Original Research Article

# Role of Ilizarov ring fixator – A three parameter test

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## Abstract

**Background:** The main surgical principle in the management of diaphyseal bone infection is thorough debridement of all nonviable tissue. None of the mentioned techniques afford surgeon the ability to correct deformities, eliminate antibiotic therapy, regenerate new bone without grafts and allow weight bearing during treatment as is possible with Ilizarov. **Aim:** The present study was conducted to evaluate the clinical follow-up results with Ilizarov technique using three parameters: union, infection and function and to know the complications if any faced by the patients.
**Material and Methods:** This was a prospective study planned to evaluate the results of Ilizarov -ring fixator on follow-up of 18 cases of either sex with infected non-union tibia. Average age of presentation was 34.5 years. Follow-up roentgenographs were used to assess alignment, bone contact and later callus formation. Healing status of the fracture was monitored using biplane roentgenographs, unchanged fracture alignment with loosening of the frame, absence of pain during ambulation with the frame destabilized. The data thus collected wereanalysed by using percentage and valid conclusions were drawn.**Result:**Pain and swelling were the most common complication after application of ilizarov ring fixator. In this studyof 18 cases, 11 (61.11%) patients had excellent, 2 (11.11%) good, 5 (27.77%) fair and none had poor results as per criterion laid down by Catteneoetal.**Conclusion:** Ilizarov technique was found to be useful to progressively lengthen the extremity, achieve union without bone grafting ,to correct deformities and control infection in infected non-union with or without bone gap.

**Keywords:** Ilizarov ring fixator, non union tibia, infection, compression, distraction.



## Introduction

In this era of modern sciences, due to industrialization and increased automobile accidents, there are varying degrees of fractures of bones. Although the fracture healing is a physiological process and is usually very successful in terms of union but often leaves a great deal to be desired in terms of functional recovery, largely because of shortening, mal-alignment, non- union, infection in compound fractures leading to chronic refractory osteomy-elitis.Chronic infection of the diaphyseal shaft of long bones is one of the most perplexing dilemmas in orthopaedic surgery. To obtain eradication of the infection, bony union, and a functional extremity often requires courageous measures with increasing risks of failure or amputation. Standard principles of debridement and antibiotic therapy alone may result in an acceptable cure rate of less severe types of infection. Difficult or resistant infections usually require a more radical debridement of the septic bone and soft tissues in addition to application of stable fixation to enhance soft-tissue healing and bony union. There are many alternatives available in the management of chronic diaphyseal infection. These include extensive debridement and local soft-tissue rotational flaps, packing the defect with antibiotic impregnated beads. Papineau-type open cancellous bone grafting,tibiofibular synostosis cancellous allograft in fibrin sealant mixed with antibiotics, and/or free microvascular soft-tissue and bone transplants. All these treatments have variable rates of success and failure and are limited in their ability to re-establish extremity length and correct deformity. The definitive environment required for many of these techniques to achieve their maximum bone-grafting potential pre-requisites the extremity to be free of infection and have acceptable soft-tissue coverage. Many of these techniques also lack, to varying degrees, the ability to provide early functional rehabilitation of the limb during treatment.The main surgical principle in the management of diaphyseal bone infection is thorough debridement of all non-viable tissue. The resulting potential shortening, instability or bone loss creates a formidable situation to overcome with standard grafting and stabilization techniques. In the 1970s, Ilizarov postulated a few basic points. [2] None of the previously mentioned techniques afford the surgeon the ability to correct deformities, eliminate prolonged pre and postoperative intravenous antibiotic therapy, regenerate new bone tissue without the use of bone grafts, progressively lengthen the extremity, and allow weight bearing during the treatment period. All of these capabilities are possible with application of the techniques of Ilizarov. The Ilizarov method and the model of distraction osteogenesis have been studied extensively. Ilizarov performed most of his experimental work on a canine tibial lengthening model. [3] Results were evaluated using parameters:union, infection and function and grading was done according to criteria laid down by Cattaneo et al.[1] Wire / pin-site inflammation was graded utilizing a six point scale of ascending severity as defined by Moore and Dahl. [4] The present study was conducted with the aims and objectives to evaluate the clinical follow-up results using three parameters: union, infection and function and to know the complications if any faced by the patients.

