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A study on clinical and radiological outcome of proximal tibial plateau fractures treated with locking plate

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Abstract

Introduction: Tibial plateau fractures are one of the most challenging fractures for an orthopaedic surgeon to understand and successfully treat. These are best treated at specialized Centres by trained surgeons who routinely treat such injuries. Anatomic reduction and internal fixation with the locking plate are the treatment of displaced intra-articular tibial plateau fractures. The goal of surgical treatment is to obtain an anatomic reduction of the articular surface while avoiding complications.

Aim: 1) To study the clinical and radiological outcome of closed intra-articular proximal tibial plateau fractures treated with a locking plate at a six-month follow-up.

2) To study the secondary displacement in closed intra-articular proximal tibial plateau fractures treated with locking plates at a six-month follow-up.

Method: 26 patients with a closed intra-articular fracture of the tibial plateau treated with locking plate admitted to Shri BM Patil Medical College, BLDE (Deemed to be university), Vijayapura, Karnataka from Sept 2014 to Sept 2015 were studied prospectively. The Radiological & functional outcomes of these patients were assessed & compared using Rasmussen's clinical and radiological scores.

Result: The study comprised 22 male and 4 female patients aged from 21 to 72 years with a mean age of 45.04 years. The right-sided injury was more (57.69%), most fractures were due to road traffic accidents. We noted excellent functional outcome in 19 (73%), good in 4 (15 %) & fair in 3 (12%) patients at 6 months. We found most patients (69.23%) had an excellent range of motion (>120°) at six months. The mean duration for fracture healing was 17.31 weeks (range 14-24 weeks) with a standard deviation of 2.4 weeks. There was no statistically significant difference in the functional outcome of patients above and below 40 years (P=0.215) at six months. There was a statistically significant better functional outcome in patients with pure lateral condyle fractures than in other higher grade fractures of the tibial plateau. (p-value = 0.009) at six months.

Interpretation: Patients with closed intra-articular tibial plateau fractures treated with locking plate have satisfactory (88%) functional outcomes at six months follow up. There is a strong correlation between radiological outcome & functional outcome at six months follow-up. An increase in severity and grade of tibial plateau fractures have a statistically significant adverse effect on the final clinical product. Younger patients have a slightly better functional outcome compared to older patients, not statistically significant, though.

Keywords: Tibial plateau, fractures, locking plate, radiological outcome, functional outcome

Introduction

The knee joint is the largest weight-bearing joint in the lower extremity. Proximal tibial fractures are one of the commonest intra-articular fractures. Generally, these injuries fall into two broad categories, high energy fractures and low energy fractures. High-energy fractures of the proximal tibia are often open due to the thick, soft tissue covering anteriorly. In such cases, the treatment of damaged soft tissues is of primary concern [1]. Low-velocity injuries are more common in elderly osteoporotic bone, and open fractures are rare in this group.

The majority of tibial plateau fractures are secondary to high-velocity accidents and fall from height [2]. Fractures result from direct axial compression, usually with a valgus (more common) or varus moment and indirect shear forces [3].

The aim of surgical treatment of proximal tibia fracture is to restore congruent articular surfaces of the tibial condyles maintaining the mechanical axis and restoring ligamentous

stability. This eventually can achieve a functional, painless and good range of motion in the knee joint [4]. Improperly treated proximal tibial plateau fractures may result in movement and ability dysfunctions [5].

The scarcity of soft tissue and the subcutaneous nature of the tibia makes this fracture more prone to soft tissue complications [6].

The number and size of incisions reportedly have an effect on the incidence of soft tissue complications in the surgical management of tibial fractures [7].

Various clinical studies have established that bone beneath a rigid conventional plate is atrophic.

The fracture site takes a longer period to unite due to interruption of vascular supply to bone secondary to soft tissue and periosteal stripping.

This led to a new concept of biological fixation. But this was difficult using conventional plates, as these needed to be accurately contoured to achieve good fixation. Osteoporosis also posed the same problem of poor fixation with traditional plates [8]. This led to the development of the internal fixators.

As more and more concepts about biological fixation became clearer, the innovation of plates progressed. Research to combine these two methods has led to the development of the anatomically contoured locking plate [9].

Tibial plateau fractures treated with a locking compression plate provides more excellent stability in unstable fractures and creates a stronger connection between the articular components [10].

