

Original Research Article

Management of infected non-unions of long bones with ilizarov external fixator: Our experience

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Abstract: Background: Infected non-union and gap non-union are challenges that orthopaedic surgeons have to face globally. The open fracture is the most common cause of infected nonunion and tibia is the most commonly involved bone in the infected nonunion. In Ilizarov technique, vascularity is increased by corticotomy and application of a circular external fixator. It also provides micro motion due to distraction and gives an excellent biological environment for fracture healing.

Material and Methods: Seventeen consecutive patients with infected nonunion of long bones were treated from 2012 to 2016. The age range was 20 to 65 year-old male patients. Five cases were admitted with femoral infected non-union and twelve with septic non-union of tibia. Patients were followed up for one year. The predominant bacteria were Staphylococcus aureus and Pseudomonas aeruginosa. Average duration of antibiotics treatment was 4.9 (range, 2-6) weeks. The outcome measures were according to the classification of ASAMI, which is based on radiological (defect filling) and clinical (functional) findings.

Results: The cases were followed with mean period of 3.5 years (range, 2-5 years). In the present study, seventeen cases with septic non union of tibia and femur were evaluated. All cases completed treatment and achieved bony union with no signs of infection. In the present study, bone union result as per ASAMI score was excellent in 76.5%, good in 23.5% cases, and also the functional results were excellent in 76.5%, good in 23.5% cases. No patient had gone for amputation in our study.

Conclusion: Ilizarov technique has been a successful treatment for infected long bone non unions of tibia and femur associated with bone loss. Our results were similar with the existing literature about the study. The lengthy treatment time and considerable number of complications must be fully understood both by the surgeon and the patient before undertaking the ilizarov treatment method.

Keywords: Ilizarov; Infected non-union; Femur; Tibia.

1. Introduction

Ilizarov method, which is used in the treatment of complicated fractures of long bones, was first introduced in 1950 by Gavril Abramovich Ilizarov, who was born in Caucasus, in the Soviet Union and worked in Siberia [1,2]. Infected non-union and gap non-union are challenges that orthopaedic surgeons have to face globally [3,4]. Infected nonunion has been defined as a state of failure of union and persistent infection at the fracture site for six to eight months. The open fracture is the most common cause of infected nonunion and tibia is the most commonly involved bone in the infected nonunion [5]. The dynamic frame enables gradual lengthening, deformity correction, and nonunion or delayed union compression while remaining minimally invasive [6].

In this technique, vascularity is increased by corticotomy and application of a circular external fixator. It also provides micro motion due to distraction and gives an excellent biological environment for fracture healing [7]. There is considerable loss due to social, financial, physical and psychological impact on the patient. Goals of treatment in infected nonunion are to obtain solid bony union, eradication of infection with maximum functional use of the extremity. In order to eliminate infection, it is critical to perform radical resection of the

necrotic bone and infected segments [8]. The following paper reports the results of treatment of tibial and femoral neglected infected nonunion by this method in seventeen patients.

2. Materials and methods

Seventeen consecutive patients with infected nonunion of long bones were treated from 2012 to 2016. The age range was 20 to 65 year-old male patients. Five cases were admitted with femoral infected non-union and twelve with septic non-union of tibia. The mechanism of injury was motor vehicle accident in fourteen and fall in three. In twelve patients the fracture was comminuted and multifragmentary. All seventeen patients had received prior conventional treatment. Patients were thoroughly evaluated and psychologically assessed. The arduous treatment programme was explained. Radiographs were taken in at least two planes. Culture swabs from draining sinuses and open wounds were carried out and appropriate therapy was initiated. The predominant bacteria were *Staphylococcus aureus* and *Pseudomonas aeruginosa*. Average duration of antibiotics treatment was 4.9 (range, 2-6) weeks. In cases with frank infection and purulence, debridement of necrotic tissues were performed at first and then Ilizarov apparatus for compression was introduced. In cases with atrophic nonunion intermittent compression and distraction on three day cycles, 0.25 mm four times a day for transfer of bone segment were enforced with Ilizarov apparatus.

