Functional Outcome of Fractures of the Distal Third Tibia Treated with Minimally Invasive Plate Osteosynthesis

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ABSTRACT

Background

The management of distal tibia fractures remains challenging. The precarious soft tissue over the distal part of tibia makes it prone to skin complications and reduces the blood supply. This can lead to delayed or non-union when treated with conventional plating. The wide medullary canal makes it difficult to control and maintain the reduction if treated with intramedullary nails. A relatively new technique of minimally invasive percutaneous plate osteosynthesis is thought to overcome the shortcomings of both of these techniques.

Method

A prospective study was designed to evaluate the functional outcome of minimally invasive plate osteosynthesis in 25 patients with metaphyseal and simple articular fractures of distal tibia in a tertiary centre from July 2020 to December 2021. The functional outcome was assessed with American Orthopaedic Foot and Ankle Society score at six months and the radiological union was assessed on radiographs.

Result

There were 12 male and 13 females in the study with mean age of 46.4± 11.84. The mean American Orthopedic Foot and Ankle Society score was 93.84 ± 6.15. All fractures united within the study period with mean time to union of 21.04 ± 8.739 weeks.

Conclusion

Minimally invasive plate osteosynthesis is a reliable technique for the treatment of distal tibia fractures with good functional outcome.

KEY WORDS

Distal tibia, Minimally invasive plate osteosynthesis, MIPO, outcome

INTRODUCTION

Although distal third tibia fractures constitute less than 7% of all tibial fractures and less than 10% of all lower extremity fractures, the management remains challenging.[1] The proximity of the injury to the ankle makes surgical treatment more complicated than mid-shaft tibial fractures.[2]

In current orthopaedic practice, minimally invasive plating osteosynthesis (MIPO) and interlocking nailing are the preferred techniques for fractures of the distal third tibia. The intramedullary nail spares the extraosseous blood supply, allows load sharing, and avoids extensive soft tissue dissection.[2,3] However, distal tibial fracture fragment can be difficult to control with an intramedullary device, increasing the frequency of malalignment.[4] Concerns regarding difficulties with reduction or loss of reduction, inappropriate fixation in fractures with articular extension, anterior knee pain and hardware failure have slowed the acceptance of intramedullary nailing as a treatment for the fractures of the distal third tibia.[2]

Plating has emerged as a common treatment for these injuries, as they are often too distal for traditional intramedullary nailing. The bone in this region has a subcutaneous location and decreased muscle cover. Any operative procedure which hampers the local vascularity can lead to complications like delayed bone union, wound complications such as dehiscence and infection. Conventional open reduction and internal fixation techniques have involved extensive dissection and periosteal stripping, which further increases the risk of soft tissue complications. Nevertheless, plate fixation is effective in stabilizing distal third tibia fractures. Plating by conventional open technique entails extensive soft tissue dissection with consequent periosteal injury even in expert hands. To minimize disruption of the particularly tenuous soft-tissue envelope and periosteal blood supply, minimally invasive plate osteosynthesis (MIPO) was developed and then applied to locked plating.[5–7]

The minimally invasive plate osteosynthesis (MIPO) technique is gaining popularity in recent years. This percutaneous plating technique uses indirect reduction methods and allows stabilization of distal third tibia fractures while preserving the vascularity of the soft tissue envelope. As a result, the MIPO technique is gradually becoming the preferred option for some surgeons.8 The study was performed to assess the functional outcome and the time of union of fractures of the distal third tibia treated with MIPO technique.

METHODS

A prospective observational study was performed in a tertiary centre to evaluate the functional outcome in patients with distal third tibia fractures who were treated with minimally invasive plate osteosynthesis from July 2020 to December 2021 after taking clearance from the Institutional Review Committee.

All patients aged 18 years and above who presented to the Orthopaedic Department of Kathmandu Medical College Teaching Hospital during the study period with extraarticular distal third tibia fractures (AO 43A) and fractures with undisplaced intraarticular extension (AO 43B) were included in the study. Patients who had open fractures, displaced intraarticular fragments, pathological fractures and were part of polytrauma were excluded from the study.

