minimal exposure, this helps in the preservation of the essential fracture hematoma, minimal soft tissue dissection, avoidance of periosteal stripping and providing an adequate fixation. The objective of the study was to analyze the functional outcome of proximal Tibial fractures treated with MIPPO technique. The method of fixation shall be evaluated for the time period required for the patients to return to active work following surgery.
Methods: In our study, all 18 patients with proximal Tibial fractures underwent definitive fixation by MIPPO technique. All our cases underwent initial stabilization as per the ATLS guidelines. Patients with closed Tibial plateau fractures associated with a tense haemarthrosis underwent aspiration of the joint under aseptic precautions. The limb was immobilized either in an above knee slab or through skeletal traction using a distal Tibial or calcaneal pin traction on a Bohler Braun splint until definitive fixation was carried out. In cases complicated with excessive swelling and blistering, definitive fixation was delayed until the swelling/ blistering subsided.
Results: The post-operative results were designated as excellent, good, fair and poor according to pain, walking capacity, the range of motion and stability of the knee using Rasmussen's grading system. In our study, the average functional knee score was 22.89. Rasmussen's score does not consider articular congruity while assessing the functional outcome of the knee.
Conclusions: MIPPO technique gives good to excellent results even in high energy Tibial condyle fractures [72.22% cases in our study]. Our patients were able to achieve a good functional range of movement, averaging 120 degrees. [Krettek et al – 124 degrees]. Those who were treated with early fixation and early mobilization were found to have a better functional outcome irrespective of the fracture type. No secondary bone grafting was required.

Keywords: Tibial plateau fractures, MIPPO technique, Rasmussen's grading system, Closed interlocking intramedullary nail fixation

INTRODUCTION

Tibial plateau fractures constitute about 1% of all fractures and complex bicondylar fractures constitute 30% of all Tibial plateau fractures. Seventy-five years ago, fractures of the proximal tibia were described as "bumper fractures" because they resulted from low energy pedestrian versus car fender accidents.[1] Presently, the majority of such fractures are secondary to high-velocity injuries like high-speed motor vehicle accidents

or falls from heights. Due to this increase in the velocity of the injuring mechanism, we are faced with more number of complex Tibial condyle fractures. Tibial plateau fractures result from direct axial compression, usually associated with a valgus [more common] or varus [less common] component, and an indirect shearing force.[2] The anterior aspect of the femoral condyle is wedge shaped; with the knee in full extension, the force generated by the injury drives the femoral condyle into the Tibial plateau.[3] The direction, magnitude and location of the force, the position of the knee at the time of impact, and the quality of the bone determine the fracture pattern. The complex Tibial plateau fractures resulting from direct forces due to high-velocity injuries are classically described as "explosion or shattered" fractures. These fractures pose an inherent difficulty in treatment due to the extent of soft tissue damage, fracture comminution, instability, displacement of articular fragments and increased risk of compartment syndrome.[4] Closed management of these complex fractures with cast bracing and traction generally has been ineffective in reducing and maintaining the congruency of the articular surface and axial alignment leading to mal-union and secondary degenerative arthritis. Though anatomical reduction is possible with conventional methods of treatment such as open reduction and internal fixation, this procedure has been associated with a large number of soft tissue problems and fixation failure.[5] This invariably leads to compromise of the overlying soft tissue envelope and results in soft tissue necrosis and deep wound infections.[6] To avoid such disastrous complications and maintain adequate bony reduction, the concept of Biological Fixation was developed. The objective of Biological fixation is to assist the physiological process of bone healing wisely and optimally with a minimal amount of operative intervention. The various methods of Biological Fixation are,

1. Ilizarov external ring fixator
2. Hybrid external fixation.
3. Limited internal fixation with external stabilization.
4. Closed interlocking intramedullary nail fixation.
5. Minimally invasive percutaneous plate osteosynthesis.

