



## A Study on Functional Outcome of Minimal Invasive Fracture Fixation Using Locking Compression Plate for Tibial Plateau Fractures

### KEYWORDS

Tibial plateau, Minimal invasive, Percutaneous plating, Bone grafting.

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**ABSTRACT** *The aim of the study was to find out the functional outcome of proximal tibial fractures treated with locking compression plate by minimal invasive percutaneous technique. All Patients admitted to the hospital with proximal tibial fractures were included in the study. The Demographic data, type of fractures (Schatzker classification), treatment given, pain score, Functional outcome as knee range of movements during discharge and follow-up upto 1 year were done and results were graded according to Rassmussen's functional grading system. The present study involved 20 patients of proximal tibial fractures, treated with the locking compression plate by minimal invasive technique (MIPO). Mostly the age groups of patients were between 41 – 60 years (60%) and Mean age group was 45.7 years. Majority of the patients had right sided injury and mode of injury was RTA in all cases. In our study majority 30% of the patients had Schatzker - Type II fracture followed by 25% Schatzker - Type IV fractures. All the patients were given Epidural Anaesthesia during surgery and 35% of the patients had undergone additional procedure along with MIPO in which Bone grafting was the common procedure (20%) done. Considering the functional outcome of our technique, majority 35% of patients had 0 – 90° flexion Range of Movements during Discharge, 90% of them had good relief of pain by 12 weeks & 90% of them had full range of movements by 6 months. Two patients had extensor lag of about 10° which improved on physiotherapy by 3 months. Minimally invasive percutaneous plating can provide favourable results in the treatment of proximal tibial fractures. Minimal invasive surgery that minimizes soft tissue trauma is the key to good patient outcome.*

### Introduction

Incidence of fractures of the long bones of the body are increasing regularly and similarly the treatment options for the same are also being modified continuously. The recent evolution in reduction and internal fixation of fractures is based on an improved understanding of biology of the bone, the biomechanics of fracture fixation and fracture healing and the analysis of previous failures.<sup>1</sup> It has been well established both clinically and experimentally that the cortex beneath a rigid plate weakens because of stress shielding, becoming thin, atrophic and almost cancellous in character. Moreover if soft tissue stripping has been extensive, avascular necrosis and revascularization may further weaken the cortex. This has lead to increased rates of re-fractures after plate removal.

To overcome these difficulties the recently developed locking compression plate (which combines the principles of compression plating and locked internal fixation methods into one system) is gaining popularity. This technology also supports the currently called 'minimally invasive percutaneous plating osteosynthesis' (MIPPO)<sup>2</sup>. Improvement in implant designs play an important role in avoiding possible complications and in achieving the primary goals of operative fracture treatment, i.e. restoration of overall function of the extremity involved and recovery of the biological and mechanical integrity of the osseous tissue, with return of prefracture tissue vitality and structure as well as prefracture stiffness and strength of injured bone segment<sup>1</sup>.

During the late 1950s and 1960s, the AO/ASIF group advocated the principles of open reduction and internal fixation to overcome the limitations encountered when treating fractures with skeletal traction or other closed methods<sup>3</sup>. Open anatomic reductions, however, may require extensive exposure and can result in the devitaliza-

tion of surrounding tissues, and the evacuation of osteogenic fracture hematoma<sup>4</sup>. Although most fractures heal without complications, these techniques can produce delayed unions or nonunions, necessitating a bone graft<sup>5,6</sup>. These dissections also can result in an increase in infections, wound breakdown, and stiffness of adjacent joints. To avoid these problems, methods of indirect reduction and percutaneous or minimally invasive plating have been developed. These techniques are designed to maximize the benefits of biologic fracture healing and minimize complications observed with other plating techniques.

