Nat. Volatiles & Essent. Oils, 2021; 8(5): 1457 - 1462

NVEO
Natural Volatiles & Essential Oils

Management of Bone gaps in Tibia with Illizarov's Ring fixator Application: A case series of 23 cases

Suvarn Gupta[1], Anirudha Chandak[1*], Vasant Gawande[2], Kunal Saoji[3], Ashwin Chavan[4], Ankush Mohabey[5], Ashutosh Parate[6]

1 Assistant Professor, Department of Orthopaedics, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences Sawangi (Meghe) Wardha

1 Junior Consultant, Chandak Hospital, Gwalior*

2 Associate Professor, Department of Orthopaedics, Jawaharlal Nehru Medical College, Datta Meghe Institute of Medical Sciences Sawangi (Meghe) Wardha

3 Assistant Professor, Department of Orthopaedics, Datta Meghe medical College, Nagpur

4 Senior Resident, Department of Orthopaedics, Datta Meghe medical College, Nagpur

5 Assistant Professor, Department of Orthopaedics, Datta Meghe medical College, Nagpur

6 Junior Resident, Department of Orthopaedics, Datta Meghe medical College, Nagpur

Abstract

Introduction: Evaluation of outcome with Illizarov's ring fixator (IRF) in the surgical treatment of bone gaps in tibia was the motive of the study.

Patients and methods: In this prospective study, 23 patients with bone gaps due to trauma and infection were managed by Illizarov's fixator application. Transport of bone segment was done in all the patients having bone defects either primarily as a first line of management or secondarily preceded by primary surgery by some other modality.

Results: Bone union was achieved in all the fractures. Of all the cases, There were 10 cases with excellent results, 7 with good, and 5 with fair and 1with poor results. Functional result was found to be excellent in 6 cases, whereas there were 10 cases with good result, 6 showing fair results and 1 case with poor result.

Conclusion:

Illizarov's ring fixator is a one of the best method for treatment of bone gaps as our results were comparable with the literature. In our series, the functional result seems to be inferior to the bone result. It was also observed that a the patient showing excellent bone union which had a severe infection does not guarantee a satisfactory functional outcome.

Keywords: Illizarov's ring fixator, corticotomy, Infected Non-union

Research Paper:

Introduction

The most commonly fractured long bone is tibia and it is also a common site for non-union and infection. Owing to its location and lack of soft tissue coverage, tibia is more prone open fractures [1]. These fractures are more commonly found in developing countries as the industrial accidents and Road traffic accidents are numerous.

Non-union as well as infected non-union very challenging in the field of orthopedics and Illizarov's external fixation technique has been used for last 5 decades to tackle long bone infected non-union. One of the causes of failure of bone to achieve union may be due to biomechanical imbalance at the fracture site or an underlying infection in cases of compound fractures and in some cases it is idiopathic [1]. The presence of non-union in closed fractures of tibia is approximately 2.5% and chances of non-union increases five to seven times when there is open fracture involving soft tissue contamination and damage [2]. Sometimes, due to quick healing of the fibular fractures, the desired compression at the tibial fracture site is not attained thus adversely affecting the union [3–5].

Hence, while planning the compression or lengthening at the non-union site, fibulectomy is always done in cases with intact fibula to increase the stability to cause union [6]. Different treatment modalities for dealing with non-unions with infection of tibia are extensive debridement and rotational flaps, usage of

antibiotic cemented beads to pack the defects, bone grafting, synostosis of tibia and fibula and bone transplants [7]

The Illizarov's technique operates on principle of distraction osteogenesis and is used for segmental defects and bone gaps as well as to correct complex deformities and to treat shortening and contractures of joint by gradual and regular stretching of soft tissues and lengthening in patients having bone gaps. It can also stimulates bone repair often by distraction alone [8,9,10,11,12,13]. The main motive of this study was to evaluate the functional outcome and complications of this technique in dealing with bone gaps in infection, trauma and tumor.

Materials and methods

This was a prospective study which was carried out on 23 cases at Datta Meghe Medical College in association with Jawaharlal Nehru Medical College, between October 2019 and January 2021 within a study period of 13 months, after an official clearence from the institutional Ethical Committee. The inclusion criteria was patients showing non-union clinically as well as radiologically with or without a draining sinus; fresh trauma cases having compound wounds were also considered. Exclusion criteria was patients having neuro-vascular injuries or any other underlying disease which would interfere with union and post-operative management.

