

Special Article

Minimally invasive internal fixation of distal tibia fractures with a nonconventional implant: description of surgical technique

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Abstract

Fractures of the distal end of the tibia without joint involvement are usually the result of high-energy trauma. Local anatomic conditions lead to high rates of infection, delayed consolidation, and exposure of fixation hardware. In this setting, minimally invasive techniques are indicated to mitigate the complications of surgical treatment. The aim of this study is to present an alternative for the surgical treatment of distal tibia fractures using a minimally invasive technique and a nonconventional implant.

Level of Evidence V; Therapeutic Studies; Expert Opinion.

Keywords: Tibial fractures/surgery; Fracture Fixation, Internal/methods; Protheses and implant; Minimally invasive surgical procedures.

Introduction

Fractures of the distal end of the tibia without joint involvement are usually the result of road traffic collisions and other high-energy impacts⁽¹⁾. Due to the scant soft-tissue coverage and limited vascularization of the skin and subcutaneous tissue in the region, complications such as infection, delayed consolidation, and exposure of fixation hardware can make treatment of these fractures a major challenge to the surgeon^(2,3).

Intramedullary nails and plates are the two main options for the treatment of extra-articular fractures of the distal tibia. Both options have some theoretical disadvantages. While intramedullary nail fixation can result in nonunion and a higher incidence of knee pain, plate fixation is associated with a higher risk of surgical wound dehiscence and infection due to less soft tissue coverage over the anteromedial aspect of the tibia. The advent of minimally invasive percutaneous plate osteosynthesis (MIPO) brought reductions in damage to soft tissues and in the rate of complications such as infection and impaired fracture healing⁽⁴⁻⁶⁾. Although intramedullary

osteosynthesis remains the technique of choice for the treatment of most tibial shaft fractures, some cases—some due to their distal location, others due to changes in the morphology of the intramedullary canal—make this form of fixation impossible⁽⁶⁾. Expansion of this indication to the treatment of distal tibia fractures has been associated with increased rates of instability and malunion⁽⁷⁾.

Treatment of distal tibia fractures aims to achieve good functional alignment and a stable fixation while respecting the soft tissue envelope, allowing early rehabilitation⁽⁸⁾. To follow these tenets and thus ensure superior preservation not only of bone circulation but also of soft-tissue coverage, minimally invasive and more biological techniques were developed to preserve the fracture hematoma by means of minimal dissection and indirect reduction⁽⁹⁾. Use of the bridge plating technique via MIPO, based on the principle of relative stability, has proven to be an effective, low-cost technique associated with few complications⁽¹⁰⁾. Likewise, Oh et al.⁽¹¹⁾ concluded that percutaneous plate osteosynthesis minimizes soft-tissue damage at the fracture site, thus increasing the consolidation rate.

Study performed at the Hospital Estadual Jayme Santos Neves, Serra, Espírito Santo, ES, Brazil.

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In this paper, we describe an operative technique for extra-articular fractures of the distal tibial metaphysis with nonconventional use of an extra-medullary internal fixator in a bridging role, inserted in a retrograde, minimally invasive fashion following the tenets of MIPO.

Description of operative technique

The treatment protocol consisted of staged management as proposed by Sirkin et al.⁽¹²⁾.

1. During the damage control orthopedics stage, external fixation in delta formation was accomplished with two Schanz screws placed on the tibial shaft and two others on the foot, one in the posteromedial portion of the calcaneus and the other at the base of the first metatarsal, with the ankle in neutral position (Figure 1).
2. A 16-hole T-shaped plate of the type usually employed for proximal tibial fractures and six full-thread screws, three 4.5-mm for cortical bone and three 6.5-mm for cancellous bone, were used for definitive fixation.

The treatment principle chosen was relative stability through the use of an extra-medullary internal fixator and the aforementioned bridge plate.

This choice of hardware was due to the fact that there is no consensus in the literature regarding the optimal principle and method to be applied in this region, the low profile and low cost of this implant model, and the operator-friendly, easy-to-perform technique. Some points bear stressing: as it is a biological technique, the use of Hohmann retractors should be avoided so there is no additional injury to the soft tissues; correction of the axes should be done manually and gently; and the screw size must be selected so as to allow placement of three screws in the distal fragment, two of which must be slightly offset and the third, placed in the hole immediately superior to and parallel to the articular surface.

