International Journal of Orthopaedics Research
www.orthopaedicsjournal.in
E-ISSN: 2663-0923, P-ISSN: 2663-0915
Received: 28-03-2021; Accepted: 14-04-2021; Published: 30-04-2021
Volume 3, Issue 2, 2021, Page No. 32-36

Analysis of functional and radiological outcome of management of tibial plateau fractures by minimally invasive percutaneous plate osteosynthesis (MIPPO)

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Abstract

Introduction: Tibial plateau fractures typically develop between 3rd and 5th decade of life and are caused by motor vehicle accidents and bumper-to-bumper injuries in adults, whereas they develop in the elderly as a result of a minor fall brought on by osteoporosis. Due to the intra-articular nature of tibial plateau fractures, they require solid stabilisation together with the restoration of articular congruity, length, and alignment to permit early range of motion.

Objective: To analyse prospectively the functional and radiological outcome of management of tibial plateau fractures treated by minimally invasive percutaneous plate osteosynthesis (MIPPO).

Methodology: 30 patients with tibial plateau fractures who were admitted to the Ortho ward between November 2018 and November 2020 were studied at the GMKMCH Salem. The Functional & Radiological assessment was done based on Modified Rasmussen criteria.

Results: We operated on 30 patients (male-24, female-6). Mean follow up period was 12.1 months. Time range required for fracture union were found to be around 11-18 weeks with mean average of 12.96 weeks.3 patients had superficial infection managed conservatively.

Conclusion: When treated with MIPPO, tibial plateau fractures have excellent to good functional and radiological outcomes & is in par with literature. There is no significant difference in the functional outcome between single plating in our study and dual plating of other studies at midterm follow up.

Keywords: modified rasmussen criteria, MIPPO plating, biological fixation, tibial plateau fractures

Introduction

Tibial plateau fractures constitutes about 1% of all adult fractures. According to reports, there are 10.3 cases per 100,000 people. Tibial plateau fractures range in energy level from low to high and are extremely susceptible to compartment syndrome and related soft tissue injuries at the knee joint. Due to the intra-articular nature of tibial plateau fractures, they require solid stabilization together with the restoration of articular congruity, length, and alignment to permit early range of motion. Conventional locking plates, minimally invasive percutaneous plate osteosynthesis (MIPPO), hybrid external fixators, alizarin, and LISS are available as alternatives. This study emphasizes the significance of anterolateral plating by MIPPO as a means of achieving good functional and radiological outcomes among these numerous choices.

AIM

to analyze prospectively the functional and radiological outcome of management of tibial plateau fractures by Minimally Invasive Percutaneous Plate Osteosynthesis.

Mechanism of injury of tibial plateau fractures

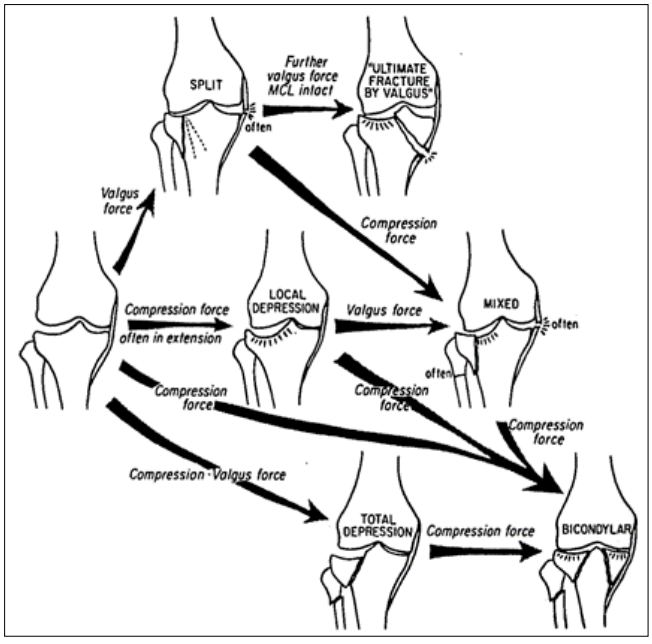

Fig 1

Classification of tibial plateau fractures
1. Schatzker classification
2. AO/OTA classification
3. Lau's three column based classification

Schatzker Classification
Most commonly used. Based on plain radiographs. This classification was first published by Joseph Schatzker *et al*. in 1979. This system divides tibial plateau fractures into six types:

- **Schatzker I:** wedge-shaped pure cleavage fracture of the lateral tibial plateau
- **Schatzker II:** splitting and depression of the lateral tibial plateau; namely, type I fracture with a depressed component (generally considered commonest)
- **Schatzker III:** pure depression of the lateral tibial plateau; divided into two subtypes:
- **Schatzker IV:** medial tibial plateau fracture with a split or depressed component
- **Schatzker V:** wedge fracture of both lateral and medial tibial plateau
- **Schatzker VI:** transverse tibial metadiaphyseal fracture, along with any type of tibial plateau fracture (metaphyseal-diaphyseal discontinuity)

Three Column Based Classification
The classification of tibial plateau fractures using three columns based on CT scan which takes into account the mechanism of injury provides guidance for treatment.

