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CASE REPORT

The locking compression plate as an external fixator for bone transport in the treatment of a large distal tibial defect: A case report

T. Apivatthakakul*, K. Sananpanich

Department of Orthopaedics, Faculty of Medicine, Chiang Mai University, Chiang Mai 50200, Thailand

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Introduction

Surgical reconstruction of tibial bone defects presents a significant challenge for the orthopaedic surgeon. The bone defect is usually a result of high-energy trauma or of debridement for osteomyelitis. These defects are often accompanied by major soft-tissue injuries which limit the functional outcome independently of the actual loss of tibial bone.

Conventional bone graft[4,8] and free vascularised fibular grafting[3] are methods of treatment of large defects after severe open fractures. The Ilizarov technique of segmented bone transport of the tibia involving a circular ring external fixator has also been used for tibial defects, with acceptable outcome.[6,10,11] Ipsilateral fibular transfer with the Ilizarov frame is another alternative treatment for massive tibial bone loss, and yields favourable results.[2]

The main disadvantages of the Ilizarov method are the lengthy treatment time and the long-term disability. Bone transport either over unreamed interlocking nailing[9,12] or combined with minimally invasive plate osteosynthesis (MIPO)[1] has clear advantages over use of the Ilizarov circular ring, including less disability, improved fixation construction, maintenance of anatomical length and alignment, and early removal of the external fixation system. The locking compression plate (LCP) is a new screw-plate system that offers the possibility of inserting conventional and locking-head screws into a specially designed combination socket,[7,13] the LCP acting as internal fixator.

In the present case, following an alternative technique of bone transport, we used an LCP as external fixator to fix the short distal tibial fragment and maintain the bone defect throughout the treatment until final consolidation of the distraction osteogenesis.

Case report

A 29-year-old man was admitted to our institution following a road traffic accident. He had sustained a Gustilo type IIIB open distal tibial fracture with 9 cm $\times$ 15 cm of soft-tissue injury and segmental bone loss (Fig. 1a and b). The tibialis anterior muscle, anterior tibial artery and superficial and deep peroneal nerves were injured. The tibial nerve

* Corresponding author. Tel.: +66 53 945544; fax: +66 53 946442.
E-mail address: tapivath@mail.med.cmu.ac.th (T. Apivatthakakul).

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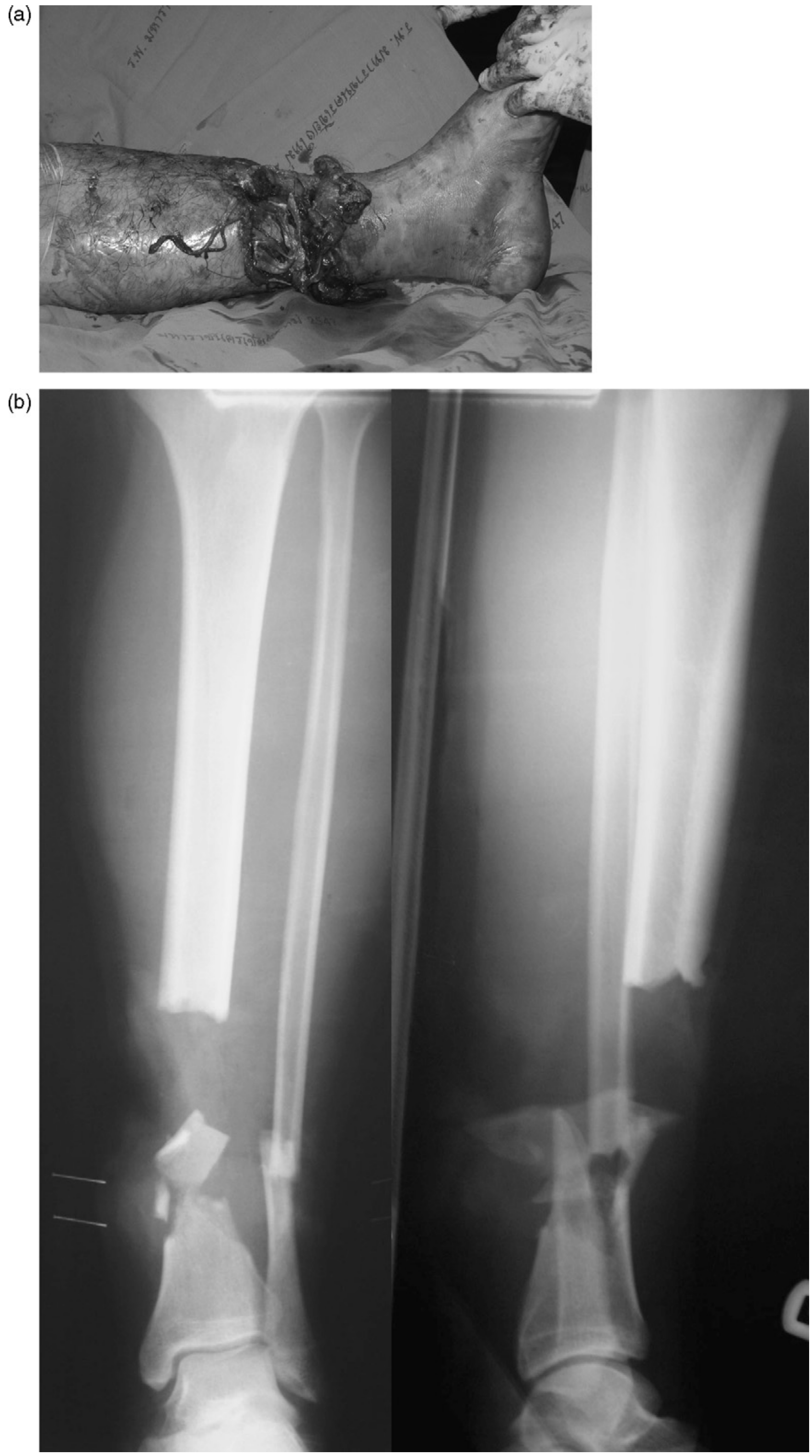

