

Research Article

A study of MIPO by locking compression plate fixation in the management of distal tibial metaphyseal fractures

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ABSTRACT

Background: Management of distal tibial metaphyseal fractures has been a difficult area because of the subcutaneous position of tibia. Exposure of implant has been a major problem in open reduction and fixation of these fractures. Minimally Invasive Plate Osteosynthesis (MIPO) is an established technique for fixation of fractures of the distal third tibia. Our study is aimed at management of intra-articular and extra-articular fractures of the distal third tibia by minimally invasive plate osteosynthesis technique by locking compression plate and follow them prospectively. Clinical and radiological outcomes were studied and clinical indications & efficacy of the procedure reviewed.

Methods: From June 2012 to May 2014, 22 patients of closed distal tibial metaphyseal fractures were operated by MIPO technique with a distal tibial locking compression plate having 4.5/5 proximal and 3.5/4 distal screw holes. The follow up duration was for 2 years at our hospital.

Results: The mean fracture healing time was 5.5 months (range 4-13months). We had 90% of union rate with good ankle movements and walking distance in 75% of the patients. Post-operatively we had complications of, superficial infection occurred in 2 patients, implant failure in 1 patient leading to non-union and delayed union in 1-patient each.

Conclusion: MIPO technique provides good, stable fixation of distal tibial metaphyseal fractures. Although slightly delayed bone healing, MIPO decreases the incidence of non-union and need for bone grafting. This technique should be used in distal tibia fractures where locked nailing cannot be done like fractures with small distal metaphyseal fragments, vertical splits, markedly comminuted fractures and in fractures with intra-articular extension.

Keywords: Metaphyseal, Locking, Minimally invasive, Osteosynthesis

INTRODUCTION

Treatment of distal diaphyseal tibia fracture with or without articular extension is challenging because of its unique anatomical characteristics of subcutaneous location with precarious blood supply and proximity to the ankle joint.¹ Most of these fractures are managed with an operative intervention such as closed reduction and intramedullary interlocking (IMIL) nailing² Open Reduction and Internal Fixation (ORIF) with plating or closed reduction and per cutaneous plating or external

fixators.³ Each of these techniques has their own merits and demerits. IMIL nailing has been reported with higher rate of malunion because it is difficult to achieve two distally locking screws. Wound infection, skin breakdown and delayed union or non-union requiring secondary procedures like bone grafting are some of the complications associated with conventional osteosynthesis with plates. Similarly, pin tract infection, pin loosening, malunion and non-union leading to osteomyelitis is potential complication of external fixators and hence not preferred as definitive fixation

method. Recently, techniques of closed reduction and Minimally Invasive Plate Osteosynthesis (MIPO) with Locking Compression Plate (LCP) has emerged as an alternative treatment option for distal diametaphyseal tibia fracture.⁴ When applied subcutaneously, LCP does not endanger periosteal blood supply, respect fracture hematoma and also provides biomechanically stable construct. Number of previous clinical studies have established MIPO with LCP as a biologically friendly and technically sound method of fixation for distal diametaphyseal tibia fracture but most of these studies except by Ronga et al. and Ahmad et al. have included both open and closed fractures. Since behaviour of both of these fracture are different, comparison will be not fair. We therefore prospectively studied only closed distal diametaphyseal tibia fracture with or without articular extension managed with MIPO with LCP and compared with other studies.⁵

METHODS

22 patients with closed distal diametaphyseal tibia fractures with or without intra articular extension treated in our centre in Government General Hospital, in between June 2012 to May 2014 were prospectively followed (Table 1). Permission from institutional ethical committee from our centers was obtained. Demographic variables, mode of injury, injury-hospital and injury-surgery interval, time required for union, complications and need of secondary procedures were recorded. Fracture was classified according to AO/OTA classification system (Figure 1). Patients with pathological fractures, ipsilateral multiple fractures were excluded. After stabilising the traumatised patient, routine pre-anaesthetic investigations were carried out. Standard antero-posterior and lateral radiographs of the affected leg with knee and ankle joint were taken. X-rays taken were evaluated for fracture morphology, level and extent of comminution. The fibular fracture was noted and surgical plan decided accordingly. The type and likely length of the plate was calculated. The leg was immobilised in a plaster slab till definitive surgery. Patients with precarious skin condition were managed with limb elevation, regular dressing care and prophylactic intravenous antibiotics; surgery was delayed till appearance of the 'wrinkle sign', but performed within 2 weeks from trauma. Surgical procedure: Surgery was performed in our tertiary care trauma centre under regional anaesthesia with a tourniquet in the supine position on a radiolucent table. In the distal tibia, the locking compression plate was applied on the antero-medial surface. A locking compression plate of adequate length so that 6-8 cortices are obtained on either side of the fracture was kept on the leg and visualised under C-arm. The fracture was reduced by indirect means without opening the fractured area. Gentle manual traction/traction with calcaneal Denham pin and external manipulation e.g. a bolster under the ankle to correct the posterior displacement and angulation were adequate to reduce AO43A1 fractures. We fixed displaced fibular