Stabilizing the joint surface by this method, due to its less invasiveness, not only seems to cause a significant decrease in side effects but also reduces the length of hospital stay and hospital costs [11, 12].

This new system is technically advanced as it offers numerous fixation possibilities and has proven to be helpful in complex fracture situations such as fractures in osteoporotic bones and comminuted fractures.

Aims and objectives of the study

- 1) To study the clinical and radiological outcome of closed intra-articular proximal tibial plateau fractures treated with a locking plate at a six-month follow-up.
- 2) To study the secondary displacement in closed intra-articular proximal tibial plateau fractures treated with locking plates at a six-month follow-up.

Materials and Methods

- A) Study Area: All confirmed cases of proximal tibial fractures admitted in Department of Orthopaedics at Shri BM Patil Medical College, BLDE (Deemed to be university), Vijayapura, Karnataka.
- B) Study Population

Inclusion Criteria

- 1) All Schatzker's type 1 to 6 closed proximal tibial plateau fractures in adults aged 18 years and above of either sex.
- 2) Patients are willing for treatment and giving informed and written consent.

Exclusion Criteria

- 1) The age group of fewer than 18 years.
- 2) Patients not fit for surgery are managed conservatively for other medical reasons.
- 3) All open fractures of the proximal tibia.
- 4) Patients with pathological proximal tibial fractures other than osteoporosis.

5) Extra-articular fractures of the proximal tibia.

C) Sample Size: 26

D) Study Design: A prospective, observational study.

E) Study duration: 1 year. 09/2014 to 09/2015

Operative technique and fracture fixation.

Surgery will be done using anterolateral, anteromedial and posteromedial approaches depending on the type of fracture using open reduction & internal fixation with locking plates under spinal anaesthesia. An intra-op image intensifier will be used to achieve the best possible reduction & fixation.

Operative procedure

Positioning

After induction of anaesthesia, the patient will be positioned on the operating table. A rolled flannel blanket will be placed under the ipsilateral buttock. This serves to set the trans-condylar axis of the distal femur parallel to the floor and assist rotational alignment during multi-fragmentary tibial fractures. External rotation of the limb is also prevented by using such a roll. The limb will be prepared and draped as per the standard aseptic technique. A thigh tourniquet will be routinely applied.

Anterolateral technique

The anterolateral parapatellar approach will be used most frequently because of the frequency of lateral tibial plateau fractures.

Incision: For the fractures of the lateral condyle, make a straight or slightly curvilinear incision, starting 3 to 5 cms above the joint line proximally and extending distally below the inferior margin of fracture site from just anterior to the lateral femoral condyle to Gerdy's tubercle. This incision provides good exposure while avoiding skin complications.

The lateral tibial condylar fragment will be replaced to lock the articular fragments together.

The lateral margin of the articular surface was reduced under the femoral condyle for support.

Insert a small thin periosteal elevator well beneath the depressed articular fragments, and by slow, meticulous pressure elevate the articular fragments. This produces a large cavity in the metaphysis that must be filled with synthetic bone grafts to prevent redisplacement.

As the fragments will be elevated and reduced, temporarily fixed them with multiple small Kirschner wires.

A contoured locking plate will be applied for definitive fixation.

The plate will be secured to the condyle with appropriate cancellous screws/locking screws of sufficient length to engage the opposite medial cortex. Cortical/locking screws (4.5 mm/5 mm) will be used to attach the plate to the tibia shaft.

Minimally invasive percutaneous plate osteosynthesis technique.

The main fracture fragments were aligned using manual traction and closed reduction technique

A 3–4-cm skin incision was made proximal and distal to the fracture.

An extraperiosteal, subcutaneous tunnel was created with a periosteal elevator.

Pre-contoured 4.5 mm proximal or distal anatomic locked plates, which included both locking and compression screw holes were used and passed along this tunnel.

Once satisfactory plate positioning was achieved, the plate was secured by passing 3-mm.

Kirschner wires through the most proximal and distal holes.

The second plate of similar size and length was placed using the same holes on the Kirschner wires. This acted as an external guide to localize the screw holes and skin incisions without the need of fluoroscopic control.

One proximal and distal screw was inserted. Additional screws were then applied using the same technique.

