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Mipo technique for management of distal third tibia fractures using LCP-precontoured (3.5mm &4.5mm)

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Abstract

Objective

To evaluate the functional outcome, duration to union, advantages and complications using this technique and to compare it with existing techniques

Methods

Twenty adult patients with closed fractures of distal tibia (AO classification: A1-10; A2-6; A3-2; B1-2) were treated with LCP using Mipo technique & were followed for a period of 2 years (sept 2012 to sept 2014)

Results

Average age of patients studied was 40.5 years (18-55) with majority being high energy (65% vs. 35%); the mean duration to surgery from the day of presentation was 4.7 days. The average duration to union was 16 weeks with two cases of delayed union (~20 weeks) due to superficial infection which was managed with dressing & antibiotics and one because of early weight bearing.

Conclusion

The above study shows that Mipo technique using LCP is a safe, effective method to treat distal third tibia fractures with respect to time to union with few complications. The study is limited only to AO 43 A & B types fractures, as we had no experience with type C fractures.

Keywords: MIPO; LCP; distal third tibia fracture

Introduction

Fractures of the distal third tibia are unique in that the bone is subcutaneous with depleted muscular cover; the consequent decreased vascularity leads to complications like delayed bone union, wound complications such as dehiscence and infection. These fractures can be managed with various techniques. Small wire fixators, and Open reduction and plating, have been used with varying results.

In current orthopedic practice, minimally invasive percutaneous plating osteosynthesis (Mipo) and interlocking nailing are the preferred techniques for fractures of the distal third tibia. The intramedullary nail spares the extra osseous blood supply, allows load sharing, and avoids extensive soft tissue dissection. However, proximal and distal shaft fractures can be difficult to control with an intramedullary device, increasing the frequency of malalignment.

Concerns regarding difficulties with reduction/loss of reduction, inappropriate fixation in fractures with articular extension, anterior knee pain and hardware failure has slowed the acceptance of intramedullary nailing as a treatment of fractures of the distal tibia. The recent innovation of nails with tip locking is a testimony that earlier nails were insufficient fixation tools for distal tibia; however tip locking is technically difficult and fractures that require it are essentially difficult to fix with nails.-

Minimally invasive sub muscular and subcutaneous plate fixation (Mipo) can address several of the issues associated with intramedullary nailing, while amalgamating all biological benefits of closed reduction and fixation ^[1].

Materials & Methods

From September 2012 to September 2014, a prospective study comprising 20 patients were admitted to KR hospital, attached to Mysore medical college, Mysore. Our institutional ethics

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committee approved the study & written informed consent was obtained from all patients.

Inclusion criteria

1. Adults (aged 18 to 60 years) males and females.
2. Simple, closed fractures unfavorable for interlocking nailing.
3. Complex fractures of the lower third of tibia.

Exclusion criteria

1. Patients aged below 18 years.
2. Subjects with severe renal, cardiopulmonary, hepatic and central nervous system disorders.
3. Pathological fractures
4. Type 3b and type 3c compound fractures of distal tibia {Gustilo Anderson}

After stabilizing the traumatized patient, routine pre-operative evaluation was done including x rays of the involved leg. CT scan was ordered for intraarticular fractures.

The leg was temporarily immobilized in above knee slab until the skin condition was favorable for surgery as evidenced by appearance of wrinkle sign. Patients with precarious skin condition were managed with limb elevation, regular dressing care & prophylactic i.v antibiotics.

Distal tibial precontoured anatomical LCP (3.5mm & 4.5mm) were used. LCP can be used in several ways as

1. As a conventional plating technique (compression method, principle of absolute stability).^[2]
2. In Mipo technique (internal fixator method, principle of relative stability)
3. LCP in a combination of both methods (compression method & internal fixator method)

The actual stability results from the friction between the plate and the bone. Anatomical reduction of the fracture was the goal of conventional plating technique, but over time a technique for bridging plate osteosynthesis has been developed for multi fragmentary shaft fractures that, thanks to a reduction of vascular damage to the bone, permits healing with callus formation, as seen after locked nailing. Since the damage to the soft tissues and the blood supply is less extensive, more rapid fracture healing can be achieved. The newly developed, so-called locked internal fixators [e.g. PC-Fix and Less Invasive.^[3] Stabilization System (LISS)] consist of plate and screw systems where the screws are locked in the plate.