Figure 1 (a) A 29-year-old man sustained an open fracture type IIIb of the distal tibia in a motorcycle accident. (b) Radiographs showing fracture of the distal tibia and fibula, with 8.4 cm of segmental tibial bone loss.

and posterior compartment of the leg remained intact. During the emergency operation, the intention was to carry out radical debridement and stabilisation of the fracture. Initially the fibula was stabilised with a six-hole small dynamic compression plate (DCP) through the lateral wound. To maintain bony length a small DCP was chosen, conferring more stability than a one-third tubular plate, particularly in a segmental tibial defect. After removal of the devitalised bone, the tibial defect measured

(a)

(b)

Figure 2 (a) The tibial fracture was stabilised with a 14-hole 4.5 broad locking compression plate as external fixator. (b) Radiographs showing the fracture initially stabilised using the locking compression plate with two screws in the proximal and distal fragments.

8.4 cm and the length of the distal fragment was 4.5 cm. The tibial fracture was stabilised with a 14-hole, 4.5 broad LCP as external fixator, 4 cm of which remained external. The short distal fragment was stabilised with two adjacent locking screws, and proximal fixation involved two spreading locking screws (Fig. 2a and b).

The soft-tissue defect was reconstructed by transferring a free, vascularised, 9 cm × 15 cm, musculocutaneous thigh flap 1 week after the injury,

(a)

(b)

