Percutaneous locked plating for complex distal tibial fractures

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Objective
To evaluate the clinical outcome and advantages of percutaneous plate fixation for complex distal tibial fractures using locking compression plate-distal tibial plate (LCP-DTP).
Design
This is a prospective case series study.
Setting
Urban, level I trauma center.
Patients and methods
Twenty-seven adult patients, who met the inclusion criteria, with closed traumatic distal tibia with or without fibular fractures were treated using the minimally invasive plate osteosynthesis technique with LCP-DTP. According to the AO fracture classification, there were 12 AO 43A fractures and 15 AO 43B fractures. The fibula was fractured in 15 patients and it was fixed in all of them.
Main outcome measurements
Perioperative complications following percutaneous fixation of the distal tibia such as infection, deformity, leg length discrepancy, ankle joint function, bony union, and metal failure within 1 year after the surgery.
Results
This study included 27 adult patients with traumatic fracture distal third tibia, 21 of them were men and six were were women. They were followed up for a period ranging from 14 to 19 months with an average of 16. None of the patients developed early perioperative complications. Deep venous thrombosis occurred in three patients, who were treated medically, residual loss of a few degrees of ankle motion in six and late infection related to the proximal screws was also observed in three obese uncontrolled diabetic patients. Union was achieved in all of them within 12–20 weeks with an average of 16.
Conclusion
Minimally invasive plate osteosynthesis for the distal tibia using the LCP-DTP is safe and effective in the treatment of complex distal tibial fractures.

Keywords:
fracture tibia, minimally invasive plate osteosynthesis, percutaneous plating tibia

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Introduction

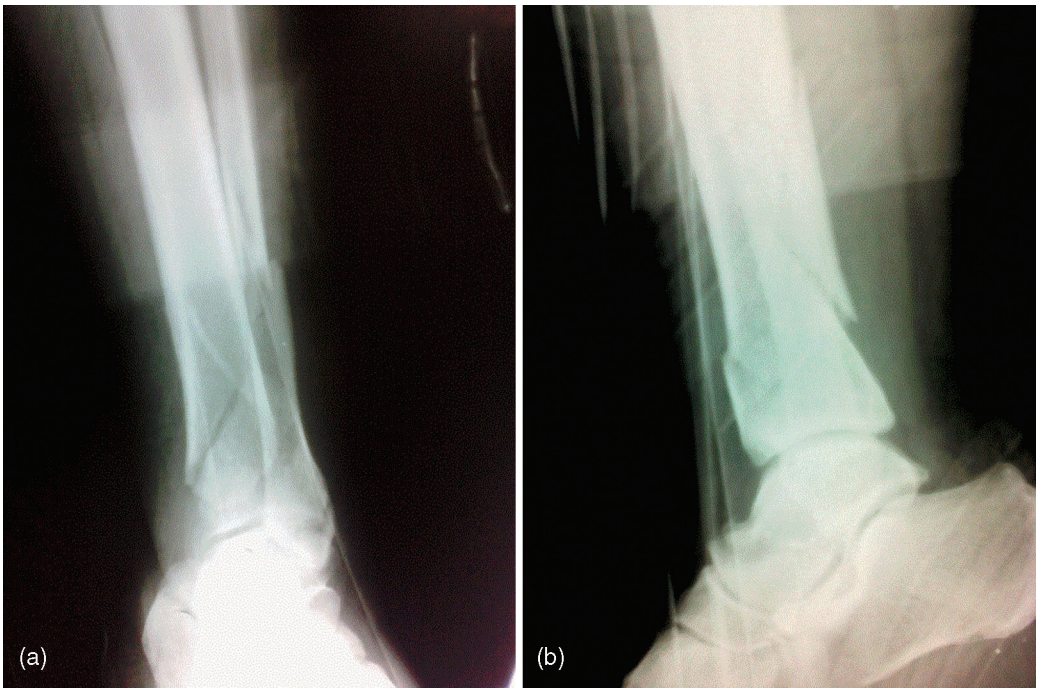
The degree of fractures of the distal tibia and the associated soft tissue damage vary according to the impact and severity of trauma. At the same time, the treatment modalities remain controversial because of the limited soft tissues, the subcutaneous location, poor vascularity, and the high incidence of complication rate [1–4]. Surgical fixation of the distal tibia is challenging, including external fixation, and the ordinary open reduction and internal fixation [2]. External fixation is indicated in open fractures with soft tissue damage that may result in inaccurate reduction, malunion, nonunion, and pin tract infection [1–7]. Intramedullary nailing is limited to diaphyseal fractures more than 7 cm above the ankle joint [8–10]. The classic open reduction and internal fixation requires extensive soft tissue dissection and possible high incidence of complication rates [11–14]. Minimally invasive plate osteosynthesis (MIPO) techniques have been developed, with union rates ranging between 80 and 100% [15–18], and reported 7–35% incidence of angular deformity [13,17], hardware failure up to 10% [17], and nonunion up to 20% [15,16]. A new advance in MIPO was achieved using the 'locked internal fixators.' These devices consist of plate and screw systems where the screws are locked in the plate at a fixed angle. Screw locking minimizes the compressive forces exerted by the plate on the bone, eventually distributes stresses along the plate, which acts as a flexible elastic fixator stimulating callus formation [19–22]. The aim of this study is to evaluate the clinical outcome of percutaneous plate fixation for complex distal tibial

fractures using locking compression plate-distal tibial plate (LCP-DTP).

