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Original article

Distal tibial fracture: An ideal indication for external fixation using locking plate

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ABSTRACT

Objective: To evaluate the feasibility and efficiency of one-stage external fixation by using locking plate in distal tibial fractures.

Methods: In this non-control prospective study, 28 patients with distal tibial fractures were included and underwent one-stage external fixation by using locking plate. There were 21 males and 7 females, with a mean age of 43 years (19–63). According to AO/OTA fracture classification, there were 9 cases of Type A1, 9 of Type A2, 10 of Type A3 fractures. There were 21 close and 7 open fractures. The locking plate was placed on the anteromedial aspect of the tibia with 4–5 bicortical screws inserted in both distal metaphysis and diaphysis. The radiographic and clinic results were evaluated.

Results: All patients were followed up for the average of 16 months (ranging from 12 to 21 months). The average surgery duration was 38 (25–60) minutes. The mean time to fracture healing were 14.6 ± 2.67, 17.5 ± 3.66, and 18.4 ± 3.37 ($p < 0.05$) weeks in type A1, A2, and A3 fractures respectively. By the end of the follow-ups, the mean AOFAS score were 96.11 ± 2.32, 92.67 ± 1.80 and 92.00 ± 2.06 ($p > 0.05$) in type A1, A2, and A3 fractures respectively. None of nonunion, deep infection, or breakage of screw or plate were observed.

Conclusions: Distal tibial fracture was the ideal indication for external fixation using locking plate. The external plating is characterized by ease of performance, less invasive, fewer soft tissue impingement, improved cosmesis, and convenient for removal.

Introduction

Distal tibial fractures are difficult to manage due to its poor blood supply and limited soft tissue envelope.[1,2] The dynamic compressive plating technique requires a large exposure to allow reduction and plate fixation to be performed. Inherit with the large exposure is an increase in the risk of non-union and infection.[3,4] Minimally invasive percutaneous plate osteosynthesis (MIPPO) reduces these risks. Nevertheless, precontoured and angular stable plates may be prominent under the skin of the medial malleolus and may cause secondary skin necrosis.[5–7] Intramedullary nailing can provide rigid stability in diaphyseal fractures of the tibia. However, secondary to the hourglass shape of the medullary canal at the metaphysis of the distal tibial, antegrade intramedullary nailing is a technically challenging procedure, carrying with it the specific risk of primary and secondary malalignment. Additionally, anterior knee pain is a common complaint after antegrade tibial nailing.[8–11]

In our experience, the distal tibial fracture should be treated as a type of "open fracture" due to its poor soft tissue envelope which will have been contused from the injury, even without an open wound. The importance of minimizing secondary damage to the soft tissues by the surgical approach and implants is equal to the importance of fixation of fracture. Therefore, we evaluated an external fixation using femoral LISS (Less Invasive Stabilization System) plate for some selected patients with distal tibial fractures.

In this study, we present the technique of external fixation of a distal tibial fracture using a femoral LISS plate. The plate was positioned over the anteromedial aspect of the tibia as an external fixator intended for definitive fixation. The purpose of this study was to evaluate the clinical outcomes and complications.

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Methods

Twenty-eight adult patients with unilateral distal tibial fractures were included from August 2011 to October 2012. Inclusive criteria were: skeletal maturity, an isolated fracture involving the distal one third of tibia, with or without fibular fracture. Exclusive criteria included: pathological fractures, Gustilo types III B or C open fractures,[12] tibial fractures accompanied with skin defect on the anteromedial aspect of lower limbs, comminuted fractures with substantial articular displacement, multiple fractures with spinal injury, and lower limbs with pre-existing neurological deficit, autoimmune disease, or vascular disease.

There were 21 males and 7 female, with the average age of 43 (19–63) years old. Four patients were caused by falling, 6 by motor vehicle accident, 10 in an automobile-pedestrian accident, and 8 in a sports related injury. The fractures were classified according to the AO/OTA guidelines,[13] including 9 type 43-A1, 9 type 43-A2, and 10 type 43-A3. There were 7 open fractures: including 2 Gustilo type I, 3 Gustilo type II, and 2 Gustilo type IIIA. The closed fractures were evaluated for soft tissue injury according to Tscherne classification.[14] An associated fibular fracture was present in 25 patients, including 10 proximal, 6 middle and 9 distal ones. Six patients were smokers. Four patients had diabetes mellitus. All smokers and diabetics were well monitored during the whole duration of treatment.