A modified Ilizarov frame was preconstructed using a proximally lateral mounting apparatus with arches together with single and multiple pin fixation bolts. Up to two rings were used for the distal fragment and one full ring for the planned intercalated segment. The proximal construct was connected to the middle and distal construct using oblique supports, as well as threaded rods for femoral fracture nonunion. All the procedures were done under general or spinal anesthesia with antibiotic prophylaxis. The protocol of treatment was based on the following principles of Ilizarov co-workers:

1. Preservation of blood supply both to the limb as well as the fracture site.
2. Preservation of osteogenic tissue (periosteum, endosteum and marrow).
3. Functional activity of limb.
4. Early mobilization.

The fracture union, complications and functional recovery were also recorded. A policy of early bone grafting was followed whenever it was considered necessary and it was employed within ten to twelve weeks of the index surgery.

Patients were followed up for one year. The outcome measures were according to the classification of ASAMI, which is based on radiological (defect filling) and clinical (functional) findings.

3. Results

We followed the cases with mean period of 3.5 years (range, 2-5 years). All cases completed treatment and achieved bony union with no signs of infection. The results were divided into radiological and functional results, according to the classification of the Association for the Study and Application of the method of Ilizarov.

The radiological results were determined according to four criteria: union, infection, deformity and leg length discrepancy. A fracture was considered to be united when there was no motion at the fracture site following removal of the Ilizarov frame with radiological evidence of union. Superficial pin tract infections developed in six patients; these evolved with local care and antibiotics. In two patients, a half pin was removed and in another patient a single wire was repositioned.

Table 1. Pre-operative work up for seventeen patients with infected non-union

Case	Age/Sex	Involved bone	Mode of Injury	Original wound
1	20 / M	Tibia	MVA	Closed
2	28 / M	Tibia	MVA	Closed
3	32 / M	Tibia	MVA	Closed
4	36 / M	Tibia	MVA	Closed
5	34 / M	Tibia	MVA	Closed
6	38 / F	Tibia	MVA	Closed
7	41 / M	Tibia	Fall from height	Open
8	40 / F	Tibia	Fall from height	Open
9	46 / M	Tibia	MVA	Closed
10	48 / M	Tibia	MVA	Closed
11	52 / M	Tibia	MVA	Closed
12	65 / M	Tibia	MVA	Closed
13	25 / M	Femur	MVA	Closed
14	34 / M	Femur	MVA	Closed
15	42 / M	Femur	MVA	Closed
16	55 / F	Femur	MVA	Closed
17	45 / M	Femur	Fall from height	Open

Table 2. Microbiology culture report

Organism isolated	Involved bone	Number of cases
Staphylococcus aureus	Tibia	10
Staphylococcus aureus	Femur	3
Gram negative rods	Tibia	2
No growth	Femur	2

Table 3. Fracture union results according to the ASAMI(for tibial and femoral non-union)

Bone involved	Union	Infection	Deformity	Limb length discrepancy(cm)	Result
Tibia (10 cases) Femur (3 cases)	Yes	No	Nil	Nil	Excellent
Tibia (2cases)	Yes	No	5°	2	Good
Femur (2cases)	Yes	No	9°	Less than 2.5	Good

Table 4. Functional results according to the ASAMI (for tibial and femoral non-union)

Bone involved	Significant limp	Joint stiffness	Pain	Able to perform daily duties	Results
Tibia	No	Two cases	No	Yes	Good
Femur	No	Two cases	No	Yes	Good

Table 5. Comprehensive details of the subjects in this study

Age / Sex	Involved bone	Mode of Injury	Original wound	Type of septic non-union	Number of old operations	Type of treatment with Ilizarov	Union (months)
20 / M	Tibia	MVA	Closed	Hypertrophy	4	Compression	6
28 / M	Tibia	MVA	Closed	Atrophic	4	Compression	6
32 / M	Tibia	MVA	Closed	Atrophic	2	Compression	11
36 / M	Tibia	MVA	Closed	Atrophic	5	Compression & Distraction	11
34 / M	Tibia	MVA	Closed	Hypertrophic	3	Compression	7
38 / F	Tibia	MVA	Closed	Atrophic	4	Compression	8
41 / M	Tibia	Fall from height	Open	Hypertrophic	3	Compression	6
40 / F	Tibia	Fall from height	Open	Atrophic	5	Compression & Distraction	6
46 / M	Tibia	MVA	Closed	Atrophic	2	Compression	9
48 / M	Tibia	MVA	Closed	Hypertrophic	2	Compression	8
52 / M	Tibia	MVA	Closed	Hypertrophic	1	Compression	6
65 / M	Tibia	MVA	Closed	Atrophic	2	Compression	9
25 / M	Femur	MVA	Closed	Hypertrophic	3	Compression	7
34 / M	Femur	MVA	Closed	Hypertrophic	5	Compression & Distraction	9
42 / M	Femur	MVA	Closed	Atrophic	3	Compression & Distraction	11
55 / F	Femur	MVA	Closed	Hypertrophic	4	Compression	7
45 / M	Femur	Fell from height	Open	Hypertrophic	3	Compression	9

