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Technical note

Minimally invasive plate osteosynthesis using posterolateral approach for distal tibial and tibial shaft fractures

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ABSTRACT

Objective: The objective of the study was to evaluate the effectiveness of the posterolateral minimally invasive plate osteosynthesis (MIPO) method for managing distal tibial or tibial shaft fractures with severe anterior and medial soft tissue injuries.

Materials and methods: Five consecutive patients with three distal tibial and two tibial shaft fractures (three open fractures) at a level-1 trauma and tertiary referral center were retrospectively reviewed. All patients were definitively treated and followed to bone union. Main outcome was measured by American Orthopaedic Foot and Ankle Society (AOFAS) ankle–hindfoot score, complications, and bone union on radiographs.

Results: The average follow-up period was 15.8 months (range, 12–24 months). The average AOFAS score was 88.2 (range, 81–90). There were no complications, such as incision breakdown, deep infection, or impingement of the flexor hallucis longus tendon. Bone union was achieved in all cases.

Conclusions: Posterolateral MIPO is a feasible option when treating these fractures, especially in cases with severe anterior and medial soft tissue injuries.

Introduction

Distal tibial and tibial shaft fractures with high energy trauma are often associated with complications of soft tissue injuries, especially in the anterior or medial side of the tibia. These fractures are some of the most problematic fractures because of incision breakdown, skin necrosis, or infection, necessitating secondary operations. With regard to fixation of these fractures, there is still no consensus regarding optimal solutions in the literature. The posterolateral approach to distal tibial fractures was first described in 1945 by Harmon et al. [1] while treating a tibial non-union. The advantage of this approach is that it avoids additional damage to the subcutaneous tissues of the anterior and medial tibia and enables abundant soft tissue coverage overlying the plate fixation. However, the posterolateral approach is no better than other approaches for pilon fractures with respect to decreasing complications, and Bhattacharyya et al. [2] do not recommend this approach as a routine approach for pilon fractures. Conversely, we speculated that a posterolateral approach using minimally invasive plate osteosynthesis (MIPO) may offer biological advantages over open reduction and internal fixation (ORIF), which results in extensive soft tissue dissection and periosteal injury.

In cadaveric study, Kritsaneephaiboon et al. [3] reported that posterolateral MIPO should be a reasonable and safe treatment option for distal tibial fractures, particularly when the anterior soft tissue is compromised. However, clinical and radiological outcomes for fixation of distal tibial and tibial shaft fractures with posterolateral MIPO have not been previously reported in the literature. Hence, we here report on previously unpublished posterolateral MIPO for distal tibial and tibial shaft fractures. We describe the clinical and radiological outcomes in five patients to assess the safety, feasibility, and potential advantages of this procedure.

Patients and methods

We included a retrospective review of five consecutive patients treated with posterolateral MIPO between August 2008 and December 2015 at a level-1 trauma center, where we had treated 69 cases of distal tibial or tibial shaft fractures with a locking compression plate (LCP) using the standard medial or anterolateral

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approach during the same time period. There were three males and two females with an average age of 48 years (range, 22–70 years). All patients had been injured in motor vehicle accidents. Open injuries were classified using the Gustilo and Anderson classification. There were three open fractures (one Gustilo type IIIA, one Gustilo type IIIB, and one Gustilo type IIIC). Plain radiographs and computed tomography (CT) scans with reconstruction images were obtained to delineate injury pattern. Fractures were classified according to the AO/Orthopaedic Trauma Association (OTA) fracture classification. All patients had an associated fibular fracture. The average time between injury and definitive surgery except for a complicated case (case 4) and a referral patient due to infection (case 5) was 6 days (range, 3–8 days).

All fractures were unsuitable for intramedullary nailing because of the fracture type or the soft tissue injury extent. Indications for posterolateral MIPO were severe soft tissue injury at the anterior and medial tibia that was difficult to treat using the standard medial or anterolateral approach. All surgical procedures were performed or supervised by a senior trauma surgeon (K.O.). All patients signed an informed consent statement.

Initial management

Surgery was performed under general or spinal anesthesia. Open fractures were debrided and irrigated. A spanning external fixation (EF) was performed with two pins in the proximal tibia outside the zone of injury and one pin through the calcaneus. The proximal pins should be placed far enough proximally to the estimated location of the proximal end of the plate that will be used for definitive fixation. The intra-articular fracture of the distal tibia was fixed using a screw, if possible. The fibula was plated depending on the fracture pattern and soft tissue injury. Radiographs and CT scans with reconstruction images were postoperatively obtained to evaluate the reduction of fragments and the fibula as well as to plan minimal reduction procedures for the anterior or medial fragments. If minor adjustments were required for displacement, these reductions could be performed during definitive fixation. The definitive fixation was performed when the skin at the incision appeared wrinkled.