Surgical technique

The surgery was not performed until the swollen soft tissue relieved. The skeletal traction and administration of medicine were prescribed to alleviate the swelling. The average pre-operation length was 3 days (2–5 days) for the closed fractures. For the open fractures, the fixation of fracture was achieved after debridement in an emergency setting. The associated distal fibular fractures were internally fixed to correct the length, and provide lateral stability. The proximal and middle fibular fractures were not fixed in this study.

For the tibial fractures with spiral and oblique morphology, an incision with a length of 3 cm–4 cm was at the anterolateral aspect of tibia to expose and clean the gap between the fracture end. Using manual traction at the ankle or through a single Steinmann pin inserted into the calcaneus, the fracture was anatomically reduced. A clamp or two K-wires were used to temporarily fix and maintain the anatomic reduction. A femoral LISS plate (9–11 holes) (Synthes, Oberdorf, Switzerland) was placed over the anteromedial aspect of tibia. The contralateral femoral LISS plate was used for fixation. i.e., a right femoral LISS plate was used to fix a left distal tibial fracture, and a left femoral LISS plate was used to fix a right distal tibial fracture. This peculiarity was incorporated into our surgical technique because we found that the contour of contralateral femoral LISS plate was matched to the anteromedial aspect of the lower leg. The broad end of the plate was placed close to ankle joint, which can provide more screws to stabilize the short distal segment. The plate was placed as close to the skin as possible to increase the stability of fixation. The folded gauge (1 cm–2 cm in thickness) was used to keep the plate apart from the skin, preventing abrasion or shear stress between the plate and skin. Successive holes were drilled over locking drill-guides through incisions where the overlying soft tissue is intact, and at this point, depth was confirmed by using a depth gauge. The locking screws of corresponding length were inserted. All screws achieved bicortical purchase. In both proximal and distal fragments, 4 to 5 bicortical locking screws were inserted respectively (Fig. 1). The position and orientation of screws were checked with X-ray. The skin was sutured and a drainage tube was placed which was pull out 24 h later.

Fig. 1. Intraoperative picture showing the position of femoral LISS plate.

For comminuted distal tibial fractures, we did not perform open reduction. Under live C-arm X-ray, the reduction of length and alignment was achieved by manual traction and percutaneous manipulation using Schanz pins. Two K-wires were used to percutaneously fix and maintain the reduction. The following steps for placement of screws and plate were the same as the steps mentioned above.

The patients were allowed to walk with partial weight bearing from post-operative Day 2. The pin sites were cleaned twice a day using a Betadine solution. Patients were examined in the outpatient clinics every 4 weeks for radiographical and functional evaluation. Once cortical bridging on biplanar radiographs was observed, the patients were allowed to walk with full weight bearing for one month before the plate was removed in the outpatient setting.

The X-ray images were evaluated by two senior physicians who concluded the final outcome. Fracture healing was defined as the resolution of pain at the fracture site and cortical bridging on biplanar radiographs. Complications were defined as the fixation failure, infection, and non-union. The functional recovery was evaluated by an independent, trained medical interviewer who was not involved in their treatment, according to AOFAS ankle scoring system at a minimum of one year after plate removal.[15]

A group *t* test and ANOVA test were used to assess associations between the variables and outcomes. The variables included age, gender, and type of fractures. A p value of <0.05 was considered with significant difference.

Results

All patients were followed up for an average of 16.2 (12–21) months. The mean surgery length was 38 (25–60) minutes. All wounds healed without complications. After four-week follow-ups, all the patients had full range of motion in adjacent joints (Fig. 2). All fractures healed at a mean of 16.7 (12–24) weeks, without evidence for non-union, deep infection, or broken screws or plates (Figs. 3–5). The Type A3 fracture demonstrated a prolonged healing time, comparing with Type A1 fracture ($p = 0.038$) (Table 1). Once cortical bridging on biplanar radiographs was observed, the patients were allowed to walk with full weight bearing. After one month of weight-bearing walking, the patients underwent plate removal in the clinics. During the procedure of removing plate, the mean VAS (visual analogue score) was 3.5 (1–7) points. All plates and screws were removed without difficulty within 3 min. At final follow-up, there were no recurrent fractures. The mean AOFAS score was 93 (88–100). There was no significant difference in AOFAS between the different groups related to age, gender, and type of fractures ($p > 0.05$) (Table 1).

Three patients had local superficial pin site effusion without compromise of the clinical outcome. Two of them presented pin site effusion at 4 weeks post the operation. The effusion was under