4. Discussion

Long standing infected non-union and gap non-union are difficult to treat and present a challenging problem for the orthopaedic surgeons. It usually leads to residual deformity, persistent infection, contracture and at worst - a useless limb. The Ilizarov ring fixator gives an option of compression, distraction and bone transport and is effective in the treatment of infected non-union of tibia and femur where other types of treatment have failed. The cyclic axial telescoping mobility, not rigidity, at the non-union or fracture site is an important requirement for the formation of a reparative callus.

The goal of treatment in infected non-union is a well aligned, healed, painless and functional limb. Infection at fracture site, not only prevents stable internal fixation, but also slows fracture healing. Infected non-union is one of the most difficult clinical situations despite major advances in fixation techniques, soft tissue management and antibiotic therapy. Furthermore, an infected nonunion is almost always associated with complications like deformity, limb length discrepancy, joint stiffness, disuse osteoporosis and soft tissue atrophy.

Ilizarov technique has been employed as a successful and dependable modality of treatment for infected nonunions of long bones [9,10]. Jain *et al.*, in their study of infected nonunions, suggested that distraction histiogenesis is the preferred procedure in nonunions with active or quiescent infection and a bone gap of 4 cm or more [5].

In the present study, seventeen cases with septic non union of tibia and femur were evaluated. 6 out of 17 (35.3%) patients in our study had pin tract infections. This is consistent with findings of Checkets *et al.*, who in their study brought out that pin tract infection are more likely when there is excessive movement of soft tissue at the pin/wire-soft tissue interface like in femur [11].

Acute shortening was done in two patients and bone transport in five. In a study performed by Tranquilli *et al.*, in Italy, on twenty patients with non-union of tibia, the result was union in all cases; mean time of union being 4.5 months [12].

By using the ASAMI criteria of evaluation of the fractures managed with ilizarov method and comparing the results with a few previous studies (shown in table 6, 7), our bone and functional results are not that different from the ones obtained in those studies. The percentage of patients requiring amputation in various previous studies ranges from 0 to 5% and in present study the percentage was nil.

Table 6. Fracture union results

Author	Number of cases	Bone Results (%)			
		Excellent	Good	Fair	Poor
Madhusudan <i>et al.</i> , [14]	22	18.2	27.3	36.3	18.2
Dendrinios <i>et al.</i> , [15]	28	50	28.5	3.6	17.9
Yin <i>et al.</i> , [16]	120	68	28	12	2
Jimmy Joseph <i>et al.</i> , [17]	42	60	15	25	0
Pande H <i>et al.</i> , [18]	18	55.6	27.8	11	5.6
Present study	17	76.5 (n = 13)	23.5(n=4)	0	0

Table 7. Functional results

Author	Number of cases	Functional Results (%)			
		Excellent	Good	Fair	Poor
Madhusudan <i>et al.</i> ,14	22	4.6	18.2	40	18.2
Dendrinios <i>et al.</i> ,15	28	25	39.3	14.2	17.9
Yin <i>et al.</i> ,16	120	37	42	21	0
Jimmy Joseph <i>et al.</i> ,17	42	55	30	5	10
Pande H <i>et al.</i> ,18	18	38.89	33.3	16.7	5.6
Present study	17	76.5	23.5	0	0

Sanders *et al.*, concluded that ankle pain and knee stiffness were the major sources of residual disability after successful treatment of tibial and femoral non unions [13]. In the present study also, knee stiffness was observed in four patients.

5. Conclusion

Ilizarov external fixation is a useful method with several advantages and certain set-backs in the treatment of tibial and femoral septic non-unions, especially in high energy trauma. Our results were similar with the existing literature about the study. The lengthy treatment time and considerable number of complications must be fully understood both by the surgeon and the patient before undertaking the ilizarov treatment method.

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