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Original Research Article

Management and outcome of gap non-union of tibia by ilizarov ring fixator

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ABSTRACT

Background: Road traffic accidents are of growing public health importance worldwide, contributing significantly to the global disease burden. Associated bone tissue defect and infection, commonly result in development of infected non-union. Non-union of long bones especially tibia when associated with infection has always been a challenge to orthopaedic surgeons. Bony union is not usually contained until the infection has been eradicated and there are usually coexisting problems of deformity.
Objective: The objective of the study was, to evaluate Ilizarov fixator method in the treatment of gap non-union.
Materials and Methods: A descriptive study was conducted on 25 patients admitted in Orthopaedic Department of Index Medical College, Hospital & Research centre, Indore from November 2022 to February 2024. Pre operative & post operative x-rays were done in each case. Debridement followed by fixator assembly and Uni-focal or bi-focal osteotomy followed by transport was done.
Results: Out of 25 patients, 23 were male and 2 were female. The mean age of patients was 38years, with 60% being in 30-40years age group. The patients with grade II open fractures 11, grade IIIA were 6, grade I were 5 and patients with closed fracture were 3. Maximum of non-union were in the region of diaphysis and metaphysis. Our results showed that 76% of the patients has excellent or good results, of bone union. There were 48% excellent, 28% good, 16% fair and 08% poor functional results in our study. There were no failures in our study. Most common post-operative complications we came across is pin tract infection and equinus. Nearly all the complications were managed and outcome was good in these cases except for 2 cases wherein there were non-union, in which results were poor.
Conclusion: Ilizarov ring fixator is an excellent treatment modality for gap non-union of tibia, in terms of union.

1. Introduction

Complex long bone fractures—particularly those of the tibia—are becoming more common as a result of the growth of the transportation sector and the progress of industrialization.[1] Bone defects can result from trauma (car accidents, fire injuries, falls, etc.), the removal of a diseased section (infection), or the disease process itself (tumour). When addressing gap non-union, it is important to address both of the two main issues: non-union and bone loss. Because of the impaired vascularity, bone loss, and soft tissue injury at the fracture site, tibial non-unions with a gap pose special complications. In order to encourage union, these elements impede the normal process of bone healing and need for intervention. Dr Gavriil Ilizarov, a Russian orthopaedic surgeon, created the Ilizarov ring fixator, which offers a dynamic approach to fracture care by increasing biological stimulation of

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bone regeneration through the concepts of distraction osteogenesis and offering regulated mechanical stability. Although there are a number of methods for treating tibial non-union with bone abnormalities that resulted in amputation, the rate of limb amputation has decreased since the advent of methods like Ilizarov osteosynthesis.[2]

2. Materials and Methods

Aim of our study is "To Prospectively assess the radiological and Functional outcome of management of gap non-union of the tibia using Ilizarov ring fixator." A prospective study on topic "management and outcome of gap non-union of tibia by Ilizarov Ring Fixator" was done at Index Medical College, Hospital and Research Centre, Indore (M.P) in time frame of November 2022 to February 2024 in 25 patients. Inclusion criteria in our study was, Age > 18years and < 60years, all patients with gap non-union, psychological stable patients and patients/legally accepted representative willing to provide written/informed consent and exclusive criteria was acute fractures, patients with pathological fractures, patients unable to take selfcare, patients with non-compliance for long duration of fixators, patients with psychiatric Illness, patients/legally accepted representative not willing to provide written/informed consent.

In the event of a chronic infection, debridement was carried out and the material was sent for sensitivity and culture testing. In each case, a free-hand method was employed to apply the Ilizarov-based ring fixator. In each segment, the wires were installed in the designated safe areas. When intraoperative deformity correction proved unfeasible, hinges were positioned appropriately to enable progressive postoperative correction. In each instance, a corticotomy was performed. After soaking gauze pieces in povidone iodine, the pin locations were dressed with a rubber stopper. Sterile gauze was used to treat the wounds from the debridement, fibulectomy, and corticotomy procedures. To avoid oedema, the limb was kept in elevation after surgery.

