

Original Research Article

Study of operative outcomes of proximal tibia fractures treated with locking plates

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ABSTRACT

Background: In this study we have studied the functional outcome of proximal tibial fractures treated by open reduction and internal fixation treated with locking compression plates after a minimum follow up period of 6 months.

Methods: We conducted the study of 50 patients that aimed at assessing the functional outcomes of radiologically confirmed proximal tibia fracture (both intra articular and extra articular) treated using locking compression plates, between July 2020 to May 2022 at Department of Orthopaedics in our Institute. The Schatzker classification was used for classifying the fractures and planning the treatment strategy using plain radiographs and CT scan films. The treatment modality was decided after classifying the type of fracture, the displacement, and the amount of depression of the tibial plateau, in our study, we included only those patients who were undergone ORIF or MIPPO for definitive treatment.

Results: Maximum number of patients (total 12) were in age group of 41-50 years (24%). Out of total 51 proximal tibia fractures, 4 (7.8%) were of type 1 variety, 12 (23.52%) were of type 2 variety, 2 (5.8%) were of type 3 variety, 4 (7.8%) were of type 4 variety, 6 (11.76%) were of type 5 variety and 9 (17.64%) were of type 6 variety according to Schatzker classification. out of 50 patients treated with locking compression plates, 26 patients (52%) showed excellent outcome with score between 28-30; 17 patients (34%) showed good outcome with score between 24-27; 7 patients (14%) showed fair results with score between 20-23, according to Modified Rasmussen's scoring system.

Conclusions: Locking compression plates (LCP) for the treatment of the proximal tibia fractures including difficult fracture situations seem to be good implant of choice for better post operative outcomes.

Keywords: Internal fixation, Open reduction, Proximal tibial fractures, Schatzker classification

INTRODUCTION

The knee joint is one of the major weight bearing joints in the lower extremity. Tibial plateau is one of the most critical load bearing areas in the human body. So the proximal tibia fractures are one of the commonest intra-articular fractures in the body. Tibial plateau fractures constitute 1% of all fractures and 8% of fractures in the elderly.¹ Isolated injuries to the lateral plateau account for 55% to 70% of tibial plateau fractures, as compared with 10% to 25% isolated medial plateau fractures and 10% to

30% bicondylar lesions.¹ There is a wide spectrum of fracture patterns that involve the medial tibial plateau (10% to 23%), the lateral tibial plateau (55% to 70%), or both (11% to 31%). From 1% to 3% of these fractures are open injuries.

The majority of tibial plateau fractures are caused due to high-speed velocity accidents and fall from height and in that fractures result from direct axial compression, usually with a valgus (more common) or varus moment and indirect shear forces.^{2,3} Older patients with osteopenic

bone are more likely to sustain depression type fracture because their subchondral bone cannot resist more the axial directed loads.⁴ Extra-articular fractures of the proximal tibia usually are due to direct bending forces applied to the meta-diaphyseal region of the upper leg.⁴ Proximal tibial fractures are challenging, attributing to the fact of their increased incidence, complexity, associated complications, and availability of different treatment options. Proximal tibia fractures represent a wide spectrum of severity, which range from simple fractures with predictably very good outcomes with non-operative treatment to complex fracture patterns that challenge even the most experienced surgeons. Complex biomechanics of its weight bearing position and complex ligamentous stability and articular congruency are the main reason why these fractures are of concern to surgeon.^{5,6} Appropriate management of fracture will be of paramount importance in maintaining mobility.

The management of tibial plateau fracture has been controversial and the objective of stable, pain free knee joint with a good functional range of motion with restoring ligamentous stability as well as good radiological restoration of tibial articular surface of knee joint maintaining the mechanical axis, eluded most of the management modalities.⁷ Non-operative modalities like cast, braces or traction are complicated by intrinsic risks of poor functional results and extended hospital stay.⁸ Conservative treatment at any age may be complicated by knee stiffness, mal union, and non-union; whereas open reduction and stable internal fixation (ORIF) helps in maintaining the articular surface and restoration of the mechanical alignment which allows early mobilization of knee.