The patients included in the study underwent a thorough history and examination and after obtaining informed written consent, the surgery was planned. All patients underwent minimally invasive plate osteosynthesis with pre-contoured locking compression plate. The functional outcome was assessed at 6 months post operatively with the American Orthopaedic Foot and Ankle Score (AOFAS) and time of radiological union was also noted.

Operative technique : (Figure 1 through 6) All patients were operated under subarachnoid block in supine position in radiolucent table. Cefuroxime 1.5g was given as prophylactic antibiotic. Painting and draping was done following strict aseptic precautions. Tourniquet was routinely used. Fracture was reduced using indirect reduction technique with manual traction whenever possible. The use of reduction clamp through stab incision was used in some cases. 2 cm incision was given proximal and distal to the fracture and epiperiosteal tunnel was made with the help of longer plate for blunt dissection. (Fig 1 through 3) The 4.5 mm locking plate was slid from distal hole into the tunnel and the position of the plate and reduction of fracture was assessed using the fluoroscope.(Fig 2 and 3) The plate was held in position with an initial cortical screw and the fracture alignment was assessed.(Fig 4) Subsequent screws were inserted through the stab incision and placed in locking mode.(Fig 5) At least 4 screws were placed in both the proximal and distal fragments. Syndesmotic fibula fractures were fixed with semi-tubular plate before tibia fixation. Splint was applied postoperatively in neutral ankle position. Splint was removed after 2 weeks. Passive range of motion was started after the removal of splints. Full weight bearing was allowed after the evidence of union. Patients were followed up at 2 weeks, 6 weeks, 3 months and 6 months. Union was defined as visible continuity in 3 of four cortices in two X ray views. Functional outcome was assessed by AOFAS score (table 1) at 6 months.

The continuous data was presented as mean and categorical data as percentage. Statistical analysis was done in Statistical Package for Social Sciences Program version 20.

Table 1. American Orthopaedic Foot and Ankle Society Score

Parameter	Value
Pain (40 points)	
None	40
Mild	30
Moderate	20
Severe	0
Function (50 points)	
Activity limitations	
None	10
Limitations on recreational activities, no limitations on daily activities, no support	7
Some limitations on daily and recreational activities, cane	4
Severe limitations on daily and recreational activities, walker, crutches, wheelchair, brace	0
Maximum continuous walking distance	
600m or more	5
400 m to less than 600 m	4
100m to less than 400m	2
Less than 100m	0
Walking surfaces	
No difficulty on any surface	5
Some difficulty on uneven terrain, stairs , inclines, ladders	3
Severe difficulty or inability to walk on uneven terrain, stairs, inclines, ladders	0
Gait abnormality	
None or slight	8
Obvious (walking possible but gait abnormality obvious)	4
Marked (walking difficulty and gait abnormality obvious)	0
Saggittal motion (flexion plus extension)	
Normal or mild restriction (30 o or more)	8
Moderate restriction (15 o - 29 o)	4
Severe restriction (less than 15 o)	0
Hindfoot motion (inversion plus eversion)	
Normal or mild restriction (75-100% normal)	6
Moderate restriction (25-75% normal)	3
Marked restriction (less than 25% normal)	0
Ankle-hindfoot stability (anteroposterior, varus-valgus)	
Stable	8
Definitely unstable	0
Alignment (10 points)	
Good, plantigrade foot, mid foot well aligned	10
Fair, plantigrade foot, some degree of midfoot malalignment observed, no symptoms	8
Poor, non plantigrade foot, severe malalignment, symptoms	0