Patients and methods

Between January 2010 and December 2012, 27 adult patients with closed distal tibial fractures with or without fibular fractures were treated using the MIPO technique with LCP-DTP. This study had been approved by the local Institutional Research Board with formal consent from all patients. Their age varied from 31 to 56 years with an average of 41; 21 of them were men and six women. Eighteen patients had a history of fall on the ground and nine presented with road traffic accidents. The inclusion criteria were closed traumatic complex distal tibial fractures and the degree of soft tissue injury was Tscherne grades 0 and 1. The exclusion criteria included open and pathological fractures, chronic preexisting neurovascular diseases. Only six of them were smokers. The time elapsed between trauma and surgery ranged from 6 to 9 days with an average of 7 until the absence of inflammatory or reactionary edema and positive wrinkle test. Fibular fracture was present in 15 of them; all patients were assessed and classified radiologically according to the AO comprehensive classification system. There were 12 AO 43A fractures and 15 AO 43B fractures (Figs 1 and 2). Immediately after trauma, the foot and ankle were splinted by below the knee posterior slab. All surgical procedures were undertaken by the same author after an average of 7 days after trauma. In the operating room, on a radiolucent operating table, under general or spinal anesthesia, while the patient in supine position, using a tourniquet, the affected foot and ankle were sterilized and draped. Starting with fibular fixation using small dynamic compression plate (DCP) in patients with an associated fibular fracture to restore its normal length and to assist the indirect reduction of tibial fractures. A curvilinear 2 cm transverse incision just above and in front of the medial malleolus was done, pass a tunneler proximally through the incision extraperiosteal to create a home to incorporate the distal tibial locked plate. Under radiography control, the LCP-DTP for the distal tibia was passed from the distal to the proximal (Fig. 3). Indirect reduction of the fractures was achieved by manual traction of the foot, ankle, and leg. A pointed reduction clamp was used through the intact skin to do temporary fracture reduction. The level of the distal tibial locked plate was adjusted radiologically in relation to the ankle joint; preliminary K wire fixation of the plate to the tibia was used. Through a small percutaneous incision fix the first screw, which is nonlocked at a combi hole within the plate proximal to the fracture lines to achieve reduction. Distal fixation was completed using three to four locked screws from the primary distal incision. Complete proximal fixation was with locked screws through small snip percutaneous incisions. Skin closure, apply sterile dressing and below the knee

Figure 1

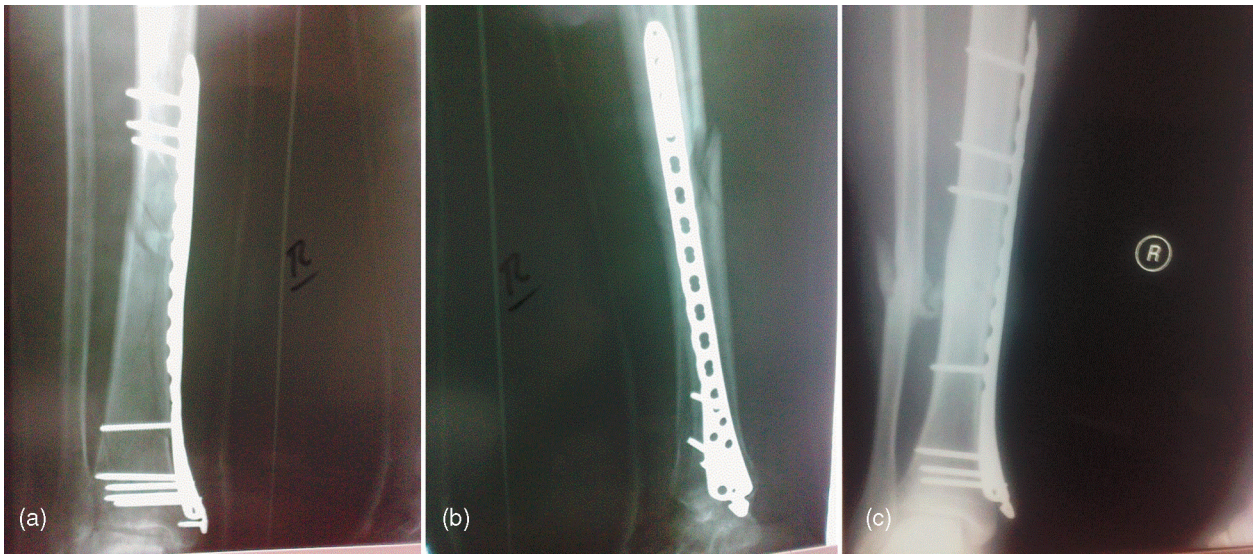


(a, b) Fracture distal tibia and fibula type 43B.

