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Original Research Article

A prospective study of surgical management of distal tibial fractures treated with minimally invasive percutaneous plate osteosynthesis using locking compression plate

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ABSTRACT

Background: Distal tibial fractures are unique and represent a significant challenge in their management. Factors affecting the outcome include location of fractures, proximity to ankle joint, less soft tissue coverage, comminution, unstable and compound fractures, method of treatment and quality of reduction. Distal tibial fractures traditionally were treated with different modalities, LCP with MIPPO (minimally invasive percutaneous plate osteosynthesis) being one of the recent advances.
Methods: Clinical, prospective observational study was conducted at J.J.M. Medical College, Davangere between October 2014 to September 2016. 21 patients with distal 1/3rd tibial fractures with or without intra-articular extensions were included in this study. All 21 patients treated with LCP by MIPPO were followed for 6 months with clinical and radiological assessment, including ankle scoring system (Olerud and Mollander).
Results: 21 patients with age between 23-65 years (mean 41.6 years) were treated with LCP by MIPPO during the study period. All the patients were followed up at 6 weeks, 12 weeks, 6 months and at 1 year with x-ray and ankle scoring system. All the patients had complete union between 14 weeks to 24 weeks with ankle score between excellent and good in majority of the patients. There were 2 cases of delayed union, 3 superficial skin infections and 3 cases of ankle stiffness.
Conclusions: Study concludes LCP with MIPPO is a safe, reliable technique to achieve complete union of difficult fractures.

Keywords: Distal tibial fracture, Locking compression plate, MIPPO

INTRODUCTION

Proximity to ankle joint and subcutaneous location, with precarious blood supply, the treatment of distal tibial diametaphyeal fractures with or without articular extension are the challenges in the treatment of distal tibial fractures.[1,2] The distal third tibial fractures are unique and represent a significant challenge to most of the surgeons even today. They are only 1-10% of all lower extremity fractures.[3] The location of the fracture is close to the ankle joint and it is not uncommon for the fracture line to extend into the joint. The distal one third of the tibia has less muscle and soft tissue coverage in comparison to rest of the tibia. Often, these fractures are comminuted and are unstable. Disturbingly, they can be associated with severe closed or open soft tissue injury.

Hence, complex fractures of the distal tibia are difficult to treat.[4] The most important variables that affected the final clinical result are the type of fracture, associated soft tissue injury, the method of treatment and the quality of the reduction. Conservative treatment of these fractures

quite often results in a number of complications including malunion, nonunion and ankle stiffness.[5,6] Traditionally, these difficult fractures have been managed by open reduction and rigid internal fixation with a compression plate. A high rate of good to excellent results have been reported.[7] However, this technique has not produced consistent outcomes and has a high incidence of complications, including infection, poor wound healing and non-union.[8] These fractures are generally not suitable for intramedullary nailing, despite certain reports indicating satisfactory results in some of these fractures.[9] External fixation can be used as either a temporary or definitive method of treatment, especially in fractures with severe soft tissue injury, but malunion and delayed union continue to be the main problems with this method of fixation.[10,11]

Conventional plate osteosynthesis with open reduction can therefore further devitalise fragments and lead to higher incidence of nonunion, infection and implant failure.[12] Therefore, minimally invasive osteosynthesis, if possible, offers the best possible option as it permits adequate fixation in a biological manner.[13,14] However, inadequate number of screws in a small oblique comminuted distal fragment presents a definite limitation even with this technique. Compared with a conventional plate, a locking plate imparts a higher degree of stability and provides better protection against primary and secondary losses of reduction and minimization of bone contact.[15,16] Locking plates (LPs) have the biomechanical properties of internal and external fixators, with superior holding power because of fixed angular stability through the head of locking screws, independent of friction fit.[17] In addition, it is possible to use these plates in a minimally invasive technique without fear of secondary displacement in the absence of perfect contouring. Locking plates are particularly useful in severely comminuted and fragility fractures due to their biomechanical properties of fixation.[18]

METHODS

Twenty one patients with closed distal tibia fractures were treated by minimal invasive percutaneous plate osteosynthesis by LCP from October 2014 to September 2016. Articular extension was included in the study. We excluded patients with compartment syndrome, pathological fractures, compound fractures, fracture with neurovascular injury and patients younger than 18 years.

