C A S E R E P O R T

Arthroscopy-assisted combined external and internal fixation of a pilon fracture of the tibia

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There are serious problems with existing methods of treating pilon fractures of the tibia caused by high-energy trauma. The method chosen to treat these fractures should not raise the risk of infection while effectively restoring the joint surface. We successfully treated a 42-year-old male patient with a pilon fracture caused by high-energy trauma using an arthroscopy-assisted unilateral external fixator and minimally invasive internal osteosynthesis. We used arthroscopy to reposition the fracture fragments and restore the joint surface. The fracture fragments were fixed with screws immediately after being repositioned. We believe that arthroscopy-assisted combined external and minimally invasive internal fixation is the treatment of choice for these fractures. We used external fixation to improve the fracture alignment, arthroscopy for restoring the joint surface, and minimally invasive screws to ensure fragment stability.

Introduction

It is important to diagnose and treat a pilon fracture of the tibia because of its intra-articular position. These fractures encompass a spectrum of skeletal injury ranging from fractures caused by low-energy rotational forces to those caused by high-energy axial compression forces arising from motor vehicle accidents or falls from a height.[1] High-energy fractures are frequently associated with open wounds or severe closed soft tissue trauma.[1,2] Classification of these fractures is important for determining their prognosis and choosing the optimal treatment. The classification system proposed by Rüedi and Allgöwer is the most commonly used one because of its simplicity.[3] According to their classification, type I fractures are intra-articular with minimal displacement; type II fractures have significant articular displacement with little comminution; type III fractures have greater comminution and metaphyseal involvement.[3]

The treatment goal should be to obtain the best possible articular reduction and alignment while respecting the soft tissues. After high-energy pilon fractures, the patient is at risk of infection in the early stage and arthritis at a later stage. To minimise these complications when treating these fractures, minimally invasive surgical treatment, stable osteosynthesis, restoration of the joint surface, and early mobilisation should all be performed.

Case report

A 42-year-old male patient presented at our clinic with a history of falling from a height. On investigation a right Rüedi-Allgöwer type III pilon fracture of the tibia (Fig 1a) and severe soft tissue swelling around the ankle was found. The patient was hospitalised for 7 days until the swelling had reduced and was operated on 8 days after admission. We gave him a 10-day course of low-molecular-weight heparin for anti-thrombotic prophylaxis. We used a hinge type ankle fixator (Orthofix-XCaliber Articulated Ankle Fixator; Orthofix, Verona, Italy) because it has a 0° to 30° range of motion that we believe is useful for preserving the viability of the articular cartilage and we carefully planned the hinge level fixation. External fixation was applied under fluoroscopy by fixing one Schanz screw to the neck of the talus and one to the postero-superior part of the calcaneus and three Schanz screws to the diaphysis of the proximal tibia. After that, under fluoroscopy, distraction was applied until alignment of the limb was achieved. We used diagnostic arthroscopy to check the articular surface by anterolateral and anteromedial portals. The fracture haematoma, synovial tissues, and loose bodies were debrided arthroscopically. Steps on the articular surface were flattened using a curette and probe (Fig 1b). After arthroscopy, we fixed two malleolar screws from the lateral fibula using a minimally invasive technique to preserve the articular surface restoration and permit healing of the syndesmosis ligament (Fig 1c). After 4 weeks when callus appeared we opened the hinge of the external fixator and

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Arthroscopy; External fixators; Fracture fixation, internal; Tibial fractures

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關節鏡輔助內外結合固定法處理 脛骨pilon骨折

目前，高能量創傷所致脛骨pilon骨折的處理方法會造成不少嚴重的問題。治理時所選用的方法應當是不會引起感染，又能有效修補關節面的。本文報告治理一名42歲男性因高能量創傷以致脛骨pilon骨折的案例，我們採用關節鏡輔助單側外固定架及微創內固定術來處理。治理過程中，以關節鏡為骨折碎塊復位並修補關節面，碎塊復位後馬上用螺釘固定。我們相信結合關節鏡輔助外固定術和微創內固定術是處理這類骨折的最佳方法，因為外固定法可改善骨折的愈合，關節鏡可修復關節面，微創螺釘可固定碎塊。

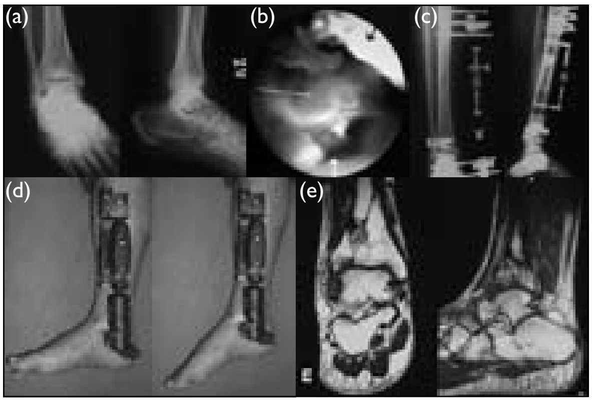

FIG 1. (a) Preoperative anteroposterior and lateral ankle direct radiography. (b) Articular surface reduction during arthroscopy; depressed articular surface (long white arrow), reduction prob (short white arrow), pilon of the tibia (short black arrow). (c) Postoperative early period, reduction achieved by unilateral external fixator and minimally invasive screw osteosynthesis. (d) Four weeks postoperative, extenal fixator hinge opened and ankle motion started. (e) T1-weighted magnetic resonance imaging done 2 years after the operation show at step-off of less than 1 mm

