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Emergent hybrid external fixation for tibial pilon fractures in adults

Gabriele Falzarano[1], Antonio Medici[1], Predrag Grubor[2], Milan Grubor[2], Luigi Meccariello[3*]

[1]*U.O.C. Orthopedics and Traumatology, Hospital "Gaetano Rummo", Benevento, Italy*

[2]*Orthopedics and Traumatology, Klinical Center University of Banja Luka, Banja Luka, Bosnia and Herzegovina*

[3]*Department of Medical and Surgical Sciences and Neuroscience, Section of Orthopedics and Traumatology, University of Siena, Siena, Italy*

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ABSTRACT

Objective: To investigate that if the hybrid external fixation is the definitive treatment and management of tibial extra articular and intra-articular pilon fractures of the adult in emergency.

Methods: We treated 237 cases of pilon fractures using hybrid external fixation with or without minimal osteosynthesis from February 1999 to December 2014. All fractures were classified according to the Association for the Study of Internal Fixation. The three groups were represented by 108 patients (45.5%) for the Type A; 75 patients (31.8%) for Type B and 54 patients (22.7%) for Type C. Road accidents [118 patients (50.0%)] were the most common cause of tibial pilon fractures.

Results: According to a mean follow-up of 7.3 years we had bone healing after 4.8 months from surgery in the 61.18% of the patients. The results were subjectively excellent, while the 54.00% were objectively excellent according to Ovadia and Beals score, and the results showed 29 complications.

Conlusions: From our data hybrid external fixation with or without minimal fixation is a good surgical method to treat pilon fractures.

1. Introduction

Tibial pilon fractures are complex and difficult to treat. They represent about 1% of all fractures of the lower extremities, and up to 10% of the tibial fractures[1,2]. In 1911 the French surgeon Destot described the tibial pilon as an anatomical unit[3], defining the anatomical limit within 5 cm from the joint line and the mechanism determining the fracture.

Pilon fractures are more common in men than in women[4], and their incidence is on the rise, probably as a result of the increase in the survival rate from road accidents[4,5]. The damage is caused by high-energy trauma mainly in axial load as the usual consequence of road accidents or falls from a considerable height[6].

The tibial pilon, taken as an anatomical unit, shows a thin skin, a precarious vascularization and no muscle insertions; these factors concur to make the healing phenomena of the soft tissue more complex, and favor the exposure of fractures due to high-energy trauma on this segment (20%–25% of these fractures are exposed)[7]. According to the Association for the Study of Internal Fixation (AO) classification, in the treatment of Type A tibial pilon fractures, various surgical methods may be used, such as external fixation, the intramedullary nail, the percutaneous synthesis with cannulated wires or Kirschner's wires and a synthesis with modern plates[8]. Surgical options are internal fixation, external fixation with or without limited internal fixation and primary arthrodesis. The condition of the soft tissues guides the therapeutic choice. The non-surgical treatment of tibial pilon fractures, based on prolonged transcalcaneal traction or casting has been superseded by modern surgical techniques and was limited only to special cases. The option of external fixation as a definitive treatment has been preferred in recent years, particularly for the benefits it provides with respect to minimal interference with the soft tissue. The treatment principle with an external fixator is through ligamentotaxis, while most fixators are built to provide a tibiotalar-calcaneal bridge; circular fixators allow a tibial-only assembly[9–11]. The aim of the present research was to investigate that if the hybrid external fixation is the definitive treatment and management of tibial extra articular and intra-articular pilon fractures of the adult in emergency.

*Corresponding author: Luigi Meccariello, Department of Medical and Surgical Sciences and Neuroscience, Section of Orthopedics and Traumatology, University of Siena, Viale Bracci 1, 53100 Siena, Italy.
Tel: +39 329 9419574
E-mail: drlordmec@gmail.com
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2. Materials and methods

From February 1999 to December 2014, at the UOC Orthopedics and Traumatology of AORNG Rummo of Benevento, we treated 237 tibial pilon fractures using hybrid external fixation with or without a percutaneous synthesis with cannulated wires or Kirschner's wires. The average age of the study population was 43.6 years (range 16–65 years), the sex ratio was 3.65 to 1; males were 186 and women 51 (Table 1). All fractures were classified according to the AO (Table 1). The three groups were represented by 108 patients (45.5%) for the Type A; 75 patients (31.8%) for Type B and 54 patients (22.7%) for Type C (Table 1). The working sector most represented was the tertiary industry, with 99 patients (41.67%), followed by the primary industry with 79 patients (33.33%) and then the secondary industry with 59 patients (25.00%). Road accidents, with 118 patients (50.00%) were the most common cause of tibial pilon fractures (Table 1). There were 82 open fractures (34.6%). According to the Gustilo-Anderson classification, the open fractures were: Type I, 28 patients (34.15%); Type II, 39 patients (47.56%); Type III A, 12 patients (14.63%); Type III B, 3 patients (3.66%); Type III C, 0 (0%). At emergency room admission, the patients had an average of 16.5 points (range 12–32) injury severity score and an average of 12.5 (range 8–15) points for Glasgow coma score. All patients were treated with the hybrid external fixation TenXor (Stryker®) and to 68 patients (28.69%), a percutaneous synthesis with cannulated wires or Kirschner's wires with Asnis (Stryker®) cannulated screws was associated. A total of 154 cases of injuries were associated with tibial pylon fractures, and 28 cases were associated with head injuries (Table 2). All patients were informed in a clear and exhaustive way about the two types of treatment and the corresponding surgical alternatives. Patients were treated according to the ethical standards of the Declaration of Helsinki and were invited to read, understand and sign the informed consent form. The follow-up was carried out with clinical and radiographic tests at 1 month, 3 months, 6 months and 12 months from surgery. After 12 months the checkup was carried out annually.