All patients had plain radiographs and fractures were classified according to AO/OTA classification of fracture of distal tibia. There were 10 A2 fracture, 9 A1 fracture, 1 A3 and 1 C1 type of fractures. The patients were taken for surgery after routine investigation and after obtaining fitness for surgery.

Results were assessed based on objective and subjective criteria as given below.

Objective criteria

- Ankle/subtalar motion- >75% Excellent, 50-75% Good, 25-50% Fair, <25% Poor.
- Tibiotalar alignment- Neutral/ no angulation- Excellent, Neutral- Good, <5 ˚Fair, >5˚ Poor.
- Tibial shortening- None- Excellent and Good, <1 cm Fair, > 1 cm Poor.
- Chronic swelling- None in excellent, Minimal in good, Moderate in fair, Severe in poor.
- Pronation/supination- No loss of movement in excellent and good, moderate decrease in fair and marked loss of movement in poor results.
- Equinus deformity- None in case of excellent, good and fair cases, equines deformity in poor cases.

Subjeective criteria

- Pain- None in excellent, Mild in Good, Moderate in Fair, Severe in Poor.
- Return to work- Return to previous work in excellent and good, modified work in fair, unable to resume normal work in poor.
- Recreational activity- Normal in excellent, mild modification in good, significant modification in fair, none in poor.
- Limited walking- Not effected in excellent and good, effected in fair and poor.
- Pain medication- No medication required in excellent and good, Non narcotics in fair and narcotics in poor.
- Limp- No limp in excellent and good results, occasional limp in fair and limping in poor results.

Surgical technique

All patients were operated under spinal anaesthesia with patient supine, affected leg elevated on a pillow, on a radiolucent table with a tourniquet.

In all cases a medial approach to distal tibia was used. A vertical incision starting from medial malleolus was made. Incision was deepened until periosteum. Periosteum was preserved. A submuscular epiperiosteal tunnel was created using blunt tip of the LCP. Fracture reduction was done indirectly or directly under the guidance of image intensifier and plate was temporarily stabilized by k-wire. Then distal locking and proximal locking was done. Fibula was not fixed unless it was involved at level of syndesmosis. Postoperatively limb was immobilized in above knee POP slab. All patients were mobilized with standard walking frame with non-weight bearing on operated limb from the first postoperative day under supervision of physiotherapist. Partial weight bearing was started once callus was visible on x-ray and gradually increased according to clinical and radiological signs. Follow up was done at 6 weeks, 12 weeks, 6 months and 1 year. Olerud and Mollander scoring system was used in this study to assess the results.

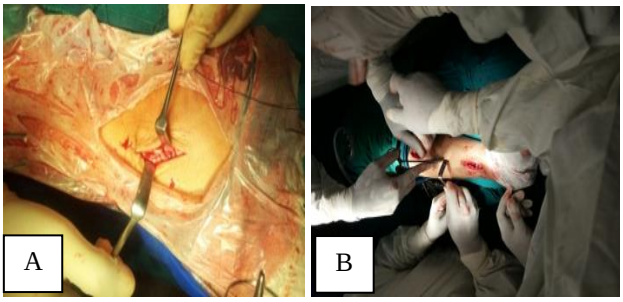

Figure 1 (A and B): Skin incision.

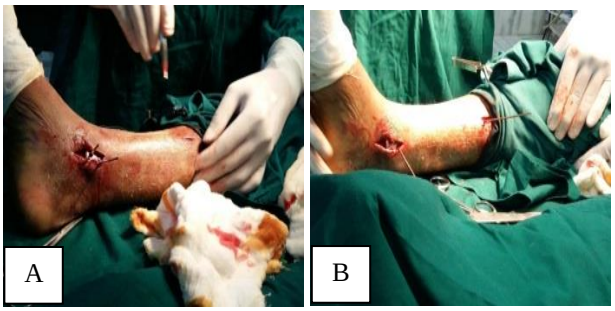

Figure 2 (A and B): Plate insertion with k wire fixation on both ends.