### Material and Methods

This prospective study was conducted at Nalanda Medical College and Hospital, Patna . The study was approved by institutional research and ethical committee. An informed and written consent was taken from all the participating subjects before the commencement of the study. The study was conducted over a period

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of two year from January 2018 to December 2019.This study evaluated the results of Ilizarov ring fixator on follow-up of 18 cases of either sex with infected non-union tibia. The patients were contacted through correspondence or personally. Results of tibia were evaluated using parameters: union, infection and function and grading was done according to criteria laid down by Cattaneo et al. [1]

Parameters

Union

$U_0$ – for failure to obtain union

$U_1$ - for solid union

Infection

$I_0$– for unchanged infection

$I_1$– for persistent minimal drainage

$I_2$ -for complete clinical remission of infection

Function

$F_0$-Invalid

$F_1$- able to perform allactivities of daily living

$F_2$ -Complete recovery

Grading-

Excellent U1I2F2

Good U1I1F2

Fair U1I1F1

Poor U1I1F0/ U0I0F0

Wire/pin site inflammation was graded utilizing a six point scale of ascending severity as defined by Moore and Dahl. [4]Grade 2 and 3 inflammation was treated, respectively with 3 day – 5 day course of oral cephalosporins at a dose of 1 g BD. All patients were personally contacted or through correspondence so that practice of full mobility was carried out during the course of the Ilizarov treatment. Wherever possible meetingswere arranged between the patients who had already undergone successful treatment and those still under treatment. The six point grade scale was as follows.

Grade

Pin-site

Normal

Inflammed

Inflammed with serous exudate

Inflammed with purulent exudate

Osteolysis

Ring sequestrum

Various components of Ilizarov External Ring Fixator

The Ilizarov device is a circular external fixator. Its principal component is a ring with a flat surface and with multiple holes.

Rings and Arches - Halfring/Five-eight ring / Arches

Ring connections

Bolts and Nuts -Connecting Bolts / Nuts / Wire fixation bolts / Washers: flat sided washers, Slotted washers, Spacingwashers

Threaded rods

Bayonet point (Corticalwires1.8 mm diameter) / Olive Wires

4.5 mm Schanz Pins

Instruments - Box Wrench for Nut / Box wrench for Bolt / Socket Wrench/ Wire Tensioner / Corticotome

Surgery:- Surgery was performed under spinal anaesthesia using standard ilizarov technique.

Post-operative Management

Wire insertion sites were covered with sterile dressing and gentle pressure was applied for 48 hours. Sponges were then applied and left in place until the wire insertion sites healed. A drop of a mild antiseptic was used on sponges once daily. Wherever possible early ambulation was started. The patients were encouraged to do active and passive stretching exercises. Foot was dorsi-flexed maximally with knee in flexion. Then with the ankle dorsiflexed maximally, knee was extended. Wherever necessary help of physiotherapist was taken. Distraction was started after the optimal latency period of 7-10 days. The rate (mm/adjustment) and rhythm(numberof adjustments/ day)was consistent with that described by Ilizarov. The usual rate and rhythm was 0.25 mm QID.Follow-up roentgenographs were used to assess alignment, bone contact and later callus formation. Healing status of the fracture was monitored using biplane roentgenographs, unchanged fracture alignment with loosening of the frame, absence of pain during ambulation with the frame destabilized.The data thus collected were analysed with the percentage method and results were reported.

**Result**

Of the 18 cases, 13 (72.22%) were in 26-40 years age group which is the most productive phase of the life with maximum mobility. 17 cases(94.44%) in our study were male and 1case was female. Compression and distraction was used in 12 cases. Distraction was started after the optimal latency period of 7-10 days. The rate (mm/adjustment) and rhythm (number of adjustments/day) is consistent with that described by Ilizarov. The usual rate and rhythm is 0.25 mm QID. Latency period in our study was 1 week to 10 days.12 cases had bone gap which varied from 2.5 cm to 11.6 cm with average of 3.95 cm.Pain and swelling were the most common complication after application of ilizarov ring fixator. Wire/pin site inflammation of grade 1-3 was present in 15 cases. In this studyof 18 cases,11(61.11%)patients had excellent, 2(11.11%) good, 5 (27.77%) fair and none had poor results as per criteria laid down by Cattaneo et al.[1] The duration of distraction was 1-2 months in 38.88% cases and 2-4 and 4-6 months in 05.55% cases. (Table1)

**Table 1: Duration of distraction**

| Duration | No. of cases | %age |
|---|---|---|
| <1 month | 3 | 16.65 |
| 1-2 | 7 | 38.88 |
| >2-4 | 1 | 05.55 |
| >4-6 | 1 | 05.55 |

Cases were graded according to wire-track infection. (Table 2) .The duration of Ilizarov Ring fixator was as elaborated in Table 3.The time taken for the consolidation of regenerate was as shown in Table 4.