The status of the distal neurovascular system was continuously observed. Six dosages of intravenous Cefuroxime were prescribed. Oral and intravenous antibiotics were then administered for a duration of three weeks, depending on the culture and sensitivity results. Patients were taught how to apply pin tract dressing using spirit or povidone iodine, and they were encouraged to perform it on their own. Before beginning the distraction, a latent period of seven days was granted. Following the latent phase, distraction was initiated at the corticotomy site at a rate of 1 mm/day, or 0.25 mm every six hours. The patient was told to use two crutches and increase his/her weight bearing gradually when walking. The frame has a foot orthosis fastened to it.[3]

Eventually, the support was reduced to just one crutch, and then the patient was allowed to bear their whole weight on their own. Ankle and knee physical therapy was started. Adjusting the speed of distraction was done based on regenerate appearance on follow-up radiography. The rate of compression was reduced to 0.25 mm/3days after docking. In any instance, there was no bone transplantation.

Based on radiological and clinical standards, Union was evaluated. Clinical criteria included the lack of discomfort and soreness at the docking site and the absence of aberrant mobility, which was determined by moving the bone segments and detaching the rings on either side of the docking site. The emergence of trabecular continuity and the consolidation of regeneration in at least three of the four cortices were the radiological criteria that were applied.

A patellar tendon bearing cast was given to a few patients following the removal of the frame, allowing them to bear their entire weight for three weeks. Following the cast's removal, the patient was permitted to walk alone. Functional outcomes and bone healing were used to evaluate the management's overall success.[3] According to ASAMI standards, when union was attained together with the absence of infection, a deformity < 7°, and a disparity in limb length of less than 2.5 cm, the bone healing was rated as excellent. When there was a union and at least two of the other three requirements were met, it was rated as good; when only one of the three requirements was met along with the union, it was rated as fair. A persistent or recurring illness combined with nonunion was seen as a bad outcome.[4]

According to the ASAMI criteria, the functional outcomes were rated as satisfactory when the patient was mobile, had no discomfort, no limp, little stiffness (<15° knee flexion deformity/15° loss of ankle dorsiflexion), and no reflex sympathetic dystrophy (RSD). When the patient was active and had one or two of the following symptoms: a limp, stiffness, RSD, or significant pain, it was graded as good; when three or more of the following symptoms were present: a limp, stiffness, RSD, or significant pain; a poor result occurred when the patient was unemployed, inactive, or unable to perform activities of daily living because of the injury. An amputation was viewed as unsuccessful. The patients were monitored for a mean of 17 months throughout a period of 14 to 22 months.[4]

3. Observations and Results

Table 1: Age distribution

Age group	No. of patients	Percentage
20-30 years	04	16%
31-40 years	13	52%
41-50 years	05	20%
51 and above	03	12%

The mean age of patients was 37.8 years with 60% being in 30-40 years age group.

Table 2: Sex distribution of the patients

Sex	No. of patients	Percentage
Male	23	92%
Female	02	08%

Table 3: Evaluation of bone result, based on ASAMI scoring system

Bone Result	No. of patients	Criteria	%
Excellent	10	Union, no infection, deformity <7 degree, limb length discrepancy (LLD) < 2.5cm	40%
Good	9	Union plus two of any of the following; absence of infection, deformity <7 degree, LLD < 2.5cm	36%
Fair	4	Union plus anyone of the following; Absence of infection, deformity <7 degree, LLD < 2.5cm	16%
Poor	2	Nonunion/refracture/union plus infection plus deformity >7 degree, LLD > 2.5cm	08%

There were almost 76% of the patients showing excellent plus good bone results i.e. 40% and 36% respectively. Excellent and good bone results together were considered as good outcome i.e. 76%.

Table 4: Functional results of patients based on ASAMI scoring system

Grade	No. of patients	Criteria	%
Excellent	12	Active, no limp, minimal stiffness [loss < 15-degree knee extension/15-degree dorsiflexion of ankle] no reflex sympathetic dystrophy (RSD), insignificant pain.	48%
Good	7	Active with one or two of the following: limp, stiffness, RSD, pain.	28%
Fair	4	Active with three over all of the following: Limp, stiffness, RSD, pain.	16%
Poor	2	Inactive (unemployment or inability to return to daily activities due to injury)	08%
Failure	0	Amputation	-

There were 48% excellent, 28% good, 16% fair and 08% poor results in our study. There were no failures in our study. Excellent and good results were considered as good outcome.

Most common post-operative complications we came across is pin tract infection and equinus. Nearly all the complications were managed and outcome was good in these cases except for 2 cases wherein there were non-union, in which results were poor.