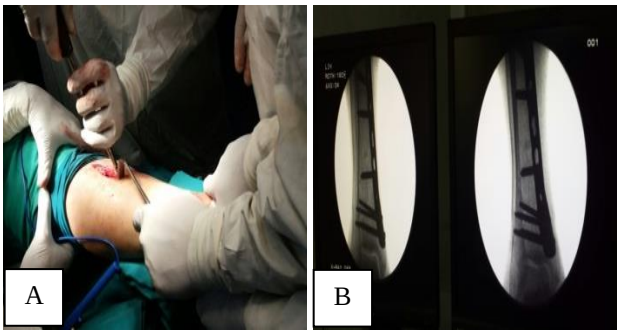

Figure 3 (A and B): Intraoperative images.

Figure 4(A and B): Wound 2nd postoperative day.

RESULTS

The present study consists of 21 cases of fracture of the distal diametaphyseal end of tibia. All the cases were fixed using the locking compression plate. The study period was from October 2014 to September 2016.

The age of patients ranged from 23-65 years with fracture being most common in 4th and 5th decade of life. Majority of 14 (67%) patients were males and there were 7 (33%) were females. Most 13 (52%) of the fractures were due to RTA and 8 (38%) of patients sustained injuries following fall.

The average duration of surgery was 55.5 minutes [range 41-70 minutes]. All the fractures were united within an average of 19.14 weeks [range 14 to 24 weeks]. There were 2 cases of delayed union.

- Objective Results- Assessed by clinical examination, Ankle/ subtalar motion, Tibiotalar alignment, Tibial shortening, Chronic swelling, Pronation / supination, Equinus deformity.
- Excellent- 15 cases (71%), Good- 3 cases (14 %), Fair 2 cases (10 %), Poor 1 case (5 %).
- Subjective Results- Assed by asking various questions like, pain, return to work, recreational activity, limited walking, pain medication, limp.
- Excellent- 14 cases (66 %), Good- 3 cases (14 %), Fair 2 cases (10 %), Poor 2 cases (10 %).

Three patients developed superficial skin infection, which resolved with antibiotic and local wound care. Ankle stiffness was present in 3 cases. The ankle stiffness ranged from restriction of ankle movement from 20-40%. There was anterior angulation of 5° in one case. However range of movement and functional score was good in this case. 2 fractures went for delayed union which united by 24 weeks. One of this case had 40% ankle stiffness and poor functional outcome.

Table 1: Age distribution.

Age	No. of Patients	Percentage
21-30	1	5
31-40	3	15
41-50	6	28
51-60	6	28
61-70	5	24
Total	21	100

Table 2: Sex distribution.

Sex	No. of Patients	Percentage
Male	14	67
Female	7	33
Total	21	100

Table 3: Side effected.

Side	No. of Patients	Percentage
Right	12	57
Left	9	43

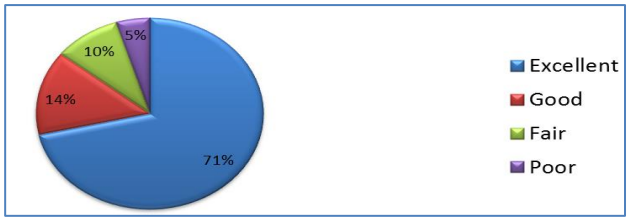

Figure 5: Objective results.

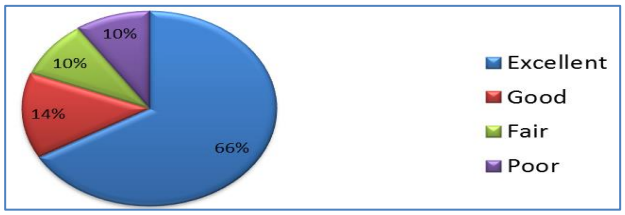

Figure 6: Subjective results.

