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Proximal tibia MIPO locking plate-prospective study of functional outcome for AO/OTA type 41-B, C fracture

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Abstract

Objective: The aim of our study was to evaluate the functional outcome using the HSS knee scoring system and complications of tibia plateau fractures in the Indian population treated with the Locking Anterolateral plate with the MIPO technique.

Method: A prospective study was carried out in our institute at Kolhapur. A total number of 57 patients with tibia plateau fracture (AO/OTA type 41-B, C) were studied between March 2019 and Jan 2021. All were treated with an anterolateral locking plate via anterolateral approach and MIPO technique. A mean follow-up of 12 months was carried out, and evaluation was done with the help of the HSS (Hospital for special surgery) Knee scoring system.

Result: The mean radiological union time was 16 weeks. The outcome was measured using HSS knee scoring. The average follow up period was 12 months with good patient satisfaction. A total of 11 patients out of 57 reported complications like Non-union (2%), Delayed union (7%), Infection (5.20%) and hardware irritation (5.20%). No case of peripheral neuropathies reported in any of the patients.

Conclusion: Locking anterolateral plating via the MIPO technique is a good treatment option showing good clinical outcome in the treatment of tibia plateau fracture (AO/OTA type 41-B, C). It offers a more stable fixation and good functional recovery after the surgery.

Keywords: Tibia plateau fracture, MIPO, locking plate, anterolateral locking plate, proximal tibia plating, AO/OTA Classification

Introduction

The tibia plateau fracture contributes around 1-2% to all long bone fracture [1, 2]. Like other periarticular fracture the tibia plateau fracture also present bimodal age distribution. Comminuted fractures are more common in high-energy mechanism of injury like motor vehicle accident, fall from height, etc. Proximal tibia fractures (AO/OTA type 41-B,C) are serious injuries and present treatment challenges and difficult to treat because of the operative approach that maybe required and the instability of the construct. The anterolateral aspect of tibia is covered with a very thin layer of skin and subcutaneous tissues so taking good care and gentle dissection becomes very crucial in treating proximal tibia fracture with internal fixation [3]. In addition, cancellous bone at periarticular area and comminution at fracture site poses a challenge to the operating surgeon in achieving stable fixation. Being an articular fractures it demands precise reduction and stable construct. Any treatment modality for these fracture demands maintenance of the normal function of the knee joint, improvement in the joint instability, prevention of lower limb malalignment and deformity, and prevention of knee osteoarthritis. We can prevent these complication by a well maintained articular surface, uniform plateau level, and a near normal range of knee joint motion. The main defined criteria in functional assessment of patients with proximal plateau fractures of tibia include >120 knee flexion, time to achieve union, patient's ability to walk pain free and to climb stairs, the pain severity while activities as well as at rest, muscle strength, severity of instability in the knee, and loss of active extension of the knee.

Recently, the use of MIPO (Minimally invasive plate osteosynthesis) technique is burgeoned in treating these type of fractures as they preserve periosteum and thus blood supply of the bone and have been showing better functional recovery than conventional plate osteosynthesis,

external fixation and intramedullary devices [4-6] The use of MIPO technique is more biological in minimizing soft tissue dissection, a single lateral plate using MIPO reduces incision size and muscle stripping; risk of infection is also reduced. Locking screws help getting perfect reduction and absolute stability [7-9]. We have been using anterolateral locking plate with MIPO technique for providing good balance between biology and mechanical stability.

Aim

The aim of our study was to evaluate the functionality using HSS knee scoring system and complications of tibia plateau fractures (AO/OTA type 41-B, C) in the Indian population treated with anterolateral locking plate using MIPO technique.

Materials & Methods

This is a prospective study done from March 2019 to Jan 2021, in 59 patients of tibia plateau fractures (AO/OTA type 41- B, C). All patients were treated with Anterolateral locking plate with MIPO technique in a tertiary care center in Kolhapur. All patients included in our study were between 23 to 57 years of age (Mean age 38.5 years). Simple random method was used as the study sampling method.

Inclusion criteria:

- Patients undergoing Proximal tibia Anterolateral locking plate using MIPO technique for AO/OTA type 41-B,C
- Closed fractures
- Patient of both sexes
- Patient of age >21 years

Exclusion Criteria

- Patients having pre-existing deficit/instability in knee function
- Patient with prior surgery around the knee joint.
- Patient having other fractures in same extremity e.g, femur fracture, and fracture around ankle joint although Fracture proximal and mid shaft fibula not considered as exception in our study.
- Pathological fractures other than osteoporosis
- Patient having neurovascular deficit
- Compound fractures with extensive soft tissue damage where the plate cannot be covered with soft tissue.

Plain radiograph of the concerned shoulder with AP (antero-posterior) and lateral views were taken along with CT of the concerned knee with 3D reconstruction done.

