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Ilizarov treatment of complex tibial pilon fractures

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Abstract We treated 21 consecutive patients between 1998 and 2002 with complex tibial pilon fractures, eight type B and 13 type C, using percutaneous reduction and fixation with the small diameter Ilizarov apparatus. The average patient age was 34 ± 5.6 years (range 28–52 years). Nine of the patients had open fractures (two type I, four type II, and three type IIIA). The patients were followed up regularly at 6-month intervals for 2 years. All fractures united. The fixator was removed at an average of 26.6 ± 4.2 weeks (range 20–34 weeks). The average American Orthopaedic Foot and Ankle Society ankle-hind foot score was excellent in 11 patients, good in five, fair in four, and poor in one. Thirteen patients were able to squat and climb stairs.

Résumé Nous avons traité 21 malades consécutifs entre 1998 et 2002 avec une fracture complexe du pilon tibial, huit de type B et 13 de type C, en utilisant une réduction percutanée et une fixation avec l'appareil d'Ilizarov de petit diamètre. L'âge moyen des patients était de 34 (28–52) ans. Neuf malades avaient des fractures ouvertes (deux type I, quatre type II, et trois type IIIA). Les malades ont été suivis régulièrement à intervalle de six mois pendant deux années.

Toutes les fractures ont consolidé. Le fixateur a été enlevé à une moyenne de 26,6 (20–34) semaines. Le score moyen d'AOFAS était excellent pour onze malades, bon pour cinq, juste pour quatre et mauvais pour un. Treize malades étaient capables de s'accroupir et de monter les escaliers.

Introduction

Tibial pilon fractures are uncommon and are difficult to manage [8]. They constitute 1% of all lower limb fractures and 5–10% of tibial fractures [2]. These fractures are the result of high energy injury to the weightbearing area of the lower end of the tibia by the talus [1]. It is usually an open injury and is often associated with significant degloving of the soft tissue surrounding the bone. In view of the precarious blood supply to the lower end of the tibia, an open reduction of the fracture fragments in these fractures can lead not only to nonunion but also to a high incidence of wound problems. Because the weightbearing articular area of the tibia is involved, the aim of treatment is directed towards achieving articular congruence, alignment, bony stability, soft tissue preservation, and early joint motion. To achieve the aforementioned goals by any closed treatment is often difficult if not impossible [3, 6, 7]. Hence, many surgeons prefer open reduction with rigid internal fixation of these fractures and report good clinical outcomes [5].

Limited internal fixation along with external fixation has become the favourite choice of many surgeons in cases of complex or open fractures of the tibial pilon [9, 10]. The Ilizarov fixator, by virtue of its use of percutaneous small diameter wires does not violate the soft tissues and the use of olive wires helps to reduce the major fracture fragments. This is a great boon, especially in intra-articular comminuted fractures of the tibial pilon with questionable soft tissue integrity. It can also be useful in treating these fractures by helping to achieve arthrodiastasis. We undertook a prospective study of Ilizarov treatment of such complex tibial pilon fractures and analysed the long-term clinical and radiological outcome and the complications encountered.

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Material and methods

Twenty-one consecutive patients with complex tibial pilon fractures [Ruedi and Allgower type B (8) and type C (13)] were treated with percutaneous reduction and fixation with the small-diameter Ilizarov apparatus from January 1998 to February 2002. Twenty of the patients were males and one was female. The average age was 34 ± 5.6 years (range 28–52 years). Eight patients had sustained leg trauma in road traffic accidents, while the remaining 13 had fallen from a height. Nine of the patients had open fractures (two type I, four type II, and three type IIIA). In cases of open fractures, the wound was debrided early, repeated after 48–72 h if necessary.

Fourteen of the patients had associated musculoskeletal injuries; eight of these patients had spinal fractures, of which one was associated with complete cord injury, and the rest recovered in 3 months to achieve independent ambulatory status. Only three patients were operated for the spinal fracture in the same sitting. Four patients with femoral fractures were treated by intramedullary nailing, and two others with distal radius fractures were treated with pinning and cast application in the same sitting.

On the day of admission, all patients were put on calcaneal pin skeletal traction with elevation of the lower limb over a Bohler–Braun splint, and measures were taken to avoid oedema. Anteroposterior, mortise, and lateral view radiographs were carefully analysed, and paper tracing of the fracture fragments was done (Fig. 1). The patients were operated after an average delay of 3–5 days once the tissue swelling started to subside. Three-dimensional computed tomography scanning was done in four of the patients in whom the radiology of the fracture pattern was difficult to interpret.