Table 4: Mode of injury.

Mode of Injury	No. of Patients	Percentage
RTA (High energy)	13	62
Fall (Low energy)	8	38
Total	21	100

Table 5: Fracture pattern.

Type	No. of patients	Percentage
Al	9	43
A2	10	47
A3	1	5
B1	-	0
B2	-	0
B3	-	0
CI	1	5
C2	-	0
C3	-	0

Table 6: Duration of fracture union.

Duration (in weeks)	No. of Patients	Percentage
14	1	5
16	2	9.5
18	8	38
20	8	38
24	2	9.5
Total	21	100

Table 7: Objective criteria.

Rating	Ankle/ subtalar motion	Tibiotalar alignment	Tibial shortening	Chronic swelling	Pronation/ supination	Equines deformity
Excellent	> 75% normal	Normal	None	None	Normal	None
Good	50-75%	Normal	None	Minimal	Normal	None
Fair	25-50%	<5˚ angulation	< 1cm	Moderate	Moderate decrease	None
Poor	< 25%	>5˚ angulation	> 1cm	Severe	Marked decrease	Present

Table 8: Subjective criteria.

Rating	Pain	Return to work	Recreational activity	Limited walking	Pain medication	Limp
Excellent	None	Same work	Normal	No	None	None
Good	Mild	Same work	Mild modification	No	None	None
Fair	Moderate	Modified	Significant modification	Yes	Non narcotic	Occasional
Poor	Severe	Unable	None	Yes	Narcotic	Yes

Table 9: Complications.

Complications	No. of patients	Percentage
Superficial skin infection	3	14
Ankle movement restriction		
>75%	0	0
50-75%	0	0
25-50%	1	5
< 25%	2	10
Anterior angulation 5°	1	5
Delayed union	2	9.5

We had superficial skin infection in 3 (14%) cases, ankle stiffness in 3 (14%), delayed union in 2 (9.5%) and anterior angulation in one case.

Table 10: Results.