In general, locking screws were used in the juxta-articular and diaphyseal segments, while nonlocking screws were selected to reduce large fragments as lag screws.

Postoperative care and Rehabilitation

Postoperatively the limbs will be kept elevated with pillows. Intravenous antibiotics will be continued for the first 24 hours—posterior splint given if fixation protection is desired. Check radiography will be done on the 3rd post-operative day. Quadriceps exercises and ankle mobilization will be started within 48 hours of surgery. Knee bending and toe touch walking with a walker on the second or third postoperative day if the fixation allowed. The dressing will be done on the 2nd, 5th and 8th postoperative days. Sutures will be removed on the 12th post-operative day. Progressive weight bearing will be allowed as tolerated by the patient.

Follow Up & Evaluation

Functional Outcome following Locking plate in proximal tibial fracture will be evaluated at three months, six months based on Rasmussen's score.

The radiological outcome will be evaluated for secondary displacement and condylar widening at 3 and 6 months based on Rasmussen's Knee Score. Condylar depression will be measured from a reference line level with the uninjured plateau. The condylar widening will be obtained by measuring the total width of the tibial plateau just below the joint line and measuring the width of femoral condyles just above the joint line. These two measurements are generally equal.

Time taken for fracture union will be noted at 6, 12, 14, 16, 18, 20, and 24 weeks based on the radiograph.

Observation and Results

In this study, most patients were between 41-50 years (42.30%) age, group. The mean age was 45.04 years with a standard deviation of 11.77 years. The age range was between 21-72 years.

In our study, we found male predominance for tibial plateau fractures. Out of 26 cases, there were 22 Male (84.62%) patients and four female (15.38%) patients. In our study, most patients were injured by vehicular accidents (22 patients, 84.6%). There were 15 right-sided and 11 left-sided fractures in our study group. We observed Schatzker's Type VI (34.6%) as the most common type fracture in our study group, followed by Type II (30.8%).

Out of 26 patients, two patients had patella fracture, and other injuries were intertrochanteric fracture, ulna fracture, subtrochanteric fracture, humerus shaft fracture. In our study, 80.8% of patients underwent open reduction and internal fixation and 5 (19.2%) patients by minimally invasive technique. In our study, most patients underwent anterolateral approach 18 (84.62%), followed by an anteromedial approach. In our study group, most patients (34.6%) had a good range of motion of 140° at six months follow up. The mean range of motion was 118.4° with a standard deviation of

23.78°. In this study, we found that the mean duration for fracture healing was 17.31 weeks (range 14-24 weeks) with a standard deviation of 2.4 weeks. In our study, 50% of patients had excellent results, 38% good, 8% fair and 4% poor functional results at three months follow up. We observed that 73% of the patients had excellent results at six-month follow-up, followed by 15% good, 12% fair results. None of them had poor functional outcomes at six months in our study group. On comparing the functional outcome, there was an increase in the percentage of excellent results at six months compared to 3 months follow up. There was an overall improvement in each component of Rasmussen's scoring system at six months compared to 3 months.

At six months follow up, we compared functional outcomes between patients below and above 40 years. We observed that 75% (below 40 years) patients had excellent results, whereas 72.22% (above 40 years) had excellent results. Even though younger patients had slightly better functional outcomes, it was not statistically significant (P-value = 0.215).

Our study comparison of the type of fracture and the functional outcome at six months showed an increase in severity of fracture affects the functional outcome. And this was statistically significant.

We observed few complications like stiff knee (15.38%), deep infection (11.53%), stitch abscess (7.69%), DVT (3.84%).

Discussion

In our study, most patients were in the age group between 41-50 years (42%). The age range was between 21-72 years, with a mean age of 45.04 years and an SD of 11.77 years. We found that most patients were males (84.62%). We noted that most patients were injured by vehicular accidents (84.6%). In our study, most patients had a right-sided injury (57.70%). In India, where vehicles are driven on the left-hand side of the road, the riders are more likely to injure their right leg when they hit the vehicle coming from the opposite direction. Type VI was the most common fracture type (34.6%) in our study, followed by type II (30.8%). In our study, two patients had patella fractures which were treated surgically. Other injuries included an ipsilateral subtrochanteric fracture, fixed with intramedullary nailing; the head injury was treated conservatively. Another patient had an avulsion fracture of the fibular head with foot drop; the patient also had a high-grade Posterior cruciate ligament tear, partial anterior cruciate tear; this patient had a poor functional outcome at six months of follow up. Foot drop showed no recovery after six months of follow up. Another patient in the study had a contralateral undisplaced distal radius fracture which was treated conservatively. One patient had an ipsilateral compound humerus shaft fracture treated initially with debridement with external fixation and ORIF later. The patient also had multiple rib fractures, which were treated conservatively.

