Research Paper

Volume : 4 | Issue : 6 | June 2015 • ISSN No 2277 - 8179

Minimally Invasive Plate Osteosynthesis in Management of Distal Tibia Fractures

Medical Science

KEYWORDS : Distal Tibia Fracture, Locking Compression Plate, Minimally Invasive Plate Osteosynthesis, Wound Infection

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ABSTRACT

Introduction: Unstable fractures of distal tibia with or without intra-articular extension can present a clinical dilemma. Historically, there have been a variety of methods of management described but with high rates of associated complications. Minimally Invasive Plate Osteosynthesis (MIPO), has now become more popular with the development of the Locking Compression Plates. MIPO offers many biological advantages including minimal soft tissue dissection with preservation of vascular integrity of the fracture as well as preserving osteogenic fracture haematoma.

Materials & Methods: A total of 30 patients with distal tibia fractures (open/closed) were included in the study after informed consent. Patients were treated by MIPO with LCP and were prospectively followed up. Duration of follow-up ranged from 12–36 weeks. Demographic variables, mode of injury, time required for union, complications and clinical improvement were recorded and analysed.

Results: Most of the fractures were united by 20th week (80%) with mean union time of 17.9 ± 3.2 weeks. Excellent clinical results with MIPO were observed in 46.7% cases while poor results were obtained in 10% cases. Complications were seen in 13 subjects (43.3%), of which most common was wound infection, seen in 13.3% of the cases. Delayed union was noted in 1 case while no case of non union was observed.

Conclusion: MIPO is an effective technique for the management of distal tibial fractures. It is minimally invasive, though technically demanding, but preserves the biological environment by preserving the soft tissue with better outcome in terms of radiological union and clinical improvement.

Introduction

Unstable fractures of distal tibia with or without intra-articular extension can present a clinical dilemma. Historically, there have been a variety of methods of management described but with high rates of associated complications. Non-operative methods can be technically demanding and may be associated with joint stiffness in up to 40% of cases as well as shortening and rotational malunion in over 30% cases [1,2].

Intramedullary nailing is the gold standard for treatment of most diaphyseal fractures of the tibia. However, although some researchers have described good results with intramedullary nailing in the treatment of distal peri-articular tibial fractures, it is generally considered unsuitable for such injuries, due to the technical difficulties and design limitations [2,3]. Traditional open reduction and internal fixation of such injuries results in extensive soft tissue dissection and periosteal injury and associated high rates of infection, delayed union, and non-union [4]. Similarly, external fixation of distal tibial fractures may also be associated with high incidence of complications, with pin infection and loosening in over half of the cases and malunion rates of up to 45% [2].

Minimally Invasive Plate Osteosynthesis (MIPO), already used with LC-DCPs [5] has now become more popular with the development of the LCP. Through a small skin incision, the plate is tunnelled extraperiostally along the medial aspect of the tibia and fixed with head locking screws. MIPO offers many biological advantages including minimal soft tissue dissection with preservation of vascular integrity of the fracture as well as preserving osteogenic fracture haematoma [6]. MIPO techniques have been used successfully in the treatment of distal femoral fractures [7-9]. Experience of the application of these techniques to fractures of the distal tibia is less extensive and opinion regarding optimal technique varies. Some clinicians advocate temporary external fixation prior to definitive MIPO and routine fixation of associated fibula fractures [10] while others advocate a more selective approach to the role of external fixation and fibular fixation [11].

Materials & Methods

A total of 30 patients with distal tibia fractures satisfying inclusion criteria admitted in R. L. Jalappa Hospital attached to Sri Devaraj Urs Medical College, Tamaka, Kolar were included in the study after informed consent. Duration of follow-up ranged from 12–36 weeks. Demographic variables, mode of injury, time required for union, complications and clinical improvement were recorded. Fracture was classified according to AO/OTA classification system [12].