Minimally invasive percutaneous plate osteosynthesis [MIPPO] is a method of biological fixation in which a plate is percutaneously inserted and fixed at a distance proximally and distally from the fracture site. By minimal exposure, this helps in the preservation of the essential fracture hematoma, minimal soft tissue dissection, avoidance of periosteal stripping and providing an adequate fixation.[7,8]

METHODS

This is a prospective study comprising of 18 patients with Tibial condyle fractures who were treated by MIPPO at Velammal Institute of Medical Sciences, Madurai during the period of May 2014 to December 2015. These patients were reviewed periodically both clinically and radiologically for a minimum of 6 months following operative fixation.

Inclusion criteria

Inclusion criteria were patients in the age group of 16-70 years; all cases of closed proximal Tibial fractures [both intra-articular and extra-articular].

Exclusion criteria

Exclusion criteria were open / contaminated Tibial condyle fractures; Schatzker's type I fractures [treated by percutaneous screw fixation]; Schatzker's type III fractures [treated by elevation and bone grafting]; patients presenting with complications such as compartment syndrome and vascular injury; inoperability in certain cases, due to multiple comorbid factors / systemic disease.

Operative technique

The surgery was performed with the patient under general anesthesia or spinal/epidural anesthesia. The patient was placed supine on a radiolucent fracture table with the affected extremity in longitudinal traction. A pneumatic tourniquet cuff with adequate padding was applied to the proximal thigh. The limb was thoroughly scrubbed primarily with betadine or chlorhexidine scrub solution, painted and draped. The operative site and exposed portion were covered with a sterile towel and the limb exanguinated with a sterile Esmarchs bandage and the tourniquet inflated, after which the operative site was painted with betadine and then with surgical spirit. With the help of an image, intensifier closed reduction was achieved by ligamentotaxis using longitudinal traction. In certain cases, percutaneous k-wires were introduced to aid in fracture alignment. A proximal tibial locking plate or a T – Buttress / L – Buttress locking plate of suitable length was taken. An incision was made as large as necessary either medially or laterally, to help insert the plate, which is carefully slid in the sub muscular plane, extraperiosteally. Utmost care was taken in handling soft tissue with as minimal dissection and judicious use of retractors as possible. Normal valgus and rotational alignment was checked. Cancellous and cortical screws were appropriately used to secure the plate adequately proximally and distally. These were introduced percutaneously through small stab incisions centered over the plate holes. A thorough wash with saline and betadine was given, a suction drain placed and the wounds closed. A sterile dressing was applied and the tourniquet deflated. Primary bone grafting was not done in any of the cases in this study.[9,10]

RESULTS

Total number of patients was 18. Mode of injury was Road traffic accident was 12 patients and accidental fall

was 6 patients. The patients were in the age group of 30 to 57 years. The average age is 42.22 years. There were 16 male patients and 2 female patients as shown in the graph below. There was a marginal predilection to the Right side as shown in the graph below. In our study 10 patients were operated within a week from injury, 4 patients between 1-2 weeks, 3 patients between 2-3 weeks and 1 patient after 3 weeks. The most common reason for the surgical delay was abrasions at or close to the operative site. Some of the patients presented late after taking initial treatment elsewhere. All our patients were followed up periodically with a minimum follow up duration of 3 months and a maximum follows up duration of 12 months. One patient is still on follow up due to poor range of motion.

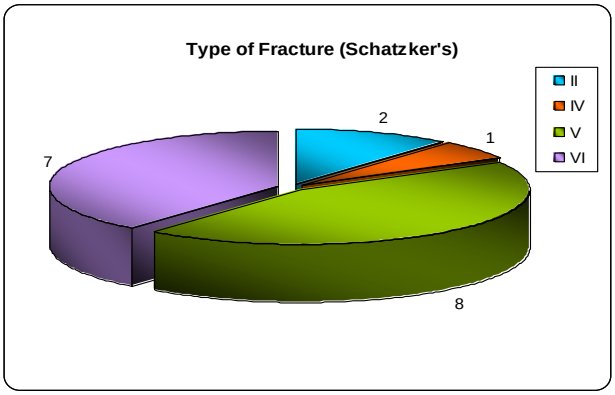

Figure 1: Schatzkers classification among patients (N=18).