The plate was inserted via a minimally invasive technique, distal to proximal, in a retrograde and upward fashion through an approximately 4-5cm incision; the greater saphenous vein was used as a landmark (Figure 2). Unlike when using a

dynamic compression plate (DCP), which must be angulated approximately 20 degrees to reproduce the distal tibial torsion, there is no such concern when using this technique because the plate adapts easily to the contour of the distal tibial segment as the screws are driven and tightened alternately.

The plate performs both bridging and reduction roles. As the first 4.5-mm cortical screw is driven proximal to the fracture site, the fracture is reduced by an implant interference mechanism. At this stage, image intensification is used to analyze the reduction and the two distalmost cancellous screws are then driven (also under fluoroscopic guidance). The fourth screw is placed into cortical bone in the most proximal hole; the fifth and sixth screws to be placed are cortical and cancellous respectively. Judicious intraoperative control is essential so that the screws placed in the distal fragment do not pierce the distal tibiofibular joint (Figure 3).



Figure 2. Intraoperative appearance, showing the distal incision and three proximal incisions.



Figure 1. Aspecto da montagem em delta utilizada como forma de controle de danos pré-operatório.

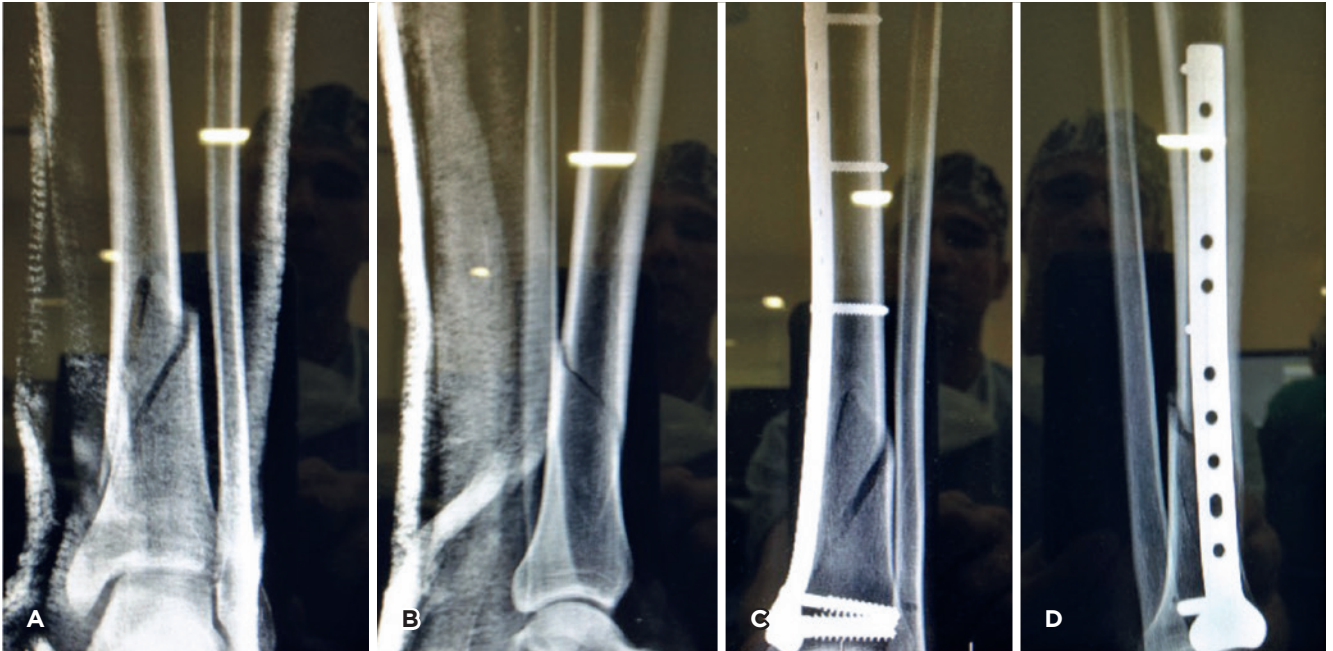


Figure 3. A and B: extra-articular fracture of the distal tibia; C and D: appearance of the fracture after placement of a T-plate inserted in retrograde, ascending fashion. Note location and arrangement of screws in the distal segment.

