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Educational Corner

Minimally Invasive Percutaneous Plate for Pilon Fractures: Educational Corner

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Background

A distal tibia fracture is a common issue in orthopedics, making up around 10% of all tibial fractures (1). Distal tibia fracture commonly occurs in patients due to a force directed from the foot toward the leg in high-energy traumatic events, such as traffic accidents, motorcycle accidents, falls, or sports injuries (2). Fractures of the tibial plafond are named pilon fractures. There are two general pilon fracture classifications, including the Rüedi and Allgöwer classification system (3) and the AO Foundation/Orthopaedic Trauma Association (AO/OTA) classification system (4).

The main goals of treating pilon fractures are to align the force line of the limb, create a good joint surface reduction, achieve well-matched joints, and ensure secure fixation to allow early functional motion exercises (5). Surgery to treat tibia fractures at the distal end may involve intramedullary nailing (IMN), external fixation, open reduction and internal fixation (ORIF), and minimally invasive percutaneous plate osteosynthesis (MIPPO). Each one has its advantages and disadvantages but there is no agreement on which one is the best modality.

MIPPO has many advantages including less surgical trauma, maintaining periosteal blood supply and fracture hematoma, and keeping a good environment for fracture healing (6). In this article, we present a patient with a pilon fracture who underwent fixation using the MIPPO technique.

Case Report

A 33-year-old man was admitted to the emergency department of our center with right ankle pain and weight-bearing disability due to a motorcycle accident. In physical examination, no blisters were observed, but there was swelling and tenderness of the right ankle. Further evaluations revealed a pilon fracture (Figure 1).

For further study and preoperative planning, the patient underwent a computed tomography (CT) scan, and the extension of the fracture into the joint was observed (Figure 2). According to the Rüedi and Allgöwer classification, it was a type I, and according to the AO/OTA classification, the fracture type was a 44-C1. Considering the type of fracture and no comminution, we decided to perform the surgery with the MIPPO technique.

Figure 1. X-ray showing the fracture of the distal tibia with extension to the articular surface

Figure 2. Computed tomography (CT) scan showing the fracture of the distal tibia with extension to the articular surface with Volkmann's fragment

We achieved an acceptable reduction using preliminary manual traction and application of the pointed reduction forceps, then confirmation of reduction with the image intensifier. A slightly curved (reversed J-shaped) skin incision on the medial aspect of the distal tibia (along the anterior border of the medial malleolus) was used. A three to five-cm incision was made on the medial side of the distal tibia, and a subcutaneous channel was formed with a blunt plate tip toward the diaphysis. The dissection was split into two parts, with the great saphenous vein and saphenous nerve both kept intact. The periosteum was also preserved while a channel was created beneath it by the blunt end of a plate. We did a small incision at the site of the proximal part of the plate. The plate was equivalent to the posterior end of the distal tibia and the plate site was viewed by the image intensifier for the right position.

Once the right position of the plate was achieved, temporary fixation was done with a drill bit, then a screw was implanted in one of the distal holes to keep the plate close to the bone and prevent soft tissue irritation. Small stab incisions were enough for completing the fixation with screws and the position of the screws was identified either by an image intensifier or by an externally placed identical plate (Figure 3).

Figure 3. Intraoperative photograph showing minimal incision

The type of plate used in this procedure was a 4.5 distal tibial locked plate. Considering that we also had a fracture of Volkmann's fragment, the fragment was reduced with plantar flexion and fixed with two partially threaded cancellous screws through the same incision (Figure 4).

Figure 4. Postoperative X-rays one day after surgery

To achieve early functional restoration, passive and active motions of the ankle joint were performed as soon as possible. The patient started non-weight bearing for six to eight weeks then started partial weight-bearing. Full weight-bearing was recommended after an X-ray showing the fracture was consolidated. The stitches were taken out two to three weeks after surgery.

The patients remained in a splint or cast immobilization until the wounds had healed and sutures could be removed and were required to return for follow-up at two weeks, six weeks, three, six, and 12 months after surgery, and each year thereafter.

Discussion

From the earliest conservative treatment to ORIF, there are many incision complications in the treatment of pilon fractures, especially the difficulty of incision closure after the operation, necrosis, infection of incision skin or local skin flap, and even catastrophic complications such as amputation.

The essential treatment goal for pilon fractures is to restore the limb force line, achieve a good articulation surface reduction, good joint matching, and strong fixation for early functional exercise (7).

Surgical fixation is considered for most distal tibia fractures which require meticulous preoperative planning. Available options for stabilizing fractures are external fixators, interlocking nails, MIPPO technique, and ORIF. The factors that determine the fixation methods include the fracture pattern, the quality of bone, and the condition of soft tissues (8).

In current orthopedic practice, MIPPO and interlock nailing are the preferred techniques for fractures of the distal third tibia. Intramedullary nails are advantageous as they preserve the blood supply outside the bone, allowing the fracture to bear weight while healing. However, fractures at the ends of the shaft can be challenging to align correctly. Concerns regarding difficulties with reduction/loss of reduction, inappropriate fixation in fractures with articular extension, anterior knee pain, and hardware failure have slowed the acceptance of IMN as a treatment of fractures of the distal tibia. The introduction of nails with tip locking allows such fractures to be treated with a nail, although this is technically difficult (9).

In IMN technique, allowed toe-touch walking with crutches right after surgery, and full weight-bearing may be resumed once X-rays show complete healing (10). In MIPPO, the patient can begin partial weight-bearing after eight weeks, with full weight-bearing depending on fracture healing seen radiographically (11).

Locking plates have the most benefit when dealing with severely broken bones, broken bones near joints, and weak bones due to osteoporosis. Compression plates need a solid bone structure to function correctly while locking plates act as internal stabilizers with several attachment points. This allows it to convert the axial load that is across the bone into compressing forces around the breakage, which leads to a smaller gap length and lower strain (9).

Considering side effects such as skin necrosis, wound dehiscence, osteomyelitis, higher rate of amputation, and arthritis, ORIF methods are not used anymore (12). ORIF leads to an increased risk of infection and non-union (8).

MIPPO is a strategy that has been thoroughly documented and provides biological benefits. It is thought to be an appropriate choice for dealing with complex, unstable fractures of the distal tibial bone or the pilon bone. Without needing to perform extensive dissection or surgery on the bone or the soft tissues nearby, a mechanically stable fracture-spanning osteosynthesis can be achieved using MIPPO. This method involves indirect reduction and internal fixation with locking compression plates. This technique utilizes a plate that is tunneled under the skin but extrudes from the

bone around the skin incision at both the proximal and distal ends of the plate, which avoids the fracture site and produces a solid construct with the help of pressure and locking screws. This method seeks to protect bone biology and reduce the amount of surgical trauma to the already traumatized soft tissue. MIPPO technique with a locking compression plate has biological advantages over traditional plating approaches, such as less surgical trauma, preservation of the blood supply, reduced removal of the osteogenic fracture hematoma, and a reliable construct (13-15).

These techniques are newer and technically demanding. Indirect reduction techniques are developed to reduce soft tissue elevation at the fracture site and to improve the rate of fracture healing. In addition, they reduce the overall incidence of infection, refracture, and the need for autologous bone grafting (9).

Conclusion

The IMN and MIPPO techniques are excellent minimally invasive choices for treating distal tibia fractures. We recommend using the MIPPO approach as the primary option to minimize the patient's suffering.

Conflict of Interest

The authors declare no conflict of interest in this study.

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