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Original Article

Treatment of Difficult Non-union of Long Bones using the Ilizarov Technique

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Abstract

Introduction: The Ilizarov technique has been the gold standard for treatment of difficult non-unions for the last few decades. Here, fine wires are inserted percutaneously, tensioned adequately and attached to rings to provide a strong frame construct.

Materials and Methods: Circular external fixation using the Ilizarov apparatus combined with compression-distraction techniques was used to treat six patients with non-union of long bones compounded by infection, bone loss, deformity, or failure of the previous internal fixation.

Results: The series comprised three males and three females, with an average age of 38.2 years (range 24-58). Five of the non-unions were in tibia and one in femur with four infected cases. They were treated with Ilizarov technique along with simultaneous correction of deformity. All the patients eventually obtained clinical and radiological evidence of union and eradication of infection in all six cases. According to the Association for the Study and Application of Methods of Ilizarov, bone score results three (50%) were classed as excellent, 2 (33%) as good and 1 (17%) as fair. Functionally, 1 (17%) was graded as excellent, 3 (50%) as good, and 2 (33%) as fair.

Conclusion: Treatment of difficult non-unions with Ilizarov technique has stood the test of time. It can be concluded that the use of Ilizarov technique for difficult non-unions yields good function in terms of union, deformity correction, pain relief, and activities of daily living in our center.

Key words: Ilizarov technique, Infection, Non-union

INTRODUCTION

In 1951, Ilizarov *et al.* in the Siberian city Kurgan developed the method of distraction osteogenesis for treating acute trauma fractures. The Ilizarov technique has been the gold standard for treatment of difficult non-unions for the last few decades. Here, fine wires are inserted percutaneously, tensioned adequately, and attached to rings to provide a strong frame construct.[1] It permits the use of compression, distraction, bone lengthening, and deformity correction. The stability of the construct permits weight bearing and joint mobilization. It demands a higher technical knowledge and supervised postoperative rehabilitation confining its use to specialist centers. The majority of tibial and femoral non-unions can be treated successfully by internal fixation. However, an infected non-union can prove a difficult problem. This can be compounded by bone loss, deformity, or failure of the previous internal fixation. The choice of such procedure can ensure limb salvage and prevent amputation.[2] The treatment of bone infections after intramedullary nailing usually includes a series of different surgical procedures, such as removal of metalwork, radical bone debridement, deep-tissue sampling, elimination of dead space, and insertion of local antibiotic delivery systems. This is followed by the application of the Ilizarov external fixator. Furthermore, local or free soft tissue transfers are employed to cover any soft tissue defect. The Ilizarov method addresses all the above problems simultaneously and offers a good solution for infected non-unions. Furthermore, bone defects can be filled by a corticotomy and bone transport. The control of infection is by debridement of the bone ends and increased

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vascularity of the limb.[3] Amputation is one of the risks of infected non-union and so the Ilizarov method can minimize this potential outcome.[2]

MATERIALS AND METHODS

We wanted to see the outcome of treatment of difficult non-unions with Ilizarov technique in our center. All patients who had a nonunion of any long bone compounded with infection, gap, shortening, or deformity presenting at the Out Patient Department of Orthopaedics, Medical College and Hospitals, Kolkata, between January 2013 and December 2013 were included in this study (Table 1).

Six patients with difficult non-unions underwent management by Ilizarov technique were undertaken for this study. There were three male and three females with an average age of 38.2 years (range 24-58). In terms of significant comorbidities, there was one smoker. In five patients, the fracture was at the tibia, and one was in femur (Table 1).

Three tibial fractures were initially open injuries which were primarily stabilized with linear external fixator. Intramedullary, nailing was done for the femoral fracture which became infected. This was followed by implant removal, stabilization with linear external fixator, and series of debridement.

Infection was present in four cases as evident by persistent pus discharge from fracture site. Five cases had a shortening with bone gap in two cases. Three cases had associated deformity.

The average time from initial injury to the application of an Ilizarov frame was 25 weeks (range 13-42). All definitive procedures were done by a single surgeon. The bone ends were debrided, and tissue samples were sent for microbiological studies. The frame was then applied with transosseous wires and half pins to preserve the anatomical axis and avoiding neurovascular structures. Proximal tibial corticotomy was done in one case. The frames were extended to the foot to minimize equinus deformity where necessary.