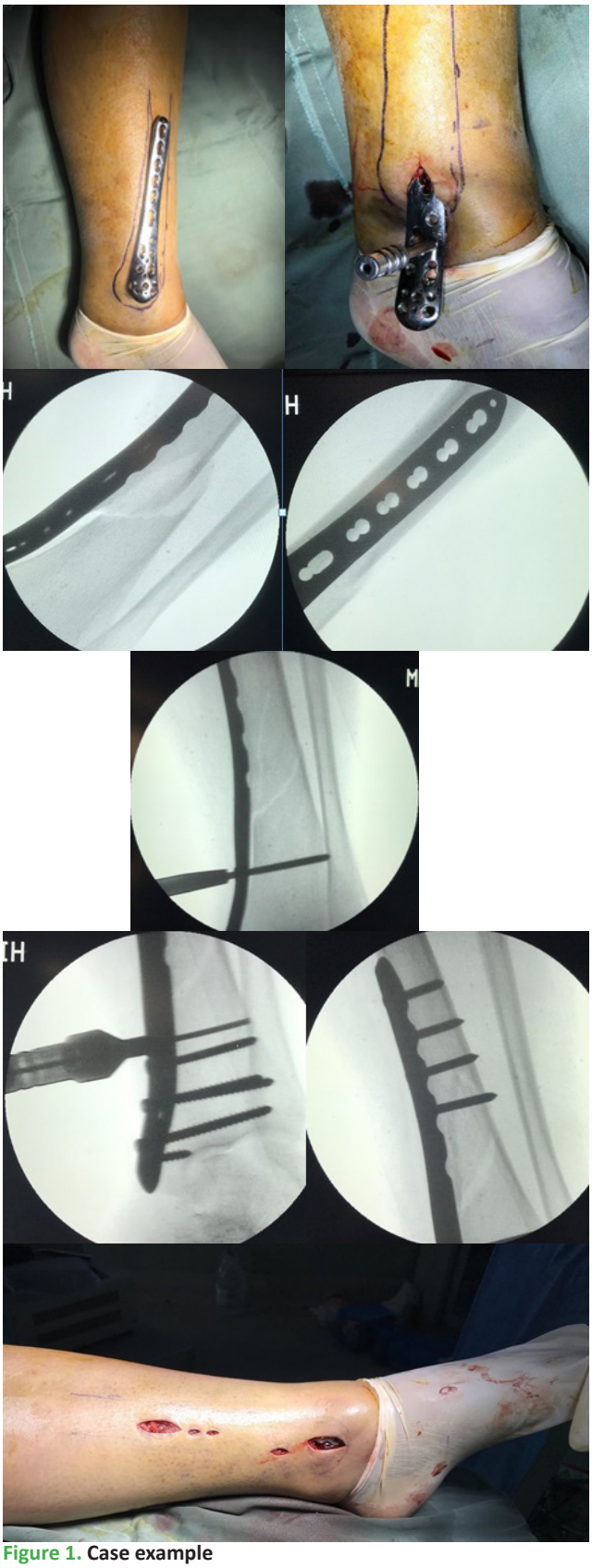

Figure 1. Case example

a. Marking the trajectory of the plate, b. Distal incision and insertion of the plate, c. Assessment of the position of plate, d. Critical screw insertion, e. distal and proximal screw insertion, f. all Incisions.

RESULTS

During the study period 29 patients were assessed for eligibility. Two compound fractures were excluded from the study and 27 patients were included. Out of them two patients were lost to follow up so were excluded from the analysis. Out of 25 patients who were included in the final analysis, 12 were males and 13 were females. The patients were aged between 27 and 67 years with mean of 46.4± 11.84years. The general information of the study population is shown in table 2.

Table 2. Demographics and General parameters of the study population

Mean Age (yrs)	46.4 ± 11.84 years
Sex	
Male	12 (48%)
Female	13 (52%)
Side	
Right	10 (40%)
Left	15 (60%)
Fibula plating	
Yes	12(48%)
No	13(52%)
Average time to surgery (days)	6.96+/- 4.7 (2-24)
Fracture classification (AO)	
43A	18(72%)
43B	7(28%)

The patients were operated on an average of 6.9 days after the trauma. The most common mechanism of injury was fall, followed by low energy twisting injury and road traffic accidents. (Table 3)

All fractures united within the study period. The union time ranged from 12 to 54 weeks with average of 21.04 ± 8.739 weeks. Functional outcome was excellent in 23 patients and good in 2 patients. The mean AOFAS score was 93.84 ± 6.15 (table 4) Three patients developed complications. Two were superficial infections that were treated with antibiotics and local wound care. One case developed delayed union which united at 1 year without any intervention.