Figure 2

(a) Surgical technique for fixation using LCP-DTP. (b) Postoperative fixation with restoration of the distal tibial and fibular anatomy. LCP-DTP, locking compression plate-distal tibial plate.

Figure 3



(a) Percutaneous plating distal tibia for long metaphyseal fracture (anteroposterior view). (b) Percutaneous plating distal tibia for long metaphyseal fracture (lateral view). (c) 20 weeks follow-up with evident union of tibial fracture.

posterior slab for 2 weeks. The patient was discharged on the second day of surgery for outpatient follow-up.

Results

Patients were followed up on the outpatient clinic; skin stitches were removed within 12–14 days, the posterior slab was removed on the second postoperative week and the patients were advised to start ankle and foot mobilization. Three obese patients developed postoperative deep vein thrombosis within 3–5 weeks, and it was controlled by medical treatment and there were no further complications (Table 1). Bony union was achieved in all of them within 12–20 weeks with an average of 16, and without the need for bone graft. Temporary functional limp was observed in seven patients, and it resolved spontaneously with the physiotherapy program. None of the patients had an angular deformity or limb length discrepancy. None of them had metal failure. Two patients had temporary late

Table 1 Results

Data	Number of patients
Deep venous thrombosis	3
Infection	
Low-grade proximal infection	3
Pyogenic ankle arthritis	None
Union	All
Metal failure	None
Loss of ankle motion	Within 5–10 deg. in 6
Deformity and limb length discrepancy	None
Temporary functional limp	7

low-grade infection related to proximal screws, both of them were smokers and diabetic. It resolved using local and systemic broad-spectrum antibiotics. At the 30th week, there was 5–10° loss of dorsiflexion of the ankle in six elderly patients with multifragmentary type 43B fractures.

Discussion

The treatment of distal tibia fractures can be challenging because of the initial soft tissue trauma, subcutaneous location of the bone, and poor vascularity. MIPO reduces the iatrogenic soft tissue injury and damage to bone vascularity, and preserves osteogenic fracture hematoma [23,24]. Initial clinical series using these methods with the usual nonlocked plates demonstrated favorable results with low rates of infection and nonunion [16,17,25–27], but several complications such as angular deformities and hardware failure have been reported [15–17]. The 3.5 mm small fragment LCP was developed to overcome these side effects. This study was designed to evaluate the early results of fixation of distal tibial fractures using 3.5 low-profile LCP-DTP. The inclusion criteria were closed, traumatic distal tibial fractures with the exclusion of pathologic, open, and infected or neglected fractures. Many studies were published to evaluate the results of this type of locked plates for distal tibial fractures with encouraging results [16,25–28]. Collinge *et al.* [25] had reported 26 patients with distal tibial fractures who were operated by the MIPO technique. All fractures had united in an average of 35 weeks and in nine of them other supplementary procedures were required. Hasenboehler *et al.* [27] reported a series of 32 patients; union was achieved in 29 of them within 27 weeks, Hazarika *et al.* [29] reported a series of 20 patients where union was achieved in 18 of them within 28 weeks. In 2010, Ronga *et al.* [30] reported a series of 19 patients and union was achieved within 22 weeks. In our study, there was no permanent complications or deformities and it was attributed to many factors namely delayed surgical intervention until clearance of soft tissue injury. Stable fibular fixation was done for all patients with an associated fibular fracture. Stable absolute fibular fixation is very important to assist indirect reduction of the complex distal tibial fractures, restoration of leg length, and to avoid periankle deformities. The used technique of indirect reduction of tibial fractures has many advantages such as preservation of fracture hematoma, maintainance of blood supply of bone fragments, and avoidance of any possible iatrogenic damage or infection at the distal tibia and ankle. Union was achieved in all patients without any permanent deformities or limb length discrepancy. At the same time, the used implant had a lot of advantages as there is a precontoured plate with fixed angle stability of the holes securing the plate to the tibial bone. All these factors add to plate stability and prevents fracture displacement. The mechanical properties of the LCP-DTP had added all these advantages, namely the high union rate, no deformities, and rapid rehabilitation after surgery. The reported complications here are also equivalent to other studies [16,25–28].

Conclusion

Although distal tibial fractures are difficult to treat and challenging, the introduction of the anatomical low-profile 3.5 mm LCP-DTP of the tibia had solved the problems of iatrogenic soft tissue injuries, early postoperative rehabilitation program, bone healing, and functional weight bearing.

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Conflicts of interest

There are no conflicts of interest.

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