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The use of Ilizarov external fixation in the treatment of distal tibial fractures

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Summary

We reviewed 31 distal tibial fractures (sixteen involving tibial plafond) treated with Ilizarov external fixation. The study population was composed of 19 males and 12 females, with an average age of 54 (range, 13-80 years). The fractures were classified according to the AO classification: A1 (3), A2 (6), A3 (6), C1 (2), C2 (8), C3 (6). There were 6 open injuries.

In 14 of the pilon cases, open reduction of the intra-articular fragments and bone grafting via a limited incision was performed. Clinical follow up averaged 28 months (range, 18-42 months). All but one fractures united with an average healing time of 13.9 weeks (range, 10-20 weeks). All but one patient with AO Type A fracture had excellent or good functional scores. The 14 cases of AO C2 and C3 group had 6 good results, 5 fair results and 3 poor results.

This method yielded satisfactory results comparable with previous studies using open reduction and internal fixation while decreasing the number of serious complications. Its usage can be recommended, especially in fractures with severe soft tissue damage and in comminuted fractures.

Introduction

Fractures of the distal tibia are among the most difficult fractures to treat. The short distal segment presents difficulty for the orthopaedic surgeon in choosing the appropriate fixation method. The intra-articular group of these injuries, the pilon fracture, is due to high energy trauma and articular comminution is frequently present. The greatest challenge to the orthopaedic surgeon lies in the relatively tight soft tissue around the ankle. The conventional method of open reduction follows by plate and screw fixation provides good outcomes only in the fractures with less severe, lower energy trauma [5-8,10,12,13-15,18]. Once complications including wound dehiscence and infection set in, patients will have a lengthy stay in hospital. Often they need multiple operations, and may even end up in having amputation [20]. As a result, it has been a recent interest in treating these fractures with external fixation and limited internal fixation [1-4,9,17,19].

The Ilizarov principle of circular external fixation has been applied to fracture treatment. The advantage in using tensioned transfixion wires is that in a small bone segment, multiple wires can be inserted and tightened, resulting in strong fixation of the bone. This is particularly useful in fixing the short distal

fragment in distal tibial fractures. The transfixion wire can bypass the area with poor soft tissue condition and the minimally invasive nature of the surgery can avoid catastrophic wound complication that may follow the conventional open fracture treatment. There is no need to extend the fixation device across the ankle joint and early range of motion is possible. This is particularly important in intra-articular fractures where joint motion is important for articular cartilage healing and nourishment [16]. The elasticity of the wire allows micromotion during weight bearing walking and that will facilitate fracture healing. This study retrospectively evaluates the efficacy of this method in treating distal tibial and pilon fractures.

Materials and Methods

Between July 1995 and March 1998, patients with distal tibial fractures or pilon fractures admitted to our institute will be treated with the technique of circular external fixation and limited internal fixation if necessary. All open fractures were treated on an emergency basis in the operation theatre with irrigation and debridement, followed by fracture fixation. The timing of operation for closed fractures depended on the condition of soft tissues and the likelihood of a limited open reduction, which was often dictated by the degree of articular

involvement (Fig. 1). The affected limbs were put in plaster slabs and elevated. The definitive procedure for fixation was delayed for an average of 2 days in the extra-articular group (AO type A) and 9 days in the intra-articular group (AO type C).

The operation was performed with the patient in the supine position on a radiolucent table. The device was Ilizarov external fixator (Smith & Nephew, Richards Inc.). with tensioned wires for the distal bone fragment. Preassembly of the frame was preferable, as this would greatly reduce the operation time. The operation started with the placement of a transverse wire across the talus or calcaneus. The pin should be fixed to a half ring for distraction of the fracture site. The pre-assembled frame was then applied to the tibia. A hybrid kind of fixation using 5mm half pins for the proximal fragment was used in order to minimize soft tissue impalement. 1.8mm wires were used to fix the distal fragment and were tensioned to 120kg. Olive wires were used for reduction of wedge fragments or for better alignment. The frame usually included 3 rings (2 for proximal and 1 for distal). The use of conical washers in connecting the threaded rods to the rings greatly facilitated the reduction of the fracture. In most cases, 3 half pins were inserted to the proximal fragment and 3 wires were inserted to the distal fragment. The effect of ligamentotaxis on reduction was

assessed with the use of a C-arm. In fourteen cases of the pilon fractures, open reductions of the intra-articular fragments via a limited open approach were performed prior to the stabilization of the metaphyseal portion of the fracture. A 5 to 6 cm long incision was made anteriorly over the major fragments. The ankle joint was visualized and anatomical reduction of the articular surface was possible. Lag screws were inserted to fix the articular fracture. Bone graft harvested from the iliac crest was placed in 15 patients (3 had extra-articular fractures) to fill up bony defects or to support the articular surface. The metaphyseal fracture fragments were not exposed. The surgical wound was closed first before proceeding to the insertion of wires. The fixation of the rest of the tibia was then performed in the above-mentioned manner. In two patients with comminuted C3 fractures, the wire through the hind foot with the ring was left behind for another two weeks to maintain the reduction by temporarily immobilizing the ankle joint. In all other patients, the wire at the hind foot was removed at the end of the procedure and the ankle would be free for movement. The average duration of the operation was 126 minutes (range, 65 to 150 minutes).