The surgery is performed with the patient under locoregional anesthesia, in the supine position, with both lower limbs prepared, thus allowing intraoperative comparison of length, rotation, and angulation. In the immediate postoperative period, active and early mobilization (including ambulation with the aid of crutches) were encouraged. Discharge was scheduled for 24h after surgery, except in cases of compound fractures, which had a longer hospital stay.

The radiographic parameter used to define consolidation was the formation of an appreciable callus on at least three tibial cortical views (Figure 4).

According to the AO classification, 23 fractures (63.9%) were classified as type 43A, 11 (30.5%) as type 43B, and only 2 cases (5.6%) as type 43C.

Radiological evaluation showed satisfactory functional alignment in 27 patients. Nine patients had rotational or axis deviations, which included varus/valgus greater than 5°, more than 5° recurvation or antecurvation, shortening greater than 1 cm, and twist greater than 10°.

Seven cases (6 compound fractures and 1 closed fracture) were complicated by infection.

Discussion

Borelli et al.⁽¹³⁾ demonstrated that open reduction and internal fixation of distal tibial fractures carries a high risk of damaging the local blood supply. This led to the development of minimally invasive techniques (MIPO) where a plate is inserted percutaneously and attached to the bone above and

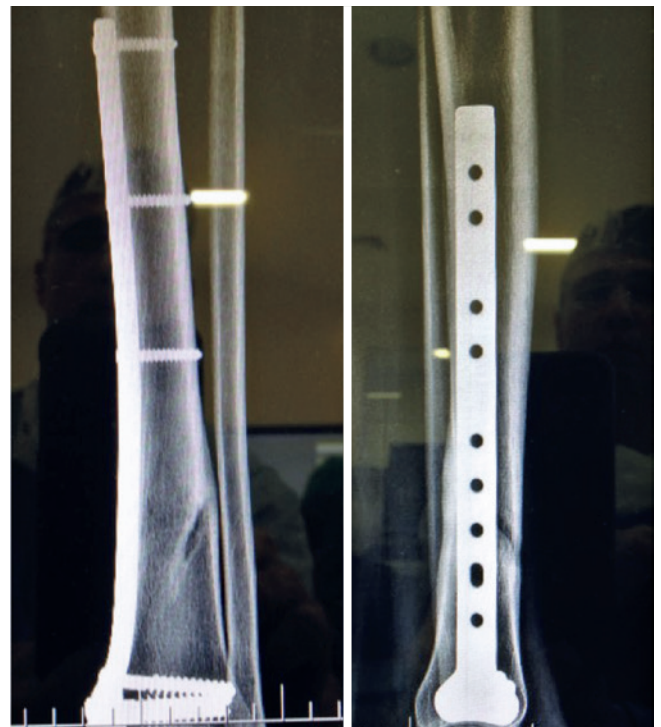


Figure 4. Extra-articular fracture of the distal end of the tibia. Note consolidation of the fracture site.


below the fracture, as described by Krettek et al.⁽¹⁴⁾. However, MIPO has been criticized for the greater difficulty in achieving adequate correction of the anatomical and mechanical axes as compared to conventional techniques. The literature is unclear as to the acceptable degree of reduction in tibial shaft fractures. Milnar et al.⁽¹⁵⁾ studied 164 tibial fractures with long-term (30-year) follow-up and concluded that there was no significant association between malunion of the tibia and development of knee or ankle arthrosis. None of the patients in this series developed valgus or varus deformity greater than 5°. Fracture of the tibia is unquestionably the leading cause of pathological leg rotation in adults. According to the literature, the incidence of rotational malreduction is less than 1%; however, the method used was clinical or not reported⁽¹⁶⁾.

Associated fibular fractures were present in 32 patients in our sample, 17 of whom underwent osteosynthesis with a

one-third-tubular plate, as they had fractures of the distal third of the fibula whose fixation contributed to the reduction and fixation of the tibia. Labronici et al.⁽¹⁷⁾ demonstrated that fibular fixation performed simultaneously with repair of fractures of the distal third of the tibia does not interfere with bone healing.

Conclusion

Internal fixation of distal tibia fractures based on the principle of relative stability, with nonconventional use of a bridge plate inserted through a minimally invasive approach, proved to be a good treatment alternative in our sample, with a high consolidation rate, low potential for soft-tissue complications, and low hardware cost.

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