During 1980's the AO/ASIF group started to work on new plate designs to minimize disadvantages of plating with respect to cortical perfusion. To overcome the negative effect of compression forces on the periosteum, a new generation of plates or internal fixators were created. The key to these internal fixators is the locking mechanism of the screw in the implant, which provides angular stability and technical detail ensures that compression forces on the bone surface are not necessary to gain stability of the bone-implant construct and also provides excellent holding force even in osteoporotic bone<sup>7</sup>. LCP is a new screw – plate system that offers the possibility of inserting conventional and locking head screws into specially designed combination holes. In a prospective multicentric study, the new system was used to treat 144 patients with 169 fractures. By this study it was concluded that the new system is technically mature. It offers numerous fixation possibilities and has proven its worth in complex fracture situations and in revision operation after failure of other implants<sup>8</sup>. In a prospective multicentric study, the new system i.e. Locking compression plates were used to treat the patients with fractures, involving all the long bones. After one year of clinical and radiological follow up, 86% of the fractures showed healing within expected period without any com-

plications or secondary dislocation<sup>9</sup>.

Various treatment modalities can be used for the treatment of proximal tibial fractures with or without intra-articular involvement. Conventional plate fixation offers the advantage that it can also be applied in cases of high proximal tibial fractures<sup>10</sup>. However, it often requires invasive exposure of the fracture zone, which may endanger the soft tissue<sup>11-14</sup>. To reduce the soft-tissue complications and deep infections, the circular or hybrid external fixator has proven efficient<sup>15-19</sup>. However, the problems of nonunion and pin-tract infections are common.

Intramedullary nailing is perhaps the most minimally invasive method, but this method reaches its limitations in the face of high proximal fractures. Because of the trumpet-shaped widening of the proximal intramedullary cavity, the intramedullary nail alone is not stable and often results in a higher rate of malalignment in proximal tibial shaft fractures<sup>20</sup>. Studies have reported recently that the length, alignment, and union of the fracture can be achieved without direct manipulation of the fracture fragments in indirect reduction and biological fixation using percutaneous plating<sup>21-23</sup>.

This technique is thought to cause no increase in the risk of infection or soft tissue damage and permits rapid mobilization of the limb and patient. When using this treatment for patients with significant bone loss, bone grafting should be considered. In this study, we reviewed clinical and radiologic results of percutaneous plating performed in 20 proximal tibial fractures.

#### Objectives:

- To findout the functional outcome of proximal tibial fractures treated with locking compression plate by minimal invasive percutaneous osteosynthesis technique (MIPO).

#### Materials and Methods

**Study Design** : Hospital based Prospective follow up study.

**Study Area** : CSI mission general hospital, Woraiyur, Trichy.

**Study Participants** : All Patients admitted to the hospital with proximal tibial fractures who are above 18 yrs age.

**Study Tool** : Pretested structured questionnaire was used, after obtaining consent from the patients.

#### Inclusion criteria:-

- Adults (aged over 18 years) both males and females.
- Fractures involving proximal tibia ( tibial plateau fractures – schatzker type II -type VI)

#### Exclusion criteria:-

- Patients aged below 18 years
- Type I (Schatzker classification) tibial plateau fractures which were treated conservatively.

On admission, demographic data was recorded. Thorough history and clinical examination was done. We assessed the extent of soft tissue injury and other associated injuries. Further investigations were done depending on the general condition of the patient and routine preoperative protocol as per our hospital guide lines. All patients had X-ray and CT scan done.

Total of 20 patients were studied. All patients underwent

fracture fixation under Epidural anaesthesia by minimal invasive percutaneous technique (MIPO). In this study, timing of surgery depended on the soft tissue conditions, and the surgery was delayed if the fractures had established severe swelling and skin blisters.

#### Procedure

Under epidural anaesthesia, patients were placed on radiolucent table. The ipsilateral iliac crest and entire lower limb was prepared and draped in the usual sterile fashion. Under image intensifier temporary reduction of fractures using large towel clip was performed by closed methods. A limited surgical approach consisting of 4 – 5 cms was made over the lateral aspect of proximal tibia. Before placing the plate, the fracture was reduced and evaluated with fluoroscopy. A submuscular plane was developed under the anterior compartment muscles and the Locked Compression Plate of adequate length was slid under the muscles. Based on the fracture pattern (Schatzker type) the fracture was reduced, tibial articular surface maintained. This was confirmed by fluoroscopy. After evaluating the location of plate both clinically and with the fluoroscopy in both coronal and sagittal planes, the plate was secured to the bone with 1 - 2 temporary K-wires. Through the slot given in the locked compression plate, buttressing of the plate was done with 3- 4 locked head screws of appropriate length using the drill sleeves. Distal screws were applied using either cortical or locked head screws by percutaneous technique as given in the picture.