All operations were performed by the senior author using similar surgical techniques. At surgery, the limb was positioned on the fracture table, and closed reduction of the fracture by traction and manipulation was attempted in all the patients. If the fibular length could not be restored by traction, an open reduction and plate osteosynthesis of the fibula was carried out. Fibular plating was required in eight

patients in this series. The uppermost Ilizarov ring was placed at the level of the fibular head. Four rods were then placed with an attached ring approximately 2 cm proximal to the fracture. Four rods were then attached to the third ring just proximal to the ankle joint. No wires were placed in the second or third rings at this stage. A calcaneal wire with olive was then placed and attached, if it had not already been done in the emergency room, to the fourth most distal ring (Fig. 2).

At this point, the construct consisted of three proximal full rings along the shaft of the tibia with the most proximal ring tensioned with wires, connected to the tensioned calcaneal half-ring. Traction was applied manually to the calcaneal half-ring, and the bolts were secured. Reduction of the large metaphyseal unreduced fracture fragments was attempted using the olive wires through two metaphyseal rings.

This usually resulted in a well-aligned fracture pattern. The decision on whether to use limited internal reduction with fixation was now determined based on the intra-articular fracture pattern. Generally, less than 2 mm was considered acceptable. If limited internal reduction with fixation was needed, the limb was elevated and the tourniquet inflated before a small incision necessary to elevate the depressed fragments was made. In eight patients with large metaphyseal bone defects and articular depression, elevation and ipsilateral autogenous iliac crest cancellous bone grafting was performed through a medial metaphyseal cortical window.

For definitive treatment, attention was directed to rings 2 and 3. Under direct fluoroscopic guidance, with previously determined fracture pattern awareness, olive wires were placed to reduce and “squeeze” the fracture pattern in a very methodical way. Generally, two wires were placed proximal to the fracture, with three wires placed in the distal fracture just above and parallel to the ankle joint. Care was taken to prevent tethering of muscles or tendons by extension or flexion of the foot as indicated.

The Ilizarov, by virtue of its rings, elevates the limb and thus helps reduce oedema in the early postoperative period. Patients were mobilized with nonweightbearing crutch-

Fig. 1 Preoperative radiographs of open type B pilon fracture

Fig. 2 Immediate postoperative radiographs following Ilizarov treatment

Fig. 3 Follow-up radiographs after 38 months, showing good fracture union

walking on the second postoperative day. Two patients required delayed primary skin grafting. They were discharged once the soft tissues healed. Correction of deformity during fracture healing was successfully done in three patients at a 3-week follow-up. The half-ring was removed at the first follow-up after 6 weeks on an outpatient basis. The calcaneal half-ring used for joint distraction helped to prevent equinus contracture of the ankle. Active and passive ankle mobilization was then started, and the nonweightbearing crutch-walking was continued for 3 months postoperatively. At the end of 3 months, the patients were allowed to start gradually increasing weightbearing using a single crutch with the Ilizarov in position. The Ilizarov frame was removed once the fracture had consolidated well clinically and radiologically.

The patients were followed up regularly at 6-month intervals for 2 years. The functional outcome was measured using the American Orthopaedic Foot and Ankle Society ankle-hind foot score at the last follow-up. Ankle instability was diagnosed by way of joint space opening on stress radiographs. Ankle arthritis was diagnosed by painful restriction of all movements with or without crepitus with radiological evidence of reduced joint space.

Results

All the fractures united without the need for secondary bone grafting. There was no neurovascular injury following Ilizarov fixation in any of the patients in this study. The patients demonstrated full weightbearing walking without crutches at an average of 21 ± 4.4 weeks (range 18–26 weeks). The fixator was removed at an average of 26.6 ± 4.2 weeks (range 20–34 weeks; Fig. 3). One of our patients had loss of fixation of the medial articular fragment, leading to fracture malunion in 16° of varus. Although nine patients had 1–2 mm articular depression, only four developed ankle arthritis. Eleven patients were very satisfied with the surgery. Nine of the patients had ankle pain. The movements of the ankle ranged from 5° to 15° of dorsiflexion and from 5° to 35° of plantar flexion. Three patients had symptoms or signs of mediolateral instability. Sixteen patients had gone back to their preinjury professions, including the ones who were tree climbers. The average American Orthopaedic Foot and Ankle Society ankle-hind foot score was excellent in 11 patients, good in five, fair in four, and poor in one. One patient with 16° varus had poor results. There was no limb length discrepancy. Thirteen patients were able to squat and climb stairs.

Fig. 4 Follow-up clinical outcome showing excellent functional outcome with ability to squat

There were seven superficial pin tract infections, which were treated with empirical oral antibiotics and daily pin-tract dressings. One patient developed deep-seated pin tract infection of the proximal tibial pin at the 3-month follow-up, which settled after the infected pin was removed. There was radiological evidence of arthritis in six of the patients, including the one with varus malunion and another with deep infection. None of the patients had joint contractures (Fig. 4).