The HSS (hospital for special surgery) knee scoring system was used as evaluation method for the calculation of functional outcome of the patient.

Surgical Technique

All 59 patient underwent surgery after taking consent in our institute. Patients were admitted and preoperative splitting with knee brace and analgesia was given. All patients were operated under spinal anesthesia in supine position on radiolucent table. To prevent maintain neutral rotation of lower limb a drape bump was kept under the gluteal region. A pneumatic tourniquet was applied. Under all aseptic precaution painting draping done below the tourniquet along with ipsilateral iliac crest for bone grafting. A 5cm long curved anterolateral incision was made from the Gerdy tubercle to lateral of tibial tuberosity. Skin, subcutaneous tissue cut. The metaphyseal component of the fracture was reduced using direct manipulation and temporarily holded

with K-wires. After Reduction LCP Plate (7 hole, 9 hole, 11 hole) introduced submuscularly through incision. With traction diaphyseal reduction achieved and plate fixed provisionally with K-wires. An acceptable reduction is less than 5° varus/valgus and less than 5° in coronal plane, less than 10° rotation. Position of plate was confirmed under C arm in both Antero posterior view and in lateral view. Plate was flush fixed to proximal tibia with help of clamps. If necessary then bone grafting was performed from iliac crest. Cancellous bone graft was taken from iliac crest and placed at the fracture site. After confirming anatomical reduction plate fixed proximally with bicortical locking screws of 4.9mm and then most distally with stab incision with 4.9mm cortical screw. A total of five or six 4.9 mm locking screws were placed to the proximal fragment and three or four locking screws were placed in the shaft fragment through small stab incision. We also used 4mm partially threaded Cannulated screws through proximal hole in the plate as in the plate as Lag screw to achieve fracture reduction by compression of fracture fragment. The fixed angled locking screw gives absolute stability at metaphyseal region and bridging gives relative stability at diaphyseal region. It is important to check knee joint stability after the fixation. Intravenous antibiotics were continued for 3 post-operative days. Post-operative X-ray is an important radiological documentation for reduction and fixation. Patients were started with Quadriceps exercises and ankle mobilization from 2nd or 3rd postoperative day according to the tolerance of patients. Patients were allowed toe-touch partial weight-bearing after one month of surgery, Progressive weight-bearing was allowed according to the callus formation as assessed in follow up X-Rays. The patients were regularly followed-up on an OPD basis and were assessed both clinically and radiologically. In follow up patients were evaluated for complication like infection, non-union, delayed union, angular deformity, shortening, or implant failure. The patients were under follow up to 12 months. The functional outcome was evaluated with HSS (Hospital for special surgery scoring system) knee score.



Fig 1: Anterolateral approach for MIPO technique



Fig 2: Postoperative day 3 images showing sutured incisions



Fig 3: AO/OTA type 41 C2 X-ray -Preoperative & Postoperative

Table 1: Demographic Variants-1

	Number	Mean Age
Male	36	35.8 yrs.
Female	21	43.0 yrs.
Total	57	38.5 yrs.

Table 2: Demographic Variants-2

		Number of patients	%
Side of injury	Right	23	40.3%
	Left	34	59.6%
Mechanism of Injury	RTA	47	82.4%
	Fall from Height	10	17.6%
Associated Injury	Isolated injury	42	73.7%
	Multiple fracture	15	26.3%

AO/OTA fracture classification system was used. 36 patients (63.2%) were AO type 41-B whereas 21 patients (36.2%) were AO type 41-C fractures respectively. Out of 21 Type 41-C patients, 15 patients (71.4%) had distal fracture extension up to proximal third of tibia shaft only and 6 patients (28.6%) had fracture extension up to middle third of tibial shaft.

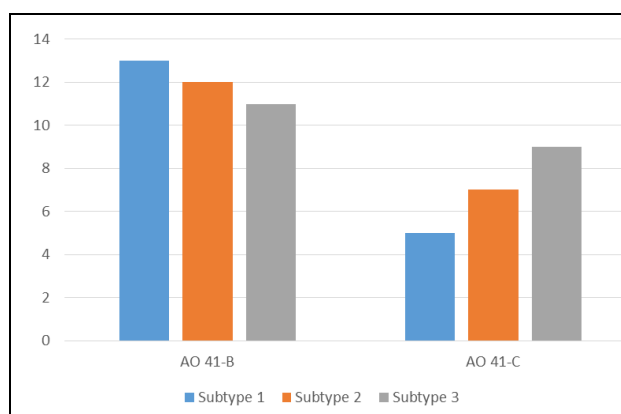


Chart 1: AO/OTA Classification

Table 3: AO/OTA Classification of cases

AO Type	No. of patients	%
B1	13	22.80
B2	12	21.10
B3	11	19.30
C1	5	8.80
C2	7	12.30
C3	9	15.70

Out of 57 patients 19 patients (33%) had chronic illness like

hypertension and diabetes. The mean time taken between onset of injury and surgical intervention was 5.2 days. Blistering over proximal leg was seen in 7 patients (12.3%), because of which their surgery was delayed, with average delay of 12 days and it ranged from 7 days to 15 days. The average duration of surgery was 93 minutes (range 60 min to 140 min). Bone grafting was done in 6 patients (10.5%).

