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Efficacy of Hybrid Ilizarov fixation in reducing time span of union in infected non-union of tibia

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Abstract
Background: Ilizarov external fixator is the modality of choice for treatment of infected non-union of tibial shaft fractures. The time duration for which the Ilizarov fixator is required to be kept (the Fixator index) is long with this method, is cumbersome for the patient, and associated with complications. Hybrid Ilizarov fixation by adding one Schanz screw in each ring along with two tensioned transosseous wires has many advantages such as reduced complications, reduced surgical time, more stable fixation, early mobilization, early union and reduced span of fixation. Aim of this study is to compare the results of Hybrid Ilizarov fixation and Ilizarov fixation in treating infected tibial non-unions.
Materials and methods: This study involved retrospective evaluation of 42 patients of infected non-union of tibia treated at our institute between August2007 to December 2013. Initially for first two years we treated 19 patients of infected non-union of tibia with Ilizarov fixation, later since August 2009 we started treating patients with Hybrid Ilizarov fixation. We used 5.5mm Schanz screw inserted anteromedially in each ring along with two tensioned transosseous wires. Total 23 patients of infected non-union tibia were treated with Hybrid Ilizarov fixation.
Results: Patients treated with Ilizarov fixation initially from August 2007 to July 2009 were labelled as Group A. From August 2009 to December 2013 we treated patients with Hybrid Ilizarov fixation and they were labelled as Group B. Good consolidation was seen on radiographs after a mean period of 6.2 months in Group A patients and 5.8 months in Group B patients, hence accordingly the Fixator index was reduced in Group B patients. Overall complication rate was reduced in Group B patients and functional outcome was better in Group B patients.
Conclusion: Our results demonstrated better outcome with Hybrid Ilizarov fixator in treating infected non-union of tibia shaft fractures.

Keywords: Infected non- union of tibia, Hybrid Ilizarov fixation, The Fixator index

Introduction

Treatment of infected non- union of tibial shaft fracture is difficult. The goals are to provide stable fixation with minimal soft tissue and periosteal stripping, to treat infection, to achieve union, to correct deformity to achieve near normal length, full function and to minimize complications.

Conventional treatment using debridement, external fixation, bone grafting, and soft-tissue coverage has got its own morbidity due to multiple procedures and multiple anaesthesia [1-6]. Ilizarov method of treatment addresses all the problems such as non-union, infection, shortening and deformity simultaneously at single stage [7-9].

In Ilizarov fixation, the wires are tensioned and supported circumferentially. Fixation is rigid enough to allow early motion and partial weight bearing. The time duration for which the Ilizarov fixator is required to be kept (the Fixator index) is long with this method, is cumbersome for the patient, and associated with complications [10]. Various modifications have been successfully invented by many researchers. Three trans-osseous wires are required in each ring to achieve good stability in Ilizarov fixation [11, 12]. Instead of three trans-osseous wires same effect can be achieved by two wires and one Schanz screw in each ring. This Hybrid Ilizarov fixation by adding one Schanz screw in each ring has many advantages such as reduced complications, reduced surgical time, more stable fixation, early mobilisation, early union and reduced span of fixation. Aim of this study is to compare the results of Hybrid Ilizarov fixation and Ilizarov fixation in treating infected tibial non-unions.

Materials and Methods

This study involved retrospective evaluation of 42 patients of infected non-union of tibia treated at our institute between August 2007 to December 2013. Initially for first two years we treated 19 patients of infected non-union of tibia with Ilizarov fixation, later since August 2009 we started treating patients with Hybrid Ilizarov fixation. We used 5.5mm Schanz screw inserted anteromedially in each ring along with two tensioned transosseous wires. Total 23 patients of infected non-union tibia were treated with Hybrid Ilizarov fixation.

In three patients infected non-union was present in proximal third of tibia. In these patients corticotomy was performed in distal third of tibia. All remaining patients had infected non-union in middle third and distal third of tibia and in these patients corticotomy was performed at proximal tibia. In patients with distal third non-union tibia, transmetatarsal half-ring wire stabilisation was performed to support foot.