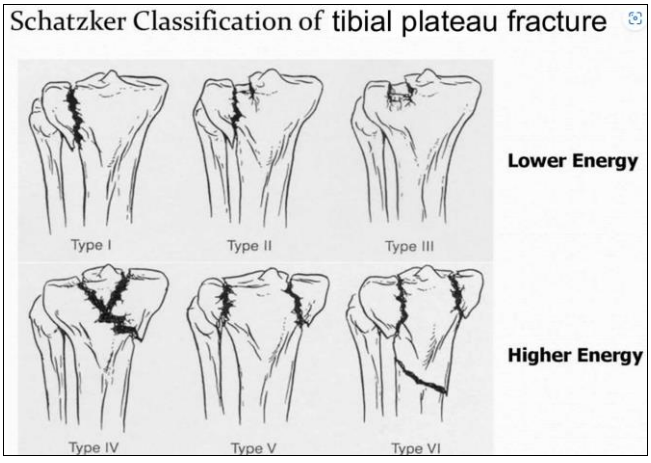

Fig 2

Management
After obtaining thorough history & complete physical examination, patients were subjected to radiological examination

Plain Radiography
To determine the fracture pattern, standard anteroposterior and lateral view radiographs are initially taken. Sometime oblique view is taken. The Tibial Plateau view with an X-ray aimed at an angle of 105° to the tibial crest was demonstrated by Moore and Harvey in 1974 [16]. This enables a more precise evaluation of the articular surface's initial depression.

Computed Tomography Scan
Preoperative examination of articular congruity, comminution of fragments, and small bone avulsions that are difficult to view on traditional x-rays can be aided by 3D CT. J. J Dias *et al*. Al in 1987 [8] advised using a CT scan to assess the degree of comminution, measure the displacement of fracture fragments, and as guiding tool for fixing the fragment precisely.

Operative Treatment
The goals of fracture fixation according to Albin Lambotte are
1. Anatomical reduction of articular surface
2. Bone graft if necessary to support joint surface
3. Alignment of the diaphyseal & metaphyseal fragments
4. Sound fixation of metaphysis to the diaphysis to initiate early range of motion

Indications for surgical fixation
The primary goal of tibial plateau fracture fixation is to achieve and preserve articular congruity in order to restore the patient to their pre-injury state, enable them to resume their normal activities, and reduce the risk and incidence of sequelae.
1. High velocity tibial plateau fractures.
2. split fractures of the lateral condyle
3. displaced medial condyle fractures
4. Compound tibial plateau fractures
5. compartment syndrome or neurovascular involvement
6. More than 10 degrees of valgus or varus instability in the 0 to 90 degree knee arc of motion

Minimally Invasive Percutaneous Plate Osteosynthesis Principle of MIPPO
In this technique, only the normal bone cortices are exposed proximal & distal to the fracture site for positioning the plate & inserting the screws, while the fracture site is not explored, so the osteogenic tissues surrounding the fracture are well protected & their blood supply is well preserved. The concept of preserving the biology at the fracture site by indirect reduction and bridging fixation, well known from the use of intramedullary nails, now became possible using these submuscular plates. This was aimed at maintaining fracture integrity and blood supply to reduce the risk of fragment devascularization with possible sequelae of delayed or nonunion, need for cancellous bone transplant and infection. MIPPO relies on relative stability rather than absolute rigid fixation because of which micromotion is produced at the fracture site & a large, rapid callus formation occurs leading rapid bone healing. Relative stability does not require accurate apposition of fragments as the fracture gaps are filled by bridging callus.

Advantages of MIPPO
1. Minimize the risk of soft tissue damage
2. Preserve vascular supply to bone & soft tissue
3. Decrease periosteum damage
4. Have better & faster callus formation
5. Have better healing & union rate
6. Decrease complication of infection & refracture
7. Decrease the use of supplementary bone grafting

Materials and methods

This prospective study was done at Government Mohan Kumaramangalam Medical College Hospital in Salem between November 2018 and November 2020. 30 patients with tibial plateau fractures who were admitted to the Ortho ward make up the study population.