Among the different options available, the surgical methods most commonly in use are plating, C.C. screws as treatment modalities for internal fixation and hybrid external fixation. Open reduction and internal fixation with plating/dual plating in such fractures is beneficial to address fracture fragments in different planes and also to achieve anatomical reduction under direct vision. With the development of anatomically contoured LCP, we can now use minimal invasive approaches over total invasive. It is done often allowing single and dual plating with enhancement in the handling of soft tissue.^{9,10} Proximal tibial anatomical contoured locking compression plate is based on biomechanical principle of external fixators and internal fixators, since the angle-stable interface between the screws and the plate allows placement of the plate without any contact to the bone giving the advantage of preserving the periosteal blood supply and bone perfusion.

Biologic fixation, a term for which the definition continues to evolve, represents an attempt to preserve blood supply and enhance fracture healing to reduce the incidence of non-union and infection. Techniques of biologic fixation have led to the current expanding use of minimally invasive percutaneous plating. It is well suited for the treatment of complex proximal tibia fractures. All screws

lock into threaded holes in the plate, providing a fixed-angle construct that can theoretically resist varus collapse. The insertion technique is optimized to allow percutaneous submuscular fixation that minimizes soft-tissue disruption and maximizes healing potential.¹¹ In this study we have studied the functional outcome of proximal tibial fractures treated by open reduction and internal fixation treated with locking compression plates after a minimum follow up period of 6 months.

METHODS

Authors conducted the prospective study of 50 patients that aimed at assessing the functional outcomes of radiologically confirmed proximal tibia fracture (both intra articular and extra articular) treated using locking compression plates, between July 2020 to May 2022 at Department of Orthopaedics, Narendra Modi Medical College and Sheth L.G. General Hospital, Maninagar, Ahmedabad. Ethical approval was taken from the institutional ethical committee and written informed consent was taken from all the participants.

All the required data for the study was collected from the patients after getting their appropriate consent during their stay in the hospital, during follow up at regular intervals and from the medical records.

Inclusion criteria

In this study, we included patients with age ranging from 18 to 75 years of either sex having proximal tibia fracture (both intra-articular and extra articular) of both open (open grade 1 and 2) and close type.

Exclusion criteria

Medically unfit patients for surgery, pathological fractures other than osteoporosis, neurovascular compromise, patients with developed compartment syndrome were excluded.

All participated patients were recruited based on history, clinical examination, radiography and with proper written informed consent. The Schatzker classification was used for classifying the fractures and planning the treatment strategy using plain radiographs and CT scan films. The three-column concept was also taken into consideration for treatment strategy. The patients were followed up for an average period of 6 months. Fractures will be considered unstable if depression of >4 mm or Displacement of >10°. All cases were treated with ORIF and approach chosen according to the column involved.

Patients with proximal tibia fractures presented to emergency room (casualty ward) of Sheth L. G. Hospital, Ahmedabad. Initially they were managed using ATLS protocol. Prompt history about mode of injury was taken followed by clinical examination of a patient done. Initial assessment of general condition, associated systemic or

limb injuries and vital parameters done. After a systematic assessment and management of life-threatening injuries, for closed type fracture, the injured limb splinted using above knee slab and assessed for neurovascular compromise. For open fractures (grade 1 and 2), wound irrigated with low pressure high volume sterile saline and macroscopic debris removed if any and wound closed using ethilon 2-0 sutures and then dressed with sterile saline gauze before splinting (Above knee slab). Prophylactic intravenous antibiotics given within golden hour and protection against tetanus administered. Once the patient's general condition was stable, relevant X-rays and CT scan done.

CT scan done for classification of a fracture. Fractures classified as tibial plateau fracture or extra-articular proximal tibia fracture. The treatment modality was decided after classifying the type of fracture, the displacement, and the amount of depression of the tibial plateau.

Various treatment modalities for treating proximal tibia fractures are as follows: 1) Conservative management, 2) Closed reduction with percutaneous cancellous screw fixation, 3) Reconstruction of articular surface using external fixator, 4) Open reduction and internal fixation: ORIF can be done using > Cancellous screws > Buttress plate and screws > Locking plate and screws, 5) Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO)/ Less Invasive Skeletal Stabilization (LISS) system.

