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RESEARCH ARTICLE

TREATMENT OF DISTAL TIBIAL FRACTURES BY LOCKING COMPRESSION PLATE USING MIPPO TECHNIQUE

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ABSTRACT

Minimally invasive plate osteosynthesis (MIPPO) of the distal tibia offers several advantages compared to classic open reduction and internal fixation. Minimally invasive percutaneous plating osteosynthesis (MIPPO) technique in fractures of distal tibia provides mechanically stable fracture-bridging osteosynthesis thereby preventing damage to bone vascularity, reduce iatrogenic soft tissue injury and preserve the fracture hematoma as compared to classic open reduction and internal plate fixation. Minimally invasive osteosynthesis offers the best possible option as it permits adequate fixation in a biological manner. A series of 25 patients treated for distal tibial fractures using a distal tibial locking plate through the MIPPO technique have been reviewed after surgery. There were 16 males and 9 females of mean age 48.5 years. The commonest cause of injury was road traffic accident. Minimally invasive plate osteosynthesis is a good and safe technique for treatment of distal tibial fractures injuries when there is no articular comminution and the soft tissue envelope is minimally disturbed.

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INTRODUCTION

The management of displaced distal tibial fractures is a controversial and debatable topic (Hazarika *et al*., 2006). The classic AO technique of open anatomic reduction and internal fixation of distal tibial fractures requires extensive soft-tissue dissection and often leads to subsequent periosteal injury. High rates of complications, including postoperative infection, delayed union, and nonunion, have been reported. (McFerran *et al*., 1992; Ruedi and Allgower, 1979) External fixation (Marsh *et al*.,1995; Mockford *et al*., 2003; Rammelt *et al*., 2004) and intramedullary nailing (Konrath *et al*., 1997; Im and Tae, 2005) techniques undoubtly minimise soft-tissue trauma and have been shown to reduce wound infection (Konrath *et al*., 1997; Mockford *et al*., 2003; Im and Tae, 2005) but their use is complicated by malunion and nonunion, imperfect reduction of articular surface, and pin tract infection (Marsh *et al*., 1995 Rammelt *et al*., 2004). Indirect reduction and biologic percutaneous plating without direct manipulation of the fracture fragments result in good clinical outcomes (Oh *et al*., 2003; Perren, 2002) The main goal of biologic plating techniques is to maintain the soft-tissue attachments and vascularity of the cortical bone fragments, thereby theoretically reducing the risk of postoperative infection and nonunion.

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Several studies have reported good clinical outcomes in distal tibial fractures treated with locking compression plates (LCPs) (Hazarika *et al*., 2006; Hasenboehler *et al*., 2007; Gao *et al*., 2009). LCPs may provide greater stiffness in some situations. They may also maintain a better periosteal blood flow by minimizing the contact of the plate with bone (Egol *et al*., 2004; Kaab *et al*., 2004).The distal tibia locking plate applied percutaneously by adhering to the minimally invasive percutaneous plate osteosynthesis (MIPPO) technique address the soft tissue problems associated with ORIF of the distal tibia. The present study reported a series of patients who were treated for fractures of the distal tibial metaphysis using this plate and minimal osteosynthesis technique.

MATERIALS AND METHODS

A retrospective study on 25 patients treated with MIPPO using the distal tibial locking plate for distal tibial fractures was carried out. The surgical indication was that if the fracture fragments were displaced. The exclusion criteria were - nondisplaced fracture fragments; AO/ Orthopedic Trauma Association Type B and Type C fractures; open Type IIIb and IIIc fractures that required indirect reduction; and conditions in which biologic percutaneous plating could not be performed. The fractures were classified according to the AO classification system. There were 4Type A1, 6 Type A2 and 15 Type A3fractures.

Even though early intervention is advantageous, it is desirable to delay surgery in the presence of gross local swelling until subsidence of swelling and appearance of the wrinkle sign (range: three to eight days) to ensure good local skin condition prior to surgery. Patients with open Type II fractures with a large open wound and Type IIIa fractures were initially treated with debridement and external skeletal fixation; 7–10 days later, they underwent percutaneous plating. Patients were placed supine on a radiolucent table, and fluoroscopic guidance was used for optimal diaphyseal–metaphyseal alignment, anatomic reduction of the joint surfaces, and implant fixation.