Ipsilateral distal humerus fracture was present in one patient, along with radial nerve palsy, ulna fracture, intertrochanteric fracture and contralateral acetabulum fracture, all treated surgically. In our study, most patients had a good range of motion of about 140° (34.6%). The mean range of motion was 118.4° with a standard deviation of 23.78°. In our study, the mean duration for fracture healing was 17.31(range 14-24) weeks with a standard deviation of 2.4 weeks.

Functional Outcome

There were 73% of patients who had excellent results treated surgically with locking plate for tibial plateau fractures. The mean Rasmussen's functional score was 26.84(range 11-30) at

six months. In this study, we observed that patients younger than 40 years had a slightly better functional outcome at six months (75% with the excellent functional outcome) as compared to those older than 40 (73% with the excellent functional outcome), but this did not reach statistical significance (P value= 0.215 calculated by Fisher's exact test). We divided tibial plateau fractures into two subgroups. In one group, type I to type III were included, and type IV to type VI were included. We found that the increase in grade and severity of tibial plateau fractures adversely affect the final clinical outcome, a statistically significant P value of 0.009 (Students t-test) at six months.

Radiological outcome at six months

Using Rasmussen's radiological grading for fracture depression, three (11.53%) patients had excellent results, 76.92% of patients had good results, and only 11.53% had fair results. Preoperative fracture depression averaged 4.48mm (range 2-7 mm), postoperative fracture depression averaged 1.96mm (0-7mm) at six months.

Using Rasmussen's radiological grading for condylar widening, two (7.69%) patients had excellent results, 84.61% had good results, and 7.69% had fair results. Preoperative fracture condylar widening averaged 7.88mm (range 4-12mm), postoperative condylar widening averaged 2.46mm (0-8mm) at six months.

In our study, one patient fell after surgery and developed posterior articular step 6 mm with 4mm of condylar widening. One patient fell and developed a medial articular step of 7 mm with the condylar widening of 8 mm. One patient lost alignment postoperatively 6 mm of both depression and condylar widening at six months follow up. We observed 11.53% of patients had a loss of alignment but did not require any active intervention.

We compared Rasmussen's clinical and Rasmussen's radiological outcome (depression) at six months noted that most of the patients (76.92%) had clinically and radiologically satisfactory outcomes. No patient had unsatisfactory results in both clinical and radiological outcomes.

There was a strong association between the clinical and radiological outcomes at six months with a P-value of 1.000 (Fisher's exact test).

Complications

In the present study, we had seven patients who developed complications. Four patients had knee stiffness (15.4 %) treated by physiotherapy; two patients had a stitch abscess (7.7%) treated with oral antibiotics, one patient suffered from deep vein thrombosis (3.8%), which settled with medications, and three patients developed a deep infection (3.8%) which were treated with debridement and antibiotics.

Conclusion

From our study, we concluded that:

- Following surgical treatment of proximal tibial plateau fractures treated with locking plate, 88% of patients had satisfactory outcomes.
- As the severity and grade of tibial plateau fracture increases, it will negatively affect the functional outcome, which is statistically significant (P value=0.09).
- Patients younger than 40 years will have slightly better functional outcomes than patients older than 40 years in proximal tibial plateau fractures treated with locking plates. Still, it did not meet statistical significance (P

value=0.215).

- 11.53% of patients had malalignment postoperatively.
- Optimal knee function is achieved by accurate anatomical reduction and secure fixation followed by early mobilization to attain functional arc of motion.
- Postoperative rehabilitation protocol regarding non-weight bearing and achieving satisfactory range of motion needs to be strictly adhered to to obtain optimal functional results.

