Management of Infected Non-United Femoral Fractures by Ilizarov Ring Fixator

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Abstract

Aim: The aim of this prospective study is to evaluate the Ilizarov external fixator system as a method of fixation for infected non-united fractures of the femur following debridement of the fracture site.

Materials and Methods: 18 patients presenting with infected nonunited femoral fractures were treated by extensive debridement and external fixation using Ilizarov external fixator. (16 male+2 females) with a mean age of 27.4 (18-45). All patients had infected nonunited femoral fractures without bone or soft tissue loss with chronic infection persistent for more than 6 months. The causative trauma was motor vehicle accidents in all cases. All cases were initially managed by internal fixation with a mean number of previous surgical procedures of 5.1 operations (1-9) in the form of repeated debridement, revision of fixation and bone grafting. The mean duration of application of the fixator was 8.9 months (6-12). Weight bearing was permitted immediately postoperative. 6 patients required iliac crest bone graft to achieve solid union.

Results: Resolution of infection was achieved in all patients, union was achieved in 15 patients, and the remaining 3 patients required further management. The most common complications were pin tract infection, loosening and fracture malalignment that necessitated exchanging of loose pins and readjustment.

Conclusion: We concluded that Ilizarov external fixator offered a reliable and successful method for stabilization of infected nonunited fractures of the femur following extensive debridement that helps in the management of such difficult condition.

Key Words: Non-union – Femur infection – Ilizarov.

Introduction

MANAGEMENT of infected nonunited fractures of the femur has always represented a difficult orthopedic challenge. Conventional treatment options included debridement, sequestrectomies, massive cancellous bone grafting together with external fixation or revision of internal fixation [1], the results of treatment with these methods were frequently unsuccessful due to many limitations including: poor vascularity at the fracture site, excessive scaring, and persistence of infection, bone loss and poor bone quality that lead to fracture instability. Significantly high incidence of complications was reported such as recurrence or persistence of infection, metal failure, re-fractures in addition to nonunion and malunion in the form of axial deviation and limb length discrepancy [2]. In 1951, Ilizarov began to use his device to treat acute fractures. Over the years Ilizarov’s techniques have evolved and the indications for the use of his external fixation device have extended to treat fractures and associated complications: nonunion, osteomyelitis, joint contractures, shortening and deformities. The Ilizarov technique for infected nonunion is essentially based on radical removal of infected tissues including bone and stabilization of the fracture by sufficiently rigid, still dynamic external ring fixator, that permit bone transport, lengthening, correction of deformities when required. Compression at the fracture site, early weight bearing are important factors that help to achieve favorable results with this technique [3]. The use of Ilizarov technique for the management of infected nonunion of the tibia is increasingly popular, however reports describing long series of patients with infected nonunited femoral fractures treated with Ilizarov technique are quite few, and they are mostly concerned with cases with bone defects that necessitated the use of distraction osteogenesis to overcome the defects [4]. This study is a prospective study that has been performed on 18 patients with infected nonunited femoral fractures treated by Ilizarov external fixator, the aim of treatment was to eradicate infection and to achieve bone union.

Materials and Methods

In a prospective study performed between January 2003 and June 2006, a total of 18 patients...
presenting with infected non-united femoral fractures were treated by extensive debridement and external fixation using Ilizarov ring fixator. 16 patients were males, two were females. The age of the patients ranged between 18 and 45 years with a mean age of 27.4 years. Motor vehicle accident was the causative trauma in all cases. 11 patients had middle third fractures, 5 patients had lower third fractures while the remaining 2 patients represented with proximal third fractures. All Patients presented with infected non-united fractures of the femur with persistent active infection for more than 6 months without bone or soft tissue defects, patients with bone defects, soft tissue defects that necessitate bone and or soft tissue reconstruction were excluded from this study. All patients sustained previous treatment in the form of internal fixation by plate and screws or intramedullary nails, debridement and or bone grafting. The number of previous surgeries performed for these patients prior to presentation to our hospital ranged from 1-9 operations with a mean of 5.1 operations in the form of repeated debridement, removal of implants, bone grafts and revision of fixation. The mean period of initial treatment before application of the fixator was 8.3 months (6-15 months).

