Acute Trauma Applications of the Ilizarov Method

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Citation

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Abstract

Objective: To evaluate the results of treatment of patients with acute trauma of the lower extremities using the Ilizarov technique.Method: Retrospective study of eight patients who were treated between 1999 and 2007 for acute trauma to the lower extremities. There were four Type III pilon fractures, five open wounds, three tibial shaft fractures, one comminuted supracondylar femoral fracture, and one tibial plateau fracture (Schatzker VI).Results: There were seven males and one female with an average age of 49 years (range 25 74 years). Results were classified in Bone and Functional results. There were six excellent, one good and one poor bone result. The functional result was good in four patients, fair in two patients with three ankles (one patient had a bilateral injury), and poor in two patients.Conclusion: The Ilizarov external fixation technique is a valuable tool in the treatment of acute trauma of the lower extremities.

INTRODUCTION

The most important factors influencing the outcome of treatment of long bone fractures are the severity of the soft tissue injury and the degree of skeletal involvement. Although the articular reduction is important, the surgeon should try to limit soft tissue damage and avoid additional complications at the risk of achieving a less than anatomic joint, which may result in a good functional outcome. The Ilizarov method is an excellent alternative to more conventional methods in cases of severe wound contamination and in cases of soft tissue and bone loss (1). The treatment of bone loss occurring as a result of acute trauma has traditionally been a complex surgical problem. In an attempt to avoid the problems associated with deficient graft materials and free tissue transfers, internal bone transport is a technique that has been a successful methodology for bony reconstruction for acute bone loss (2). In addition, the Ilizarov fixator may achieve stability even in cases of bone comminution when internal fixation devices can do no better than tenuous fixation.

This article describes the author's experience with the Ilizarov method for the treatment of patients with acute trauma of the lower extremities.

SUBJECTS AND METHODS

Between September 1999 and October 2007 eight patients with acute trauma to the lower extremities were treated by the author. All patients were treated with the Ilizarov technique. The mechanism of the injury was motor vehicle accidents in six patients, a motor cycle accident in one patient and a fall in one patient. Four injuries in three patients were closed, (one patient had bilateral fractures), and five injuries were associated with an open wound. There were four displaced intra-articular fractures of the distal tibia (Rüedi and Allgöwer Type III pilon fractures). There were three tibial shaft fractures; one comminuted supracondylar femoral fracture and one tibial plateau fracture (Schatzker VI) (Table 1).

Figure 1

Table 1: Patient Data

Case	Age(years)/ Gender	Diagnosis	Treatment	Time in fixator (mths)	Follow-up (mths)
1	52/M	Open Type III Pilon fracture	Debridement Ilizarov fixator Autogenous bone graft	5	15
2	54/M	Closed Type III Pilon fracture	Limited internal fixation Autogenous bone graft Ilizarov fixator	4	15
3	33/M	Grade IIIB distal tibial fracture	Debridement x 2 Ilizarov fixator Bone transport	7	20
4	25/M	Grade IIIB diaphyseal tibial fracture	Debridement x 2 Ilizarov fixator Rotation of a fascio-cutaneous flap Bone transport	7	20

Figure 2

Case	Age(years)/ Gender	Diagnosis	Treatment	Time in fixator (mths)	Follow-up (mths)
5	43/M	Closed bilateral Type III Pilon fractures	Limited internal fixation Ilizarov fixator Autogenous bone graft	6 (right ankle) 7 (left ankle)	15
6	58/F	Grade IIIB comminuted supracondylar fracture of femur	Debridement x2 Ilizarov fixator Autogenous bone graft	4	20
7	74/M	Grade IIIB diaphyseal tibial fracture	Debridement x 2 Ilizarov fixator Shortening of bone defect Gradual lengthening	12	6
8	52/M	Schatzker VI	Elevation Limited internal fixation Ilizarov fixator	5	8

mths (months)

All of the patients with open injuries were treated with serial wound debridement, parenteral antibiotics and application of the Ilizarov fixator. Bone transport was performed in two patients (Case 3, 4) for 9cm and 8cm bony defects respectively. A fascio-cutaneous flap was used to close the soft tissue defect in Case 4, prior to bone transport. In Case 7, gradual shortening of the bony defect was performed in order to facilitate wound closure and avoid the need for a fascio-cutaneous flap. A proximal metaphyseal tibial osteotomy was performed and lengthening was commenced.

No regenerate bone developed despite discontinuing distraction. The method of compression and distraction at the osteotomy site was performed. No regenerate bone was visualized. The osteotomy site was then compressed until bony union occurred. Bone grafting was required to assist in the healing of the compressed bony defect.