Case Studies

- Case 1 – 35-year-old male, RTA



Fig 1: Pre Operative A.P. and Lateral Radiograph





Fig 2: Immediate Postoperative A.P. and Lateral views



Fig 4: 6 Months Post-op radiographs



Fig 3: 3 Months Post Op Radiographs



Fig 5: Clinical photographs showing complete extension and flexion, respectively



Fig 6: Full Weight Bearing

2) Case number 2 – 38-year-old male, RTA, left side tibial plateau fracture, Schatzker type IV with patella fracture with anterior angulation.



Fig 7: Preoperative A.P. and Lateral radiographs



Fig 8: Immediate postoperative A.P. and Lateral views



Fig 9: 3 Months Postoperative A.P. and lateral views

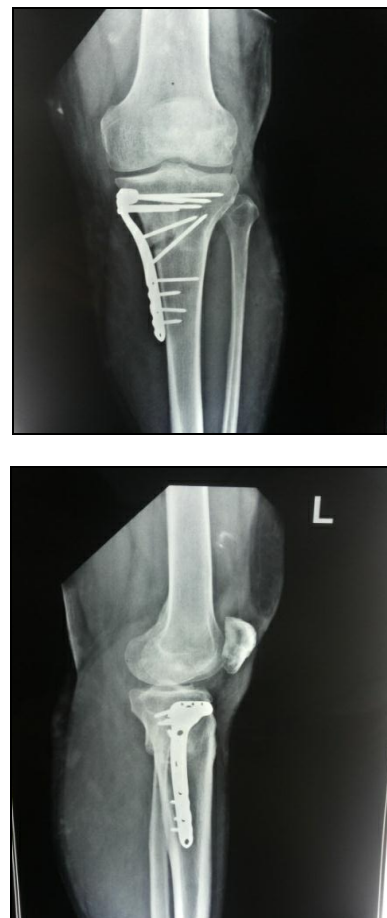


Fig 10: 6 Months Postoperative A.P. and lateral views



Fig 11: Complete flexion and extension respectively at six months follow-up



Fig 12: Full weight-bearing

3) Case number 3 – 40-year-old male, RTA



Fig 13: Pre Operative A.P. and Lateral radiographs



Fig 14: Immediate postoperative A.P. and Lateral radiographs





Fig 15: Three months postoperative lateral and A.P. radiographs



Fig 16: Six months postoperative A.P. and lateral radiographs



Fig 17: Complete flexion and extension at six months follow-up

Summary

Twenty-six patients with proximal tibial plateau fractures treated with locking plate admitted in Shri BM Patil Medical College, BLDE(Deemed to be university), Vijayapura, Karnataka from Sept 2014 to Sept 2015 were studied prospectively. Radiological & functional outcomes of these patients were assessed & compared using Rasmussen's radiological & functional scoring system at 3 and 6 months postoperatively.

The study comprised 22 male and four female patients aged 21 to 72 years with a mean age of 45.04 years. We observed excellent functional outcome in 19 (73%), good in 4 (15%), fair in 3 (12%) patients at 6 months.

Open anatomic reduction and internal fixation with locking plate give satisfactory radiological & functional outcomes in most patients with tibial plateau fractures.

Younger patients had slightly better functional outcomes than elderly patients, though it was not statistically significant (p-value 0.21) at six-month follow-up.

An increase in severity of fracture affects the functional outcome of tibial plateau fractures statistically significant (p-value 0.009) at six months follow up.

Radiological results were excellent in 3 (11.53%), good in 20 (76.92%) and fair in 3(11.53%) at six months follow up. At six months, three patients had malalignment.

There was a strong correlation between clinical and radiological outcomes at six-month follow-up with a p-value of 1.00.

Recommendations

1. Tibial plateau fracture fixation demands careful evaluation, classification of fracture type & preoperative planning. It also requires specialized surgical skills & instruments. Open reduction and internal fixation with locking plate are the methods to achieve satisfactory final functional & radiological outcomes.
2. Our aim should be to achieve an anatomic reduction (< 2mm gap) of the articular surface while avoiding complications like knee stiffness, post-traumatic osteoarthritis of the knee.
3. Only initial perfect anatomical reduction alone may not be a satisfactory, functional outcome. It also depends on various factors like the age of the patient, type of fracture.
4. The use of an intra op image intensifier helps to reduce complications like the intraarticular placement of screws.
5. The role of variables like the fracture's complexity, comminution, displacement, osteoporosis in the functional & radiological outcome needs to be studied.

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