Surgery was performed under regional anesthesia with a tourniquet in supine position. The plate was applied on the anteromedial surface & fixed to tibia using cortical & locking screws under c-arm guidance. Manual traction, k-wires, Steinmann pin, reduction forceps were the tools used for indirect reduction of fracture.

After provisional reduction, a 3-4 cm vertical incision was made over the medial malleolus towards proximally with care not to injure the saphenous nerve and vein.^[4] A subcutaneous tunnel was made using a specialized elevator; the selected locking plate was applied based on the fracture pattern and body habitus of the individual as shown in Fig 1. The plate was tunneled proximally across the fracture site using the locking sleeve as a handle for insertion of the plate.



Fig 1

The plate was centered on the tibia, confirmed on AP & lateral views; cortical screws were inserted first depending on the need for reduction in proximal or distal fragment. After the reduction was confirmed, locking screws were inserted with aim of achieving a minimum of 6 cortices on either side of the fracture. Fig 2 shows pre-operative and post-operative x ray of the patient. For articular fractures pointed reduction forceps were used. Lag screws were inserted first across the fracture site followed by metaphyseal & diaphyseal fixation. The incision was closed in layers & immobilized in A/K slab till suture removal.



Fig 2



Fig 3

Post-operative regimen was to immobilize the fracture in below knee walking cast for a period of 4 to 6 weeks with restricted weight bearing until there was radiological evidence of fracture healing. Full weight bearing was ensued after callus was seen in at least three cortices on AP & lateral views.

Results

In this study, twenty cases with twenty fractures of lower one-third fractures of tibia in adults were surgically managed by closed reduction and internal fixation using minimally invasive percutaneous plate osteosynthesis (Mipo) with LCP from September 2012 to September 2014 at K.R hospital attached to Mysore medical college and research institute, Mysore.

- All patients were evaluated clinically and radiologically before and following surgery, for an average period of follow up was 6 months.
- The age of the patient in this study, ranged from 18 years to 55 years average being 40.5 years.
- There were 15 male patients as compared to 5 female patients in this study.
- 6 patients had fracture of left lower one third of tibia and 14 patients had fracture of right tibia.
- All 20 fractures were closed fractures
- 15 cases sustained fracture following road traffic accident (high energy trauma) and 5 cases sustained fractures following self-fall (low energy trauma).
- The mean duration to surgery from the day of presentation and injury was 4-7 days for soft tissue swelling around the fracture to subside as evidenced by appearance of wrinkles on the skin as shown in table 1 & 2.

Table 1: Showing age of the injury at presentation.

Age of injury	No. Of patients	Total
<24 hours	17	17
24 – 48 hours	3	3
>48 hours	0	0

Table 2: Showing time between arrival and surgery

Time duration	No. Of patients	Total
Within the golden hour	0	0
1-5 days	10	10
>5 days	10	10

- The fractures united in 18(90%) patients with 2(10%) case of delayed union, which took 20 weeks of time period for the radiological signs of callus formation as shown in table 3.

Table 3: Showing duration of fracture union

Duration (In Weeks)	No. Of patients	Percentage
14	7	35
16	7	35
18	4	20
20	2	10
Total	20	100

- The fracture was additionally supported by an above knee plaster of Paris slab postoperatively for 10 days and later converted to complete below knee walking cast and patient was made to walk with restricted weight bearing over operated limb. Post operatively patients after 4 to 6 weeks depending on the check x ray patients were allowed full weight bearing.
- Post-operatively, 1 patient developed superficial skin infection and 2 patients developed ankle stiffness due to

loss of postoperative protocol as shown in table 4.

- Good amount range of mobility of ankle joint was present in almost all patients.
- In our present study of 20 cases, 10(50%) patients had excellent outcome, 4 (20%) had good outcome, 4(20%) had fair outcome and 2 (10%) had poor outcome.

Table 4: Showing complications

Complications	No. of Patients	Percentage
Superficial skin infection	2	10
Ankle stiffness		
1. >75%	0	0
2. 50-75%	0	0
3. 25-50%	1	5
4. <25%	1	5
Varus malalignment	2	10
Malleolar skin irritation	1	5

By the analysis of the data collected in the present study, closed reduction and internal fixation with locking compression plate using Mipo technique for lower one third fractures of tibia is the choice of treatment for adult fractures, predominantly AO type A1, A2 and A3 where intramedullary nails are not the choice.