Contact between the two bony segments was obtained, and then inter-fragmentary compression was performed to stabilize the entire frame. Following this, slow uninterrupted distraction (1 mm/day) was applied to the bone fragment; the resulting distraction gap regenerates new tissue and undergoes ossification within this newly created space. The newly regenerated bone can be stretched in virtually any direction by progressive manipulation of groups of Ilizarov rings to accomplish lengthening, reconstruction of the gap, and axial and torsional correction. Necessary gradual correction of deformity was done simultaneously during this period using hinges.

Postoperatively, the patients were encouraged to bear weight immediately with the aid of crutches. Antibiotics were administered as per the sensitivity report, and the patients were trained regarding the compression-distraction of fixator and pin site care. Patients were then subsequently discharged into the community along with hand written protocol for the fixator manipulation. They were followed up at weekly interval till the correction of deformity and then biweekly till union is achieved. Radiological pictures of one such case is depicted in Figure 1.

Functional and radiological outcomes were assessed using the Association for the Study and Application of Methods of Ilizarov (ASAMI) criteria (Tables 2-4).[4]

RESULTS

All six fractures eventually united. None had any residual infection. None required amputation. The mean time to union was 34 weeks (range 20-46 weeks). The average follow-

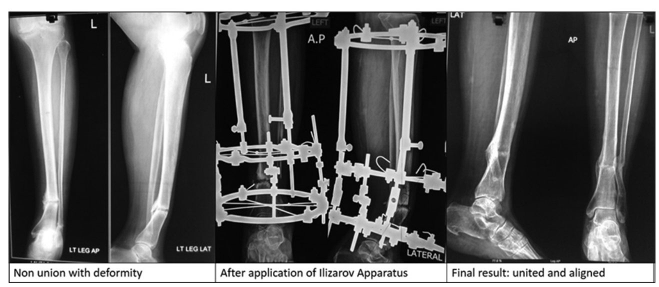

Figure 1: Illustration showing one of the cases of the study

Table 1: Details of the patients undertaken in the study

Patient name	Age (years)	Sex	Bone	Initial injury	Initial management	Type of non-union	Infection	Shortening (cm)	Gap	Deformity
LB	58	F	Tibia	Closed	Plaster immobilization	Hypertrophic	Absent	Nil	Nil	Procurvatum varus
MB	45	F	Tibia	Open	External fixator	Atrophic	Present	1.5	Nil	Recurvatum valgus
FS	42	M	Tibia	Open	External fixator	Atrophic	Present	3.5	Present	Nil
MA	24	M	Tibia	Closed	Plaster immobilization	Hypertrophic	Absent	2	Nil	Procurvatum valgus
NB	32	F	Femur	Closed	IM nailing	Atrophic	Present	4	Present	Nil
PS	28	M	Tibia	Open	External fixator	Atrophic	Present	2	Nil	Nil

up time was 68 weeks (30-110 weeks). The average leg length discrepancy was 1.7 cm (0-4 cm). Three had an obvious limp. One had appreciable deformity, and two had soft tissue dystrophy. Two patients developed pin site infections which were successfully treated with oral antibiotics.

Only one patient (MB) needed a second procedure for the adjustment of fixator for correction of deformity. One patient (MA) insisted for premature removal of fixator and had a persistent procurvatum and valgus deformity (Figure 2). Another patient (NB) refrained from a second procedure to equalize the limb length and had a final shortening of 4 cm in the femur (Figure 3).

All the patients eventually obtained clinical and radiological evidence of union and none required bone grafting at the fracture or at the corticotomy site.

Table 2: Bone results using the ASAMI scoring system

Bone results	Description
Excellent	Union, no infection, deformity<7°, limb length discrepancy<2.5 cm
Good	Union+any two of the following: Absence of infection<7° deformity and limb length inequality of<2.5 cm
Fair	Union+only one of the following: Absence of infection, deformity<7° and limb length inequality<2.5 cm
Poor	Non-union/refracture/union+infection+deformity>7° + limb length inequality>2.5 cm

ASAMI: According to the Association for the Study and Application of Methods of Ilizarov

Table 3: Functional results using the ASAMI scoring system

Functional Results	Description
Excellent	Active, no limp, minimum stiffness (loss of<15° knee extension/<15° dorsiflexion of ankle), no RSD, insignificant pain
Good	Active, with one or two of the following: Limp, stiffness, RSD, significant pain
Fair	Active, with three or all of the following: Limp, stiffness, RSD, significant pain
Poor	Poor inactive (unemployment or inability to perform daily activities because of injury)
Failure	Amputation

ASAMI: According to the Association for the Study and Application of Methods of Ilizarov, RSD: Reflex sympathetic dystrophy

According to the ASAMI bone score results, 3 (50%) were classed as excellent, 2 (33%) as good, and 1 (17%) as fair. Functionally 1 (17%) was graded as excellent, 3 (50%) as good, and 2 (33%) as fair.