Table 3. Mechanism of injury

Mechanism of Injury	n(%)
Fall inury	10 (40%)
Twisting Injury	7 (28%)
RTA	6 (24%)
Direct Injury	1 (4%)
Sports Injury	1 (4%)
Total	25

Table 3.Radiological and Functional Outcome

Mean union time		21.04±8.74 weeks
Mean AOFAS score		93.84±6.15
Functional outcome	Excellent	23 (92%)
	Good	2 (8%)

DISCUSSION

Various treatment options for distal third tibia fractures are available like open plating, intramedullary nailing and MIPO. Among them MIPO technique is gaining popularity as it can avoid soft tissue complications and can retain fracture hematoma for better fracture healing.[9,10] However there is no consensus in the literature regarding the superiority of one method of fixation over the other. We evaluated the outcome of treatment of these fractures with minimally invasive plating using locked plates.

We found majority of cases with excellent (92%) and good (8%) functional outcome with mean AOFAS score of 93.84± 6.15. Similar scores have been reported by Ashwani et al in 21 patients and Collinge C et al in 38 patients with average AOFAS score of 96.52 ± 4.16 and 85 respectively.[11,12] Many contemporary studies have showed excellent to good outcomes in majority of the patients treated with MIPO technique.[9,13,14] Compared to these studies, our study shows slightly more average AOFAS score which could be due to the difference in the inclusion criteria. Most of these studies have included AO type C fractures and compound fractures also whereas we had excluded these types of cases from our study. Studies on extraarticular and simple intraarticular fractures have shown higher mean AOFAS score.[11,15]

All the fractures united during the study period with average union time of 21 weeks. Literature reveals union time of such technique to be between 15 to 23 weeks.[11–13,15–18] The average union time in our study is within the reported range. The wide dispersion in the union time could be due to difference in the rigidity of the construct as none of these studies mention the length of the plate and the screw density which are known to affect the rigidity of the construct and thus healing of fractures fixed with the locked plates.[19]

The subcutaneous location of distal tibia leads to the precarious blood supply to this part and more risk of soft tissue complications after fracture and open surgery.[9] Blood supply to the tibia comes from two systems namely endosteal and periosteal. The endosteal blood supply is disrupted in cases of displaced fractures so the bone fragments depend solely on the periosteal blood supply for nutrition. Extensive soft tissue dissections in such situation may devitalize the vascular pedicles that may result in non-union or delayed union.[10]

The development of minimally invasive fixation technique and indirect reduction has allowed more biological environment for fracture healing and avoidance of complications of other plating techniques.[20] The MIPO technique has been compared with other methods of fixation in the literature.

Intramedullary interlocking nailing offers a minimally invasive option; however, concerns have been raised regarding the biomechanical stability of fixation due

to wide medullary canal in the tibial metaphysis and risk of malunion or nonunion.[21] Although few studies in metaphyseal fractures and fractures with simple intraarticular extension have shown comparable functional and radiological outcomes with nailing or minimally invasive plating, second surgery for implant removal, overall complications like anterior knee pain and malunion were observed to be significantly more in nailing group.[22–24] It can be a good option for more proximal fractures but when the fracture line is less than 5 cm proximal to the ankle joint, intramedullary nailing is not a suitable option of treatment.[25,26]

Compared to the open plating, MIPO has shown comparable functional outcome but proved to be better in terms of skin complications, operative time and hospital stay, reoperation and malalignment.[27–29]

Vascular injection studies have demonstrated preservation of blood supply to the bone after MIPO of the distal tibia. Open plating of the medial aspect of the distal tibia caused a greater disruption of this extraosseous blood supply than did percutaneously applied plates. Disruption of these extraosseous vessels following fracture and subsequent operative stabilization may slow healing and increase the risk of delayed union and nonunion. These findings support current efforts to develop less invasive methods and implants for operative stabilization of distal tibia fractures.[30]

This study has few limitations. This is a single arm study and has a small sample size. Had the sample size been bigger, the power of the study would have had been better. A comparative study with other methods of fixation would be desired to establish the superiority of this technique over other methods of fixation.

CONCLUSION

Minimally invasive percutaneous plate osteosynthesis has a good functional and radiological outcome and is a reliable option for the treatment of distal third tibial metaphyseal fractures.

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