Discussion

Although open reduction and anatomical reconstruction of the articular surface is ideal in any intraarticular fracture, it is particularly difficult in high-energy tibial pilon fractures. Pre-existing severe soft tissue injury will preclude open reduction in view of the potential wound problems due to ischaemia or infection of the soft tissues. Precarious blood supply in this region of the tibia can add to the problems of nonunion along with infection.

In a prospective randomized trial of plating versus external fixation of tibial pilon fractures, Wyrsh et al. concluded that external fixation of these fractures is associated with clinical outcomes similar to those obtained with traditional methods of open reduction and internal fixation but with significantly fewer complications [12]. The timing of the operative intervention after the fracture in the group that underwent open surgery (mean 5 days) has been subject to criticism, and it has been suggested that this may have contributed to the incidence of wound dehiscence after internal fixation. In the present study, the patients were brought to the hospital with a delay of a couple of days, and there was no chance to perform primary surgery on them.

A retrospective study of 107 tibial pilon fractures by Watson et al. has shown that there is a significantly higher complication rate with the use of open plating techniques in AO type C fractures of the distal tibia, and this is probably related to the amount of dissection and stripping of soft tissues needed to achieve reduction and plate fixation [11]. Interestingly, it was felt that the worse the initial soft tissue injury was, the poorer the overall function tended to be, regardless of the initial fracture pattern. With this in mind, the authors felt that any treatment method should try first and foremost to limit soft tissue damage and avoid additional complications.

In a recent study of 31 patients with high-energy tibial pilon fractures treated with early internal fixation and soft tissue cover with vascularised muscle flap, Conroy et al. found encouraging results with good functional outcome, as well as reduced rates of amputation and infection [4]. There were no long-term problems with fracture union, and no patient required an ankle fusion at the end of 1 year of follow-up. Compared with their patients (all with grade IIIB injuries), our series had less severely injured patients and hence better outcomes.

Most of our patients were men, with the major mode of injury being fall from a height. This can be attributed to the increased number of men going into the fields to earn a

living; as our institute is a tertiary referral centre for two states along the western coast, the main agricultural activity of our patients involves climbing coconut trees. Ilizarov fixators, being very economical, are of immense help. Most of our patients were manual labourers, quite tolerant to the prolonged course of treatment, and very satisfied with the ultimate result of surgery despite some inconvenience of the fixator. Also, the fact that none of the patients required a secondary procedure to achieve fracture union, the cost of treatment is reduced.

Tensioned small-wire fixation gives good stability to the reduced fracture fragments; none of the patients had loss of fixation except for one with varus malunion. Although a significant percentage of our patients had superficial pin tract infections, they were all successfully treated with just local pin tract care and oral antibiotics. The only case of deep infection also subsided once the infected pin was removed and the pin tract curetted out. None of the patients had equinus contracture of the ankle due to the use of the calcaneal half-ring to maintain the ankle in neutral position.

More than half of the patients had associated major musculoskeletal injuries, signifying the high energy involved in the fracture. During the fall from a height, most of the energy is dissipated in the ankle by the impact of the foot on the ground. The ankle injury is therefore likely to receive the brunt of the injury. This series has an exceedingly high number of spine fractures compared with reports of tibial pilon fractures described in the literature. This can be attributed to the higher number of patients with falls from heights, with increased propensity to spinal fractures.

In accordance with the literature, articular depressions less than 2 mm were considered acceptable in this study and had no significant impact on the final long-term clinical, radiological or functional outcome in most of the patients except for the four who developed arthritis. This again proves that closed reduction, although less anatomical, is better than anatomical open reduction in high-energy tibial pilon fractures with articular disorganization.

Although 76% of the patients in this series had excellent or good functional results, six patients (28.6%) developed ankle arthritis as early as 2 years after the fracture, and the results cannot be compared with any other study in the literature because most of the fractures in this series were due to falls from significant heights with very high-energy trauma to the limb.

The Ilizarov percutaneous fixator, preserves endosteal and periosteal blood supply, helps capture the small metaphyseal and subchondral bony fragments, and also helps compression of fracture fragments using the olive wires. The rigidity of fixation can be adjusted to suit the stage of fracture healing. It also allows correction of deformity during the process of fracture healing.

Although most authors stress the importance of open reduction and internal fixation, fractures that are severely comminuted or open are difficult to manage under these conditions. It is in these complex fractures that the thin wire fixators with minimal internal fixation and low-cost have been most promising. Satisfactory articular reconstruction

with fairly good functional results in most patients, with a moderate perioperative complication rate, have led us to use this treatment method in these comminuted pilon fractures.

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