Table 4: Associated condition

Condition	No of cases	%
Blistering	7	12.3
HTN	13	22.8
DM	11	19.3

There were no cases of neurovascular injury encountered in the present study. The average duration of the radiological union was 15 weeks in 41 (71.9%) cases, 17 weeks in 9 (15.8%) cases, and 20 weeks in 3 (5.3%) cases. Delayed union was seen in 4 (7.0%), Infection 3 (5.3%), Nonunion 1 (1.8%), hardware irritation 3 (5.3%), Knee ROM >120 degree 36 (63.15%) and Knee ROM <120 degree 21 (36.85%) cases. The infection was in the superficial plane and was treated with daily dressing and the appropriate antibiotics after isolating the organism by pus culture and sensitivity method. There was no recurrence of infection in that case. There were no case of deep infection encountered in the present study. None of the patients in the present study required the knee brace after 6 weeks post-operatively. 6 (10.5%) patients started physiotherapy after 4 weeks post-operatively due to poor compliance.

Table 5: Complications

Complication	No. of cases	%
Infection	3	5.3
Delayed Union	4	7.0
Non Union	1	1.8
Hardware Irritation	3	5.3

Table 6: Average Surgery Duration

AO Type	Duration
B1	70.4 min
B2	80.9 min
B3	99.5 min
C1	95 min
C2	119.3 min
C3	122.3 min

Table 7: HSS Knee score result

AO Type	Average Score	Excellent	Good	Fair	Poor
B1	89.90	12	1	0	0
B2	85.52	7	5	0	0
B3	82.88	3	8	0	0
C1	78.40	1	4	0	0
C2	75.44	0	6	1	0
C3	69.43	0	5	3	1



Fig 4: One year follow up showing weight bearing and squatting

Table 8: Hospital for special Surgery (HSS) Knee scoring-1 Numbers indicative of number of patient falling in that category of score

AO Type	Pain (30points)									Functions (22points)								ROM (18 points)	
	No pain	Walking Pain			Rest Pain			Unlimited	Walking & standing			Stairs		Transfer					
		No	Mild	Mod	severe	No	Mild		Mod	severe	5-10blocks,>30min	1-5block,<30min	<1block	No	Without support	With support	Without support		With support
B1	4	2	8	0	0	9	1	0	0	4	8	1	0	0	11	2	10	3	132°
B2	3	0	9	0	0	6	3	0	0	4	7	1	0	0	12	0	9	3	118°
B3	0	0	11	0	0	9	2	0	0	4	4	3	0	0	8	3	7	4	112°
C1	0	0	5	0	0	1	4	0	0	1	2	2	0	0	3	2	4	1	119°
C2	0	0	7	0	0	1	5	1	0	2	3	2	0	0	3	4	4	3	117°
C3	0	0	9	0	0	2	3	4	0	2	4	2	1	0	5	4	5	4	91°

Table 9: Hospital for special Surgery (HSS) Knee scoring-2 Numbers indicative of number of patient falling in that category of score

AO Type	Muscle Strength (10 points)				Flexion deformity (10 point)				Instability (10 points)				Subtraction score							
													Support (-1/-2/-3)		Extension Lag (-2/-3/-5)		Varus/ valgus (-1/5°)			
	Excellent	Good	Fair	Poor	No	<5°	5-10°	>10°	No	<5°	5-15°	>15°	1 cane	1 crutch	2 crutch	5°	10°	15°	5°	10°
B1	11	2	0	0	11	2	0	0	5	8	0	0	1	0	0	1	0	0	0	0
B2	6	6	0	0	5	7	0	0	6	6	0	0	1	1	0	3	0	0	1	0
B3	8	3	0	0	5	6	0	0	5	6	0	0	2	0	0	1	1	0	1	0
C1	2	3	0	0	3	2	0	0	2	3	0	0	1	0	0	0	0	0	2	0
C2	4	2	1	0	3	4	0	0	2	5	0	0	1	0	0	2	0	0	1	1
C3	3	4	2	0	2	5	2	0	2	6	1	0	2	0	0	1	0	1	3	0