The evaluation criteria of the two groups were: the visual analog pain scale (VAS) of the traumatized ankle; the subjective/objective Ovadia and Beals score; the time, the average derigidification time of the system; the average time of return to walk freely; the average healing time of the fracture, and complications. The endpoint assessment was set at 12 months for both groups. All patients had soon moved the ankle passively and actively. Derigification was performed by removing all those components of the external fixator which reduced the lever arm, making the implant dynamic.

Table 1

Description of the patients.

Description	Value
Number of patients	237
Average age (years)	43.6
Range of age (years)	16–65
Gender ratio (M:F)	3.65:1 (186:51)
Type of fracture according AO's classification [*n* (%)]	Type A: 108 (45.5%) Type B: 75 (31.8%) Type C: 54 (22.7%)
Work of population [*n* (%)]	Agricultural activity: 79 (33.33%) Industrial sector: 59 (25.00%) Tertiary industry: 99 (41.67%)
Cause of trauma [*n* (%)]	Fall from high: 79 (33.33%) Car accident: 118 (50.00%) Farm accident: 12 (16.67%)
Open fractures [*n* (%)]	82 (34.6%)
Open fracture according Gustilo-Anderson's classification [*n* (%)]	Type I: 28 (34.15%) Type II: 39 (47.56%) Type III A: 12 (14.63%) Type III B: 3 (3.66%) Type III C: 0 (0%)
Average injury severity score	16.5 (range 12–32)
Average Glasgow coma score	12.5 (8–15)
Hybrid external fixation [*n* (%)]	237 (range 100%)
Minimal osteosynthesis using Asnis (Stryker®) cannulated screws [*n* (%)]	68 (28.69%)

Table 2

Description of associated injuries.

Type of injuries	Number of injuries
Head trauma	28
Fat embolism	0
Haematic pneumo thorax	23
Liver injuries	8
Spleen injuries	14
Bowling injuries	2
Contralateral femoral fractures	7
Contralateral tibial fractures	8
Ribs fractures	26
Clavicle fractures	2
Humerus fractures	3
Forearm fractures	4
Patella fracture	7
Pelvic fractures	4
Acetabulum fractures	8
Spine fractures	10

3. Results

The degree of pain measured with VAS decreased on average within 12 months from the trauma: 0 points VAS before trauma, 9.8 (range 8–10) points VAS at moment of the trauma, 4.2 (range 3–6) points VAS 1 month after the trauma, 3.8 (range 2–5) points VAS 3 months after the trauma; 2.2 (range 0–4) points VAS 6 months after the trauma; 1.6 (range 0–4) point VAS 12 months after the trauma. The radiographic bone healing occurred in about 4.8 months (range 4–7.5 months) while derigidification of the external fixator was performed on average at 2.1 months (range 2–6 months) after surgery. The total weight-bearing on the lower limb was granted to approximately at 2.4 months from the trauma (range 2.0–3.2 months) after surgery. A total of 145 out of 237 patients (61.18%) had excellent subjective results, while 54.00% (128 out of 237) had excellent results from the objective point of view; good results with 68 (28.69%) patients in subjective view and 82 (34.60%) in objective view; discrete results with 17 (7.17%) patients in subjective view and 22 (9.28%) in objective view; insufficient results with 7 (2.95%) patients in subjective view and 5 (2.12%) in objective view. During the follow-up period of about 7.3 years (range 6 months–15 years), we had 29 complications: 21 Ankle's osteoarthritis; 2 skin infection; 1 malunion; 1 nonunion; 2 delayed bone healing; 1 bad alignment pro curved/retro curved < 10; 1 bad alignment in varus/valgus > 5. However, the complications of mobilization of proximal fiches, breaking distal K-wires, breaking implant and deep infections were not observed.