Table 5: Post operative complications

Complications	No. of patients
Pin Tract infection	7
Post operative edema	5
Nerve injury/Neurological deficit	0
Dermatitis	3
Equinus	7
Joint stiffness/Knee contracture	2
Persistent infection	2
Non-union	2

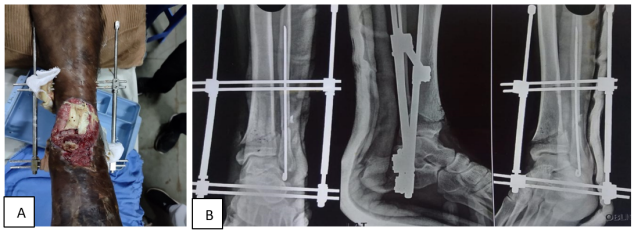

Figure 1: (**A**) Clinical (**B**) X-ray at the time of presentation

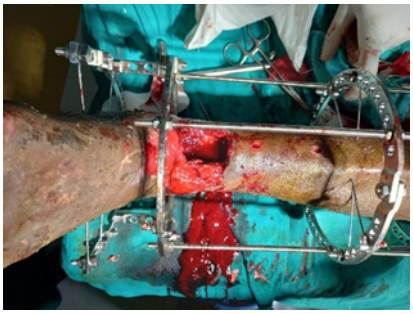

Figure 2: Intra-op

4. Discussion

Our study comprises 25 instances, with an average age of 38 years. Results from several additional studies have been comparable. Magadum et al (2006),[5] Sachin R Jain et al (2012),[6] Xie J et al (2021),[7] Agrawal(2022),[8] Kumar A. (2024)[9] with an average age of 39 years, 38.87 years, 37.5years, 36.5 years, 35.75 years respectively. Given that this age group is the most active and mobile, this is also predicted.

Man, predominance in RTA (Road Traffic Accidents) can indeed be influenced by societal factors such as gender roles and occupational patterns. Our study is also male predominant with 23 males and 2 females like others. Male to Female Ratio in different studies are: P Yin

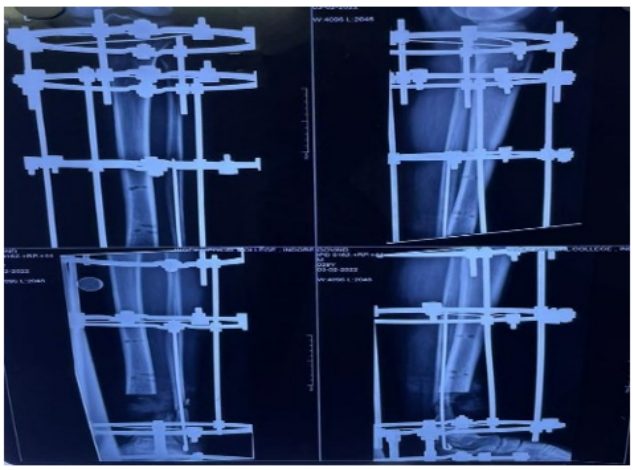

Figure 3: Immediate post-op

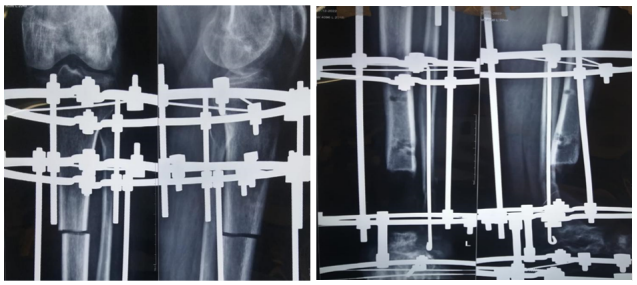

Figure 4: Post corticotomy

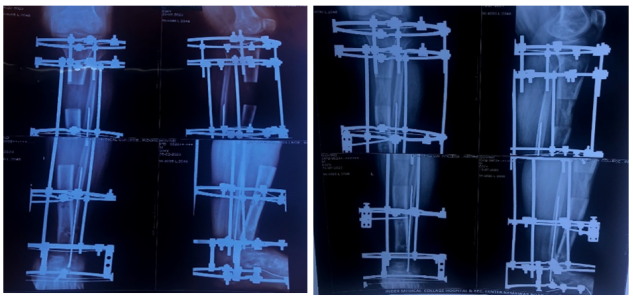

Figure 5: Follow up

et al (2014)[10] 62:4, Vel. Sarath (2016),[11] 17:3, Rohilla (2016)[12] 30:5, Amit Kumar Sharma, Jayant Sharma (2017)[4] 13:3, Hrishikesh P (2017)[13] 16:2.