Inclusion Criteria

1. Patient >18 years.
2. Closed and Open tibia type I and II fractures.
3. Intra-articular extension of the fracture.

Exclusion Criteria

1. Pathological fractures.
2. Patients with co-morbid conditions posing a risk for surgery.

Pre-Operative Regimen

The patients were resuscitated in emergency room and a complete examination of the patient for other associated injuries was done. Neurological and vascular assessment of the involved limbs was carried out. Wound lavage, dressing and splintage was done as per the initial assessment and injury to the patient. Analgesics, Antibiotics, I.V fluids were administered as per protocol and tetanus prophylaxis as per requirement was given. Basic blood parameters were evaluated. Gram positive and gram negative antibiotic cover was given for closed fractures. Anaerobic antibiotic cover was given to patients with open fractures along with the above mentioned antibiotics. The patients were taken for surgery after initial resuscitation, stabilization of vital parameters and after getting pre anaesthetic check-up and clearance.

Surgical techniques

Once the patient was prepared and draped, intra-operative antibiotics were given before the inflation of tourniquet. By traction and manipulation reduction was attempted. The provisional reduction was then confirmed by image guidance under C-ARM (IITV). After adequate reduction and alignment is achieved,

plate size was selected under image guidance so as to provide adequate fixation and stabilization of fracture.

In MIPPO technique, incision was made obliquely at the tip of medial malleolus and extended proximally to create easy passage. The medial malleolus was exposed, with care taken to protect the great saphenous vein. Percutaneous elevators were then inserted to create a submuscular, extraperiosteal tunnel for the plate. The passage of the plate till fracture site was confirmed with C-ARM imaging. An incision was made proximally at the estimated proximal edge of the plate. The anterior and posterior borders of the medial tibia were then palpated, and incision was extended longitudinally exposing the periosteum. Sub-muscular plane was developed in proximal incision and tunnel developed till fracture site and the plate was pushed by the surgeon's opposite hand. The plate was palpated in the proximal incision and confirmed to be well seated. The plate was then fixed on the tibial surface with a Kirschner wire inserted through a fixation bolt. Adequate positioning was then confirmed with antero-posterior and lateral imaging. The proximal position of the plate was then checked to ensure central placement of the tibial shaft (using the C-Arm).

This was then followed by insertion of fixation screws following the standard procedure for non locking cortical screws and locking screws. All the non locking screws were inserted first as decided pre-operatively and after attaining adequate reduction, locking screws were inserted. A minimum of four screws were used in each main fracture fragment. After the plate was inserted with the screws, the stabilization bolt was removed from the middle distal hole and screw was inserted in its place. The principles of fixation using LCP was adhered to at every stage of fixation.

This was followed by irrigation of all the incisions with normal saline and wound closure in layers. The technical problems/ complications during the procedure (if any) was recorded.

Post operative regimen

Post operative X-ray was done to document proper reduction and fixation of fracture fragments. Ankle mobilization was started from 2nd or 3rd post operative day according to the tolerance of patients or associated injuries. Antibiotics (Intravenous /oral) were continued till the wound condition necessitates. Progressive weight bearing was allowed according to the callous formation as assessed in follow up X Rays. Regular follow up of the patients was done in OPD with X-rays and evaluation of functional outcome. All long term complications like non union, malunion, angular deformity, implant breakage, shortening or infection were recorded. The patients were followed up till the bony union of the fracture / upto 9 months, whichever was earlier. The final results were based on the functional and radiological outcome. Operated patients were followed up using OLERUD and MOLANDER scoring system and final result were graded as: excellent/good/fair/poor [14].

Results

Table 1 shows Distribution of patients based on AO/ OTA Classification. Most of the fractures were united by 20th week (80%) with mean union time of 17.9 ± 3.2 weeks (Table 2). Excellent clinical results with MIPO were observed in 46.7% cases while poor results were obtained in 10% cases (table 3). Complications were seen in 13 subjects (43.3%), of which most common was wound infection, seen in 13.3% of the cases. Mal-union was seen in 10% while Infection and Ankle stiffness was seen in 10% and 6.7% cases respectively (Table 4). Delayed union was noted in 1 case while no case of non union was observed.