A

B

C

Figure 1. Preoperative x-rays of distal tibial fracture

A Kirschner wire, if required, was placed through the calcaneus for continuous manual traction. Under fluoroscopic guidance, two 3- to 4-cm skin incisions were made on the medial side of the tibia at the proximal and distal parts of the estimated position of the plate. A vertical or curvilinear incision was made at the level of medial malleolus with utmost care not to injure saphenous vein and nerve. Subcutaneous plane was made with hemostat without striping periosteum and disturbance to fracture haemotoma.

A

B

C

Figure 2. Post operative x-rays of distal tibial fracture fixed with distal tibial locking plate

Fracture was reduced under fluoroscopy, sometimes K-wire is used as joystick to aid in fracture reduction and towel-clip or reduction clamp to hold reduction. Pre-contoured LCP was tunnelled into subcutaneous plane and its position was confirmed under fluoroscopy.

Two or three 4.5-mm locking screws were inserted into the distal tibial fracture fragment, and two 4.5-mm locking screws and one 4.5-mm cortical screw were inserted into the proximal tibial fracture fragment. If there was a concomitant fracture of the distal one-third of the fibula, open reduction and internal fixation using a conventional or locking reconstruction plate was performed in the same operation (Figure 2). Physical rehabilitation with active motion of the ankle joints was initiated on the second postoperative day and continued until the day of discharge. After discharge, the patients were encouraged to perform straight leg-raising exercises and active ankle motion (extension and flexion).

A short leg splint was applied to protect the injured limb for 8 weeks. Partial weight bearing was recommended 8–12 weeks after surgery when evidence of callus bridging was seen on plain radiographs. Full weight bearing was recommended 12 weeks after surgery. Patients were monitored every 4 weeks until the radiographs showed solid continuous callus formation. Anteroposterior and lateral radiographs were obtained at each visit. The ankle scoring system described by Olerud and Molander was used to evaluate patients outcomes at the 12-month follow-up. According to the ankle scores, clinical outcomes were categorized as excellent, good, fair, and poor (Table 1).

Table 1. The ankle scoring system of Olerudand Molander (1984)

Score	
1.Pain	
(a) None	25
(b) Walking on uneven surface	20
(c) Walking on even surface	10
(d) Walking indoors	5
(e) Constant and severe	0
2. Stiffness	
(a)None	10
(b)Stiffness	0
3 .Swelling	
(a) None	10
(b) Evenings	5
(c) Constant	0
4.Stair-climbing	
(a) No problems	10
(b) Impaired	5
(c) Impossible	0
5. Running	
(a) Possible	5
(b) Impossible	0
6. Jumping	
(a) Possible	5
(b) Impossible	0
7.Squatting	
(a)No problems	5
(b)Impossible	0
8.Supports	
(a)None	10
(b)Tape, wrapping	5
(c))Stick or crutch	0
9.Work, activities of daily living	
(a)Same as preinjury	20
(b)Reduced	15
(c)Change of job	10
(d)Severely impaired	0
Total 100	

Excellent: above 92 units; Good: between 86 and 92 units; Fair: between 64 and 86 units; Poor: below 65 units

RESULTS

25 patients of distal tibial fracture treated with distal tibial locking plate were evaluated. There were 16 males and 9 females with mean age 48.5 years. The commonest cause of injury was road traffic accident (64%).Ten cases were open fractures and classified by the Gustilo Anderson classification, six cases were Type IIIA, two cases were Type II and two case were Type I. Four cases were A1, 6 were A2 and 15 were A3 based on the AO classification. In 16 cases, the distal fibula was involved and plated. Mean time to fracture healing was 14.2 weeks. There were two cases of superficial infection. Overall there were 8 excellent, 12 good and 5 fair results (Table 2).