Iliac bone grafting was performed in four cases where there was metaphyseal defect. Final fracture reduction and plate position were confirmed with image intensifier. Wound was closed in layers with drain in situ. Sterile dressing was done. The average time of surgery was 80 minutes and the average blood loss during the surgery was < 150 ml. Drain was removed on the 2<sup>nd</sup> post operative day. Wound dressing was done on the 2<sup>nd</sup> and 7<sup>th</sup> post operative day. Sutures were removed on the 12<sup>th</sup> post operative day.

#### Post Operative Care:

In the immediate post operative period care was given to the general condition and fluid balance. Adequate antibiotics were given as per the hospital protocol for the orthopaedic surgeries. Oral analgesia was started from the 2<sup>nd</sup> post operative day till adequate pain relief. This also helped us to mobilize the patient faster.

#### Rehabilitation:

Rehabilitation was started from the 2<sup>nd</sup> post operative day, static quadriceps exercises was started immediately following surgery as pain tolerated by the patients. All patients were started on non-weight bearing ambulation from the 3<sup>rd</sup> post operative day till 6 weeks. External support was given in the form of long knee brace, which was removed intermittently for range of motion exercises. Sutures were removed on the 12<sup>th</sup> post operative day. Partial weight bearing ambulation was begun after atleast first post operative visit, after confirming the beginning of healing process by radiographs. Complete weight bearing was allowed after confirmation of fracture union by radiology and adequate pain relief.

#### Follow up:

The first follow up was usually between 6 – 8 weeks and later on patients were followed up at regular intervals of 6 – 8 weeks, till complete fracture union.

During the Follow up,

1. The course of fracture healing was documented radiologically (with minimum of 6 weeks between successive radiographs). The moment of complete healing was defined as radiologically complete bone regeneration at the fracture site.
2. Evaluation of any possible loss of reduction that might have occurred compared to immediate post op radiographs.
3. Amount of pain relief following surgery.
4. Assessment of improvement in knee range of movements post operatively.
5. Assess the functional knee score.
6. Assessment and analysis of any complications observed.

All patients were followed up 1 year following surgery till fracture union which were assessed radiologically and clinically.

**RESULTS**

The present study involved 20 patients of proximal tibial fractures, treated with the locking compression plate by minimal invasive technique (MIPO), Mostly the age groups of patients were between 41 – 60 years (60%) and Mean age group was 45.7 years, 90% of the patients were males. Considering the side of injury, many patients had right side injury (R: L=55:45) and

Mode of injury was Road Traffic Accidents in all the cases. In our study majority 30% of the patients had Schatzker - Type II fracture followed by 25% Schatzker - Type IV fractures (Fig-1). 30% of the patients had associated injuries along with tibial plateau fractures namely Fracture of clavicle, Grade II compound supracondylar fracture femur, Optic nerve injury, Ipsilateral fracture shaft of femur, Degloving injury of the thigh, Intertrochantric fracture of the contralateral femur and Fracture both bones of the contralateral leg. 35% of the patients had co-morbid conditions like DM, CAD, Hypothyroid, and Anaemia and 20% of the patients had compound injury ie, open fracture. Majority 75% of the cases had primary treatment with posterior slab application & 20% of them with pin traction (Fig-2). All the patients were given Epidural Anaesthesia during surgery. 35% of the patients had undergone additional procedure along with MIPO in which Bone grafting was the common procedure 20% done.(Table -1).