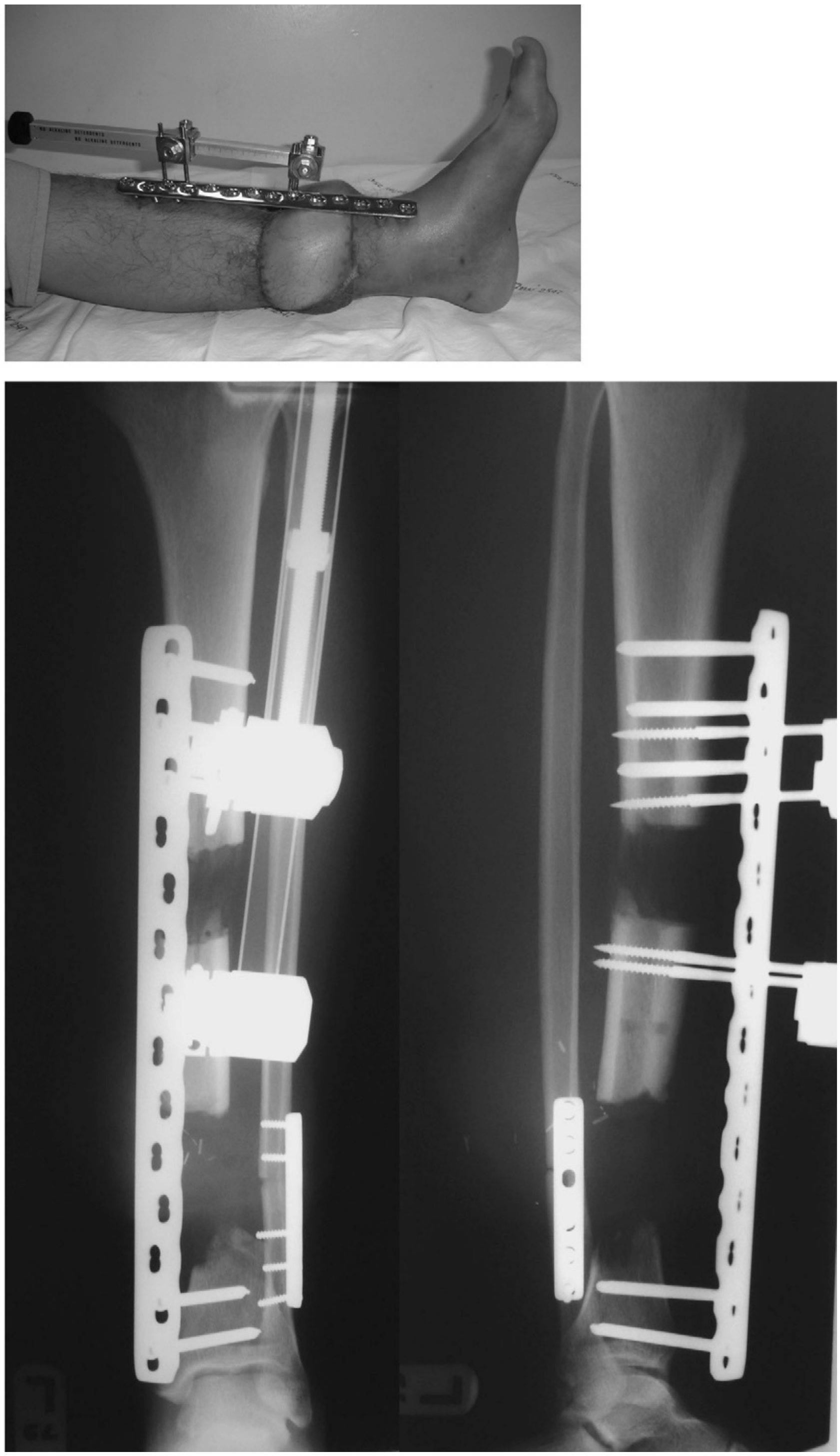

Figure 3 (a) The soft-tissue defect covered by a free, vascularised, anterolateral thigh flap. The bony defect was treated by distraction osteogenesis using the Wagner lengthening device. (b) Anteroposterior and lateral radiographs during the distraction period.

anastamosis with the proximal stump of the injured anterior tibial artery being carried out. At 4 weeks after healing of the flap wound, the bone transport procedure was performed. Two additional locking screws were fixed for the proximal fragment above the corticotomy site, and the locking screw below the corticotomy site was removed. The corticotomy was carried out by a small anterolateral approach. A small Wagner lengthening device was applied on the anterior surface of the tibia for distraction osteogenesis (Fig. 3a and b). Distraction began on the 7th day at 0.5 mm/day in the first 3 weeks, to allow flap revascularisation, since the pin cuts the upper part of the anterolateral thigh flap. After 3 weeks the distraction rate was increased incrementally to 1 mm/day. Active and passive motion of the knee and ankle were encouraged as far as tolerable, and the patient was advised to attempt partial weight bearing up to 20 kg. He was able to go home during distraction period. Radiographic evaluation was performed every 3 weeks during the distraction phase and every 6 weeks during the consolidation phase. The total distraction time was 96 days.

When the transport segment was at its target position, bone grafting was carried out to assist the union. One additional locking screw was fixed to the transport segment to provide more stability and prevent redisplacement of the segment, and then the Wagner distraction device was removed. During the 5 months between removal of the distraction device and fracture consolidation, the man was able to wear ordinary trousers without hindrance (Fig. 4a and b). Once consolidation was radiographically and clinically complete, the LCP was removed in the outpatient department and the man walked with a single crutch for 6 weeks to protect against possible refracture. The total external fixation time (EFT) was 10 months and the external fixation index (EFI: EFT per cm distraction gap) was 1.2 months/cm.

The man's functional outcome was excellent with no pain, satisfactory ankle movement, no need for a walking aid, and return to normal daily living and work (Fig. 5a and b). Radiography was satisfactory, showing healing of the docking site and consolidation of the distraction tube (Fig. 5c).