All patients underwent complete resection of the infected/necrotic bone, debridement of the soft tissue, Part of the fibula at the non-union site was resected to facilitate acute compression. A pre- assembled Ilizarov ring fixator was applied in all cases. 4 Rings were used for middle third and upper third infected non-union and 5 rings were used for distal third infected non-union. Three 1.8-mm wires were placed in the proximal tibia with adequate tensioning in patients who were treated initially with Ilizarov fixation. (Group A) Later on in Hybrid Ilizarov fixation we used two 1.8-mm wires placed in the proximal tibia with adequate tensioning along with one 5.5mm Schanz screw inserted anteromedially and fixed to the ring with post. (Group B) Second ring was applied below the level of corticotomy with three tensioned wires in patients who were treated initially with Ilizarov fixation and later in Hybrid Ilizarov fixation we used two tensioned wires and one 5.5mm Schanz screw inserted anteromedially. Third ring was applied 5 cm proximal to the distal end of the proximal fragment with same difference in two groups as mentioned above. Acute compression of the defect site was performed as the gap was less than 6 cm in all our study cases. At this point the vascularity of the limb was carefully monitored. The distal segment of the limb was stabilised by placing fourth and fifth rings with difference in two groups as mentioned above. Alignment of the bone was achieved under an image intensifier and acute compression was given. Buldging soft tissue occurred due to acute shortening was used to cover the debrided site and excess skin was excised.

Fig 1 A&B: Preoperative antero-posterior and lateral radiographs of infected non-union of tibia with intramedullary nail in situ.

7 days after surgery, the corticotomy site was distracted at a rate of 1 mm per day till desired limb length achieved. Active physiotherapy of the knee and ankle was given to all the patients. Weight bearing was permitted with a footplate extension and walker or crutches. Through care was taken to prevent pin site infection. Distraction and pin site care protocols were explained to the patients and relatives. Around 3 weeks after surgery patients were discharged when they were able to perform distraction and pin site care according to protocols. All patients were called for follow up every 2 weeks. In all patients radiographs were performed at every 4 weeks. The Ilizarov ring fixator was removed after complete union on radiographs. Bone healing and functional results were evaluated according to a modified Association for the Study and Application of the Method of Ilizarov (ASAMI) classification [13].

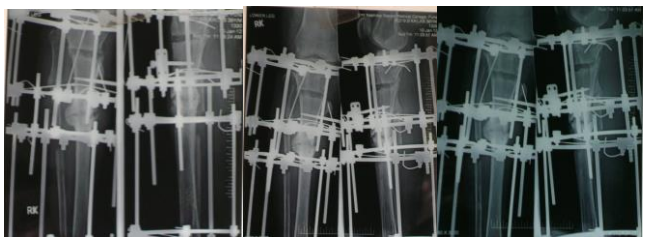

Fig 2 A, B, C: Postoperative antero-posterior and lateral radiographs of different stages of distraction and healing.

Fig 3A&B: Antero-posterior and lateral radiographs after union and removal of fixator.

Fig 4: shows the functional results of a patient after treatment.

Results

42 patients with infected non-union of tibia were treated at our institute between August 2007 to December 2013 are included in the study. We divided these patients in two groups. Patients treated with Ilizarov fixation initially from August 2007 to July 2009 were lebelled as Group A. From August 2009 to December 2013 we treated patients with Hybrid Ilizarov fixation and they were lebelled as Group B.

Results were evaluated according to a modified Association for the Study and Application of the Method of Ilizarov (ASAMI) classification [13].

For evaluation following 5 criteria were considered:

1. Cure of infection
2. Union
3. Correction of deformity
4. Achieving normal limb-length.
5. Functional outcome.

Functional outcome was based on: limp, equines, ankle

stiffness, soft tissue dystrophy, pain, and inability to walk. An excellent result was defined as one with union, no infection, deformity of <7°, leg-length discrepancy of <2.5 cm in the tibia and normal walking ability. A good result was defined as union plus any 2 of the last 3 features of excellent union and a fair result as union plus any one of the latter features. A poor result was defined as non-union, refracture, or patients requiring amputation.

The t test was used with modified degrees of freedom. One-way analysis of variance was used to compare the means of 2 groups. Level of significance for all inferences was set at $p<0.05$.

Table 1: Clinical variables and functional outcome in patients of Group A and Group B.