In our study right side is commonly more involved as compared to left side i.e. 16 right sided and 09 left sided which is quite similar in studies of Farmanullah et al. (2007),[14] Paresh et al (2022),[15] N Gaurav (2023)[16] as well. These are mere a coincidence or a point to further research about the right-side predominance.

Initial trauma in majority of patients in our study were due to RTA i.e. 19, rest due to fall from height and simple fall. The series of Farmanullah et al (2007),[14] Vel. Sarath et al (2016),[11] G. Testa et al (2020),[17] Paresh (2022)[15] also

Figure 6: Post removal

Figure 7: Post removal reasonable rom

had same findings.

Mean time of union in our study is 8.5 months. There is very discrete data on mean time of union in different studies. The studies of Rajesh Chandra et al (2001),[18] Vel. Sarath et al (2016),[11] Hrishikesh Pande et al (2017),[13] Paresh et al (2022)[15] have similar results but studies of Paley D, Cattaneo R (1989),[19] Patil S (2006)[20] had opposite results.We can deduce from above data that mean time to union depends on various factors including environmental, patient and surgeon dependent and the results of various studies rely on that too.

In our study, case series of 25 patients, Average time in the fixator was 241 days i.e., approximately 8 months. There are various studies which showed similar results. Krishnan A (2006):[21] 234 days, Madhusudan et al (2008):[22] 279 days,P Yin et al (2014):[10] 284 days, Vel. Sarath (2016):[11] 240 days. In all our cases the assembly removal was done post union and dynamization except two cases in which union was delayed.

Evaluation of bone result was based on ASAMI scoring system, and in our study, results was excellent in 10, good in 9, fair in 4 and poor in 2 patients. In series of Krishnan A, Pamecha C, Patwa J[21] Excellent: Good: Fair: poor fraction is 13:4:1:2, Patil, S., & Montgomery, R. (2006)[20] is 17:14:4:6, Amit Kumar Sharma, Jayant Sharma (2017)[4] 11:4:0:1, Kumar A et al.(2024)[9] 16:7:5:2.

In terms of functional results which was also based on ASAMI scoring and the fraction of Excellent: Good: Fair: Poor: Failure is 12:7:4:2 with no failure. 2013 Mohammad Shahid[23] 6:4:2:2, Hrishikesh Pande (2017)[13] 7:6:3:1:1, Amit Kumar Sharma, Jayant Sharma (2017)[4] 10:4:0:2, Kumar A et al. (2024)[9] 15:6:5:4.

5. Conclusion

Though the study was not free of complications, all the patients of the study were satisfied with the results. But good to excellent functional outcomes can be achieved in majority of patients. Ring fixator systems reliably achieve union in infected large bone defects of tibia and help in treating infection, shortening, bone and soft tissue loss simultaneously. We advocate early freshening of fracture ends and removal of interposed soft tissue at docking sites to achieve union. This prevents the need of bone grafting. The transporting fragment carries overlying skin along with-it during distraction, thus avoiding the need of flap or skin grafting. Ilizarov's ring fixator is a good treatment option in tibia non-union with bone defect. It helps in control of infection as well as restores the tibial length. Moreover, Ilizarov's fixation helps in early mobilization and decreases morbidity due to immobilization.

6. Ethical Considerations

All patients gave written informed consent to be included in this study, and the study was authorized by the local ethical committee carried out in accordance with the Code of Ethics of the World Medical Association.

7. Source of Funding

None.

8. Conflict of Interest

The authors have none to declare.