Among these treatment modalities, in our study, we included only those patients who were undergone ORIF or MIPPO for definitive treatment. The patients were taken for surgery as early as possible time depending on their comorbidities and skin condition. Fracture fixation (definitive management) done by open reduction and internal fixation (ORIF) and/or MIPPO under image intensifier. Patients having external fixator were undergone external fixator removal before the definitive fixation by ORIF when their skin and soft tissues conditions permitted.

DVT prophylaxis started in high-risk patients like patients with previous history, obesity, prolonged bed rest, oestrogen use. Active knee mobilisation was encouraged as much as the patient could tolerate. Quadriceps exercises and ankle mobilization were started from 2nd or 3rd postoperative day according to the tolerance of patients or associated injuries. Drains removed after 48 hours after surgery. Wound was kept clean and dry, soaked dressing changed. Suture removal was done on 13th-15th post-operative day depending on the condition of a stitch line. Status of fracture healing and callus formation checked in 6 weeks follow up X-ray. Progressive weight bearing was allowed at 6 weeks, according to the callus formation as assessed in follow up X-rays.

The first follow up was done at 3 weeks, during that time the surgical scar was examined for any discharge or

tenderness and range of movements noted. The second follow up done at 6 weeks during which a repeat X-ray was taken to look for fracture union or loss of reduction. The third follow up was done at 3 months post operatively during which one more repeat X-ray was done and a clinical evaluation of union also done. During follow up postoperative complications related to procedure like infection, wound break down, arthrofibrosis and angular deformity were recorded. The final result was based on the functional and radiological outcome at 3months and 6 months, during which time the functional evaluation was done using the modified Rasmussen clinical criteria. A preference for data collection of follow-ups was post-op visits up to 6 months.

Statistical analysis

The recorded data was compiled and entered in a spreadsheet computer program (Microsoft Excel 2019) and then exported to data editor page of SPSS version 15 (SPSS Inc., Chicago, Illinois, USA). Quantitative variables were described as means and standard deviations or median and interquartile range based on their distribution. Qualitative variables were presented as count and percentages. For all tests, confidence level and level of significance were set at 95% and 5% respectively.

RESULTS

In this study, we included 50 patients of either sex having proximal tibia fracture (both intra articular and extra articular) who were treated using locking compression plates between July 2020 to May 2022.

Maximum number of patients (total 12) were in age group of 41-50 years (24%). In this study, 25 patients had right side limb involvement (50%) and 24 patients had left limb involvement (48%). 1 patient had bilateral limb involvement (2%) (Table 1).

Table 1: Age incidence.

Age group (in years)	No. of patients
18-20	4
21-30	10
31-40	9
41-50	12
51-60	9
>60	6

In this study, 5 patients (10%) suffered injury due to assault, 6 patients suffered injury due to fall down (12%) and 39 patients suffered injury due to Road Traffic Accident (RTA) (78%). Most common mode of injury was RTA. In this study, 10 patients had open type fracture (20%) and 40 patients had close type of fracture (80%).

In this study, out of 50 patients, 1 patient had bilateral limb involvement. Out of total 51 proximal tibia fractures,

4 (7.8%) were of type 1 variety, 12 (23.52%) were of type 2 variety, 2 (5.8%) were of type 3 variety, 4 (7.8%) were of type 4 variety, 6 (11.76%) were of type 5 variety and 9 (17.64%) were of type 6 variety according to Schatzker classification (Table 2).

Table 2: Schatzker classification.

Schatzker type	Frequency
Type 1	4
Type 2	12
Type 3	2
Type 4	4
Type 5	6
Type 6	9
Not applicable	14

In our study, proximal tibia Fractures involving ZERO column constitute 3.91%, involving ONE column constitute 31.37%, involving TWO columns constitute 9.80%, involving THREE columns constitute 27.45%. This classification didn't involve extra-articular fractures which constituted 27.45% (Table 3).

Table 3: THREE column classification.