1.Type II: 2 patients; 2.Type IV: 1 patient; 3.Type V: 8 patients; 4.Type VI : 7 patients.

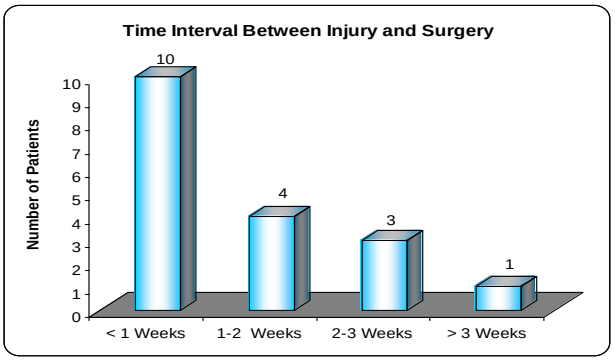

Figure 2: The time interval between injury and surgery.

In our study 10 patients were operated within a week from injury, 4 patients between 1-2 weeks, 3 patients between 2-3 weeks and 1 patient after 3 weeks. The most common reason for the surgical delay was abrasions at or close to the operative site. Some of the patients presented late after taking initial treatment elsewhere.

Nine of our patients had other associated injuries at the time of initial presentation. The most common associated injury was distal radius fractures in five patients. The other associated injuries were fracture shaft of the femur, calcaneal fracture, ACL injury, head injury and bimalleolar fracture. Some of these nine patients had more than one associated injuries. All the associated injuries were treated except ACL injuries. The fractured calcaneum was treated conservatively.

Table 1: The associated injuries among patients (N=18).

Associated injuries	No. of cases
Distal radius fracture	5
Fracture shaft of femur	1
ACL injury	4
Calcaneal fracture	1
Bimalleolar fracture	1
Head injury	1

In our study comprising of 18 patients, 9 patients [50%] had excellent results, 4 patients [22.22%] had good results, 3 patients [16.67%] had fair result and 2 patients [11.11%] had poor result as shown in the graph below.

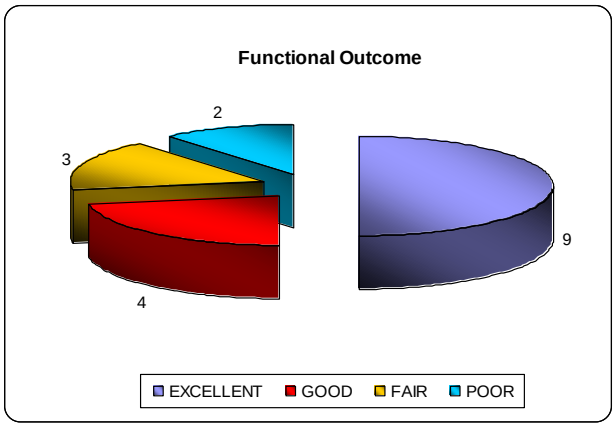

Figure 3: The functional outcome after surgery (N=18).

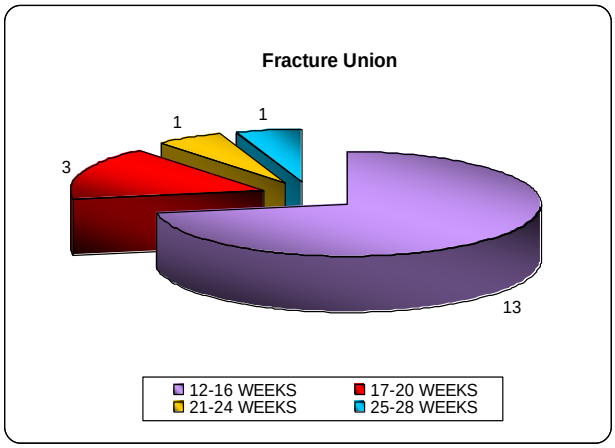

Figure 4: Fracture union.