Discussion

Every case of tibia plateau fracture needs to be individualized for treatment plan. Every case demands to be individualized. The conservative treatment is a good option for minimally displaced stable fracture, but complications like Malunion, shortening, joint stiffness and osteoarthritis of knee joint have been reported [10, 11]. Open reduction of tibia plateau fractures and internal fixation with plate disrupts fracture biology. Achieving anatomical reduction with large incisions, extensive soft tissue dissection and periosteal stripping results in loss of fracture hematoma and increases chances of non-union, delayed union and infections [12, 13]. In attempt to avoid these complication we need to balance between mechanical and biological fixation during treating these fractures. Our previous concept of absolute stability and mechanical fixation is being shifted to biological approach with minimal soft tissue dissection and less rigid fixations [14]. Minimally invasive plate osteosynthesis (MIPO) technique maintains a biologically favorable environment for fracture healing. Visualization of fracture fragment and direct reduction is difficult with small incisions and learning curve of MIPO

technique with fluoroscopy guided reduction is quite takes long [15].

In this study we favored early surgical fixation, but the timing of surgery depended on the soft-tissue conditions, and surgery was delayed if the fractures had established severe swelling and skin blister (12.3% cases, average delay 12 days). All other patients were operated within the first week (Mean time 5.2 days) as the delay in surgery makes the reduction difficult [16]. In this study, it was observed that fractures of the proximal tibia were more prevalent in younger and middle-aged population with the mean age being 38.5 years (ranges 23 to 55 years). Males (63%) were more commonly affected than females (37%). In the study by Tul B Pun *et al.* (2014), the mean age of the patients was 43.85 years (range 22-61 years). There were 20 male patients and 1 female [17]. In the study by R. Jiang *et al.* there were 29 males and 12 females with mean age of the patients 41.4 years (range 19-83) [18]. In another study by P Phisitkul *et al.* 22 males and 15 females aged between 22 and 71 years (mean age of 45 years) were included [9]. Zura RD *et al.* included 78 patients with an average age of 43 years (range 14 to 81 years) in their study

with 59 male patients and 19 female patients [19]. Hence, it can be concluded that the tibia plateau fracture were found to be more common in male and in middle-aged population. Tibia plateau fracture being a high velocity injury is more common in this group. In the our study of 57 cases, 82% of fractures were due to Road Traffic Accidents and 18% fractures were due to fall from height. Hak DJ *et al.* included 142 patients in study, the mode of the injury was due to high energy injury in which 40% cases were pedestrians hit by vehicle and 40% cases were fall from height and 4% were due to sports injury and remaining were due to motorcycle collision [20]. In the study by P Phisitkul *et al.*, 15 patients sustained a fracture after falling from a height, 17 patients through RTA, 2 patients in a crush injury, and 1 patient during the fight [9]. This signified that the majority of tibia plateau fractures occurs due to high velocity mechanism leading to severely comminuted intra-articular fractures.

Regarding surgical procedure, under spinal anesthesia patients in supine position on a radiolucent table, with tourniquet, ipsilateral iliac graft site also prepared.

Strategy of surgery is to first convert type 41-C fracture into type 41-A fracture by provisionally fixing the articular fragments as a single articular block. Then the lateral plate is inserted submuscularly and metadiaphyseal component is bridged.

The proposed steps for lateral locked plating are outlined as follows:

- Articular fracture reduction and provisional fixation;
- Reduction of the reconstructed metaphyseal part to the diaphysis;
- Percutaneous locking plate insertion and fixation.

Reduction clamps can be used to reduce split fractures.

A window through the cortical bone can be made to reach the subchondral metaphyseal region for centrally depressed articular fragments (when reduction was not feasible by ligamentotaxis). The articular surface can visualized with sub-meniscal approach when needed.

Once the elevation of the depressed articular fragments was done and the lateral split fragment is reduced to the medial condyle, subchondral screws were placed using 4.9 mm locking bicortical screws. It is not necessary to place screws in all the holes of proximal holes, sometimes screws may interfere with the reduction and bone grafting of the depressed part of articular surface.

In our study, the average duration of union was 16 weeks, which was comparable to other studies of biological plating. Complication rate was low. Our incidence of complications included 3 case of superficial infection, only 1 case of non-union, 4 case of delayed union, 3 case of hardware irritation. Superficial infections did well with daily dressing and appropriate antibiotic cover. The cause of non-union was early mobilization, comminution, fracture pattern, and was the first case in our learning curve. This case required a revision surgery with bone grafting to achieve union.

In our study, all the fractures had good reduction and the location of plate was good. The highlights of this study were absence of deep infection, high rate of union with average time of 16 weeks and early mobilization. The excellent success rate was achieved due to indirect or closed reduction of fracture without disturbing fracture hematoma. The limitations in our study were the small sample size and the lack of a control group.

To conclude, locking compression plate system acts as a good biological fixation for proximal tibial fractures even in difficult fracture situations. MIPO technique offers faster

healing and better outcome than ORIF in patients with proximal tibial fractures.

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