The three patients with four Type III pilon fractures (one patient had bilateral pilon fractures) were treated with the Ilizarov fixator. Limited internal fixation and bone grafting were used in Case 2 and 5, with no internal fixation in Case 1. In Case 6, the internal fixator was applied to the femur following serial debridement. The fixator was extended across the knee for greater bony stability. Autogenous bone graft was applied to the bony defect following wound healing. Below-knee casts were applied in Cases 3, 4 as temporary protection of the regenerate bone following removal of the fixator.

The Schatzker VI fracture (Case 8) was treated at five weeks. Through medial and lateral incisions, attempts were made to elevate the depressed articular surfaces. Suboptimal reduction was achieved. Two large screws were placed across the condyles. The Ilizarov fixator was then used to stabilize the metaphysis and diaphysis.

Active and passive ranges of motion of the ankles and knees in all patients were commenced following application of the fixator.

RESULTS

There were seven males and one female with an average age of 49 years (range 25 – 74 years). The average follow-up period was 15 months (range 6 – 20 months). The results were divided into bone and functional results according to the classification of the Association for the Study and Application of the Method of Ilizarov (3, 4). Table 2 details the bone results as determined according to four criteria: union, infection, deformity and limb length discrepancy.

Figure 3

Table 2: Bone results according to the classification of the Association for the Study and Application of the Method of Ilizarov

Case	Union	Infection	Deformity	Limb-length Discrepancy (cm)	Result
1	Yes	No	No	1.5	Excellent
2	Yes	No	No	No	Excellent
3	Yes	No	No	No	Excellent
4	Yes	No	7°	2	Good
5 (right ankle)	Yes	No	5°	1.5	Excellent
5 (left ankle)	Yes	No	5°	2	Excellent
6	Yes	No	No	2	Excellent
7	Yes	Yes	9°	5	Poor
8	Yes	No	5°	2	Excellent

There was union in all eight patients with one treatment. The time to union ranged from four months to twelve months (average 6.3 months). Superficial pin-tract infections developed in all patients and the infections resolved with local care and oral antibiotics. There were two deep infections (Case 2, 7). Incision, drainage and antibiotics were used to successfully treat the infection in Case 2. At the time of the latest follow-up (15 months), there was no infection in that patient (Case 2). Case 7 developed a small draining sinus at the site of the osteotomy which was in the proximal tibial metaphysis. The infection has persisted despite the use of oral antibiotics. Surgical debridement is

planned. At the latest follow-up, the infection had not resolved.

An excellent result was defined as union, no infection, deformity of less than 7 and a limb-length discrepancy (LLD) of less than 2.5cm. A good result was defined as union and any two of other three criteria; a fair result, as union and one of the other criteria; and a poor result as non-union, or as union with none of the remaining criteria. In this study, the bone results were excellent in six patients, good in one patient and poor in one patient.

The functional results were based on five criteria: a significant limp, stiffness of either the knee or ankle (loss of more than 15 of full extension of the knee or 15 of dorsiflexion of the ankle in comparison with the normal contralateral ankle), soft tissue sympathetic dystrophy, pain that reduced activity or disturbed sleep and inactivity (unemployment or an inability to return to daily activities). According to these criteria, the functional result was good in four patients, fair in two patients with three ankles, and poor in two patients (Table 3).

Figure 4

Table 3: Functional results according to the classification of the Association for the Study and Application of the Method of Ilizarov

Case	Significant Limp	Joint Stiffness	Soft tissue sympathetic dystrophy	Pain	Able to perform daily activities	Result
1	Yes	Yes	No	No	Yes	Good
2	Yes	Yes	No	No	Yes	Good
3	Yes	Yes	No	No	Yes	Good
4	Yes	Yes	No	No	Yes	Good
5 (right ankle)	Yes	Yes	No	Yes	Yes	Fair
5 (leftankle)	Yes	Yes	No	Yes	Yes	Fair
6	Yes	Yes	No	Yes	Yes	Fair
7	Yes	Yes	No	Yes	No	Poor
8	Yes	Yes	No	Yes	No	Poor