Discussion

Distal diaphyseal 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 diaphyseal tibia.

Distal tibia has got circular cross sectional area with thinner cortex as compare 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 (0-29%) and implant failure (5-39%) [6].

ORIF with conventional plate, which needs stripping of periosteum, is also not an ideal treatment option because tibia is subcutaneous bone and periosteum provides 2/3 rd. of blood supply. Non-union, delayed union and infection are reported with the range of 8.3-35% and 8.3-25% ¹ respectively with ORIF with plating.

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

With the development of technique of Mipo with LCP, which preserve extra osseous blood supply, respect osteogenic fracture hematoma, biologically friendly and stable fixation method is available for distal diaphyseal tibia fracture. Indirect reduction method and sub-cutaneous tunneling of the plate and application of locking screws with small skin incisions in Mipo 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.

Mipo with LCP for distal diaphyseal tibia fracture has been found to be an effective treatment option. But unlike the present study, most of the previous studies have included both open and closed fractures and are retrospective study. Comparative studies with IMIL or conventional open techniques have found conflicting results with MIPO with

LCP for distal diaphyseal tibia fracture. Vallier *et al.* reported significantly more angular malalignment in distal diaphyseal tibia fracture, treated with IMIL in comparison to those treated with plating (22 patients vs. 2 patients, $p=0.003$)^[2] whereas Guo *et al.* in a comparative study of extra articular distal diaphyseal tibia fracture reported that patients treated with IMIL nailing had better function, alignment and American Orthopedic Foot Ankle score, though none of them were statistically significant whereas operative time (81.33 vs. 97.9 minutes, $p<0.001$) and radiation exposure (2.12 vs. 3 minutes, $p<0.001$) was significantly more in LCP group and higher mean pain score was found in IMIL group^[3]. Cheng *et al.* in a small sampled paired comparison (15 in each group) of MIPO and open technique with LCP found former is not statistically better in terms of union time (16.8 vs., 19.2 wks. $p=0.737$), recovery time to return to work (21.1 vs. 27.7 weeks, $p=0.35$) and functional results. Kao *et al.* found no statistically significant advantages of LCP over conventional plate group.

In spite of use of Mipo with LCP as internal external fixators, anatomical reduction of the fracture by using indirect reduction maneuvers before applying the plate is very important surgical step^[5].

Malreduction and suboptimal pre contouring of the plate can result delayed union, non-union, prominent hardware, malleolar skin irritation and pain. Low profile metaphyseal LCP has been designed to reduce hardware prominence related complications but plates specifically designed according to measurement of adult distal tibia of western population may not perfectly match to other communities and often need change in pre contouring to avoid mismatch which in turn, can change the direction.

Indirect method of reduction of fracture under c arm can be

difficult on a few occasions. No calcaneal pins or mechanical distractors were used in our present series. 3mm k wires and reduction forceps were used to facilitate proper reduction in difficult cases.

Concomitant fibula # at the same level plays an important role in reduction. Though a few authors advocate fixation of fibula before fixation of the tibia to achieve a better alignment and to prevent valgus/varus malalignment, no clear-cut indication/protocol exists as far as fibula fracture fixation is considered.

No routine fixation of the fibula fracture was done in the present study. No secondary procedures like percutaneous bone marrow injection /bone grafting were done for delayed union. Immobilization was continued for these cases till fracture union was seen.

Blisters were common features when the injury –hospital interval was > 3 days. Tight osteopathic bandage and even non-splintage of the fracture also contributed.

The protocol of fixation was early as possible considering the gross swelling and fracture blisters. However this delay did not have bearing on the duration of fracture union, which was at an average of 14-16 weeks as comparable to other studies.

No cases of injury to the saphenous nerve or long saphenous vein or the posterior tibial tendon were observed. Atraumatic placement of the drill sleeve and careful attention towards skin incision, tunneling prevents these complications.

No plates and screws were removed in this series and hence the difficulty encountered in the removal was not studied.

The present study was under taken to determine the efficacy of the locking compression plates in treatment of the fractures of the distal tibial metaphysis using Mipo technique.