In the sample size of 23 cases, 19 males and 4 females were included. The mean age of the study population was 35 years (14–65). 18 patients of infected non-unions, 5 patients of trauma were included in the study. Out of 23 patients, 11 had previously undergone 1 surgery, 2 were operated twice and 4 patients got operated thrice out of which 2 patients had a previous history of treatment by Illizarov's fixator method, rest of the patients were fresh cases with the mean bone defect was of 8.5 cm (5 - 18). In fresh trauma, 4 were compound fractures and 1 was closed fracture. Discharge from the sinuses were sent for cultures pre-operatively and 9 cases showed *Staphylococcus Aureus*, 3 cases pseudomonas, 2 cases showed Klebsiella growth and *E. Coli* was seen in single case. 22 patients had 1 segment lengthening and 1 patient had two segment lengthening.

Simple fractures getting infected secondary to operative intervention are taken in Infection group. Compound injuries were taken in trauma group and these cases needed extensive debridement The Illizarov's fixator was applied after a mean duration of 35.5 weeks (20–120 weeks) after injury in cases of infected non unions. Distraction was begun on 7^{th} day of corticotomy at the rate of 1mm per 24 hours. Average rate of distraction was 12.5 days/cm (11.3 - 20). Average rate of consolidation was 19.3 days/cm (14.5 - 26). Lengthening index which is the total treatment time per cm of lengthening was 32 days/cm (28 - 44). Spinal anaestheisa was required in all the surgeries. Pre-operative designing of construct was done on the basis of clinical and radiological findings. Any hardware and sequestrum was removed and debridement of non-union site was carried out. In patients having intramedullary nail, reaming and irrigation of canal with normal saline was done .The average bone defect came out to be 8.5cm (5 - 18cm). Fibulectomy was done according to the site of non-union. Post-operatively,limb elevation was given and the neuro-vascular status (DNVS) of the lower limb was assessed. Usually Intravenous antibiotics were given upto 5^{th} post-operative day. Ceftriaxone, amikacin and metronidazole were commonly used antibiotics in this study. On the first post-operative day, pin sites and frame stability was assessed. The routine checking of pin sites were explained to patients relatives. Static quadriceps and ankle pumps exercises were initiated. Weight bearing was started second post-operative day. From the 7th post-operative day (range 7–9 day), distraction of 1mm per 24 hours was started. Follow up was done at regular interval of 6 weeks, 12 weeks and 6 months in which frame stability, pin site and range of motion of joints and complications were assessed and treated. Antero-posterior and lateral radiographs were taken advised for visualization of union and/or progression of regenerate.

Pin tract pain was found to be one of the commonest complication and it was graded according to Dahl's [14] grading which was as follows:

Grade I normal pin site.
Grade II inflamed.
Grade III inflamed with serous discharge.
Grade IV inflamed with purulent discharge.
Grade V inflamed with osteolysis.
Grade VI inflamed with ring sequestrum.

Maximus patients having grade II and III were given local care and for patients with grade above III, antibiotic therapy or changing the wire was done.

The regenerate was seen on the follow-up radiographs and was classified on Fernandez Esteve [15] grading for quality of regenerate which is described in literature as follows:

Grade I empty space between fragments without radio-opacity.
Grade II presence of haziness showing bony callus.
Grade III periosteal bridging present in at least one diaphyseal wall in both AP and lateral view
Grade IV periosteal bridging present in at least both diaphyseal wall in both AP and lateral view
Grade V structured callus is visible.

The quality of regenerate depends on

1. Stability of frame
2. Quality of corticotomy
3. Latency period
4. Rate of distraction
5. Rhythm of distraction
6. Function of limb
7. Time of frame removal

At fracture site, quality and condition of callus and visibility or disappearance of fracture lines were assessed. After visibility of structured callus the ring fixator frame was removed.

Observations and Results:

Assessment at follow-up results was done in accordance with Association for the Study and Application of the Method of Ilizarov (ASAMI) criteria which is globally accepted [16].

The criteria for determining bone results were as follows:

- An excellent result should include union (without bone grafting), Healing of infection (no infection), Status of deformity (deformity less than 7°), and Amount of residual shortening (leg-length inequality <2.5 cm);
- A good result, as union plus any two of the other three criteria;
- A fair result as union plus any one of the other criteria; and
- A poor result as union but none of the other three criteria, or non-union or re-fracture.

Excellent results were observed in 9, Good in 7, fair in 5 and poor in 2 cases.

The functional assessment of results was done on the basis of 5 criteria: a noticeable limp, knee or ankle stiffness, sympathetic dystrophy of soft tissue, pain causing decreased activity or disturbed sleep, inability to resume routine activities due to injury. Functional results were excellent in 6, good in 10, fair in 6 and poor in 1.