In all patients there was active purulent discharge, culture and sensitivity test was performed for all patients, Staphylococcus aureus was the infective organism in twelve patients 3 of them were MRSA, Pseudomonas aeruginosa in four patients and klebsiela in two patients. At the time of presentation all patients had moderate to severe limitation of the knee joint, 8 patients had knee flexion < 70º, 6 patients < 30º while the remaining 4 represented with completely stiff knees. Seven patients had mild to moderate post-traumatic arthritis of the knee joints manifested radiologically by narrowing of the joint space irregularity of the articular surface. All patients have extensive scarring at the affected thigh with discharging sinus or sinuses and moderate to severe muscle wasting. All patients were unable to bear weight. Preoperative investigations included plain radiographs and culture and sensitivity tests, together with routine laboratory investigations, liver function tests revealed that 3 patients had viral hepatitis C and one patient had viral hepatitis B and C. routine precautions were undertaken. Full extent of infection could be determined only intra-operatively.

Surgical technique:

Patients were operated under spinal anesthesia, the patient was positioned supine on the fracture table and the limb was abducted adequately to allow access to the femur medially and laterally. Generous exposure was performed using lateral approach; all devitalized and infected tissues were removed and sent for culture and sensitivity testing. Any remaining implants were removed, copious wash by normal saline solution was performed, the edges of bone ends at the fracture site were freshened and the medullary canal was reconstituted. In 4 patients opening a gutter at the medullary canal was necessary starting from the fracture edges and extended on both sides of the fracture according to the extent of infection, rigid reamers and curettes were used to efficiently remove devitalized infected tissues from the medullary canal. Open reduction of the fragments was performed trying to achieve the best possible contact between them and the maximum internal stability at the fracture site. The accuracy of reduction and the alignment of the femur were confirmed using image intensifier radiographs in antero-posterior and lateral planes. A preassembled ilizarov frame was applied and was anchored to the femur using both 1.8mm smooth wires and 6mm Schanz screws. The frame consisted of three or four rings in addition to a proximal semicircular ring or a femoral arch with 2 oblique supports. Fixation was started distally by application of 1.8mm smooth wire transcondylar at the distal femur introduced into a lateral to medial direction, parallel to the joint line. The position of the wire was checked by image intensifier radiographs, this was necessary to adjust the mechanical axis of the femur. The frame was anchored to the femur from distal to proximal using 6mm Schanz screws, the screws were introduced lateral to medial or postero-lateral to antero-medial direction to avoid hazardous planes and to minimize transfixing the Quadriceps muscle to the femur. Only one Schanz screw was introduced into a postero-medial to antero-lateral direction at the distal femur through the medial femoral condyle to enhance stability of fixation at the distal fragment. Trans-articular ring was used in one patient; it was anchored to the proximal tibia using one 1.8mm smooth wire and two 6mm schanz screws. It was used to enhance stability of the construct distal to the fracture site in this patient with short osteopenic distal fragment. Closure in layers over a suction drain was then performed.

In one patient ring fixator was substituted by mono-lateral frame (Orthofix) because of excessive obesity of the patient that made ring fixation intolerable and unfeasible. The average hospital stay was 4.7 days (3-8 days). All patients were given instructions about pin care and local care of the wound before they were discharged. Antibiotics
were administrated for a period of 6 weeks post-operatively according to culture and sensitivity tests and intermittently throughout treatment for the control of pin tract infection when required. Partial weight-bearing was permitted when tolerated using a walker or two crutches. Physiotherapy was initiated immediately post operative and continued throughout the treatment duration aiming to improve the range of motion of the knee joint and included muscle strengthening programs especially for the Quadriceps muscle and hip abductors. Follow-up was performed on weekly bases for 4 weeks, then on monthly bases until removal of the fixator. The mean duration of treatment was 8.9 months (6-12 months). Bone union was assessed both clinically and radiologically. Clinical evaluation was performed according to common criteria in the literature. Fractures were considered clinically united in the absence of pain or movement on stressing the fracture site. Radiographic union was achieved in the presence of uniform continuous ossification of callus bridging the fracture. Non union was diagnosed in the absence of clinical or radiological signs of healing after 12 weeks of treatment. Mal-union was considered if one or more of the following criteria were detected: shortening of more than 2.5 cm, angulation of more than 10º or rotational malalignment of more than 5º.