We evaluated our results and compared them with those obtained by various other studies utilizing different modalities of treatment, our analysis is as follows.

Table 5: A comparison of the findings of various studies.

Publication	No of patients	Average age of patient (in yrs)	Average operative time (in mins)	Average fluoroscopy time	Average time to union	Post-operative infection (%)	Malalignment (%)	Delayed/ Nonunion (%)	Mean AOFAS score at union (Max 100)	Implant removal (% of patients)
Borg <i>et al.</i>	21	-	82 min	-	5.44 m	14.3%	28.5%	19%	-	9.5%
Bahari <i>et al.</i>	42	35 yrs	-	-	22.4 wks	7.14%	-	-	-	7.14%
Mafulli <i>et al.</i>	20	-	-	-	-	0	36.8%	5.3%	-	-
Redfern <i>et al.</i>	20	38.3 yrs	-	-	23 wks	5%	5%	0	-	15%
Hasenboehler <i>et al.</i>	32	45 yrs	86.6 min	-	75% at 6 m, 84% at 9 m	3.4%	0	17.2%	-	65.6%
Williams <i>et al.</i>	20	-	-	-	-	10.5%	-	31.5%	-	-
Lau <i>et al.</i>	48	-	-	-	18.7 wks	16.7%	-	10.4%	-	-
Gupta <i>et al.</i>	71	-	-	-	-	3.8%	2.5%	12.7%	-	-
Ronga <i>et al.</i>	21	-	-	-	-	42.3%	19%	4.8%	-	-
Stink <i>et al.</i>	80	43 yrs	-	-	87.5% by 6 m	9%	6%	13%	-	-
Hazarika <i>et al.</i>	20	44.7 yrs	-	-	58.3% at 6 m (closed #)	5%	-	10% (open fractures)	-	15%
J J Guo <i>et al.</i>	54	44.4 yrs	97.9 min	3 min	17.6 wks	14.6%	-	-	83.9	92.7%
Collinge <i>et al.</i>	38	-	-	-	21 wks	All inf. Superficial	2.63%	8%	85	5%
Current study	20	40.5 yrs	60 min	-	16 wks	10%	10%	10%	-	-

Included AO-41, 42, 43 fracture

Conclusion

According to the study, 20 patients with fractures of the distal tibia had undergone closed reduction through MIPO techniques of application of locking compression plates. This technique has resulted in the effective stabilization of these fractures. It does provide adequate stability and allows early motion.

The greatest advantage of the MIPO technique is the ability to preserve the blood supply and fracture hematoma undisturbed, which helps in fracture healing and the soft tissue scaffold, which is crucial for minimizing the already compromised soft tissue around the fracture. Fractures of distal third are known for delayed union and malunion because of the precarious blood supply in this area and the technique of minimally

invasive procedure preserves the blood supply and thereby helps the fracture union.

It is an effective in extra articular fractures occurring within 5cm of the joint because Intramedullary nails often do not provide enough stability and external fixators usually applied for primary stabilization until soft tissue edema get subsided delays the return to work with fixators.

It is a simple, has a rapid and straight forward application and has a reduced surgical time in more extra articular fractures and intra articular fractures due to newer anatomically contoured locking compression plates for the distal end tibia fractures.

Although, a larger sample of patients and longer follow up are required to fully evaluate this method of treatment, we recommend fixation of simple distal third tibia fractures (AO A1, A2, A3) with lcp using Mipo technique. Since majority of the fractures encountered at our study were simple fractures, further studies encompassing a larger group of patients with more varied fracture patterns are required to know the efficacy of lcp using Mipo to treat such fractures. Prospective randomized controlled trial specially comparing newly available intramedullary nails which has various distal locking options is necessary to establish superiority of the technique.

Limitations of the study

1. Study sample size is small (20).
2. Plates were designed to the anthropometric western population standards, hence necessitates optimal contouring for the Indian population.
3. Malreductions always remains a challenge.
4. Since majority of the patients were from village and uneducated and chronic alcoholics, immobilization for the first 4 weeks with below knee cast was deemed necessary to protect the fracture site.
5. Comparison with newer intramedullary nails with various distal locking options is necessary to establish the superiority of Mipo with lcp.
6. Long-term complications related to implant needs to be evaluated as follow up in the study was short and we had no experience in the difficulty of removal implants.

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