Usually patients with extra-articular fractures were allowed weight bearing walking as tolerated, while those with pilon fractures were kept non-

weightbearing for at least 8 weeks (Fig. 2). All patients were encouraged to have early range of motion exercises. Clinical and radiological assessment was done every two weeks until the fracture united (Fig. 3a to 3e). The fixator was removed at an average of 15 weeks post-operatively (range, 10 to 20 weeks).

Results

There were 31 patients treated under the protocol. The study population comprised 19 males and 12 females. The average age of the population was 54 years (range, 13-80 years). The fractures were classified according to the AO classification [11]: A1 (3), A2 (6), A3 (6), C1 (2), C2 (8), C3 (6). Partial articular fractures (AO type B) were excluded from the study since a rigid fixation of the diaphyseal-epiphyseal junction is not necessary. The fibula was intact in 5 patients.

There were 6 open injuries, and in 19 patients (61%) the mechanism of injury was high-energy trauma, including fall from height, direct crush by heavy object and motor vehicle accident. The average injury severity score was 8.3. Ten patients had multiple fractures which included second long bone fractures

(4 patients), spinal fractures (3 patients), pelvic fractures (2 patients) and one ipsilateral talus fracture.

Union

Clinical follow-up averaged 28 months (range, 18-42 months). All but one fractures united with an average healing time of 13.9 weeks (range, 10 to 20 weeks). The only non-union case was a patient complicated with infection and he would be discussed later.

Clinical assessment

In order to evaluate the pain and function of the subjects, a clinical scoring system based on the one used by Teeny and Wiss [18] was obtained in 30 patients, excluding the one who had an arthrodesis. The results were graded as excellent, good, fair, or poor (Table 1). The presence of intra-articular involvement greatly affected the result (Table 2). In the fifteen patients with AO extra-articular types A1-A3 fractures, fourteen of them had excellent or good results and one had fair results. There was no poor result. The two fractures in the C1 group also had excellent or good results. However, in the 14 patients with C2 and C3 fractures, there were all together 6 good results, 5 fair results and 3 poor results.

Radiological assessment

Patients returned for follow-up visits at least every three months for the first year and every six months thereafter. Serial radiographs were made and evaluated for the bone healing, fracture alignment and the development and progression of osteoarthritic changes. Degenerative changes were rated as mild (one millimeter of narrowing of joint space), moderate (two millimeters narrowing with small periarticular cysts or spurs) and severe (complete loss of joint space with osteophytes or cysts). Only patients with C2 and C3 fractures had radiographic signs of degeneration (Fig.3d to 3e). Out of fourteen patients in this group, four had no changes, five had mild changes, three had moderate changes and two had severe changes. The presence of moderate to severe degeneration correlates well with the clinical outcome as all of them having either fair or poor clinical score results. However, despite radiographic signs of degeneration, no patients had symptoms severe enough necessitating an ankle arthrodesis up to the time of follow up.

Complications

There were nine (29%) pin tract infection in this series. All responded to oral antibiotics and local pin care although six of them had an early removal of the

involved pin as fracture healing progressed. Most of these infections involved the wires in the region of the ankle. There seemed to be no correlation with the fracture type.

There was one patient complicated with deep infection after the operation. He was a 42-year-old patient who had an open pilon and ipsilateral talus fracture. He had circular external fixator put on as an emergency procedure. He developed pain and swelling at the fracture site and discharge from the distal transfixion wire two months after the external fixator. He was diagnosed to have osteomyelitis of the distal tibia and repeated debridements were performed. The infection was under control and the fracture healed eventually with subsequent bone grafting. However, there was destruction of the ankle joint and subsequently the patient needed an ankle arthrodesis.

There was one case of skin necrosis in a thirteen-year-old boy who had an A3 fracture. There was initially some abrasion of the skin around the fracture region which after the fixation showed a necrotic patch. Retrospectively, the necrotic skin was caused by the jeopardized blood supply at the time of distraction during fracture reduction. The necrotic skin was debrided and the wound finally healed with granulation.

Two patients were found to have unsatisfactory reduction on follow-up and had frame adjustment under fluoscopic guidance in the operating theatre. One sixty-two year old lady had fifteen degrees of varus angulation, but she refused further adjustment. Despite she had a malunion, she had an excellent functional score at the end of follow up.