A total of 18 secondary procedures were required in the form of 7 cases of debridement, 8 cases of cancellous Iliac crest bone grafting, 2 cases required pin exchange and readjustment of the fixator and one case required revision of fixation with substitution of the fixator device by Orthofix monolateral frame due to intolerance of the fixator and failure to achieve adequate stability of fixation because of excessive obesity in a diabetic patient with MRSA infection.

Results

The results were evaluated according to the ASAMI evaluation system [5], this evaluation included both bone and functional evaluation.

Table (1): Classification of the results according to the modified association for the study and application of the method of Ilizarov.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Bone results</th>
<th>Functional results</th>
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<tr>
<td><strong>Excellent</strong></td>
<td>Bone union, no infection</td>
<td>Ability to perform previous activities of daily living (ADL), no pain or mild pain</td>
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<tr>
<td></td>
<td>Deformity &lt; 7º</td>
<td>No limp, No soft tissue reflex sympathetic dystrophy</td>
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<tr>
<td></td>
<td>LLD &lt; 2.5cm</td>
<td>Loss of &lt; 70º of knee flexion or &lt; 15º of knee extension</td>
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<tr>
<td><strong>Good</strong></td>
<td>Bone union</td>
<td>Almost all ADL with minimal difficulty</td>
</tr>
<tr>
<td></td>
<td>Failure to meet one of the other criteria</td>
<td>No pain or mild pain</td>
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<td></td>
<td>Failure to meet two of the other criteria</td>
<td>Failure to meet one of the other criteria</td>
</tr>
<tr>
<td><strong>Fair</strong></td>
<td>Bone union</td>
<td>Most ADL with minimal difficulty</td>
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<tr>
<td></td>
<td>Failure to meet two of the other criteria</td>
<td>No or mild pain</td>
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<td>Failure to meet three of the other criteria</td>
<td>Failure to meet two of the other criteria</td>
</tr>
<tr>
<td><strong>Poor</strong></td>
<td>Nonunion or refracture</td>
<td>Significantly limited ADL</td>
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<td>Failure to meet three of the other criteria</td>
<td>Significant pain that reduced activity or disturbed sleep</td>
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ADL: Activities of daily living. LLD: Limb length discrepancy.

Bone union was achieved in 15 patients, infection was controlled in all patients, and none of the patients developed more than 7º angular deformity or more than 2.5 cm shortening. 12 patients preserved their previous knee and hip range of motion. 15 patients could regain normal or nearly normal daily activities. Regarding bone results 12 cases were rated as excellent, 2 cases as good, one patient was fair and 3 cases were rated as poor. However functional evaluation resulted in 7 excellent cases, 5 good cases, 3 cases were rated as fair and 3 cases were rated as poor.
The commonest complication was pin tract infection; it was controlled by pin care and antibiotics in all cases except in 2 patients where pin exchange was necessary. None of the patients had neurovascular complications; none of the patients developed re-fractures during the follow-up period. Persistence or recurrence of infection necessitated a second debridement procedure in 7 patients. Delayed union was encountered in 8 cases and was managed by autogenous iliac crest bone graft. Nonunion was encountered in 3 cases that necessitated further management. 6 cases developed limitation of knee range of motion that ranged between 15° and 40° of flexion range. All patients ended up with limb length discrepancy that does not exceed 2.5cm.
Discussion