DISCUSSION

The methods of Ilizarov, including compression-distraction and osteosynthesis offer alternatives to the standard treatment of infected non-unions of bone. Conventional methods of non-union treatment are successful in cases of non-infected non-unions, in which bone vascular supply and soft tissue integrity are not compromised. Repeated surgical procedures, osteomyelitis, non-union, bone loss, disuse osteoporosis, muscle dystrophy, impaired arterial circulation, and decreased venous and lymphatic drainage ensue when bone fractures do not consolidate. The Ilizarov method is the method of choice in these situations and can be considered as limb salvage operation.

Use of the Ilizarov circular frame allows resection of the infected bone, repair of the defect, and stabilization to consolidation while maintaining or restoring the length of the limb. Joint function is encouraged while the apparatus is worn and functional loading can be initiated within the first few days after application of the frame.[5] The Ilizarov apparatus is very resistant to torsion and bending forces but is adaptable to axial loading.[6]

Union achieved by repairing defects with cancellous bone grafts, as recommended by Johnson *et al.* and Lack *et al.*,[7,8] may be satisfactory, but the biomechanical structure of the restored bone may require the years of remodeling to achieve the radiological appearance that is obtained by distraction regeneration by the Ilizarov method.[9]

In our study, radiological and clinical union was achieved in all cases along with eradication of infection. Nearly, all of our patients were able to stand and walk with partial extremity loading immediately after the circular frame was installed. This is considered the most essential part of this method. One patient had a persistent deformity due to non-

Table 4: Results of the patients undertaken in the study

Patient name	Injury Ilizarov time (in weeks)	Union time (in weeks)	Follow-up period (in weeks)	Union	Infection	Shortening (cm)	Deformity	Bone ASAMI score	Functional ASAMI score
LB	42	26	110	United	Nil	Nil	Nil	Excellent	Excellent
MB	30	28	50	United	Nil	1	Nil	Excellent	Good
FS	26	40	68	United	Nil	2.7	Nil	Good	Fair
MA	17	20	30	United	Nil	2	+	Good	Good
NB	13	46	80	United	Nil	4	+	Fair	Fair
PS	25	44	70	United	Nil	1	Nil	Excellent	Good

ASAMI: According to the Association for the Study and Application of Methods of Ilizarov

Figure 2: Infected femoral gap non-union with shortening after treatment

Figure 3: Persistent tibial deformity after early removal of fixator

compliance with the treatment, however, the fracture got united. The patient with femoral fracture had a shortening of 4 cm, but she refrained from further intervention to correct it.

Barbarossa *et al*. in their study of 30 patients with chronic osteomyelitis and infected pseudoarthroses of the femur showed the efficacy of the Ilizarov method for treatment of such conditions but emphasized the importance of patient compliance and involvement in order the achieve the best results.[10]

Even though many patients perceive the clumsy looking Ilizarov fixator as a social stigma, it provides them with immediate weight bearing. They were able to perform daily activities notably locomotion independently, thus minimizing the social and economic burden.

Maini *et al*. in their study had excellent results in 21 patients (70%), good in 3 (10%), fair in none (0%), and poor in 6 (20%). The functional results were excellent in 8 patients (26.7%), good in 12 (40.0%), fair in 3 (10%), and poor in 7 (23.3%).[11] The outcome in terms of ASAMI bone and functional scores in our study were appreciable with no poor results. The main limitation to the study was our numbers. The total treatment time can take up to 2 years, therefore, we would not expect to have such high numbers.

CONCLUSION

Treatment of difficult non-unions with Ilizarov technique has stood the test of time. It can be concluded that the use of Ilizarov technique for difficult non-unions yields good function in terms of union, deformity correction, pain relief, and activities of daily living in our center. However, this is a long and arduous process requiring patient compliance and involvement.

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