Clinical variables	Group A Consisting 19 patients	Group B Consisting 23 patients
Infected gap non-union	11	14
Infected hypertrophic non-union	06	07
Infected atrophic non-union	02	02
Number of surgeries performed before	Mean=2	Mean=2
Bone gap after debridement	Mean=3.8cm	Mean=4.1cm
Mean time required to perform surgery	2 hours 35 minutes.	2 hours 14 minutes.
Time period to achieve union	Mean 6.2 months	Mean 5.7 months
Complications	Pin tract infections=11 Loosening=8	Pin tract infections=12 Loosening=6
Functional outcome according to the modified ASAMI classification	Excellent=12(63%) Good=06(31.5%) Fair=00(00%) Poor=01(5.5%)	Excellent=17(74%) Good=05(21.70) Fair=00(00%) Poor=01(4.3%)

Good consolidation was seen on radiographs after a mean period of 6.2 months in Group A patients and 5.8 months in Group B patients, hence accordingly the Fixator index was reduced in Group B patients as shown in Table 1. Follow-up was done following removal of fixator. The mean duration of follow up was 4.3 years, the range being 2-8 years.

Minor complications such as pin tract infections and loosening occurred in both Groups as shown in Table: 1. Major complication requiring amputation occurred in 2 patients, one patient in each group.

Discussion

Infected non-union of tibial shaft fractures are very difficult to treat. Conventional treatment include debridement, external fixation, bone grafting, and soft-tissue coverage. This form of treatment requires multiple procedures and multiple anaesthesia. Inspite of this, complication rates is high and the time span required to complete the treatment is long [1-6]. Option available in such a situation is the Ilizarov technique of distraction osteogenesis. Ilizarov technique is the definitive modality of treatment and addresses all the problems in infected non-union such as non-union, infection, shortening and deformity simultaneously at single stage [7-9]. Time span required to complete the treatment is long. The time duration for which the Ilizarov fixator is required to be kept (the external fixation index) depends on the length of distraction required and is not free of complications. Once the distraction phase is over, the consolidation phase starts which is more than double the distraction time. It is associated with many complications such as pin-track infection, angulation; postoperative scarring, loosening of the frame, mal alignment and stiffness of the knee and ankle joints. The Ilizarov fixator cannot be removed before sound consolidation as it can lead to fracture, deformity, and shortening occurring through the distracted callus [14, 15].

To enhance bone regeneration during consolidation phase to shorten the duration of an Ilizarov external fixator, few modalities were successfully invented by many researchers. These modalities include mechanical stimulation of the regenerate, new surgical techniques, exogenous application of low-intensity pulsed ultrasound (LIPU) or pulsed electromagnetic fields (PEMFs), local injection of bone morphogenetic protein (BMP), pluripotent stem cells, and platelet rich plasma (PRP) [16-20].

ASAMI12 modified the frame and obtained better overall results by using Schanz screws for femur [9, 21, 22]. We used Schanz screws in treating infected non-union of tibia. Schanz screws were inserted anteromedially at the level of all rings and fixed to the ring with post. The stability of an assembly is proportional to the number of rings, number of wires in each ring, the diameter, number, tension, degree of crossing, and location of the wires. Addition of Schanz screws at each ring reduced the necessity of inserting third trans-osseous wire, increased the stability of the construct thereby reduced the incidence of pin site infection, loosening, allowed early mobilisation, achieved early union and thereby reduced the span of fixation as compared to only Wire fixation. This Hybrid frame is easy to apply, versatile, and less expensive than other commercially available adaptors and frames. This Hybrid frame allows immediate functional stabilization of infected non-unions and postoperatively reduced the time for union and thus reduced span of fixator.

Conclusion

Our study results demonstrated advantages of Hybrid Ilizarov fixation such as

- Reduced surgical time.
- More stable fixation.
- Reduced incidence of pin loosening.
- Reduced pin site infections.
- Early mobilisation.
- Reduced time in fixator. (The Fixator index)
- Better functional results.

On the basis of our experience this Hybrid Ilizarov fixator is safe, versatile and effective in providing stability and allowing early union and thus reducing the time span in fixator (the Fixator index) while treating infected non-union of tibia shaft fractures.

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