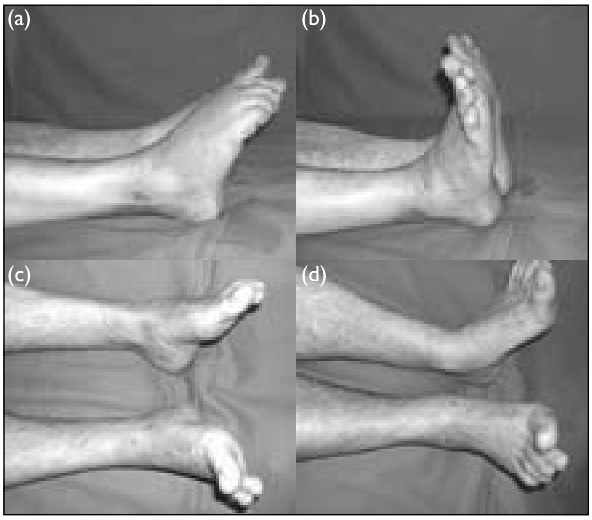

FIG 2. Range of motion after full healing is shown after 2 years: (a) plantar flexion, (b) dorsal flexion, (c) inversion, (d) eversion

mobilised the tibio-talar joint (Fig 1d). After 12 weeks we took off the screws and the external fixator and applied a splint that permitted ankle motion. At the end of the 16th week, the patient was permitted to weight bear and return to his normal daily activities. Two years after the injury, we found the ankle had a good range of motion (Fig 2), and functioned well when the patient was walking and squatting. The articular surface showed a step-off of less than 1 mm on magnetic resonance imaging (Fig 1e). The patient said he only suffers mild pain after long walks, and this pain does not last long, nor does he need to take drugs to relieve it.

Discussion

Several methods have been proposed for the treatment of pilon fractures of the tibia.[1,2] Formerly, traditional treatment methods such as skeletal traction or immobilisation in a cast were frequently used.[1,2] Nowadays, those methods are rarely used because they had unsatisfactory results including insufficient anatomical reduction and joint stiffness. Instead, surgical methods are becoming important today. Open reduction and internal fixation was used initially but it is now known that open reduction increases the risk of complications after high-energy trauma.[4,5] To minimise the risk of postoperative complications, methods combining external fixation with minimally invasive fixation materials were developed. Today, various external fixation methods such as circular, unilateral, and hybrid exist.[1,2,6,7]

External fixation aims to reduce fractures by ligamentotaxis[6,7] but it is difficult for an external fixator to reduce the tibial articular surface alone. We used arthroscopy to improve reduction of the fracture with the external fixator. The type of fixator we used is a unilateral hinge and it was chosen for two important reasons. Firstly, it does not prevent arthroscopic intervention during surgery; indeed it distracts the joint interval, leading to easier arthroscopy. The value of using arthroscopy to assist with the reduction is that it allows easy restoration of the tibial articular surface with minimal invasion. Secondly, this external fixator provides early mobilisation of the tibio-talar joint. Early motion has a significant role in intra-articular fractures because immobilisation of the joint interferes with the blood supply to the articular cartilage, thus increasing the risk of osteoarthritis.[8]

Pilon fractures have a high incidence of early and late complications, such as wound problems, skin sloughing, infection, nonunion, malalignment, joint stiffness, and post-traumatic arthritis. This high complication rate is due to the high-energy nature of the injury and the tenuous soft-tissue envelope of the lower tibia. Skin sloughing may occur after the injury or open surgery. The surgical factors predisposing to skin loss are poor timing of the definitive procedure, rough handling of the soft tissue, and long incisions.[9] Open reduction and internal fixation requires extensive surgical dissection that will result in periosteal stripping and devascularisation of bone and longer operating time, thus increasing the risk of wound problems and infections. These poor results are usually associated with type III fractures according to the Rüedi and Allgöwer classification.[10]

Arthroscopic surgery is reported to have complication rates of between 1% and 8%. These are either intra-operative complications such as vascular or neurological injuries, and fluid extravasation, or early postoperative complications such as haemarthrosis, deep vein thrombosis, infection, and compartment syndrome.[8] Therefore we used low-molecular-weight heparin for anti-thrombotic prophylaxis for 10 days and avoided using an arthropump during the arthroscopic fracture surgery.

It is commonly accepted that, in intra-articular fractures, especially those in load-bearing joints, a minimal step-off should reduce the risk of late osteoarthritis.[8] When fractures associated with high-energy trauma are treated with open surgery the infection rate is higher. Dillin and Salabaugh[4] found that the osteomyelitis rate in fractures associated with soft tissue injuries that were treated with open surgery was 55%. Teeny and Wiss[5] also found an infection rate of 37% in type III fractures with soft tissue injuries treated with open surgery. This shows that using open reduction to treat fractures associated with soft tissue injuries increases the risk of infection. Infection rates are very low in fractures that are treated with external fixators and minimally invasive fixation.[6]

We believe that, to get good results when treating intra-articular fractures, it is essential to minimise possible complications in the postoperative period. Anatomical repositioning of the joint surface, application of minimally invasive surgical methods, and early mobilisation of the joint make this possible.

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