References

1. Pal CP, Kumar H, Kumar D, Dinkar KS, Mittal V, Singh NK. Comparative study of the results of compound tibial shaft fractures treated by Ilizarov ring fixators and limb reconstruction system fixators. *Chin J Traumatol*. 2015;18(6):347–51.
2. Khan MA, Saqib M, Khan MI, Karam F, Ali A. Management of gap non union by bone transport of tibia using Ilizarov fixator. *Pak J Surg*. 2013;29(4):281–4.
3. Sharma J, Upadhyaya P. Basic Principles of Ilizarov Surgery. 2nd ed. Delhi, India: IP Innovative Publications; 2022.
4. Sharma AK, Sharma J. Role of distraction compression Osteogenesis by Ilizarov ring fixator in complex non-union of long bones. *Indian J Orthop Surg*. 2017;3(1):1–5.
5. Magadum MP, Yadav CMB, Phaneesha MS, Ramesh LJ. Acute compression and lengthening by the Ilizarov technique for infected nonunion of the tibia with large bone defects. *J Orthop Surg (Hong Kong)*. 2006;14(3):273–9.
6. Jain SR, Shah HM, Shetty N, Patel M, Tekkati RK, Khanna A. Study of efficacy of ilizarov external fixation in infected non union tibial fractures. *J Med Thesis*. 2014;2(1):16–8.
7. Xie J, Zhao G, Yasheng T. Ilizarov bone transport to treat infected non-union of long bones: a multicenter retrospective cohort study. *J Int Med Res*. 2021;49(3):03000605211002701.
8. Agrawal AK, Puram CP, Mutha YM, Mehta VJ, Arora S, Golwala P. Surgical and functional outcomes of infective non-union of femur and tibia using Ilizarov ring fixator. *J Limb Lengthening Reconstr*. 2022;8(2):130–7.
9. Kumar A, Kumar R, Shankar A, Kumar R. An evaluation of effectiveness of Ilizarov external fixation in treating infected non-union tibial fractures: a prospective observational study. *Int J Res Med Sci*. 2024;12(3):771–6.
10. Yin P, Zhang Q, Mao Z, Li T, Zhang L, Tang P. The treatment of infected tibial non-union by bone transport using the Ilizarov external fixator and a systematic review of infected tibial non-union treated by Ilizarov methods. *Acta Orthop Belg*. 2014;80(3):426–35.
11. Sarath V, Venkateswarlu C, Rao BN, Sreeram RS. A study on functional outcome of Ilizarov fixation in the management of infected non-union of long bones. *J Evol Med Dent Sci*. 2016;5(3):225–8.
12. Rohilla R, Siwach K, Devgan A, Singh R, Wadhwani J, Ahmed N. Outcome of distraction osteogenesis by ring fixator in infected, large bone defects of tibia. *J Clin Orthop Trauma*. 2016;7:201–9.
13. Pande H, Singh CM, Prabhakara A, Philipa VM, Iqbal MS, Sharma Y. Management of complex long bone nonunions using limb reconstruction system. *Int J Res Orthop*. 2017;3:557–64.
14. Farmanullah, Khan MS, Awais SM. Evaluation of management of tibial non-union defect with Ilizarov fixator. *J Ayub Med Coll Abbottabad*. 2007;19(3):34–6.
15. Agrawal AK, Puram CP, Mutha YM, Mehta VJ, Arora S, Golwala P. Surgical and functional outcomes of infective non-union of femur and tibia using ilizarov ring fixator. *J Limb Lengthening Reconstr*. 2022;8(2):130–7.
16. Nain G. A study to evaluate the functional and radiological outcome of the Ilizarov ring fixator in the treatment of infected non-union fracture shaft of Tibia. *Int J Orthop Sci*. 2023;9(3):24–8.

17. Testa G, Vescio A, Aloj DC, Costa D, Papotto G, Gurrieri L, et al. Treatment of Infected Tibial Non-Unions with Ilizarov Technique: A Case Series. *J Clin Med*. 2020;9(5):1352.
18. Chandra R, Swamy MK, Sharma V, Murthy B, Rao K. Treatment Of Difficult Tibial Non-union By Ilizarov Method. *Indian J Orthop*. 2001;35:245.
19. Paley D, Catagni M, Argnani F, Villa A, Bijnedetti G, Cattaneo R. Ilizarov treatment of tibial nonunions with bone loss. *Clin Orthop Relat Res*. 1989;(241):146–65.
20. Patil S, Montgomery R. Management of complex tibial and femoral nonunion using the Ilizarov technique, and its cost implications. *J Bone Joint Surg Br*. 2006;88(7):928–32.
21. Krishnan A, Pamecha C, Patwa JJ. Modified Ilizarov technique for infected non-union of the femur: the principle of distraction-compression osteogenesis. *J Orthop Surg (Hong Kong)*. 2006;14(3):265–72.
22. Madhusudhan TR, Ramesh B, Manjunath K, Shah HM. Outcomes of Ilizarov ring fixation in recalcitrant infected tibial non-unions - a prospective study. *J Trauma Manag Outcomes*. 2008;2(1):1–6.
23. Khan MS, Rashid H, Umer M, Qadir I, Hafeez K, Iqbal A. Salvage of infected non-union of the tibia with an Ilizarov ring fixator. *J Orthop Surg (Hong Kong)*. 2015;23(1):52–5.

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