All fractures in this study healed without requiring any additional procedures such as bone grafting. The average time taken for fracture healing was 16.67 weeks [Krettek et al – 16 weeks]. 1.12-16 weeks: 13 patients.2.17-20 Weeks: 3. 3 patients. 21-24 Weeks: 1 patient.4.25-28 Weeks: 1 patient (Figure 4).

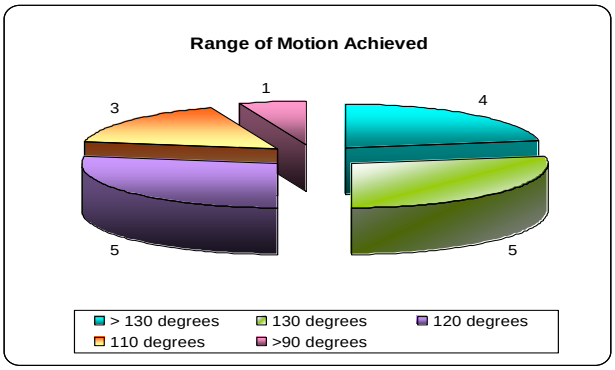

Figure 5: Range of motion.

The average range of movement achieved was 120 degrees. 4 patients achieved slightly more than 130 degrees of flexion, 5 achieved almost 130 degrees, 5 achieved almost 120 degrees, 3 achieved approximately 110 degrees and only 1 patient had movement less than 90 degrees of flexion delayed as there were the rative site.

Table 2: The postoperative complications.

Type of complication	No. of patients
Superficial infection	1
Knee stiffness	5
Delayed union	2
Shortening	2

The various complications encountered in our study as listed in the table below. Some patients had more than one complication.

X-ray interpretation of patients after surgery and regular follow up

Changes observed in x-ray after surgery technique

The postoperative results were designated as excellent, good, fair and poor according to pain, walking capacity, the range of motion and stability of the knee using Rasmussen's grading system. In our study, the average functional knee score was 22.89. Rasmussen's score does not consider articular congruity while assessing the functional outcome of the knee. The average range of movement achieved was 120 degrees. 4 patients achieved slightly more than 130 degrees of flexion, 5 achieved almost 130 degrees, 5 achieved almost 120 degrees, 3 achieved approximately 110 degrees and only 1 patient had movement less than 90 degrees of flexion. The patient with less than 90 degrees of flexion had an ipsilateral fracture shaft of femur, surgery was also delayed as there were abrasions over the operative site.[11,12]

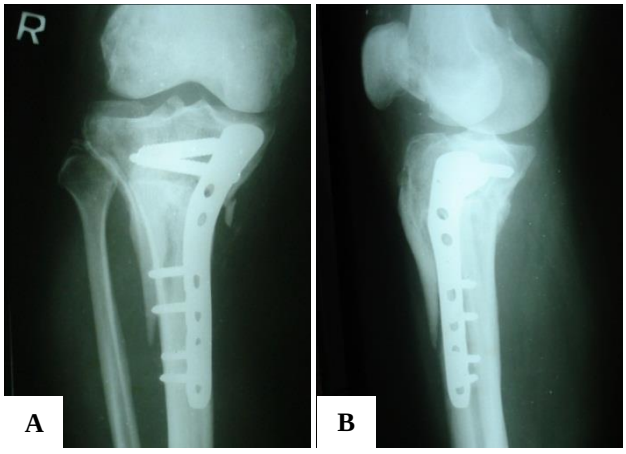

Figure 6: A: Post op X- ray AP view -1, B: Post op X-ray lateral view -2.

