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Study of clinical and radiological outcome of extra-articular proximal tibia fracture treated with minimally invasive plate osteosynthesis (MIPO) technique

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Abstract

Background: The management of proximal extra-articular tibia fractures is challenging to a surgeon because of its complex fracture pattern and anatomical location. The aim of our study is to assess the functional, clinical and radiological outcome of MIPO in extra articular proximal tibia fractures.

Materials and Methods: This is a prospective study of 43 closed extra articular proximal tibia fracture patients. The study was done in between July 2017 to September 2019 at a tertiary care centre in India.

Results: The mean age was 32.5 years (range 31-65). The primary bony union was achieved by an average of 16.32 weeks (range 14 to 24 weeks). According to the Modified Rasmussen's criteria, 23 patients (53.48%) had excellent outcome, 12 patients (27.90%) had good outcome and 8 patients (18.60%) had fair outcome. The mean range of motion of the knee is 124.23° (Range 10-150°). The complications include Infection (9.3%) and varus malunion (18.60%).

Conclusion: Minimally invasive percutaneous plate osteosynthesis technique offers biological advantage with minimal complication and fulfils the demands of fast implantation, soft tissue protection and high biomechanical stability.

Keywords: Extra-articular fractures, proximal tibia, minimal invasive plate osteosynthesis (MIPO), Rasmussen's score, locking compression plate

1. Introduction

Tibia fractures are one of most common long bone injuries in the lower limb. The incidence of extra-articular proximal tibia fractures accounts for 5-11% of all tibia fractures ^[1]. The anatomy, position and pattern of proximal tibia fractures make its management challenging to a surgeon. Even as multiple treatment options like close reduction and casting, open reduction and plating and intra-medullary nailing are available, the treatment of choice is still debatable. Conventional open reduction and internal fixation of such injuries result in extensive soft tissue dissection, periosteal injury, compromise of the blood supply, high rates of infection and delayed union ^[2, 3]. Intramedullary nailing shows high rate of malreduction and malunion of fracture ^[4, 5]. Similarly, external fixation of metaphyseal tibia fractures may be associated with a high incidence of pin site infection and malunion ^[2]. Management of these fractures with closed reduction and cast application usually leads to problems related to prolonged immobilization, malunion and joint stiffness ^[2].

After development of low profile plates, the minimally invasive plate osteosynthesis (MIPO) technique offers the best biological advantage. It offers stable fixation without compromising the surrounding soft tissues ^[6]. The aim of our study is to assess the functional, clinical and radiological outcome of MIPO in extra articular tibial fractures.

2. Material and methods

This is a prospective study of 43 patients in between July 2017 to September 2019 at a tertiary care centre in India. Ethical committee approval was taken from the ethical committee of the institution. Written informed consent was obtained from each of the patient for the study. Inclusion criteria includes, closed extra articular proximal tibia fractures in 19-65 years age

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group. The open fractures, fractures of paediatric age group, pathological fractures, patients with severe comorbidities and fractures associated with neurovascular deficit were excluded from the study. Plain radiographs (anteroposterior and lateral view) of the fractured tibia with knee were taken to assess the fracture pattern. Fractures were classified with the help of AO/OTA classification.

Management protocol: Initial assessment and resuscitation of the patient was done in the casualty department according to the Advanced Trauma Life Support protocol. After preoperative workup and subsidence of the soft tissue swelling, we scheduled the patients for operative procedure. Under regional anesthesia, the surgery was performed on a plane table in supine position. We didn't use tourniquette in any of the patient. The knee was flexed on a quadriceps board by placing a bolster under the knee for fracture alignment and ease of reduction. Painting and draping was done under aseptic conditions. Preliminary fracture reduction was done with traction and manipulation under image intensifier before starting the surgical procedure. Small skin incision of 3-4 cm length was made, starting just distal to the knee joint line and extending distally with anterior convexity, ending just near the shin of the tibia. The subcutaneous tissue was cut in the line of the incision & the origin of the tibialis anterior muscle was stripped off. The periosteum was preserved to prevent the compromise of the blood supply of the underlying bone [Fig - 1]. We have used proximal tibia locking plate in all the patients. The plate was slid across the fracture site under the submuscular plane. Indirect reduction was achieved by traction and physical manipulation. Fracture reduction and plate position was confirmed by use of an image intensifier. Provisional k-wires were inserted through the plate holes to maintain reduction. At least three Locking cancellous screws were passed proximally in the metaphyseal bone for adequate stability. The distal incision was kept directly over the holes of the plate, just lateral to the shin of the tibia over the lower end of the plate. Depending on the quality of bone, cortical screws or locking screws were used to fix the plate distally. Plate placement and its length were evaluated according to the fracture geometry. Proximal & distal incisions were closed in layers. Sterile dressing was applied. Before shifting the patient out of the operation theatre, distal pulses were confirmed. Post-operative limb elevation was advised to the patient and patients' vitals and soakage were monitored. Postoperative physiotherapy was started from the first postoperative day. Surgical site was evaluated and the patients were discharged on the 3rd postoperative day. Surgical sutures were removed after the 14th postoperative day on outpatient basis. Partial weight bearing was encouraged after 6-8 weeks, after confirming the callous formation using radiographs. Full weight bearing was advised after the confirmation of the bony union. All the patients were regularly followed up at intervals of 6-8 weeks till complete fracture union. On follow up, the patients were evaluated for clinical and radiological outcome according to the Modified Rasmussen's criteria [6, 7].