DISCUSSION

High-energy fractures of the tibial plafond are commonly associated with severe soft tissue compromise and extensive bony comminution. The classic methods of open reduction and fixation were shown to be associated with a high rate of early soft-tissue complications, including skin necrosis, superficial infection, osteomyelitis, and even amputation (5, 6). The classification of intra-articular fractures of the distal tibial by Rüedi and Allgöwer were based on the severity of the skeletal injury (7, 8). Bourne (9) reported only 44% acceptable results in patients with Type III fractures. These patients had a high rate of soft-tissue complications. McFerran et al (6) reported a 54% complication rate with the majority of complications occurring in patients with Type III fracture pattern. The use of limited internal fixation combined with a circular external fixator especially for the Type III fractures have resulted in a marked reduction of the catastrophic soft-tissue complications (10, 11). Tornetta et al (11) reported 81% good to excellent results overall and a 69% good to excellent results for patients with the Rüedi Type III injuries using limited open reduction and internal fixation in combination with a hybrid external fixator. More importantly, the rate of severe complications was reduced dramatically to almost 0% with this technique.

In the author's small of cases, there were four pilon fractures, all Type III. There was one wound infection and no deep bone infections. The wound infection resolved with incision, drainage and antibiotics. All the four cases developed superficial pin-tract infections which resolved with local care and a short course of oral antibiotics.

All the patients with pilon fractures had a significant limp due to ankle joint stiffness. Two patients (Case 1, 2) reported ankle stiffness but no pain. Their main complaints were inability to run or walk briskly. Case 5 had stiffness in both ankle joints and some pain which reduced activity. This patient was able to perform activities of daily living.

Marsh et al (12) reported the functional results of 31 patients who were treated for tibial plafond fractures with a monolateral hinged transarticular external fixator coupled with screw fixation of the articular surface. The majority of patients had some limitation with regard to recreational activities, with an inability to run being the most common complaint. Fourteen of their patients changed jobs because of the ankle injury. Fifteen ankles were rated by the patient as excellent; ten as good; seven as fair; and one as poor. The authors concluded that although tibial plafond fractures have an intermediate-term negative effect on ankle function, pain and on general health, few patients required secondary reconstructive procedures. In this paper, the patients with pilon fractures were able to return to their occupations. The patient with bilateral pilon fractures had an office job. None of the patients were able to participate in any sporting activities.

Severe acute trauma to the lower limbs often results in extensive soft-tissue loss in concert with large segmental defects. The principles of open fracture management must be adhered to prior to reconstruction of the bony defects. Acute

shortening can be accomplished safely for defects up to 3cm to 4cm in the tibia. Shortening aids in soft-tissue coverage by decreasing tension and gaps in the open wound. This approach may allow wounds to be closed by delayed primary closure, or healed by secondary intention or simple skin grafting.

With this technique, one may avoid extensive flap coverage (13, 14). Case 7 was treated by gradual shortening followed by attempted lengthening at the proximal metaphyseal tibial osteotomy site. Poor local blood supply and damage to the periosteum are possible reasons for failure of the regenerate bone formation. This patient had poor bone and poor functional results. Patients with skeletal defects greater than 5cm are candidates for bone transport alone or combined shortening and lengthening. Cases 3 and 4 had successful bone transport with union at the docking sites. In preparation for docking, fibrous tissue was excised and the sites were grafted with autogenous iliac bones. Good functional results were achieved in Cases 3 and 4. Docking site augmentation has been shown to decrease the overall rate of union and decrease frame time (15, 16).

The patient (Case 6) with the open comminuted supracondylar femoral fracture was treated with repeated debridement and application of the Ilizarov fixator and tibial extension of the frame. The wound was treated by delayed primary closure. Autogenous bone graft was used to reconstruct the skeletal defect. Following removal of the fixator, there was a 2cm limb length discrepancy. This patient had an excellent bone result and a fair functional result.

The treatment options for tibial plateau fractures depend on the fracture pattern, energy of the injury, the soft-tissue compromise, and the type of host. Wire ring fixation of bicondylar tibial plateau fractures compared to open reduction and internal fixation demonstrates similar knee range of motion, time to union, and surgery time (17). The number of wound complications, deep infections and time to full weight-bearing, however, is reduced with wire ring fixation compared to standard dual plating techniques (17, 18).

At eight months follow-up, Case 8 had complete bony union, no infection, 5° varus angulation at the metaphyseal diaphyseal junction, 2cm leg length discrepancy, restriction in knee flexion and pain with limited activities of daily living. This patient required an external walking aid.

The Ilizarov external fixation technique is a valuable tool in the treatment of acute trauma of the extremities. Although this technique is labour intensive, it can be applied successfully in the treatment of the most severe open and closed fractures of the lower limb, with a relatively low incidence of complications and a high rate of healing.

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