DISCUSSION

Tibial condyle fractures especially those due to high energy mechanisms [Schatzker type IV, V] and those separating the Tibial metaphysis from the diaphysis [Schatzker type VI] are inherently unstable injuries associated with fracture comminution, displacement, severe soft tissue injury and a higher incidence of complications.[13] Closed treatment of these complex fractures has resulted in a high percentage of unsatisfactory results [up to 70%] as seen in long term follow up in other studies.[14] The most widely used method for treatment of displaced Tibial plateau fractures has been open reduction and internal fixation.[15] The main focus on this modality was the restoration of the articular surface to as near anatomical position as possible and to maintain the reduction while early knee joint mobilization is commenced. This rigid fixation is, however, possible only after extensive soft tissue dissection.[16] Due to the association of soft tissue injuries with these fractures, additional soft tissue stripping involved in open reduction and internal fixation often render bony fragments avascular and also significantly increase the chance of infection.[17] Moore et al in his series reported a 23% incidence of infection after ORIF in these complex fractures. Mallik et al encountered 4 of his 5 cases being infected after ORIF for such fractures. Barrak reported of deep infection in seven of eight fractures that were treated with a medial plate.[18] To limit the extent of soft tissue damage in addition to the soft tissue damage associated with these complex fractures, minimally invasive biological fixation procedures have evolved over the last couple of decades. Among these procedures, minimally invasive percutaneous plate osteosynthesis potentially has become a good option in the treatment of these complex fractures.[19] In our study comprising 18 patients treated by MIPPO, we had

72.22% of excellent and good results in the functional outcome. These results were attributed to patients who underwent early surgery and early mobilization. In our study, patients who were treated and mobilized earlier had a better functional outcome irrespective of the fracture type as shown in the graph below.[20] Delay in surgery was mainly due to the presence of abrasions over the operative site; hence surgery was performed only after the abrasions healed. We, fortunately, encountered only a single case of infection in our study [5.56%].[21] This patient developed serosanguinous soakage of the dressing on the 8th post-operative day, this was treated with an aggressive approach in the form of wound debridement, a thorough wash, and resuturing without disturbing the implant. Krettek et al reported one case of infection for which he did a wound debridement and resuturing and leaving the implant in situ. We encountered knee stiffness in five of our patients. One of these patients had a head injury, an ipsilateral fracture shaft of femur and abrasions over the operative site and was hence immobilized for a longer period of time prior to and post-surgery.[22] This prolonged immobilization and delay in surgery were probably contributory to the development of knee stiffness. Of the other four, one presented to us ten days after the injury has taken treatment elsewhere in the form of plaster cast application. The remaining three patients were highly uncooperative to the initial range of motion exercises. Patients with terminal 10 degrees restriction of movement on comparison to the normal side were not considered to have stiffness.[23] Krettek et al had no complications of knee stiffness probably due to the short time interval between injury and surgery. We encountered two cases of delayed union in our study. These cases, however, went into the union without the necessity for any subsequent procedure such as bone grafting. There was no incidence of nonunion in our study.[24] Borrelli et al reported preservation of extraosseous blood supply and decreased the risk of nonunion. In the study conducted by Krettek et al, no cases of delayed or nonunion were reported.[25]