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 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 [15,16]. Other potential complications of nailing are malunion (0-29%) and implant failure (5-39%) [15-18]. ORIF with conventional plate which needs striping of periosteum is also not an ideal treatment option because tibia is subcutaneous bone and periosteum provides 2/3 rd of blood supply. Non union, delayed union and infection are reported with the range of 8.3-35% and 8.3-25% respectively with ORIF with plating [19-22,23]. 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 non union and hence recommended only for temporary method of stabilization in open fracture with severe soft tissue injury [24].

With the development of technique of MIPO with LCP which preserve extraosseous blood supply, respect osteogenic fracture haematoma, biologically friendly and stable fixation method is available 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 MIPO technique prevents iatrogenic injury to vascular supply of the bone [25]. 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 [26].

Comparative studies with IMIL or conventional open techniques have found conflicting results with MIPO with LCP for distal diametaphyseal tibia fracture. Vallier et al. [21] reported significantly more angular malalignment in distal diametaphyseal tibia fracture, treated with IMIL in comparison to those treated with plating (22 patients vs 2 patients, p=0.003) where as Guo et al. [27] in a comparative study of extra articular distal diametaphyseal 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. 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 [28]. Kao et al. found no statistically significant advantages of LCP over conventional plate group [29].

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. Malreduction and suboptimal pre contouring of the plate can result delayed union, non union, prominent hardware, malleolar skin irritation and pain [26,30,31].

Indirect reduction of fracture under C arm control can be difficult at time. Various reduction maneuvers such as calcaneal pin traction, external fixators or mechanical distractors have been described to achieve reduction [17,32] We used Kirschner wires (3 mm) as a joystick or a towel clip after making small opening at fracture site whenever reduction could not be achieved by mechanical traction. Concomitant fibula fracture also play the role in success of reduction especially when fracture is at same level of tibia. Some authors recommend fibula fixations before tibia fixation to achieve better tibial alignment and to prevent valgus malalignment but clear indications for fibula fixation are still lacking and controversial [17,29,30,33]. We did not routinely fix fibula unless it has involved syndesmosis. MIPO technique can

Volume : 4 | Issue : 6 | June 2015 • ISSN No 2277 - 8179

restore alignment in high velocity distal diametaphyseal tibia fracture and patients can expect predictable return of function. However, Collinge et al. reported increased secondary procedure rate like bone grafting for delayed union [34]. Rate of secondary procedures like iliac crest bone grafting or per cutaneous bone marrow injection for delayed union or non union or change of hardware has been reported 3.8% to as high as up to 35% [30,34]. In the current study, no patient required secondary procedures while delayed union was observed in one patient. The average time for fracture union in the present study is also comparable to other studies [30,35,36].

Reported rate of wound infection varies between 2.6% to 14.6% depending upon whether open fracture are included in the study or not [36]. The present study which included both types of fractures found wound infection in 4 (13.3%) cases. Three patients who had superficial wound infection improved with antibiotics but patient with wound breakdown and exposed implant had protracted post operative rehabilitation period requiring repeated wound debridemet and long hospital stay.

Conclusion

MIPO is an effective technique for the management of distal tibial fractures. It is minimally invasive, though technically demanding, but preserves the biological environment by preserving the soft tissue with better outcome in terms of radiological union and clinical improvement.

Table 1. Distribution of patients based on AO/ OTA Classification

AO/ OTA Classification	N	Percent
43. A1	16	53.3%
43. A2	6	20.0%
43. A3	5	16.7%
43. B1	3	10.0%
Total	30	100.0%

Table 2. Distribution of patients based on Union Time

Union time (weeks)	N	Percent
< 12	5	16.7%
12 -20	19	63.3%
> 20	6	20.0%
Total	30	100.0%
Mean Union time: 17.9 ± 3.2 weeks		

Table 3. Distribution of patients based on Clinical Improvement

Clinical Results	N	Percent
Excellent	14	46.7%
Good	9	30.0%
Fair	4	13.3%
Poor	3	10.0%

Table 4. Distribution of patients based on Complications

Complications (n-30)	N	Percent
Wound Infection	4	13.3%
Malunion	3	10.0%
Infection	3	10.0%
Ankle Stiffness	2	6.7%
Delayed Union	1	3.3%

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