The healing index was as tabulated in table 5.In this study of 18 cases,11 (61.11%) patients had excellent, 2(11.11%) good, 5 (27.77%) fair and none had poor resultsas per criterion laiddown by Catteneo et al. [1]

**Table 2: Grading of Cases (on basis of wire-track infection)**

| Grade | No. of cases | %age |
|---|---|---|
| 0 | 3 | 16.66 |
| 1 | 10 | 55.55 |
| 2 | 4 | 22.22 |
| 3 | 1 | 5.55 |
| 4 | - | - |
| 5 | - | - |

**Table 3: Total duration of ilizarov ring fixator (months)**

| Duration (months) | No. of cases | %age |
|---|---|---|
| 3 - <4 | 2 | 11.11 |
| 4 - <6 | 10 | 55.55 |
| 6 - <8 | 5 | 27.77 |
| 8 - <10 | - | - |
| 10-<12 | 1 | 05.55 |

**Table 4: Time taken for consolidation of regenerate**

| Duration | No. of cases | %age |
|---|---|---|
| 3-5 | 8 | 44.44 |
| >5-7 | 2 | 11.11 |
| >7-9 | 1 | 05.55 |
| >9-11 | - | - |
| >11-13 | - | - |
| >13-15 | 1 | 05.55 |

**Table 5: Healing index (months/cm)**

| Healing Index | No. of cases | %age |
|---|---|---|
| 1.21-1.30 | 1 | 05.55 |
| 1.31-1.40 | 3 | 16.66 |
| 1.41-1.50 | 3 | 16.66 |
| 1.51-1.60 | 2 | 11.11 |
| 1.61-1.70 | 3 | 16.66 |

**Discussion**

The methods of Ilizarov, including compression; distraction and osteosynthesis offer alternative to the standard treatment of infected non-unions,segmental bone loss and chronic osteomyelitis. Use oftheIlizarov circular frame allows resection of 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 with in first few days after application of the frame. The Ilizarov apparatus is very resistant to torsion and bending forces but is adaptable to axial loading. This versatile method is giving simultaneous stabilization and micromotion.Corticotomy and "tension stress effect" of compression or distraction creates a hypervascular environment which burns out infection as well as helps in soft tissue and bone repair. The reconstructed segment retains the hollow tubular shape similar toorginal bone which is ideal for weight bearing.In this study, 18 cases treated by this technique were reviewed prospectively with the objective to analyse the results of Ilizarov fixator technique. Of the 18 cases, 13(72.22%) were in 26-40 years age group which is the most productive phase of the life with maximum mobility. No doubt maximum number of cases occurs in this age group.In our study average age at time of presentation was 34.5 years as compared to Ong et al [5]average age of patient was 34.1 years in a study of 29 cases, while Green et al[2] reported average age of 32.8years. 17 cases (94.44%) in our study were male, may be due to more outdoor activities of the males and hence making them more prone to trauma. Similarly, Lalit et al [6]studied 30 cases with 27 males and 3 females. None of the case had Ilizarov ring fixator as primary mode of treatment after initial injury. 13 cases had 2-3 previous surgical interventions before application of Ilizarov ring fixator. 18 cases had undergone mean of 2.89 previous surgical procedures as compared to study conducted by Honsy and Shawky [7] showing mean of 2, Patel et al [8]showing meanof 2.6, and Ong et al [5]showing mean of 2. 12 cases had bone gap which varied from 2.5 cm to 11.6 cm with average of 3.95 cm as compared to 4 cms reported in research work of Cattaneoet al, [1]6 cm in Dandrinos et al.[9]Honsy and Shawky[7]used Ilizarov ring fixator combined with compression and distraction technique to treat 11 cases of infected non-union tibia, Paley et al[10] treated 7 cases of infected non-union with shortening but no bone gap using compression and distraction technique. However, compression and distraction was used in 3 cases of infected nonunion with no bone gap and having limb length discrepancy in our study.Here, distraction at corticotomy site to gain limb length and acute docking at fracture site was done to achieve union and achieve limb length.Distraction in our study was done at rate i.e. 1 mm/day at a rhythm of 0.25 mm qid as done in the study of Paley et al, [10]Green et al. [2]Latency period means the time period between application of Ilizarov ring fixator and starting of distraction. Compared to Greenetal studied with latency period of 11days and Thirumal and Shong[10]studied with latency period of 10days, Lalitetal[6]with latencyperiod of 7 days,whereaslatencyperiod in our study was 1 week to10days as in the study of Paley etal.[10]In comparison to average 6 cm new bone reconstruct in 28 patients study of Cattaneo et al[1] and average new bone reconstruct of 5.14cm in 17 patients study of Green et al, [2] average new bone reconstruct in our study was 3.95 cm. Alternate compression and distraction was done at the rate of 1mm/ day with rhythm of 0.25mm QID.Compression was combin-ed with intermittent distraction at the same rate and rhythm to stimulate consolidation, Paley et al [10]used compression at rate of 1 mm/day and rhythm of 0.25 mm qid for infected non-union with-out bone loss.After phase of distraction and/or compression, Ilizarov ring fixator was kept for a varied period to allow consolidation of regenerate new bone and/or union at docking site, assessed radiologically by taking serial x-rays at each follow up to look for consolidating radiolucent regenerate. The fracture was considered united when it appeared so radiologically or when there was no motion at fracture site after loosening of the connecting rods and when patient was able towalk without pain at the fracture site after dynamisation of assembly.Pain was the most common complaint and was quite intense the first few days of post-operative period. It gradually decreased in intensity in a week or two. Patients experienced dull aching pain during distraction probably due to stretching of muscles and nerves. Although pain was present almost all the time but its intensity was seen to be more at night, during physiotherapy and walking. Not much pain was noticed when patient remained occupied during the day time,however, at night intramuscular opiod derivatives were used as pain killers to relieve intense pain. In cases with intolerable pain, rate of distraction was decreased from 0.25 mm qid to 0.25 mm tds for few days.Swelling too was a persistent finding especially in the calf region. However no case required replacement of proximal