CONCLUSION

Those who were treated with early fixation and early mobilization were found to have a better functional outcome irrespective of the fracture type. No secondary bone grafting was required. The average time taken for fracture healing was 16.67 weeks [Krettek et al – 16 weeks. Although our study comprises only a small group of patients, we can confidently say that MIPPO technique is an effective method of treating proximal tibial fractures due to its overall good functional outcome.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Dendrinos GK, Kontos S, Katsenis D Dallas K; Treatment of high energy tibial plateau fractures by Ilizarov external fixator. J Bone Joint Surg. 1996;78B:710-71.
2. Kennedy JC Bailey WH: Experimental tibial plateau fractures. J Bone Joint Surg. 1968;50:1522.
3. Honkonen SE. Degenerative arthritis after tibial plateau fractures. J Orthop Trauma. 1995;9:273-7.
4. Moore TM, Patzakis MJ, Harvey JP. Tibial plateau fractures: definition, demographics, treatment rationale and long term results of closed traction management or operative reduction. J Orthop Trauma. 1987;2:97-117.
5. William S, J Mills, Sean E Nork: Open reduction and internal fixation of high energy tibial plateau fractures. Orthop clinic. North America. 2002;33:177-98.
6. Young MJ, Barrack RL. Complications of internal fixation of tibial plateau fractures. Orthop Rev. 1994;23:149-54.
7. Brunner CF, Weber BG. Special techniques in internal fixation. Berlin: Springer – Verlag, 1982
8. Gerber C, Mast JW, Ganz R. Biological internal fixation of fractures. Arch Orthop Trauma Surg. 1991;109(6):295-303.
9. Koval KJ, Sanders R, Borrelli J, Helfet D, DiPasquale T, Mast JW. Indirect reduction and Percutaneous screw fixation of displaced tibial plateau fractures. J Orthop Trauma. 1992;63(3):340-6.
10. Mast J, Jakob R, Ganz R. Planning and reduction technique in fracture surgery. Berlin; Springer-Verlag; 1989: 254.
11. Perren SM. The concept of biological plating using the limited contact DCP. Injury 1991;22(1):s1-s41.
12. Weber BG, Cech O. Pseudoarthrosis: Pathology, Biomechanics, Therapy, Results. Berne, Switzerland: Hans Huber Medical Publisher; 1976: 323.
13. Rockwood CA. Rockwood and Green's – Textbook of fractures in adults. Volume 1. 5th edition. 2001: 191.
14. Apley AG. Fractures of the lateral tibial condyle treated by skeletal traction and early mobilization. A review of 60 cases with special reference to long term results. J Bone Joint Surg. 1956;38B:699.
15. Shelton WR, Sage FP. Modified Nicoll graft. Treatment of gap nonunion in the upper extremity. J Bone Joint Surg. 1981;63(2):226-31.
16. Barrington T, Dewar F. Tibial plateau fractures. Can J Surg. 1965;8:146.
17. Anger R. Critical intraarticular fractures of the proximal tibia. Rev Chir Orthop. 1968;54:259.
18. Rasmussen P. Tibial condyle fractures, impairment of knee joint stability as an indicator of surgical treatment. J Bone Joint Surg. 1973;55A:1331-50.

19. Burn C, Bartzka G, Coldeway J, Muggler E. Fractures of the tibial plateau. Clin Orthop. 1979;138:84.
20. De Coster TA, Nepola JV: Cast brace treatment proximal tibial plateau fractures. Ten years follow up study. Clin Orthop. 1988;231:196-204.
21. Sarmiento A, Kingman KB, Latta LL. fractures of the proximal tibia and tibial condyle. A clinical and laboratory comparative study. Clin Orthop. 1979;145:136-49.
22. Schatzker J, MC Broom R, Bruce D. Tibial plateau fractures: the Toronto experience 1968-1975, Clin Orthop. 1979;138:94-104.
23. Brunner CF, Weber BG. Besondere Osteosynthesetechniken. Berlin Heidelberg. New York Springer; 1981.
24. Weber BG, Blatter. Wave plate Osteosynthesis as a salvage procedure. Acta Chir Orthop Traumatol Cech. 1993:60(5):273-7.
25. Muller ME, Allgower M, Schneider R, Willengger H. Manual of internal fixation technique recommended by AO ASIF group Ed3, Berlin 1990, Springer Verlag; 1991: 2,229-231,738-739.

Cite this article as: Arumugam S, Arumugam V, Raviraman V. To analyze the functional outcome of proximal tibial fractures treated with minimally invasive percutaneous plate osteosynthesis technique. Int J Res Orthop 2017;3:1205-10.