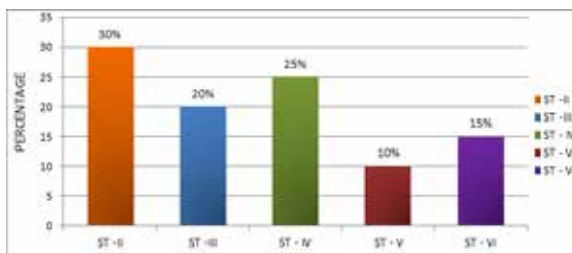
In our study with MIPO, majority 40% of them had moderate pain during discharge and had 90% of them had good relief of pain by 12 weeks (Table-2). Considering the functional outcome of our technique, majority 35% of patients had 0 – 90° flexion Range of Movements during Discharge & 90% of them had full range of movements by 6 months (Fig-3). Two patients had extensor lag of about 10° which improved on physiotherapy by 3 months. In this study all patients were followed up for a period of 1 year but 6 patients lost to follow-up after 6 months. At 6 weeks 35% of patients had 0 -110° Range of Movements, 50% of patients had >120° Range of Movements, at 3 months and 90% of them had full Range of Movements by 6 months (Table-3). According to Rassmussen’s functional grading system during follow up , 60% had Fair Outcome at 6 weeks, 95% had Good Outcome by 3 months and 80% had Excellent Outcome by 6 months (Table-4).

**Table 1. Demographic and other variable distribution of the patients**

Variable	No of patients (n = 20)	Percentage%
Age –group		

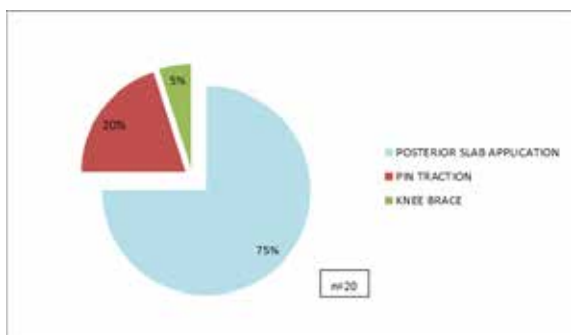
0-20	0	0
21-40	7	35
41-60	12	60
61-80	01	05
Sex		
Male	18	09
Female	02	10
Fracture classification		
Type-II	06	30
Type-III	04	20
Type-IV	05	25
Type-V	02	10
Type-VI	03	15
Associated injury		
Yes	06	30
No	14	70
Co-morbid conditions		
Yes	07	35
No	13	65
Compound injury		
Open injury	04	20
Closed injury	16	80
Primary treatment given		
Posterior slab application	15	75
Pin traction	04	20
Knee brace	01	05
Additional procedures		
Done	07	35
Not done	13	65
TOTAL	20	100

**Fig 1: Type of Fracture**



**Schatzker classification**

**Fig 2: Primary Treatment given to the patients.**

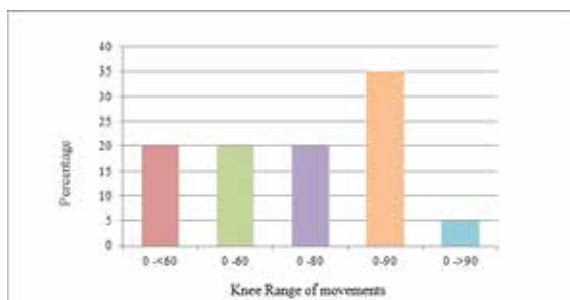


**Table 2. Distribution according to pain score**

	Dis-charge		1 Months		3 Months		6 Months		1 Year	
	No	%	No	%	No	%	No	%	No	%
No pain	4	20	10	50	18	90	20	100	14	100
Mild	8	40	10	50	2	10	-	-	-	-
Moderate	8	40	-	-	-	-	-	-	-	-
Severe	-	-	-	-	-	-	-	-	-	-

6 patients lost to follow up at 1 year

**Fig. 3: Functional Outcome by Knee Range of movements (ROM) during discharge**



**Table 3. Distribution according to functional outcome – Range of movements during follow up**

Range of movements	6 weeks		3 months		6 months		1 Year	
	No	%	No	%	No	%	No	%
0-<90°	5	25%	-	-	-	-	-	-
0-90°	4	20%	1	5%	-	-	-	-
0 - 100°	3	15%	4	20%	-	-	-	-
0 -110°	7	35%	5	25%	2	10%	-	-
>120°	1	5%	10	50%	18	90%	20	100%
	20	100%	20	100%	20	100%	20	100%

**Table 4. Distribution according to Rasmussen’s functional grading system during follow up**

Grade	6 Weeks		3 Months		6 Months	
	No	%	No	%	No	%
Excellent	-	-	1	5	16	80
Good	8	40	19	95	4	20
Fair	12	60	-	-	-	-
Poor	-	-	-	-	-	-

