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Minimally invasive posteromedial percutaneous plate osteosynthesis for diaphyseal tibial fractures: technique description

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KEYWORDS

Tibial fractures
Fracture fixation
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ABSTRACT

Purpose: The aim of this study was to evaluate the feasibility of performing minimally-invasive plate osteosynthesis (MIPO) in tibial fractures using two posteromedial incisions, and to measure the distance between the plate and neurovascular structures.
Materials and methods: We performed nine dissections of specimens that were submitted to tibial MIPO with two posteromedial incisions. One locking compression plate (LCP) of 14 to 16 holes was inserted into the submuscular tunnel in a retrograde manner. Incisions were linked to evaluate the distance between neurovascular structures and the plate.
Results: During the proximal incision, a blunt dissection between semitendinosus and medial gastrocnemius tendons, as well as their lateral shift, helped to protect the main local neurovascular structures. In its distal portion, the submuscular plate tunnel insertion and its direction to the proximal incision prevented direct contact and possible damage to neurovascular structures. Moreover, we obtained successful results from a patient submitted to this procedure.
Conclusion: Posteromedial MIPO represents a safe and attractive alternative for tibial fractures, particularly if there are damaged soft tissues in the anterior and medial side, or when access to intramedullary osteosynthesis is blocked.

Introduction

Tibial fractures are the most common lesions of long bones. Data from the National Center for Health Statistics indicate an annual prevalence of 492,000 tibial fractures per year in the United States [1]. Open fractures usually occur as a result of high-energy trauma and closed fractures are related to falls and sports accidents. Tibial diaphyseal fractures represent more than 70,000 hospitalisations per year and 800,000 office visits per year in the United States [2–4].

Tibial fractures are usually associated with soft tissues injuries, particularly in the anterior and medial side [5]. Moreover, incision breakdown, skin necrosis and infections are possible outcomes in such fractures [6].

Interlocking intramedullary nail (IMN) and minimally invasive plate osteosynthesis (MIPO) on anterior or medial sides of the tibia are the most common treatment options for diaphyseal tibial fractures [7]. Staged treatment with temporary external fixators can be used until soft tissue conditions are suitable for internal fixation [8].

To perform MIPO in the posterior side of the tibia, we combined two techniques: the Lobenhoffer approach for treatment of tibial plateau fractures and the Assal modified tibial pilon posteromedial approach [9,10]. Both techniques are safe, with a low rate of complications.

The aim of this study was to evaluate the feasibility of performing MIPO in tibial fractures using two posteromedial incisions, and to measure the distance between the plate and neurovascular structures. This technique can be a treatment option for selected cases, like patients with poor anterior and medial soft tissue condition, peri-implants and periprosthetic fractures, and adolescents with open physis.

Materials and methods

Anatomical aspects

After approval by the Ethics Committee in Research from the institution, nine legs from five fresh cadavers were dissected. All procedures were realised in ventral decubitus.

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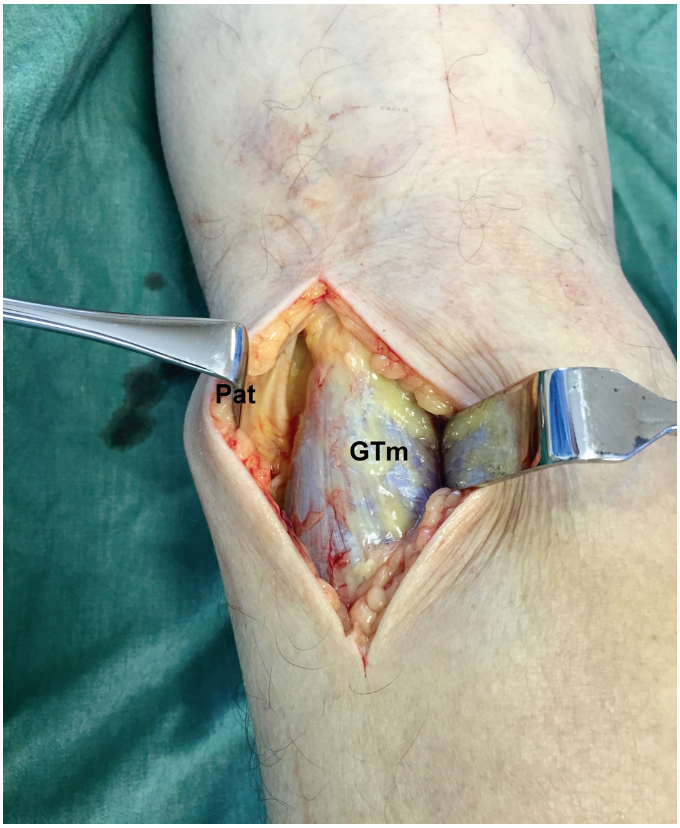

Fig. 1. Posterior view of right leg depicting the dissection of the proximal medial approach. Dissection between Medial Gastrocnemius muscle (GTm) and Pes anserinus tendons (Pat).

