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Hybrid external fixation in the treatment of tibial pilon fractures: A retrospective analysis of 162 fractures

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ABSTRACT

Objectives: To determine the efficacy of hybrid external fixation in the treatment of tibial pilon fractures.
Design: Retrospective, multicentre study.
Patients/Participants: Adult patients with tibial pilon fractures treated with hybrid external fixation.
Intervention: Fracture reduction with ligamentotaxis and fixation with XCaliber hybrid external fixator.
Main outcome measurements: Fracture union, complications, functional outcome (Mazur Ankle Score).
Results: Union was obtained in 159 fractures at an average of 125 days; there were three delayed unions and three non-unions. The most frequent complication was superficial pin-track infections (48), all of which responded to local wound care and antibiotics. There were no deep infections and no DVT. Only one fracture had loss of reduction that required frame revision. The overall functional scores were 91 (excellent) for AO/OTA type A fractures, 89 (good) for type B fractures, and 75 (satisfactory) for type C fractures.
Conclusions: Hybrid external fixation is an effective method of stabilising tibial pilon fractures, particularly those with marked comminution. The minimally-invasive technique and stable fixation enable early mobilisation, with good functional results and minimal complications.
Level of evidence: Level IV Case series.

Introduction

Tibial pilon fractures are relatively uncommon injuries, representing only 1% of all fractures of the lower limb and 5% to 7% of those of the tibia [1–3]. Frequent comminution and the thin soft-tissue envelope in the area make the treatment of these fractures challenging. The tibial pilon is characterised by a total absence of muscle coverage and marginal vascularity, therefore, even moderate trauma often results in extensive soft-tissue damage.

Two distinct mechanisms are believed to be responsible for most tibial pilon fractures: low-stress trauma (sports injuries), which is less common and secondary to rotational forces, and high-stress trauma (motor vehicle accidents, falls from height, workplace accidents), which is more common and produces axial transmission of the load with the talus pushed onto the distal tibia, resulting in a multifragmentary implosion of bones and cartilage structures [4,5]. The pattern of the fracture with this mechanism of injury depends on the position of the foot at the time of trauma [4–7]. With the foot dorsiflexed, compressive forces are placed on the anterior part of the plafond, whereas with the foot plantarflexed the forces are directed posteriorly. If the foot is in a neutral position, the axial force can also compromise the integrity of the articular surface [4,7,8].

Several classification systems have been proposed for tibial pilon fractures. Rüedi and Allgöwer introduced a classification that

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divides fractures into three groups according to the degree of displacement and comminution of the articular and metaphyseal fragments, to which Ovadia and Beals added two fracture variants [7,9]. Currently, the most widely used classification is the AO/OTA classification, which divides fractures into three groups: type A, extra-articular; type B, partially intra-articular; and type C, completely intra-articular10. Each group is further divided into subgroups that indicate the severity of comminution and the fracture pattern.

The treatment of tibial pilon fractures, particularly high-stress fractures, is complex and often difficult. The historically disappointing results of conservative treatment and the first attempts at limited internal fixation led the AO to develop guidelines for open reduction and internal fixation [3,11]. This method has produced and still produces good results, particularly in less severe, low-stress fractures, but results are not as good in high-stress injuries. In fractures with severe soft-tissue damage and metaphyseal comminution, the introduction of plates and screws through an extensive exposure is associated with a high rate of failure and severe complications, such as surgical wound infections, osteomyelitis, and non-union [9,12–20]. Hybrid external fixation represents a possible alternative method to provide stable fixation and reduce complications. These devices have gained increasing popularity among orthopaedic surgeons because they provide a stable fracture synthesis that can drastically reduce soft-tissue damage; however, in some cases, a relatively simple and standardised method of assembly of the external fixation is balanced by the need for minimal additional internal fixation to restore proper joint congruity [21]. Despite the growing interest in this type of technique, most of the studies in the literature are based on relatively small numbers of cases [21–32].

The purpose of this study was to determine the effectiveness of hybrid external fixation in the treatment of both high- and low-stress tibial pilon fractures in a large sample of patients (162 patients). To the best of our knowledge, this is by far the largest group of patients with hybrid external fixation of tibial pilon fractures to be reported.