Column involved	Frequency	Percentage
Zero	2	3.91
One	16	31.37
Two	5	9.80
Three	14	27.45
Not applicable	14	27.45

Out of total 50 patients, 14 patients required temporary fixation using external fixator due to their soft tissue conditions. The time between temporary fixation and definitive fixation was 4-6 days in 5 patients (35.71%), 7-9 days in 7 patients (50%), and 10-12 days in 2 patients (14.28%) out of total 14 patients. The average duration was 8 days. Among these patients, no patient reported pin-tract infection during duration. In our study, out of 51 fractures (considering 1 patient had bilateral limb involvement), 40 fractures (78%) were operated using Open Reduction Internal Fixation (ORIF), and 11 fractures (22%) were operated using Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO).

In our study, 20 patients (40%) had radiological union of fracture by 10-15 weeks, 28 (56%) patients had union by 16-20 weeks and 2 (4%) patients took more than 20 weeks for radiological fracture union.

In our study, out of 50 patients 2 patients (4%) had post operative infection and 2 patients (4%) had knee stiffness. Rest 46 patients (92%) had no post-operative complication.

In our study, we followed patients up to 6 months. At the end, we assessed them using Modified Rasmussen's

clinical criteria. We observed that out of 50 patients treated with locking compression plates, 26 patients (52%) showed excellent outcome with score between 28-30; 17 patients (34%) showed good outcome with score between 24-27; 7 patients (14%) showed fair results with score between 20-23, according to Modified Rasmussen's scoring system. No Patient showed poor results (score below 20). Majority of patients (52%) had score between 28-30 (excellent outcome) (Table 4).

Table 4: Modified Rasmussen's clinical assessment criteria.

Modified Rasmussen's clinical criteria		No. of patients
Score	Result	
28-30	Excellent	26
24-27	Good	17
20-23	Fair	7
<20	Poor	0

DISCUSSION

Fractures of proximal tibia are quite challenging to manage and difficult to reduce, align, and stabilize and are prone to develop wound complications and infections. The spectrum of injuries to the proximal tibia is much variable that no single method has proven uniformly successful. High energy, complex bicondylar tibia plateau fractures, typically present with an associated severe soft-tissue injury. Extensive dissection through this soft-tissue cover to achieve reduction and application of conventional stabilizing implants, particularly through a midline incision, may significantly increase postoperative infection rates, wound complication and implant failure, leading to loss of fracture reduction impairing long-term successful outcome. Stable internal plate fixation without damaging the soft-tissue cover is much difficult to achieve. The implementation of contemporary reduction techniques and novel implants allow the surgeon to attain stable fixation without compromising the surrounding soft tissues coverage.

Prompt diagnosis, thorough pre-operative assessment of the bony and soft tissue trauma adequate soft tissue monitoring and resuscitation, anatomic reduction and sound fixation allowing early joint movement and intensive rehabilitation are mandatory for good clinical results.¹²⁻¹⁵

The invention of locking compression plates has allowed the surgeons in using MIPPO technique for unilateral plating with improved care and management in handling the soft tissue. Laterally applied locking compression plates provide better stability in context of complex proximal 1/3rd tibia fracture associated with metaphyseal comminution and serves as a good alternative to medial plate or external fixator which are used for additional support of the medial column when a non-locking plate is used for bicondylar fractures. This plate allows fixation

through single incision to avoid wound dehiscence, prolonged immobilization and infection associated with extensile approaches.

In our study, we found that majority of patients affected were male (78%) and only 22% patients were female. Various other studies supporting our data is given in the table 5.

The mean age was in our study was 41.98 years. Similar results were obtained by Rademakers et al, Gaston et al and Sangwan et al.^{16,13,17}

In our study, out of 50 patients, 25 patients (50%) had right side limb involvement, 24 patients (48%) had left side limb involvement. One patient (2%) had bilateral limb involvement. The other previous studies, we saw no significance of side of the limb involvement. In our study, we classified fractures according to Schatzker classification, and we observed that 7.8% patients had type 1 variety, 23.52% had type 2 variety, 5.8% patients had type 3 fracture, 7.8% patients had type 4 fracture, 11.7% had type 5 fracture and 17.6% patients had type 6 fracture. Majority of patients had lateral condyle (type 1/2/3) fractures.