Discussion

Massive segmental bone loss from trauma or infection is a considerable surgical challenge, particularly when associated with extensive skin and soft-tissue damage. Historically, tibial bone defects have most often been treated by bone grafting.[4] Conventional bone graft is useful for defects less than 6 cm in length, in well-vascularised, non-infected bone.

In a large defect, conventional bone grafting poses risks of non-union and infection. Since 1981, the use of a vascularised fibular graft has been advocated for large defects, and the results have been superior to those of conventional bone grafting. However, vascularised fibular grafting is technically difficult, and may be impossible in the presence of vascular injury.[3]

The Ilizarov bone transport method using a circular ring external fixator is a reliable method of treatment of large tibial defects.[6,10,11] The main disadvantage is the lengthy external fixation time, and patients must be cooperative.

Medial fibular transport with the Ilizarov device is another alternative method for salvage after the massive tibial bone loss,[2] and has the advantages of avoiding surgery of the contralateral limb and allowing early weight bearing in the Ilizarov frame. The main disadvantage is the longer time required for fibular hypertrophy.

The hybrid fixator was developed to complement and extend the use of current monolateral fixation systems, by combination with the external fixator ring in the treatment of distal tibial fractures.[5] The ring is used for the fixation of the short distal tibial segment and connects with the tubular external fixator in the proximal fragment.

The monorail system of bone segment transport over unreamed interlocking nails can be used as an alternative to the Ilizarov method in selected cases providing there is no infection, the defect is in the diaphyseal area and there is satisfactory soft-tissue status.[9,12] The total external fixation time is decreased in the consolidation phase, by stabilisation with the intramedullary nail.

MIPO combined with distraction osteogenesis in the treatment of distal femoral bone defects has been reported.[1] The fracture was fixed with the percutaneous plate and bone transport was performed over the plate. After transport-segment docking, a percutaneous screw was fixed to the transport segment and the distraction device was removed. The advantages of this technique include a decrease in the duration of external fixation, protection against refracture and earlier rehabilitation.

In our case (in which there was no infection), the distal tibial length was only 4.5 cm; so monorail bone transport over an interlocking nail was not possible. Fixation of the short distal fragment could have been by Ilizarov circular ring or hybrid fixator, with the disadvantage of the bulky, inconvenient frame. MIPO combined with bone transport was another choice, but the 4.5 narrow or broad DCP

(a)

(b)

Figure 4 (a) After removal of the Wagner device and fixation of the transport segment. The patient can wear trousers as normal. (b) The distraction tube formed well and the docking healed.

Figure 5 (a and b) The clinical results of flap coverage; the distal tibia and ankle movement were satisfactory. (c) Radiographs at 1 year showing the bone defect filled with consolidated bone and good healing at the docking site.

or LCP would have caused a skin problem on the medial side of the tibia, particularly on the distal part.

The LCP is a new screw-plate system that offers the possibility of inserting conventional and locking-head screws[7,13]; it acts as an angle-stable fixation device. It may be fixed internally or externally. Our approach involved using an LCP as an external fixator that was less bulky and more easily tolerated than other external fixators. The broad 4.5 LCP stabilised the short distal tibial segment with two locking screws. This was combined with fixation of the fibula for support of the lateral column, affording stability sufficient for partial weight bearing and also ankle joint movement during the distraction and consolidation phase. The case required four planned operations including debridement and initial stabilisation, free vascularised flap coverage, corticotomy and lastly bone graft and fixation of the transport segment. The EFI was 1.2 months/cm and the total EFT was 10 months. The external fixator was monitored during the 3-month period of distraction.

After removal of the Wagner lengthening device, the patient was able to wear normal trousers and was tolerant of the remaining LCP external fixator (Fig. 4a). Weight bearing was resumed comparatively early, and no cast or brace was required after final removal of the external fixator. There was no complicating pin tract or bone infection, and no docking site malalignment or ankle joint contracture. The partially limited dorsiflexion of the ankle joint was caused by partial injury of the ankle dorsiflexor muscle.

The only concern regarding the LCP external fixator was adequate stability of the two locking screws in the distal tibia for early weight bearing. This requires further study. Although we have presented only one case, we consider that the procedure described can be used as alternative technique in the management of difficult distal tibial defects. The patient considered that this approach was preferable to a tubular or ring external fixator.

Conflict of interest statement

There are none.

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