fractures most of them by closed Rush nailing (Figure 2). After provisional reduction, a 3-4 cm vertical incision was given at the centre of the medial malleolus and a subcutaneous tunnel was opened with a haemostat or artery forceps. Then the selected locking compression plate with a locking sleeve screwed into its distal hole was held with a pen-like grip. The plate was tunnelled proximally subcutaneously across the fracture site, using the locking sleeve as the handle with a dagger hold. Smooth and gentle supination-pronation motions were used while inserting the plate. The thumb was kept anteriorly on the tibial crest and was used to guide the proximal part of the plate onto the antero-medial surface of the tibia. The plate was centred on the proximal fracture fragment in both antero-posterior and lateral views with the help of a locking sleeve inserted into the most proximal hole (Figure 3). Following confirmation, a drill bit or K-wire was used to fix the plate onto the tibia. Non locking screws were inserted first in either the proximal or distal fragment as required to aid in the reduction of the fracture so as to pull the bone to the plate. Locking screws were then passed through holes of the plate.

Post operatively the limb was elevated and a removable below knee slab was given. Toe touch weight bearing and knee range of motion was started on the 2nd postoperative day. Sutures were removed alternate at 2 weeks and all at 3 weeks, slab was continued for 4-6 weeks. Weight bearing was increased depending on the progress of clinical and radiological fracture healing. Full weight bearing was allowed at fracture union, which was defined as union in 3 cortices and painless weight bearing.

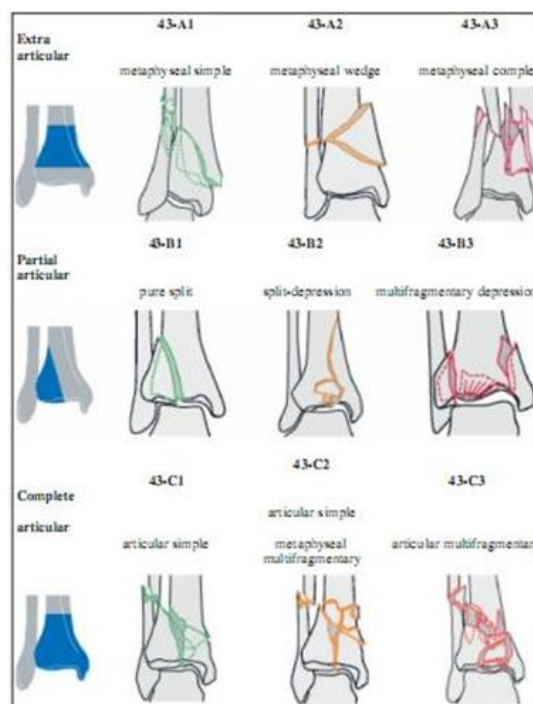


Figure 1: AO/OTA classification system type 43 distal tibial fracture.



Figure 2: Fixed displaced fibular fractures most of them by closed Rush nailing.



Figure 3: The plate was centred on the proximal fracture fragment in both antero-posterior and lateral views with the help of a locking sleeve inserted into the most proximal hole.

RESULTS

Mean time to union was 5.5 months (range 4-13 months). 20 (90%) fractures healed with good functional outcome. 1 patient (4.5%) had delayed union. 1 (4.5%) patient had non-union and underwent revision; the fracture ultimately healed with good functional outcome. 2 (9%) patients developed superficial wound infections, this infection was controlled by an appropriate antibiotics, the fractures united completely (Table 1). 16 patients (72%) had good Ankle dorsiflexion and extension. The walking distance was good in 16 (72%) patients. In 15 (65%) patients there were no Gait problems.

Patient 15 an osteoporotic elderly patient with a comminuted fracture both bone leg suffered mal-reduction with posterior angulation of 11° despite plating of the associated fracture fibula. He was re-operated with bone graft and locking plate it healed well. The fracture united after 8 months. Implant removal was done in 2 patients after union due to symptomatic skin impingement over the medial malleolus. Another plate was removed secondary to implant failure at re-surgery.