Inclusion criteria

1. All closed tibial plateau fractures
2. All skeletally mature patients and ability to walk without assistance before injury

Exclusion criteria

1. Patients with skeletal immaturity
2. Neurovascular injuries & compartment syndrome
3. Concomitant lower limb fractures like patella, femur & ankle
4. Open fractures & pathological fractures

Management Protocol

Preoperative management

After Patients were admitted to the emergency room, a comprehensive physical examination is carried out after stabilizing vitals. The limb was then immobilized with an above-the-knee slab and maintained in a Bohler Brown splint. To improve the patient's outcome, associated injuries must be ruled out. The patient is treated with analgesics, intravenous fluids, and comorbidity management. Always apply ice to the affected area to decrease leg edema. X-rays such as anteroposterior, lateral, and occasionally oblique, as well as manual traction views, are acquired. A CT scan with 3D reconstruction is frequently done to evaluate the fracture pattern and help with the planning of surgical care. In order to rule out compartment syndrome, the skin above the fracture site should be constantly watched until the edema and fracture blisters have subsided(wrinkle sign). Passive stretch pain and the distal pulse should also be evaluated twice daily.

Surgical management

Inj. cefotaxime given for all patients 1hr before surgery as routine prophylaxis. Patient was positioned in the supine posture while under spinal or general anesthesia. The operating limb was cleaned and draped. During the procedure, the limb should be free for reduction techniques. Under C-arm guidance, reduction was achieved by ligamentotaxis. Proximally, incision begun just proximal & lateral to gerdy's tubercle & extended in a curvilinear fashion for 5-6cm. A 3–4 cm longitudinal incision was made distally, about 2 cm lateral to the tibial crest. Dissection is epiperiosteal & submuscular. In accordance with the specific needs of each case and depending on the reduction, combined traction with varus or valgus strain was performed in knee flexion or extension. Compression bony clamp was used in cases to bring the fracture fragments together. Under C-arm guidance, after confirming reduction, fracture fixation was done through MIPO with locking plate.

Intra-Operative Images

Fig 3: Skin Incision for MIPPO Technique

Fig 4: Plate positioning & preliminary fixation

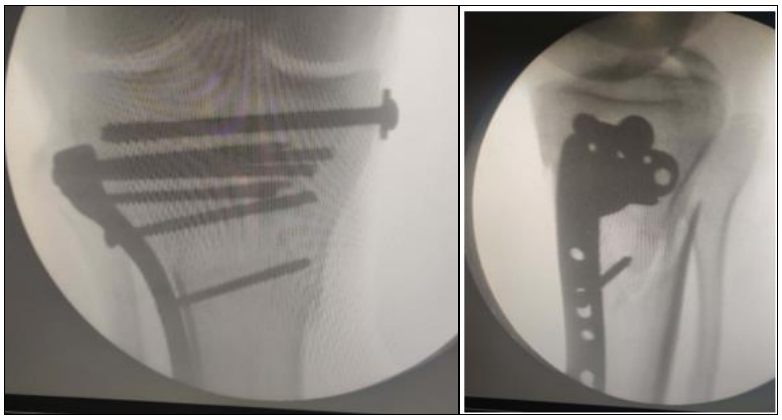

Fig 5: C-Arm Images

Postoperative Follow-up protocol

Dressing done with adequate pads. Limb is elevated with pillow or on Bohler brown splint. Drain removed on second post operative day. Limb is monitored for wound healing & compartment syndrome. On third postoperative day, Active mobilization was started. On 12th day, sutures were removed and finally patient discharged with non weight bearing on crutch walking.

Follow-Up

To assess union and allow for partial weight bearing at the end of 8 weeks, the patient was on regular follow-up every 4 weeks. Full weight bearing was started once the radiological union is achieved.

Complications

3 patients had superficial infection managed by intravenous antibiotics, daily sterile dressing & wound debridement. One patient had proximal 6.5mm cancellous screw prominence which was removed on 4th month of postoperative period. 3 patients had sometime pain treated with analgesics.

Assessment

The Functional & Radiological assessment was done based on Modified Rasmussen criteria

Table 1

Table 1
Criteria for Rasmussen clinical assessment.