3. Observation and Results

Forty three proximal extra articular tibia fracture patients met the inclusion criteria. Total study sample contains 32(74.4%) males and 11(25.58%) female patients. The mean age was 32.5 years (range 31-65). The Road Traffic Accidents 34(79.06%) was major cause of injury in this study group [Table 1]. According to AO/ OTA classification 28(65.1%) fractures are AO/OTA 41A2 and 13(34.8%) fractures are AO/OTA 41A3 category. The average duration between

injury and procedure was 7.39 days. 72.09% of patients were operated within the first week of trauma and 27.90% patients underwent operative procedure in the 2nd week after trauma because of local swelling and oedema. Mean hospital stay of patients was six days. Primary bony union was achieved in all 43 patients by an overall average of 16.32 weeks (range 14 to 24 weeks). The clinical and radiological outcome was assessed according to Rasmussen's criteria [Table 2] Mean loss of extension is 4.34° (Range 5-16°) and mean range of motion of knee is 124.23° (Range 10-150°). The overall Infection rate was 9.3%. 3(6.97%) Patients had superficial skin infection at the surgical site which healed eventually by wound dressing and antibiotics and 1(2.32%) patient had a deep infection which required implant removal after fracture union.

A malunion was defined as a coronal plane (varus-valgus) or sagittal plane (anterior-posterior) angulation of >5 degree [8]. In our study 8(18.60%) patients had varus malunion of an average of 7 degree.

4. Discussion

The management of proximal extra articular tibia fractures is challenging to a surgeon because of its complex fracture pattern and anatomical location. Road traffic accidents are one of most common cause of this type of fracture. Any fracture around the weight bearing joint like knee joint is of paramount importance as it would result in significant morbidity and reduced quality of life [9]. Even as varieties of treatment options are available, the choice of treatment is still debatable [10]. Goal of treatment is early restoration of strength of bone and function of knee joint with minimal injury to soft tissue. Proper preoperative planning, less soft tissue damage, stable fixation and early knee joint mobilizations are the key points to achieve a good outcome [11, 12]. Conventional plating results in extensive soft tissue dissection and periosteal injury, compromising the blood supply, and may be associated with high rates of infection, delayed union, and nonunion [2, 3]. Intramedullary nailing shows high rate of malreduction and malunion. Factors responsible for mal-alignment include the tibial nail entry, angulation of nail, pull of patellar tendon and difference between the diameter of the implant and medullary canal in the metaphysis [13]. External fixation method shows high rate of pin tract infection and malunion [2].

Minimal invasive plate osteosynthesis (MIPO) is the effective method of stabilization. It is internal fixation of fractures using indirect reduction techniques and insertion of implant remote from fracture site by using small incision [14]. It fulfills the demands of fast implantation, soft tissue protection and high biomechanical stability [15]. Because of predominance of metaphysical bone and rich vascular supply the non-union is rare in these fractures [16]. In our study, we used the anatomically contoured plate and locking screws. It helps to provide angular stability at the screw plate junction. The load transmission across the fracture site occurs through the screw-plate junction. In this case the tight apposition of plate to bone is not required, which spares the bone vascularity. The problems associated with stiff fixation are avoided by not using excessive locking screws unnecessarily. To prevent mal-alignment, the plate is placed with the knee in semi-extended position, and the fixed angle screws prevent the displacement of the reduced fracture [13, 17].

The radiological and functional outcome were assessed according to the Modified Rasmussen's criteria [6, 7]. In our study, 23 patients (53.48%) had excellent outcome, 12 patients (27.90%) had good outcome and 8 patients (18.60%)

had fair outcome. Mean loss of extension is 7.34° (Range $5-20^\circ$) and average range of motion is 124.23° (Range $10-150^\circ$). Meena R.C^[8] and Dr AD Gupta^[7] also reported average knee range of motion of 115.2 degree and 147.33degree respectively. Primary bony union was achieved in all 43 patients by an overall average of 16.32 weeks (range 14 to 24 weeks). Monappa A Naik *et al.*^[18] reported union after 20 weeks in closed fractures.

Overall Infection rate was 9.3%. 3(6.97%) Patients had superficial skin infection at surgical site which healed eventually by wound care, 1(2.32%) patient had deep infection which required implant removal after bone union. Lindvall *et al.*^[19] reported high rate of infection rate (24%). In our study 8(18.60%) patients had varus malunion of average 7 degree. monappa A Naik *et al.*^[17] and Lindvall *et al.*^[18] reported 20.14% and 20.6 malunion respectively.



Fig 1: intraoperative picture of operative procedure.



Case 1: Preoperative and postoperative radiographic images of proximal tibia extra articular comminuted fracture treated with MIPO plating.



Case 2: Preoperative and postoperative radiographic images of proximal tibia extra articular fracture treated with MIPO plating

Table 1: Mode of trauma in proximal tibia fracture

Mode of trauma	Number of patients	Percentage
Road traffic accident	34	79.06%
Domestic	6	13.9%
Industrial	3	6.9%

Table 2: Clinical and radiological outcome according to Rasmussen's criteria

Rasmussen's outcome	Number of patients	Percentage
Excellent	23	53.48%
Good	12	27.90%
Fair	8	18.60%

5. Conclusion

Minimal invasive plate osteosynthesis technique (MIPO) is a better choice in extra-articular tibia fracture treatment due to its better result with minimal complication. It requires proper pre-operative planning, intra-operative radiographic intervention to maintain fracture alignment, limb axis and the limb length.

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