Table 1: Follow-up of 22 patients with closed distal diametaphyseal tibia fractures with or without intra articular extension.

Age (years)	AO type	Union (months)	Full weight bearing (weeks)	Complications
58	43A1	5	6	None
46	43A3	6	5	None
62	43B2	7	7	Superficial infection
52	43A2	9	8	None
54	43A1	5	6	None
48	43C2	5	5	None
36	43B2	6	9	None
76	43A2	6	6	None
40	43A2	11	10	None
45	43A3	13	12	Delayed union
67	43B2	6	6	None.
51	43A2	4	6	None.
28	43C1	6	6	None
33	43A2	5	5	None
76	43C1	-	22	Non union
38	43A2	6	6	None
36	43A2	4	4	None
48	43C2	7	6	None
57	43B3	9	8	Superficial infection
34	43A3	9	9	None
57	43A1	6	6	None
34	43A3	5	6	None

DISCUSSION

Distal tibial fractures remain one of the most substantial therapeutic challenges that confront the orthopaedic traumatologist. Though conservative management of these fractures has been described,⁷ these methods have been largely superseded by operative techniques for displaced or irreducible fractures, and fractures with intra-articular extension.

MIPO is by now an established technique of management of fractures of the distal third tibia. A comprehensive review of the technique is lacking, though some very good attempts have been made. Table 1 reviews the results of 22 such studies vis a vis our own.

In the fractures operated within 1 week of injury, the operative time was 85.4 min and time to union was 5 months. In the cases operated in the second week of trauma, the operative time was 91.2 min and time to union was 6 months. These findings were not statistically significant. As the time interval between surgery and the injury increase it becomes more and more difficult to indirectly reduce the fracture fragments. The ability to maintain a mechanically stable reduction with

intramedullary nailing becomes more difficult the further a fracture extends distally. The wide medullary canal in the metaphyseal area, results in reduced stability due to the large diameter of distal part of the tibia in relation to the diameter of nail. Fractures with minimal involvement of the ankle can be treated successfully by intramedullary nailing but this technique is inappropriate for pilon fractures with significant articular involvement.⁶ Modern tibial nail designs have interlocking holes that enable distal placement of screws in close proximity to the tip of the nail, but these screws have less purchase in metaphyseal bone; there is increased stress on the screws to maintain fracture alignment.⁷ Consequently late complications, in particular loss of reduction, are attributed to implant failure at the distal locking sites of the intramedullary nail.⁸

The mean time to union in smokers was 6 months while the mean time to union in non-smokers was 5 months, which was found statistically significant at 10% level of significance. The time to union varied from 5 months in AO 43-B1 fractures, 6 months in AO 43-C1 fractures (Table 1). The mean time to union in patients with fracture isolated tibia was 4.5 months, while fractures with the fibula fractured at the same level united at a mean of 6 months. We have fixed associated fracture fibula with Rush nail. The indication being a fracture in the distal 5-7 cm of the fibula.⁹ The mean time to union of the tibia in fixed fractures of the fibula was 5 months. The mean time to union of the tibia in unfixed fractures of the fibula was 6 months. Thus in our study, there was no relevance of the status of the fracture fibula in the time to union.

The Locking Compression Platen (LCP) is part of a new plate generation requiring an adapted surgical technique and new thinking about commonly used concepts of internal fixation using plates.^{10,11} Understanding of the mechanical background for choosing the proper implant length and the type and number of screws is essential to obtain a sound fixation with a high plate span ratio and a low plate screw density. A high plate span ratio decreases the load onto the plate. A high working length of the plate reduces the screw loading, thus fewer screws need to be inserted and the plate screw density can be kept low.^{12,13} Selection of mono or bi-cortical screws is done according to the quality of the bone structure and it is important to avoid problems at the screw thread bone interface with potential pullout of screws and secondary displacement.^{14,15} We recommend bicortical locking screws for the tibia, since the working length of the monocortical screw depends only on the thickness of the bone cortex.

CONCLUSION

The MIPO technique is a reliable fixation approach to fractures of the distal third tibia, preserving most of the osseous vascularity and fracture haematoma and thus providing for a more biological repair. The bone healing,

though slightly delayed, was universal with this type of fixation. This technique can be used in fractures where locked nailing cannot be done like distal tibial fractures with small distal metaphyseal fragments, vertical split and markedly comminuted fractures. Due to preserved vascularity, there is lesser incidence of delayed union and non-union. There was reduced incidence of infection due to limited exposure. Infection can also be prevented by careful handling of soft tissues and by minimising the operating time.

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