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Case report

Posterior approach using a proximal humeral internal locking system long plate for open fractures of the distal tibia: A report of three cases

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1. Introduction

Open fractures of the distal tibia are a high-energy injury, and difficult to treat because these fractures are often associated with extensive soft tissue damage and bone defects [1]. Although external fixation is often performed initially, staged internal fixation following external fixation is desirable because long-term external fixation can lead to pin-tract infection, delayed union, malunion, loosening, and stress to the patient [2,3]. Intramedullary nailing is an option for tibial shaft fractures, but not for fractures of the distal tibia with periarticular fragments [4]. Recent reports show that minimally invasive locking plate osteosynthesis (MIPO) is effective for treating closed and open fractures of the distal tibia [5–8]. However, wound breakdown has been reported with MIPO because the locking plate is usually placed on the anteromedial surface of the tibia, where there is little subcutaneous tissue. Because wounds are often located on the anterior tibia in open fractures of the distal tibia, MIPO is not always the best choice considering the possibility of wound complications [7].

We propose a surgical procedure for open fractures of the distal tibia to prevent complications associated with traditional plate fixation, including MIPO and report the use of proximal humeral internal locking system (PHILOS) long plate fixation through a posterior approach for three cases of open distal tibial fracture.

2. Case presentation

2.1. Case 1

A 52-year-old man suffered an open fracture of the left distal tibia and fibula in an industrial accident (Fig. 2A). The fracture was treated with a Taylor spatial frame and the wound was closed primarily. Postoperative radiographs showed segmental bone defects of the distal tibia and fibula (Fig. 2B) and skin necrosis occurred at the fracture site 1 week after the initial surgery. The necrotic tissue was removed and repeated wet dressing was used to promote epithelialization. The skin defect healed after 3 months and a free iliac bone graft was then used to fill the segmental bone defect. Partial necrosis of the surgical wound occurred 1 week after bone grafting, which resolved with conservative therapy. Three months after the bone grafting, the Taylor spatial frame (Fig. 2C) was removed because of recurrent pin-tract infection and was replaced with a patellar tendon-bearing brace. Valgus deformity developed following removal of the external fixator because of nonunion of the distal tibia and fibula (Fig. 2D) and 3 months after removal of the external fixator, PHILOS long plating and an iliac bone graft were performed using the posterior approach (Fig. 3A). The patient was positioned prone on a radiolucent table with a tourniquet surrounding the proximal thigh and standard intraoperative fluoroscopy was used throughout the procedure. The skin incision was longitudinal and located on the midline over the posterior aspect of the lower leg. Although the length of the skin incision is determined based on the length of the PHILOS long plate that is used for open reduction and internal fixation, the operative field should be secured as widely as possible to safely retract posterior muscles and the neurovascular bundle. The fascia was incised following the skin incision and the gastrocnemius and soleus muscles were retracted laterally to expose the flexor hallucis longus and flexor digitorum longus muscles. The flexor hallucis longus was retracted laterally and the flexor digitorum longus was retracted medially to expose the tibialis posterior, revealing the tibial nerve on the surface of the tibialis posterior. The flexor digitorum longus and tibialis posterior, including the tibial nerve, were retracted medially, protecting the tibial nerve, to reveal the posterior crest of the tibia. Bone grafting for the entire circumference of the non-

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Fig. 1. Reversed PHILOS long plate is anatomically suited to the posterior surface of the distal tibia.

union site was performed posteriorly, separating the periosteum of the tibia at the non-union site. A reversed PHILOS long plate was placed on the posterior crest of the tibia to stabilize the fracture site, and because a reversed PHILOS long plate is anatomically suited to the posterior surface of the distal tibia, there was no need to bend the plate (Fig. 1). Both the superficial and deep posterior compartments were released by exposing the surface of the posterior tibia, and the incised fascia of the triceps surae was not sutured to avoid causing posterior compartment syndrome. Non-weight-bearing ambulation was permitted using a patellar tendon-bearing brace 2 weeks postoperatively, and weight-bearing on the affected leg was restricted until a callus was evident at the fracture site. To promote bone union, low intensity pulsed ultrasound was used at the fracture site on the anterior surface of the tibia, with fracture union occurring 9 months after the posterior plating (Fig. 3B).