In our study, we used Schatzker classification and three column concept classification to classify proximal tibia fractures. The advantage of three column classification is that it increases the inter observer reliability due to its simplicity and also it considers posterior fracture fragment which is often not considered in Schatzker classification. The posterior column fragment usually addressed by buttressing the fragment using posteromedial approach. If the posterior column is not considered for fixation it may lead to varus collapse in the post operative period and reduced range of movements of the knee.

Out of total 50 patients, 14 patients required temporary fixation using external fixator due to their soft tissue conditions. The time between temporary fixation and definitive fixation was 4-6 days in 5 patients (35.71%), 7-9 days in 7 patients (50%), and 10-12 days in 2 patients (14.28%) out of total 14 patients. The average duration was 8 days. In the study, out of 51 fractures, 40 fractures (78%) were operated using Open Reduction Internal Fixation (ORIF), and 11 fractures (22%) were operated using Minimally Invasive Percutaneous Plate Osteosynthesis (MIPPO). The 11 fractures were extra-articular proximal tibia fractures. Similar study done by Rademakers et al.¹⁶

In the study, 20 patients (40%) had radiological union of fracture by 10-15 weeks, 28 (56%) patients had union by 16-20 weeks and 2 (4%) patients took more than 20 weeks for radiological fracture union. This data shows that majority of the patients had radiological union by 16 to 20 weeks. Other studies supporting our data are given in the table 5.

Table 5: Studies and time of radiological union.

Studies	Time of radiological union (weeks)
This study	Avg. union time 15.86 weeks
Rademakers et al¹⁶	Not mentioned
Singh et al¹⁸	Avg. union time 16 weeks
Sangwan et al¹⁷	Avg. union time 12.08 weeks
Gaston et al¹³	Not mentioned

In our study, out of 50 patients 2 patients (4%) had post operative infection and 2 patients (4%) had knee stiffness. Rest 46 patients (92%) had no post-operative complication.

In our study, the mean range of motion (flexion of knee joint) was 132.95 degrees. The overall range of motion of majority of patients is quiet good suggesting better outcome of proximal tibia fractures when treated using locking compression plates.

Various other studies supporting our data are mentioned in the table 6:

Table 6: Studies and average range of motion.

Studies	Average range of motion (knee flexion)
This study	132.95 degrees
Rademakers et al¹⁶	135 degrees
Singh et al¹⁸	67% patients had >120 degrees
Sangwan et al¹⁷	107.8 degrees
Gaston et al¹³	82% patients had >100 degrees

In our study, we followed patients up to 6 months. At the end, we assessed them using Modified Rasmussen's clinical criteria. We observed that out of 50 patients treated with locking compression plates, 26 patients (52%) showed excellent outcome with score between 28-30; 7 patients (14%) showed good outcome with score between 24-27; 17 patients (34%) showed fair results with score between 20-23, according to Modified Rasmussen's scoring system. Various other studies with functional outcome results are Rademakers et al, Sangwan et al and Singh et al.¹⁶⁻¹⁸

Locking plate failures can be mechanical (bending stresses on the plate, the screw-to-plate junction) or biological (the screw-to-bone interface, bone quality). The locking plate can fatigue or fail in long unsupported sections or if it is stressed too much at one level making working length important.

This study has limited number of patients so it was not possible to compare with other major prospective studies. All the patients in our study were not operated by a same/single surgeon. Same type of fracture was not treated with different implants. So, we could not compare outcome of different implants.

CONCLUSION

Locking compression plate system acts as a good biological fixation for proximal tibia fractures even in difficult fracture situations. MIPPO technique has advantage of short duration of procedure, less blood loss, less soft tissue injury, better and faster wound healing and better clinical outcome than ORIF in patients with proximal tibia fracture. However, MIPPO demands more surgical techniques. From this study, we concluded that Locking compression plates (LCP) for the treatment of the proximal tibia fractures including difficult fracture situations seem to be good implant of choice for better post operative outcomes.

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