The results of conventional treatment of infected nonunion of the femur are poor, due to the causative high energy trauma, multiple surgeries, late presentation, bone and soft tissue infection, nonunion, bone loss, osteoporosis, dystrophy, poor vascularity and associated deformities and limb length discrepancy, the use of Ilizarov external fixation helps to manage these difficulties, the presence of infection and bone loss that is found in many cases rule out internal fixation, external fixation is the only option left, the use of external fixation for the treatment of infected nonunion of the femur has been previously reported [4]. Compared to mono-lateral frames the Ilizarov external fixator is more resistant to torsion and bending stresses still allowing axial compression during physiological loading that accelerate bone healing and lower the incidence of refracture and disuse osteoporosis that may be encountered with prolonged immobilization [3]. Although the use of Ilizarov external fixator for the treatment of infected nonunion of the tibia is well established [6], reports on large series of patients with infected nonunion of the femur treated with Ilizarov external fixator are quite deficient. The use of Ilizarov external fixator for the management of femoral fractures is more difficult however promising and satisfactory results have been reported by many authors, in a study by Marsh et al. [8] cases of infected nonunion of the femur among 46 cases of infected nonunion were managed by Ilizarov external fixation with satisfactory results [7], in another study by Saridis et al. [13] cases with infected nonunited femoral fractures were managed using Ilizarov external fixator, in all cases infection was eradicated and union was achieved [8]. However in these studies and many others the cases studied were associated with long bone defects as excessive bone resection was mandatory to eradicate infection and distraction osteogenesis was necessary to overcome bone loss [8,9]. In this study cases with extensive bone defects were excluded, and only those cases with less than 2.5cm bone loss after radical debridement were included in the study. Acute shortening was performed with all cases and re-lengthening was considered as an option but in all cases there was no significant functional disability that necessitated lengthening. The rigidity of fixation could minimize the chances for axial deviation and none of the cases developed axial deviation more than 7º and only 2 cases required readjustment of the fixator frame due to pin loosening that complicated intractable pin tract infection. The stability of fixation could be increased by increasing the diameter of the half pins when 6mm pins were used, also with increasing the number of half pins or wires anchored to each single ring, multi-planar fixation adds to stability, in addition it added to the stability to use the smallest ring diameter that fits the limb with leaving only 2cm space around the limb, also increasing the number of connecting rods and decreasing the unsupported distance between the rings. Rigidity of fixation has minimized the incidence and severity of pin tract infection and the need for pin exchange or readjustment of fixation, also improved patient’s tolerance of the fixator throughout the fixation period. In only one case the patient could not tolerate ring fixation, the patient was a diabetic obese female patient with a mid-shaft fracture infected with MRSA, she sustained an extensive debridement and fixation by Ilizarov frame, the size of the thigh has implicated the use of large diameter rings (260mm) and long half pins which compromised the stability of fixation, intractable pin tract infection and subsequent loosening have made the fixator intolerable by the patient and finally ring fixator was substituted by an Orthofix monolateral frame after a second debridement procedure.

3 cases failed to achieve bone union as infection persisted after the initial procedure, a second debridement was performed which failed to control infection, and there was no evidence of progressive bone healing during follow-up, they ended up with infected atrophic nonunion that necessitated more radical debridement with bone resection that resulted in bone defects requiring reconstruction. Bone transport by distraction osteogenesis was used to fill the gaps and to control infection. They were considered as nonunited at the end of this study as they required further management.

With the overall evaluation of the results, bone results were found to be superior to functional results; this was attributed to soft tissue complications that resulted from previous surgeries such as excessive scaring, contractures, joint stiffness and muscle weakness that affected the functional results at the end of treatment, however functional results could be greatly improved with physiotherapy and rehabilitation programs.

Conclusion:

External fixation using Ilizarov ring fixator has proved to be an efficient method for treatment of infected nonunited femoral fractures with favorable results regarding eradication of infection and achievement of solid bone union with limited and mostly minor complications, this method allows early mobilization, weightbearing and rehabilitation programs.
of the patient that permitted the maximum functional gain compared to conventional treatment options.

References