2.2. Case 2

A 34-year-old man suffered an open segmental fracture of the right distal tibia and fibula in a motorcycle accident. Multiple operations including Ilizarov external fixation, bone transport, and bone grafting were performed at another hospital; however, the fracture remained ununited and was complicated with methicillin-resistant *Staphylococcus aureus* osteomyelitis. When the patient was referred to our hospital 1 year after injury, the distal tibia was exposed through a 4 cm skin defect and the external fixator had already been removed (Fig. 4A). Surgical repair involved two steps: First, a PHILOS long plate was placed on the surface of the posterior tibia to properly align and stabilize the nonunion site (Fig. 4B). Second, using an anterior approach, the recipient tibia was debrided of nonviable bone and a vascularized osteocutaneous fibula free flap was applied (Fig. 4C). The fibula flap was harvested from the left lower leg and the graft was inserted into the intramedullary canal of the tibia to form a bridge. The fibula graft was fixed with screws at only the proximal and distal ends of the fibula to avoid damage to the nutrient vessels of the transplanted fibula. The peroneal artery was anastomosed end-to-end to the anterior tibial artery and venous anastomosis was created using the venae comitantes of the anterior tibial artery in an end-to-end fashion. Split-thickness skin grafting was performed 6 weeks after the osteocutaneous fibula free flap because of partial flap necrosis. Debridement was performed at the junction of the distal end of the fibula graft and the distal tibia 9 months after the fibula graft because of recurrent osteomyelitis with purulence from the anterior aspect of the distal end of the fibula graft. There was no infection associated with the posterior plate. The osteomyelitis resolved two months after debridement and iliac bone grafting was then performed for nonunion of the distal docking site between the fibula graft and the tibia. Twenty-seven months after PHILOS long plating, the fibula graft was completely incorporated and the osteomyelitis had resolved (Fig. 4D).

2.3. Case 3

A 34-year-old man suffered an open fracture of the left distal tibia and fibula with a closed fracture of the contralateral diaphyseal tibia in a traffic accident. The open fracture was treated with a Hoffmann external fixator and the wound was closed primarily, and 6 days after the initial surgery, intramedullary nailing was performed for the right diaphyseal tibial fracture. The left anterior tibial wound was adequately healed 1 month after the initial surgery, at which time the Hoffmann external fixator was removed and internal fixation using a PHILOS long plate was performed with iliac bone grafting, using a posterior approach. Non-weight-bearing ambulation was permitted using a patellar tendon-bearing brace 2 weeks after the surgery. Because fracture site nonunion persisted 5 months after the PHILOS plating, additional cancellous bone grafting and decortication were performed using an anterior approach, which resulted in complete union three months after the additional cancellous bone grafting.

3. Discussion

Reversed PHILOS long plating is anatomically suited to the posterior surface of the distal tibia. The distal fragment in distal tibial fractures is usually so small that it is difficult to insert sufficient numbers of screws to obtain good stability with plate fixation. The PHILOS plate was developed for proximal humeral fractures, and the proximal part of the plate has nine locking screw holes to stabilize the proximal humeral head, which is rich in cancellous bone [9,10]. When this plate is reversed and used on the posterior surface of the tibia for distal tibial fractures, up to nine locking screws can be inserted into the distal fragment, providing rigid stability. However, PHILOS plates were developed for humeral fractures, which do not undergo as much mechanical stress and do not need to be as strong as plates in distal tibial fractures. As a result, weight bearing on the affected leg should be restricted until a callus can be seen at the fracture site. In our experience, plate breakage has not occurred.

The posterior approach for fractures of the distal tibia is not a common or simple procedure compared with the anteromedial or anterolateral approach because it necessitates retracting several muscles, the tibial nerve, and the tibialis posterior artery. However, the advantage of the posterior approach is that plate fixation can be performed without incising the skin of the anterior tibia where the open wound is located. As seen in case 2 with an anterior skin