4. Discussion

The main objectives of the treatment of tibial pilon fractures are the maintenance of length, recreation of the joint surfaces and restoration of limb alignment. Open reduction provides the safest way of achieving fracture reduction and restoring joint congruity, considering also the possibility of external fixation to restore severe articular comminution in Type C fractures (AO/OTA)[12]. Delayed surgical intervention is to be recommended in all those situations where there is even minimal evidence of soft tissue injury. There are indeed situations, such as low-energy fractures of AO/OTA Type A or B with no significant soft tissue injury, where internal fixation may be undertaken without prolonged delay. The management of Type C fractures remains a source of discussion[12]. However, this type of therapeutic choice must not come at the expense of the soft tissues, where severe injury could lead to failure of even the most anatomical reconstructions, with serious consequences such as surgical wound breakdown with exposure of hardware and infection[13,14]. Joveniaux *et al.*[15] reported in their experience between 2002 and 2004, that one hundred patients (101 fractures) were reviewed with an average follow-up of 19 months (range, 12–46). Internal fixation, external fixation, limited internal fixation (K-wires or screws), intramedullary nailing and conservative treatment were used. Outcome parameters included occurrence of complications, radiographic analysis, evaluation of the American Orthopedic Foot and Ankle Society ankle score and measures of the ankle range of motion. The average functional score was 76 points (range, 30–100 points), and complications occurred in 30 patients. Predictive factors of poor results were fracture severity, complications, malunion and the use of external fixation. They concluded that the first stage consists of an approximate reduction and application of an external fixator spanning the ankle joint[15]. The second stage is delayed from 7 to 10 days until soft tissue recovery and consists of an open reduction and internal fixation[15]. Our experience, along with Lerner and Stein[16], reported that hybrid thin wire external fixation is an effective, minimally invasive treatment for the stabilization of pilon fractures. The extent of bone and soft-tissue loss, high risk of infection, and further damage to the soft tissues precludes open reduction and internal fixations a safe treatment method[16]. External fixation preserves the soft-tissue envelope with minimal damage and allows fracture stabilization, early loading, and mobilization, which promote bone healing[16]. For the treatment of Type B and C fractures, Mitkovic *et al.*[17] described 26 patients with 28 Type C3, distal intraarticular tibial (pilon) fractures treated by dynamic external fixation. Follow-up was at least two years, and the results (subjective and objective) were classified according to the Ovadia system, they found 71% subjectively and 67% objectively excellent results. The mean to fracture union was 14 weeks (range: 12–20 weeks). There were three cases with angulation deformity (from 7° to 20°)[17]. There were no cases with nonunion or deep infection despite a high frequency of infections (11%) and osteoarthritis (15%)[17]. Based on these results, this treatment with closed reduction and dynamic external fixation allowing early motion appears as a suitable method for treatment of comminuted intraarticular tibial pilon fractures.

The rate of amputation, arthritis, chronic osteomyelitis and dehiscence of the surgical wound stood at approximately 2% with the use of open reduction and internal fixation with a rate of skin necrosis of 13%[12]. Another study of Golubovi *et al.*[18] included 47 patients with tibial pilon fractures [33 (70.2%) males and 14 (29.8%) females]. The patients mean age was 45.8 years. In the first group, which consisted of 22 patients, open reduction and internal fixation of both the tibia and the fibula was performed in the two separate incisions[18]. The second group consisted of 25 patients managed with external fixation by external fixator "Mitković" with limited internal fixation[18]. Besides external fixation, a minimal internal fixation was performed by the use of Kirschner wires and screws[18]. The patients were followed-up inside a 24-month-period. The obtained was a substantially high number of complications after open reduction and internal fixation in the group of patients[18]. There was no difference in a long-term clinical outcome. Postoperative osteitis, as the most severe complication in the management of closed pilon tibia fractures, was not registered in the second group. Considering the results obtained in this study, it can be concluded that external fixation by the "Mitković" external fixator with the minimal internal fixation is a satisfactory method for the treatment of fractures of the tibial plafond causing less complications than internal fixation[18]. Despite the best current efforts at treatment, OA develops in as many as 25% of patients after fractures of the acetabulum, between 23% and 44% after intra-articular fractures of the knee, and in more than 50% of patients with fractures of the tibial plafond[19–23]. Posttraumatic osteoarthritis (PTOA) following an intra-articular fracture has been attributed to the initial joint injury and to elevated cartilage stresses from residual surface incongruity[24]. Tibial plafond fractures are an ideal injury in which to assess the roles of injury severity and chronic contact stress elevation in the pathogenesis of PTOA OA very frequently develops following ankle trauma, but rarely occurs primarily. Both the amount of articular comminution and the quality of obtained articular reduction exhibit a wide degree of variability providing ample opportunity to study how these factors influence outcomes[24–26]. Anderson *et al.*[24] in their mathematical model reported: in fractured joints identified as being most highly at risk to develop PTOA, the value of accurate surgical reduction should be especially carefully weighed against the backdrop of potential surgical complications[24].

On the basis of these results and of what we found in the literature, we understand that the use of a technique limits the minimum surgical trauma of soft tissues and bone component, while ensuring a good primary stability, an early joint mobilization is undoubtedly to be preferred for the treatment of this type of injury. The complexity of the treatment of tibial pilon fractures and the importance of further studies (including randomized controlled trials) directed at the formulation of evidence-based recommendations for treatment.

Conflict of interest statement

The authors report no conflict of interest.

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