All the study population achieved desired bone length, union of the tibia and no signs of active infection or recurrence of infection was seen at the final follow-up. At the last review all but one patient were able to walk on their operated leg with or without an orthosis Lengthening index which is the total treatment time per cm of lengthening was 32 days/cm (28 - 44).

Complications

Pin site pain was commonest complication in our study and was seen in 18 patients. Local abscess was seen in 2 patients and loosening of wire was seen in a single patient. Three patients had delayed consolidation at the docking site. Knee and ankle joint stiffness was seen in maximum patient which was improved after removal of frame with gradual physiotherapy. varus/valgus angulations >7° was seen in 9 patients at final follow up.

Discussion

Bone gaps or non-union of long bones like tibia due to infection, trauma and tumors are challenging surgery in the field of orthopedics. In many fractures, inability to achieve union results due to mechanical instability or due to infection in compound fractures followed by osteomyelitis and bone loss, repeated requirement of surgical procedures, atrophy of soft tissues, decreased vascular supply, and decreased lymphatic drainage [17]. Bone defect formed due to debridement of necrotic/infected bone can be managed with simple/vascularized bone grafting and osteosynthesis. As per literature, bone grafting is successful in only 40% patients in the presence of infection [18]. Availability of autogenous bone graft is difficult and cancellous bone graft takes years to consolidate as cortex when infection is present [19]. Illizarov's fixator allows gradual resection of the infected bone, bone defect repair and provides stabilization to the bone thereby helping in consolidation while restoring the desired limb length. Patient is encouraged for mobilization and weight bearing within the first week after application of fixator.

According to study done by Schwartzman et al. [6], fibular osteotomy is almost always required to achieve compression at fracture site and bone lengthening. Pin tract inflammation was commonest complication as was seen in other studies as well [20]. In our study, we recommended open pin site care and patients attendants were taught pin site dressing as it is easier to observe signs of infection in closed pin site dressing. The high percentage of pin site inflammation in our study is probably due to lower socio-economic status of the study population resulting negligence of pin site dressing. It leads to loosening of wires and instability of the frame. Pin site pain causes decreased weight bearing mobilization of the patients. Hence, proper pin site dressing is very important factor in functional outcome. The healing index was 32 days/cm (28 - 44). Similar results were obtained by other studies in literature. [12,13]

All the patients in the study were completely relieved form the infection. In our series, the functional result seems to be inferior to the bone result. However, it should be emphasized that our series included many complicated cases. Patients with severe infection having good bony union does not assure a good functional result.

Except two patients, bony union of fracture was attained in all patients, These two patients showing signs of delayed union were smokers. Same results were seen by others [21].

Our overall bone results were excellent in 9, good in 7 and fair in five and poor in 2. Functional results were excellent in 6 (35%), good in 10 (42%), fair in 6 (19%) and poor in one (4%). Our results compared favourably with those of the Goldstrohm, Weiland and Paley.

Some of the results obtained by different studies were, Dendrinos et al. [22] in his patients had 50% excellent and 18% poor results. Mugadum et al. [23] in a study 76% excellent results. These results were comparable to our results. All the patients started to walk and bear weight immediately after the

application of the ring fixture. Ilizarov's considered this as an essential principle of his method. 12 of our patients were able to return to their work during the treatment period.

Conclusion:

Though the study was not free of complications, all the patients of the study were satisfied with the results. Illizarov's ring fixator is a good treatment option in tibia non-union. It helps in control of infection as well as restores the tibial length. Moreover, illizarov's fixation helps in early mobilization and decreases morbidity due to immobilization.

REFERENCES:

1. Frost HM (1989) The biology of fracture healing; an overview for clinicians. Part II. Clin Orthop Relat Res 248, 294–309. [PubMed]
2. Phieffer LS, Goulet JA (2006) Delayed union of tibia (instructional course lecture). J Bone Joint Surg Am 88-A, 205–216. [PubMed]
3. Delee JC, Heckman JD, Lewis AG (1981) Partial fibulectomy for un-united fractures of the tibia. J Bone Joint Surg Am 63A, 1390–1395. [PubMed]
4. Jorgensen TE (1974) The influence of the intact fibula on the compression of a tibial fracture or pseudoarthrosis. Acta Orthop Scand 45, 119–129. [PubMed]
5. Sorensen KH (1969) Treatment of delayed union and non-union of the tibia by fibular resection. Acta Orthop Scand 40, 94–104. [PubMed]
6. Schwartzman V, Choi SH, Schwartsman P (1990) Tibial nonunions. Treatment tactics with the Ilizarov method. Orthop Clin North Am 21, 639–653. [PubMed]
7. Dell P, Sheppard JE (1984) Vascularised bone grafts in the treatment of infected forearm non-unions. J Hand Surg 9A, 623.
8. Cattaneo R, Catagni M, Johnson EE (1992) The treatment of infected nonunions and segmental defects of the tibia by the methods of Ilizarov. Clin Orthop 280, 143–152. [PubMed]
9. Paley D, Chandroy M, Pirone AM, Lentz P, Kantz D (1990) Treatment of malunions and mal-nonunions of the femur and tibia by detailed preoperative planning and the Ilizarov technique. Orthop Clin North Am 21, 667–691. [PubMed]
10. Ilizarov GA (1990) Clinical application of the tension-stress effect for limb lengthening. Clin Orthop Relat Res 250, 8–26. [PubMed]
11. Saleh M, Royston S (1996) Management of nonunion of fractures by distraction with correction of angulation and shortening. J Bone Joint Surg Br 78 - B, 105 –
109. [PubMed]
12. Kawoosa AA, Majid S, Mir MR, Mir GR (2003) Results of tibial lengthening by Ilizarov technique. Indian Journal of Orthopaedics 37, 7.
13. Wani N, Baba A, Kangoo K, Mir M (2011) Role of early Ilizarov ring fixator in definitive management of type II, IIIA and IIIB, open tibial shaft fractures. Int Orthop 35(6), 915–923. [PM C fre e article] [PubMed]
14. 38. Brij Raj Singh, Nandkishor Bankar, Dr. Ranjit S. Ambad, Dr. Ujwal Gajbe. AGE DETERMINATION FROM EPIPHYSEAL UNION OF BONES OF ANKLE JOINT IN GIRLS BY THE ROENTGENOGRAPH "GOLD STANDARD METHOD. Journal of critical reviews, Vol 7, Issue 8, 2020; 1093-1095.
15. Catagni M (1991) Imaging techniques: the radiographic classification of bone regenerate during distraction, in Operative Principles of Ilizarov. Maiocchi AB, Aronson J, Editors London, Williams and Wilkins, pp. 53–57.

16. Association for the Study and Application of the Methods of Ilizarov Group (1991) Nonunion of the femur, in Operative Principles of Ilizarov fracture treatment, nonunion, osteomyelitis, lengthening, deformity corrections. Maiocchi AB, Aronson J, Editors Baltimore, Williams and Wilkins, pp. 245–262.
17. DiPasquale D, Ochsner MG, Kelly AM, Maloney DM (1994) The Ilizarov method for complex fracture nonunions. J Trauma 37(4), 629–634. [PubMed]
18. Wood MB, Cooney W P, Irons GB (1985) Skeletal reconstruction by vascularized bone transfer: indications and results. Proc Mayo 60, 729. [PubMed]
19. Ilizarov GA (1989) The tension-stress effect on the genesis and growth of tissues: part II. The influence of the rate and frequency of distraction. Clin Orthop Relat Res 239, 263–285. [PubMed]
20. Green SA, Jackson JM, Wall DM et al. (1992) Management of segmental defects by the Ilizarov intercalary bone transport method. Clin Orthop Relat Res 280,
136. [PubMed]
21. Marsh DR, Shah S, Elliott J, Kurdy N (1997) The Ilizarov method in nonunion, malunion and infection of fractures. J Bone Joint Surg Br 79-B, 273–279. [PubMed]
22. Dendrinos GK, Kontos S, Lyritsis E (1995) Use of the Ilizarov technique for treatment of non-union of the tibia associated with infection. J Bone Joint Surg Am 77-A(6), 835–846. [PubMed]
23. Magadum MP, Basavaraj Ya dav CM, Phaneesha MS, et al. (2006) Acute compression and lengthening by the I l izarov technique for infected nonunion of the t ibia with large bone defects. J Orthop Surg 14(3), 273–279. [PubMed]

CLINICAL FEATURES:

28 years old male c/o Non-union fracture tibia (9 months old).
A] Radiograph showing signs of non-union in tibia with external fixator in situ.
B] Post-operative Radiograph showing Illizarov's fixator in situ
C] Post-operative Radiograph showing Illizarov's fixator in situ after distal corticotomy.
D] After removal of Illizarov's fixator.
E] Follow-up radiograph at final follow up after union.