GRADE - SCORE: EXCELLENT: 27; GOOD: 26 – 20; FAIR: 19 -10; POOR: 9 – 6

**DISCUSSION:**

Open reduction and internal fixation is typically reserved for the treatment of patients with articular and periarticular tibia fracture. This approach can result in extensive dissection and tissue devitalization with damaged soft tissue after the high energy of proximal tibial fracture, conventional open reduction and internal fixation have often resulted in significant soft tissue complications such as wound breakdown and deep infection<sup>10,11,24-27</sup>. White side & lesker<sup>28</sup> described extra periosteal dissection with muscle injury, as performed in classic open plating, which evidently retarded healing of tibial osteotomies in rabbits. More ever, when compared with standard approach, the minimally invasive plate osteosynthesis technique has been known to be superior in preservation of the vascular supply to the bone.<sup>29</sup>

In our prospective study, we treated 20 cases of proximal tibial fractures from June 2006 to Aug 2008 with MIPO technique and all patients were followed up until 1 year. Mostly the age groups of patients were between 41 – 60 years with the mean age of 45.9 years. Similar age group was quoted by Duwelius P.J. et.al<sup>30</sup> in their study. In 1979 schatzker et al<sup>10</sup> introduced the classification for tibial plateau fractures that distinguish low energy spilt depression fractures from high energy bicondylar (schatzker V & VI) fractures. In our study we had 6 patients of type II , 4 pa-

tients type III, 5 patients of type IV , 2 patients of type V and 3 patients of type VI fractures by schatzker classification. In our study 90% of the patients were male which is similar to another study done by Duwelius P.J, et al<sup>30</sup> having 64% males has majority. 4 patients had compound injury in which 2 were Grade II and 2 were Grade III A by Gustilo Anderson’s classification which is similar to other study having 3 in Grade I, 2 in Grade II and 1 in Grade III B injury by the same classification<sup>30</sup>.

30% of the patients had associated injuries like fracture clavicle, Grade II compound supracondylar fracture femur, optic nerve injury, ipsilateral fracture shaft of femur etc. which is similar to 49% of associated injuries in an another study<sup>30</sup> involving complex pelvic fractures to long bone fractures. Waddell et al<sup>27</sup> reviewed 95 patients with tibial plateau fractures of which 69 had open reduction. Over all, there was a satisfactory result in only 65% of the surgically treated fractures. However, the results of bone grafting and internal fixation were superior to either internal fixation or bone grafting alone. Likewise in our study bone grafting was done in 4 patients where there was a metaphyseal defect. Bone grafting was very essential in the fractures where there is metaphyseal defect for good functional outcome. Kelly.L.Mueller et al<sup>31</sup> did a Biomechanical study on bicondylar tibial plateau fractures and suggested that lateral fixed angle device was effective at controlling medial condylar displacements in our study we used lateral plating for the treatment of the fractures.

Using Rasmussen’s criteria a score from 0 – 30 was assigned to each patient. The categories used to assess functional outcome were pain, walking capacity, extension, Range of Movements and stability<sup>32</sup>. In our study the mean score was 18.95 at 6 weeks of follow up, 24.25 and 28.20 at 3 months and 6 months of follow-ups respectively. 80% of patients had excellent functional outcome by 6 months. 10% of the patients had extensor lag of about 10° which improved by physiotherapy at 6 weeks post operatively. All patients had excellent results on radiographic evaluation during postoperative visits. 6 patients lost to follow up at 1 year because all had full range of movements by 6 months itself. There was no case of implant failure in our study. There was one case of superficial infection at the iliac bone graft site which healed with adequate antibiotics. There was no case of mal-alignment (varus/valgus Deformity) in our study.

**CONCLUSION**

The Percutaneous plating technique offer surgeons a good method of bone stabilization in patients with complex proximal tibial fractures. Percutaneous plate stabilization is a feasible and worthwhile alternate biological fixation methods that provides promising result with minimal complications in the treatment of intra-articular fractures of proximal tibia. When using this method of treatment in patients particularly those with bone loss, early bone grafting should be considered for good outcome. Minimal invasive surgery that minimizes soft tissue trauma is the key to good patient outcome.

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