Surgical techniques

Patients were positioned in a half lateral position on a radiolucent table with EF to maintain alignment and reduction. Routine preoperative antibiotics were administered. A pneumatic tourniquet was not used to minimize additional soft tissue injury and blood circulation disturbance. When direct reduction was necessary depending on the nature and pattern of the fracture, pointed bone forceps or Kirschner wires were percutaneously used to achieve satisfactory reduction prior to MIPO. First, a 4-cm skin incision was made midway between the posterior border of the distal fibula and the lateral aspect of the Achilles tendon (Fig. 1A), beginning at the tip level of the lateral malleolus and proximally extending to the distal fibular shaft [3]. Care should be taken to protect the sural nerve and lesser saphenous vein, and dissection was performed down to the peroneal fascia. The peroneal fascia was incised, and partial of exposure of the posterior surface of the distal tibia was achieved by separating the interval between peroneal tendons laterally and flexor hallucis longus (FHL) and gastrocsoleus complex medially. With limited sharp dissection of the FHL along its lateral attachment from the fibula, the space for plate insertion on the posterior surface of the distal tibia was exposed by retracting the FHL muscle belly. Dissection around this region should be carefully performed because of the wide variation in vasculature, and the peroneal artery may bifurcate and perforate through the interosseous membrane as little as 41 mm from the tibial plafond [4]. It is important not to injure the posterior tibiofibular ligament. The level of proximal skin incision at the posteromedial border of the tibial shaft was decided by the proximal screw hole location as observed on the fluoroscopic image (Fig. 1B). The posterior surface of mid-tibia was exposed by laterally retracting the soleus. A submuscular extraperiosteal tunnel was developed along the posterior surface of the tibia by gentle blunt dissection and by passing an elevator from the distal to the proximal incision to avoid injury to the posterior tibial artery and tibial nerve at the posterior end of mid-tibia.

Here the LCP applied in the definitive fixation was LCP Distal Tibia Plate 10 holes (DePuy Synthes, Warsaw, IN, USA) used on the ipsilateral side or PERI-LOC Ti Medial Distal Tibia Locking Plate 13 holes (Smith & Nephew Inc., Memphis, TN, USA) used on the contralateral side. These LCPs were used as a bridging plate across the diaphyseal–metaphyseal fragment. The plate was bended to come as close as possible to the anatomical angle, and twisting of the distal tibia was performed to prevent FHL impingement. Then, a periarticular plate was slipped in without periosteal stripping from the distal to the proximal incision (Fig. 1C and D). Contouring and positioning of the plate were centrally adjusted on the posterior surface of the tibia through the proximal and distal

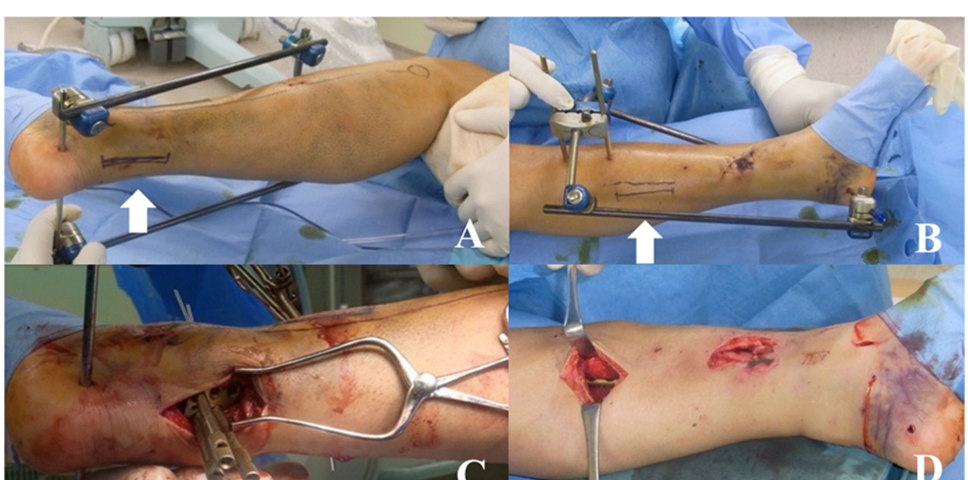

Fig. 1. (A and B) With the left leg in a half lateral position, intraoperative images of the posterolateral approach using the minimally invasive plate osteosynthesis technique with spanning external fixator show the proximal incision (arrow) and the distal incision (arrow). (C) The plate was fixed to the distal tibia after the plate was slipped in from the distal incision to the proximal tibia. (D) View through the proximal incision after fixation.