Table 2. Characteristics of distal tibial locking plate for distal tibial fractures

S.No	Characteristics	No
1	Age (yrs) Range (21-66) Mean age	48.5
2	Sex Male/Female	16/9
3	Mode of trauma Automobile accidents/Fallstairs and height/ Sports	16/4/5
4	Limb side injured: Right/left	15/10
5	AO classification	A1/A2/A3 4/6/15
6	Closed fracture	15
7	Open fractures	10
	I/II/IIIA	2/2/6
8	Fibula fracture Proximal/middle/distal	2/7/16
9	Time for weight bearing (wks) mean	
	Partial	9.6
	Full	13.6
10	Time for radiological union (wks) Mean	14.2
11	Complications Infection	2
12	Result grading excellent/good/fair	8/12/5

DISCUSSION

The key point in management of distal tibia fractures is to recognize the importance of the soft tissue component (Mockford *et al*., 2003) as injury is invariably complicated with infection, wound dehiscence or non union. Where the soft tissue injury is significant, bridging external fixation is advantageous for skeletal and soft tissue stabilisation (Rammelt *et al*., 2004). Definitive fixation is only advisable when the soft tissue allows it, when the 'wrinkle sign' is evident. Even though early intervention is advantageous, it is desirable to delay surgery in the presence of gross local swelling until subsidence of swelling and appearance of the wrinkle sign (range: three to eight days) to ensure good local skin condition prior to surgery. (Rakesh Gupta *et al*., 2010).

The literature on ORIF of distal tibial or pilon fractures are plagued by wound infection (Sands *et al*., 1998; Teeny and Wiss, 1993; Wyrsch B*et al*., 1996). The anteromedial aspect of the distal tibia is most at risk of wound infection and dehiscense (Konrath *et al*., 1997). ORIF has been shown to have the highest infection rates compared to other methods of treatment (Teeny and Wiss, 1993). Wound debridement, antibiotics, skin grafting, myocutaneous flap and even arthrodesis have a role to play in management (Sands *et al*., 1998). Studies using external fixation techniques reported significant reduction in infection rates (Marsh *et al*., 1995; Mockford *et al*., 2003; Rammelt *et al*., 2004). Infection rates in the MIPPO technique are better than in previously reported ORIF studies and comparable to external fixation technique

(Sands A *et al*., 1998; Perren, 2001; Sirkin *et al*., 2004). This is reflected in our results, with only two cases of superficial wound infection, which completely resolved with appropriate antibiotics. Reports suggest that intramedullary nailing has the lowest infection rates compared with other techniques (Konrath *et al*.,1997;Im and Tae, 2005) but the technique is associated with other complications such as malunion, fat embolus syndrome, compartment syndrome and anterior knee pain (Im and Tae, 2005). Studies involving external fixation techniques showed complications such as loosening, malunion, imperfect articular reductions and pin tract infections (Rammelt S*et al*., 2004). ORIF has the lowest rate of angular malunion (Im and Tae, 2005,) compared to external fixation (Rammelt *et al*., 2004) or intramedullary nailing (Im and Tae, 2005) but the downside is the high infection rates. The distal tibia locking plate applied with minimally invasive techniques allows fracture reduction and alignment without the associated wound complications in ORIF. The distal tibia plate is pre-contoured to the anatomy of the distal tibia and thus allows placement of the plate without disruption of fracture fragments. The distal end of the plate allows placement of locking screws that provide stability where satisfactory bone purchase is difficult. The threaded holes lock to the locking screw head and minimize plate-bone interface and maintain the vascularity of the fracture site. The proximal combination holes allow insertion of locking or cortical screws where relative or absolute stability can be achieved (Syah Bahari *et al*., 2007). Distal tibia plating allows early active range of movement as postoperative plaster immobilization is not necessary.

Conclusion

Minimal Invasive Locking Plate Osteosynthesis was used for definitive fixation of high energy, open and closed, peri-articular distal tibia fractures. This approach aims to preserve bone biology and minimize surgical soft tissue trauma.

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