Results	No. of cases	Percentage
Excellent	15	71
Good	3	14
Fair	2	10
Poor	1	5

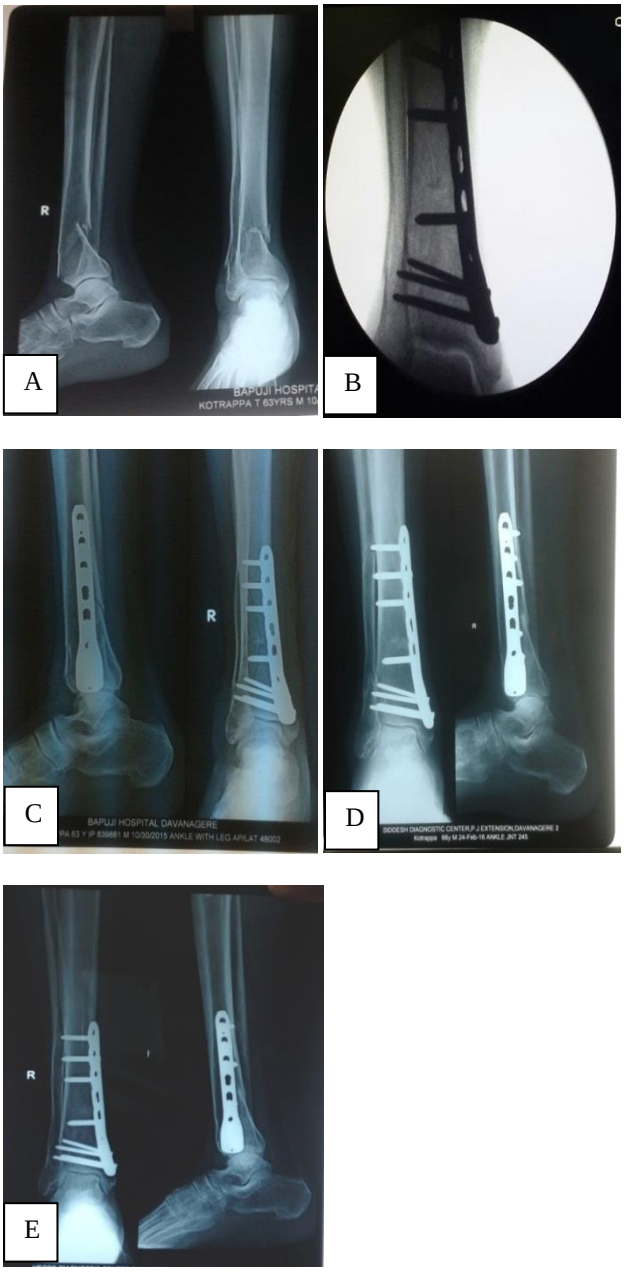

Figure 7: A=Preoperative, B=Intraoperative, C=Immediate Pop, D=4 Months, Complete Union, E=6 Months Follow Up.

DISCUSSION

Distal diametaphyseal tibia fracture with or without intra articular extension is one of the difficult fractures to manage. None of the treatment options available perfectly fulfill requirements of fracture characteristics of distal diametaphyseal tibia. Distal tibia has got circular cross sectional area with thinner cortex as compared to triangular diaphysis with thicker cortex. So, intramedullary nail which is designed for tight interference fit at diaphysis cannot provide same stability at distal fracture. Other potential complications of IMIL nailing are malunion and implant failure. ORIF with conventional plate which needs striping of periosteum is also not an ideal treatment option because tibia is subcutaneous bone and periosteum provides 2/3rd of blood supply.

Similarly external fixators as a definitive method of treatment for distal diametaphyseal tibia fracture are also reported with higher rate of infection, implant failure and malunion or nonunion and hence recommended only for temporary method of stabilization in open fracture with severe soft tissue injury.

With the development of technique of MIPPO with LCP which preserve extraosseous blood supply and osteogenic fracture haematoma, which are biologically friendly and obtain stable fixation can be obtained for distal diametaphyseal tibia fracture. Indirect reduction method and sub-cutaneous tunneling of the plate and application of locking screws with small skin incisions in MIPPO technique prevents iatrogenic injury to vascular supply of the bone. Unlike conventional plates, LCP is a friction independent self-stable construct which provides both angular and axial stability and minimizes risk of secondary loss of reduction through a threaded interface between the screw heads and the plate body.

Hazarika et al, in a series of 20 patients treated with minimally invasive LCP for fractures of distal tibia had 87.5% of good to excellent result and concluded that this approach preserves bone biology and minimize surgical soft tissue trauma.[13]

Rongo et al, studied 19 cases of distal tibia fractures, with MIPPO method and concluded that with high rate of union and low rate of complications, LCP by MIPPO is a reasonable alternative for treating distal tibia fractures.[19]

Ozkaya et al, in a retrospective review of 22 patients with distal third tibial fractures treated with titanium locking compression plates found that this technique resulted in prolonged secondary healing with 81% good to excellent results. However with non-locking contoured plate, they observed shorter healing time due to relative stability.[20]

We studied 21 cases of distal tibia fractures treated with LCP by MIPPO and found that MIPPO with LCP is an

effective treatment option. There were 71% of excellent and 14% good results. Our results are comparable to studies of Hazarika et al and Ozkaya et al. However our study is limited by small number of patients. The cost of the plate, radiation exposure and technical expertise all to be considered before selecting this procedure.

CONCLUSION

With all currently available treatment options, distal diametaphyseal tibial fracture with or without intra articular extension is one of the difficult fractures to manage. Before selection of fixation method, fracture pattern, concomitant articular extension, condition of soft tissue are important factors to be considered. The present case series though small in number shows that MIPPO with LCP is an effective treatment method with high percentage of union and low rate of complications by preserving most of the osseous vascularity, fracture haematoma and thus providing for a more biological repair.

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Ethical approval: The study was approved by the institutional ethics committee

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