metaphyseal full ring with halfring to allow for calf swelling.Four cases had unexplained haemmorhage from wire track immediately on first postoperative day. 1 case required removal of offending wire and application of crepe bandage. Reinsertion of wire was done after control of haemmorhage. Wire/pin site inflammation of grade 1-3was present in 15 cases of 18 cases in our research work, whereasin Doreen et al [12] study of 17 cases. 11 patients had grade 2 pin/wire site inflame-mation, two patients had grade 3 and one patient had grade 3 and 4 inflammation. Wire/pin site inflammation is probably related to pin-skin motion, amount of soft tissue between skin and bone. Adequate wire tension helped decrease pin-skin and pin-bone motion. With aggressive skin care and short course of antibiotics, pin/wire site inflammation resolved without further treatment, except in 2 cases with grade 3 infection which were further managed by taking cue from the study of Paley et al [10] in which cases having pin/wire site infection with purulent discharge (grade 3) were given local injection of antibiotic solution radially around the pin/wire sitefrom within the tract, similarly antibiotic solution of 100 mg/ml cefazolin once OD for 3 days was injected in our study. Infection resolved within a week time.

Average duration of application of Ilizarov ring fixator in months was 5.51, whereas Valdamir et al [13] reported average of 5.7 months and Patel et al [8]reported average of 6 months. Consolidation of the regenerate assessed radiologically and average time taken for consolidation of regenerate was 5.73 months. Average new bone reconstruct was 3.95 cm in our study. Average healing index was 44.4 days/cm. This average healing index is comparable to healing index of 37 +- 2.77 days/ cm in study by Aldegheri[14] and 30-40 days/ cm in study of Paley et al.[10]Inspite of lengthy period of treatment, financial problem, all the patients were satisfied with IlizarovRing Fixator because these patients were usually tired of discharging wounds and repeated unsuccessful operative procedures. Regular follow-up every fortnight was difficult for majority (83.33%)of cases due to long travelling distance and limited means of transportation. In this study, out of 18 cases, 11(61.11%) patients had excellent, 2 (11.11%) good, 5 (27.77%) fair and none had poor results. In comparison Catteneoetal [1] reported 21 excellent, 6 fair and 2 poor in the study of 29 cases. Thirumal and Shong [11]reported 7 excellent, 7 good, 5 fair, 2 poor in 21 case study. Honsy and Shawky[7] reported 5 excellent, 3 good, 2 fair and 1 poor in 11 cases study. Dandrinos et al [9]reported 15 excellent, 7 good, 1 fairand 1 poor in 24 cases study. Tucker et al [15]reported 21 excellent, 4 good and 1 fair in 26 cases study.Our results show that Ilizarov ring fixator is a useful technique which allows the surgeons the ability to correct deformities, eliminate prolonged pre and post operative intravenous antibiotic therapy, regenerate new bone tissue without the use of bone grafts, progressively lengthen the extremity and allow weight bearing during the treatment period. In the present study, Ilizarov technique was found to be useful to progressivel lengthen the extremity, achieve union without bone grafting and to correct deformities in infected non-union with or without bone gap. Hence, Ilizarov'sdiscoveries and clinical principles are playinga significant role in orthopaedics and traumatology.

**Conclusion**

Ilizarov technique was found to be useful to progressively lengthen the extremity, achieve union without bone grafting and to correct deformities in infected non-union with or without bone gap.

**Conflict of Interest: Nil**
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