Subjective	Points
A. Subjective complaints	
a. Pain	
No pain	6
Occasional pain	5
Constant pain after activity	4
Significant rest pain	0
b. Walking capacity	
Normal walking capacity (in relation to age)	6
Walking outdoors for at least 1 h	4
Short walks outdoors for >15 min	2
Walking indoors only	1
Wheel-chair/bedridden	0
B. Clinical signs	
a. Extension	
Normal	6
Lack of extension (0–10°)	4
Lack of extension > 10°	2
b. Total range of motion	
≥140°	6
≥120°	5
≥90°	4
≥60°	2
≥30°	0
c. Stability	
Normal stability in extension and 20° of flexion	6
Abnormal instability 20 °of flexion	5
Instability in extension < 10°	4
Instability in extension > 10°	2
Maximum	30
Excellent	27–30
Good	20–26
Fair	10–19
Poor	<10

Table 2

Table 2
Criteria for Rasmussen radiologic assessment.

Subjective	Points
A. Articular depression	
Not present	6
<5 mm	4
6–10 mm	2
>10 mm	0
B. Condylar widening	
Not present	6
<5 mm	4
6–10 mm	2
>10 mm	0
C. Angulation (valgus/varus)	
Not present	6
<10°	4
10–20°	2
>20°	0
Maximum	18
Excellent	18
Good	12–17
Fair	6–11
Poor	<6

Results & D iscussion

Road traffic accident was the mode of injury for all patients included in the study. Male preponderance is more common than females (4:1.) Right side incidence is around 47%, and left side incidence is 53%.Type I -33.33%(10) is the most common followed by Type VI -26.66% (8).Out of 30 cases operated, incidence of fracture in the middle age group 40-60 years was 60% (18 patients) Two patient had associated injuries.Bone grafting was done for 5 patients(16.66%) out of 30 cases where it was necessary to elevate the depressed fracture.Average follow up month is 12.1 (3 to 22).Time range required for fracture union were found to be around 11-18 weeks with mean average of 12.96 weeks.

About 1.2% of all fractures are complex intraarticular tibial plateau fractures, which compromise knee stability & function and cause significant morbidity. These fractures result from high-velocity injuries and are frequently accompanied by substantial soft-tissue injury and comminution. Restoring joint congruity, limb alignment, and early joint mobilization are the objectives of treatment. Only fair results are seen in 20% to 50% of these fractures due to difficulty in achieving stable internal plate fixation without injuring the soft-tissue envelope. The hybrid

external fixator avoids soft tissue issues but runs the risk of malalignment, pin tract infections, and poor patient compliance. Open reduction and internal fixation (ORIF) with plates and screws enables direct fracture visualization, reduction, and fixation, but there is a high risk of soft tissue injury, stiffness, and deep infection.

Biological fixation techniques were created as a result of the idea of protecting the blood supply and atraumatic surgery. This method results in less soft tissue injury and a higher union rate. The creation of locking implants has improved the management of the soft tissue while enabling the adoption of a minimally invasive approach for unilateral plating. In the proximal third of the tibia fracture with metaphyseal comminution, lateral locking plates offer improved stability. They can also be used in place of a medial plate or external fixator to give additional support for the medial column in bicondylar fractures. With the use of this plate, fixation is possible by a single incision, preventing the wound dehiscence, infection, and protracted immobilization caused by extensile techniques. MIPPO offers percutaneous sub muscular implantation and indirect fracture reduction. Favorable results in MIPPO are attributable to less extensive soft-tissue envelope dissection and devitalization of fracture fragments.

The goal of our study was to analyse the functional & radiological outcome of tibial condyle fractures treated by minimally invasive percutaneous plate osteosynthesis. There is no standard scoring system for evaluating the functional outcome for these fractures. The literature lists a number of scoring systems. In our study, we used the Modified Rasmussen Functional & Anatomical Score to evaluate the patients. A single lateral plate was used to treat all of these fractures. Percutaneous cancellous screws were used to fix the opposing condyle in type V and type VI fracture cases as needed.

In our study, unilateral plating for type V and type VI fractures did not result in any late problems, such as loss of reduction or malalignment. Functional outcome at the halfway point of the study is comparable to literature. We weren't able to statistically determine which surgery is better because our study sample was small.

Conclusion

We concluded from our study that, when treated with MIPPO plating, tibial plateau fractures have excellent to good clinical, functional, and radiological outcomes. Early care in post operative period is crucial for early mobilization of the joint to achieve good functional range of movement. Adequate anatomical reduction and rigid fixation is must without delay in surgical procedure for good soft tissue cover. Our results in minimally invasive percutaneous plate osteosynthesis (MIPPO) technique is in par with the literature. There is no significant difference in the functional outcome between single plating in our study and dual plating of other studies at midterm follow up. Choice of the procedure/implant should be based on the fracture pattern, bone quality and intraoperative fracture reduction.

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