Patients and methods

A retrospective, multicentre review identified 162 tibial pilon fractures treated with the XCaliber Hybrid External Fixator (Orthofix, Surrey, England, UK) between March 2000 and September 2010 at five trauma centres in Italy. The 107 males (66%) and 55 females (34%) had an average age of 44.2 years (range, 12 to 82 years). A total of 119 of the fractures occurred as isolated trauma, and 43 were part of multi-trauma.

Preoperative anteroposterior (AP) and lateral radiographs and CT scans of the ankle were obtained for all patients to enable an accurate assessment of the type of fracture. The fractures were classified according to the AO/OTA system: there were 46 type A fractures, 34 type B, and 82 type C (Table 1) [10]. Thirty-nine (24%) open fractures were classified as Gustilo-Anderson type 1 (16), type 2 (16) or type 3 (7), and 123 (76%) closed fractures were classified as Tscherne type 1 (66), type 2 (47) or type 3 (10) [33,34].

The timing of the operation was dictated by the status of the soft tissues. The fractures in 34 patients (21%) were treated as emergencies, with immediate debridement and temporary external fixation, and 12 patients (7%) had immediate definitive treatment. The remaining 116 patients were placed in calcaneal traction with elevation, and surgery was delayed until soft-tissue healing was obtained, an average of 8 days after trauma (range, 1 to 15 days) (Figs. 1 and 2). An XCaliber external fixator was used for final fixation of all fractures. The distal tibial fragment was fixed with a minimum of three Kirschner wires tensioned and fixed to a 3/4 circular ring frame; traditional Shanz screws were used for the proximal fragment. Calcaneal transfixation pins were used in only six patients (4%). Simultaneous fibular fractures occurred in 85 patients and were stabilised with Kirschner wires (67 patients) or plates and screws (18 patients).

Surgical technique

The surgery was performed with the patient supine and the involved limb in transcalcaneal traction. General anaesthesia was used in emergency treatment; in all other cases, spinal anaesthesia was used. The degree of fracture reduction obtained with ligamentotaxis was verified using fluoroscopy.

The application of the external fixator was as follows: at least three Kirschner wires, with or without olives and with an angle of 35° to 40°, were placed transosseously distal to the fracture site, respecting the security corridors and with great caution to avoid the neurovascular bundles. Once placed, the Kirschner wires were tensioned to 1400 Newtons to increase the stability of the construct and were anchored to the 3/4-ring portion of the fixator. Three hydroxyapatite-coated Schanz screws were placed on the anteromedial surface of the proximal tibial fragment and attached with a tubular rod through clamps. When adequate reduction was achieved, the construct was locked and secured. To avoid inadequate anatomic joint reduction, particularly in the more complicated pilon fractures patterns, a 4 to 5 cm long incision was made anteriorly and the ankle joint was inspected to obtain the most satisfactory anatomical reduction of the articular surface. Kirschner wires and/or screws were then inserted for additional fixation of the intra-articular fragments in 50 fractures (1 type A, 6 type B, and 43 type C); 17 were open fractures and 33 were closed (Fig. 3).

Table 1
OA/OTA classification of 162 tibial pilon fractures.

Type A—extra-articular fracture		46 (28%)
A1	Simple	13
A2	Wedge	22
A3	Complex	11
Type B—partial articular fracture		34 (21%)
B1	Pure split	4
B2	Split-depression	3
B3	Multifragmentary	27
Type C—complete articular fracture		82 (51%)
C1	Articular simple, metaphyseal simple	39
C2	Articular simple, metaphyseal multifragmentary	17
C3	Articular multifragamentary	26

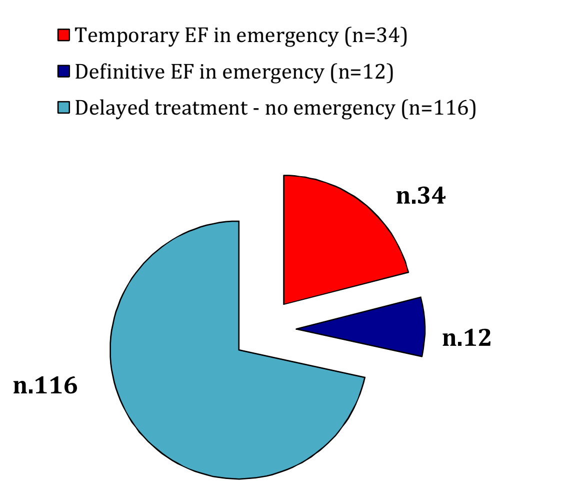

Fig. 1. Type of treatment depending on severity of injury.