Proximal approach

This surgical technique was developed using the incision described by Galla and Lobenhoffer for the treatment of posteromedial tibial plateau shear fractures [9,11]. Thus, we used as a reference the medial gastrocnemius muscle (GTm) head and the pes anserinus tendons. An 8-cm longitudinal incision at the GTm head was performed, distal to the popliteal fold. After dissecting the subcutaneous tissue, we dissected the fascia in the same direction. Superficial structures between the gastrocnemius heads, such as the small saphenous vein (SSv) and the sural nerve (Sn), were not approached. The dissection was continued medially to the GTm at the interval of semitendinosus tissue (Fig. 1).

In a deeper layer, popliteal and soleus muscles were elevated from the bone to enable insertion of the implant. In this deeper dissection, the popliteal artery (Pa) is located between GTm heads. It is divided in the anterior and posterior tibial arteries (ATa and PTa, respectively). The ATa penetrates the posterolateral portion of the interosseous membrane at 46 mm from the joint [12]. As the head of GTm is shifted laterally, the muscle protects all these structures, without any contact with the implant.

The tibial nerve (Tn) is a neural structure that remains close to the synthesis material. The plate is inserted underneath the flexor digitorum longus (FDL) and posterior tibial (PT) muscles, protecting the Tn. Also, the posterior tibial vein (PTv) and PTa remain laterally located to the Tn.

Distal approach

The references for the distal approach are the Achilles tendon and the medial malleolus. The incision starts 1 cm medially to the Achilles tendon and at 8 cm proximally to its insertion, for an extension of 5 cm. After opening the superficial fascia, the Achilles tendon is shifted to the lateral side. The intermuscular septum that divides superficial and deep compartments is sectioned.

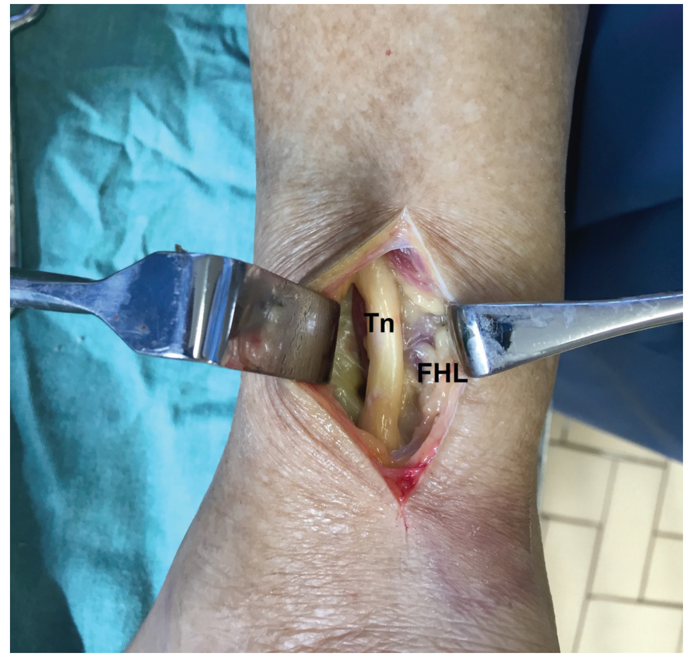

Fig. 2. Posterior view of right leg. Exposure of the Tibial nerve (Tn) on the deep posterior compartment of the leg. Flexor Hallucis Longus (FHL) should be retracted laterally.

We then identify the Tn and the muscular portion of the flexor hallucis longus (FHL) (Fig. 2). An interval between FHL and Tn is developed, exposing the metaphyseal region of the bone, leaving the PTa, the PTv and the Tn protected without traction [10]. The FHL is moved laterally.

Submuscular incisions are linked using periosteal elevators. A 4.5-mm locking compression plate (LCP; DePuy Synthes) of 14 to 16 holes was inserted in a retrograde manner after previous modelling (Fig. 3).

Finally, to secure the procedure, we connected the incisions (Fig. 4). The shortest distances between the plate and these neurovascular structures were measured using a Vernier calliper with precision of 0.01 mm (Starret Co, Ltda São Paulo, Brazil).

Results

Proximal approach

As SSv and Sn are situated at the superficial layer, we measured the distance from these structures to the incision in the skin. The range of distances between the distal portions of the incision to the Sn was 27.54–38.94 mm (mean, 32.60 mm) and to the SSv was 22.33–34.52 mm (mean, 27.08 mm).

From the deepest layer, the distance between the Tn and the implant was 6.3–10.2 mm (mean, 7.9 mm).

Distal approach

Care was taken to open the intermuscular septum: Tn is located just below the incision.

The risk of vascular injury was higher than that of neural injury. The shortest distance between the plate and the Tn was 7.8–21.16 mm (mean, 12.7 mm), whereas the distance between the PTa and implants was 7.6–17.4 mm (mean, 10.6 mm), and the distance between the plate and PTv was 8.3–18.1 mm (mean, 11.6 mm).