Discussion

Distal tibial fractures are complex injuries, not only regarding the bony component, but also in terms of the management of the soft tissue problem. Failure to recognize this often resulted in repeated surgery and even amputations. In 1969, Ruedi and Allgower [13] reported a 74 per cent excellent or good functional result when they reviewed 84 pilon fractures treated with open reduction and internal fixation. Thereafter grew a widespread enthusiasm for such technique. The four principles that they advocated [13-15] were: (1) restoration of fibula length, (2) reduction of articular surface, (3) cancellous bone grafting of the metaphyseal defect, and (4) Stabilization with a medial buttress plate. While some authors [5-8] shared the same good results as Ruedi and Allgower, others have reported less favorable results, together with a high

rate of complications. Teeny and Wiss [18] reported eleven (37 per cent) of thirty patients having deep infection, and McFerran et al.[10] reported twenty-one (40 per cent) of fifty-two patients having a major complication. Wyrsch et al.[20] reported three (16%) amputations of nineteen patients having open reduction and internal fixation. These reports reflected the fact that with extensive surgical dissection in achieving an anatomical reduction, the vascularity of the bony fragments are often jeopardized and these devascularized fragments will act as foci for infection. The insertion of a bulky plate into the tight soft tissue envelope of the distal tibia also impaired wound healing. The incidence of skin slough and wound dehiscence was as high as 27% in the Teeny and Wiss series [18].

While anatomical reduction is still crucial in the reconstruction of the articular surface, it is less important regarding the metaphyseal fragments. The biology of the bony fragments should always be preserved maximally. The concept of external fixation, when combined with minimal internal fixation if necessary, can deal with both mechanical and biological aspects for better fracture healing. Reduction is achieved largely through ligamentotaxis and extensive surgical dissection is obviated. External fixation device spanning across the ankle joint had been used with promising result [1-4,9,17,19]. A randomized, prospective

study on pilon fractures performed by Wyrsch et al.[20] comparing open reduction and internal fixation with external fixation with or without limited internal fixation showed similar results in the two groups. However, the latter group was associated with fewer and less severe complications than internal fixation.

The Ilizarov circular external fixation system provides the advantage of sparing the ankle joint and allows early motion. The usage of tensioned wires is an effective way to fix a short bony segment. Minor readjustment of the frame can also be done as an outpatient procedure. This option is not possible with cast immobilization, rigid internal fixation or uniplanar external fixation.

The current study yielded good results concerning the use of this technique in treating AO type A extra-articular fractures. Fractures extending distally to within 4 to 5 cm of the ankle joint can be satisfactorily treated. There was no nonunion although three patients with comminuted fractures had primary bone grafting. Early weight bearing walking could also be achieved in most patients.

It is extremely difficult to compare the results for the sixteen cases of pilon fractures in this series with those reported in the literature on the technique of

open reduction and internal fixation although the incidence of major complications in our series appears much lower. Radiological changes of moderate to severe degeneration were noticed in 36% of our patients with C2 and C3 fractures. This may reflect the intrinsic difficulty in treating an intra-articular fracture of the ankle joint. However, no patient in this series had an ankle arthrodesis because of pain in a degenerated ankle.

Although the procedure was time-consuming and the safety zones for wire insertion posed limitation on fracture reduction, its usage can still be recommended, especially in fractures with severe soft tissue damage and in comminuted fractures. The issue of whether fibular fixation is needed has not been looked into in our current study, although we think that rigid fixation on the lateral side may predispose to varus alignment during fracture healing, especially in the case of marked tibial metaphyseal comminution.

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Rating	Results
Excellent (>92 points)	No pain, normal gait, normal range of motion, no swelling
Good (87-92 points)	Minimal pain, ¾ normal motion, normal gait, trivial swelling
Fair (65-86 points)	Aching with use, ½ normal motion, normal gait, non-steroidal anti-inflammatory drug, mild swelling
Poor (<65 points)	Pain with walking or rest, ½ normal motion, limp, swelling

Table 1 . Clinical rating system according to Teeny and Wiss

AO Classification	Clinical Scoring System				Total
	Excellent	Good	Fair	Poor	
A1	2 (67%)	1 (33%)	/	/	3
A2	3 (50%)	3 (50%)	/	/	6
A3	2 (33%)	3 (50%)	1(17%)	/	6
C1	1 (50%)	1 (50%)	/	/	2
C2	/	5 (63%)	2 (25%)	1 (12%)	8
C3	/	1 (17%)	3 (50%)	2 (33%)	6
					31

Table 2. The results of clinical scores according to different fracture types

Legends for illustrations

Fig. 1 Open reduction of articular fragments via a small incision. The frame had been put on for ligamentotaxis

Fig. 2 Weight-bearing walking for extra-articular fractures

Fig. 3a A 36-year-old man sustained a C2 fracture showing the lateral view

Fig. 3b Same patient showing the A-P view

Fig. 3c Post-fixation AP view

Fig. 3d 22 months after the injury. Lateral view showed mild degeneration.

Fig. 3e AP view showing the same patient

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