

## Original Research Article

# Ilizarov's technique outcome in non-union tibial fracture

Anuranjan Dubey<sup>1</sup>, Ashish Kumar Ragase<sup>2\*</sup>

<sup>1</sup>Department of Orthopedics, Government Medical College, Ambikapur, C.G, India

<sup>2</sup>Department of Orthopedics, Raipur Institute of Medical Sciences, Raipur, C.G, India

**Received:** 20 May 2021

**Accepted:** 31 May 2021

### \*Correspondence:

Dr. Ashish Kumar Ragase,

E-mail: [drashish1912@gmail.com](mailto:drashish1912@gmail.com)

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## ABSTRACT

**Background:** Tibia being a superficial bone of the body and vulnerable to trauma, often becomes fractured among all long bone fractures. Tibial surface is subcutaneous most of its length so open fractures are common.

**Methods:** The present cross sectional study was conducted on 20 patients attending the outpatient department Of Orthopedics, Government Medical College and Hospital, Ambikapur, Sarguja (C.G) India between September 2020 to February 2021. Patients within the age group of 18-60 years, having fracture of any duration with gap non union and those having duration of fracture more than 36 weeks without bony gap were included in the study. Details of Patient's characteristics concerning primary injury and treatment were recorded and evaluation of results were based on Paleys criteria.

**Results:** In bone/radiological results, seven were classed as excellent, eleven as good with the remainder of 2 being fair and poor each. Functionally nine were graded as excellent, nine as good and two as fair and poor each.

**Conclusions:** It was found that Ilizarov ring fixator is an excellent treatment modality for tibial non-union with infection. However the technique requires long treatment follow up. Multiple interventions may be necessary to overcome the difficulties which come across the treatment.

**Keywords:** Ilizarov, Tibial non union, Osteomyelitis, Bone and functional score

## INTRODUCTION

Fracture nonunion accounts for a small percentage, they cause a surgeon stress, anxiety, and frustration. Nonunion may be anticipated following a severe traumatic injury, such as an open fracture with segmental bone loss. They also may occur following a low-energy fracture apparently destined to heal. It is a chronic medical condition associated with functional deformity, often accompanied by Psychosocial disability.<sup>1</sup> Managing becomes further difficult with wide variations in patient's response to various stresses.<sup>2</sup> 90-95% of all fractures heal well. Non-union accounts for a small percentage of cases where biological process of fracture repair could not overcome the local biology and mechanics of the bony injury.<sup>3</sup>

Tibia being a superficial bone of the body and vulnerable to trauma, often becomes fractured among all long bone fractures. Tibial surface is subcutaneous most of its length so open fractures are common. The blood supply to the tibia is more precarious than that of bones enclosed by heavy muscles.<sup>4</sup> High-energy tibial fractures can be associated with compartment syndrome, neural or sometimes vascular injury further leading to delayed union, non-union, and infections.

The U.S. Food and Drug Administration (FDA) defines a nonunion as a fracture that is at least 9 months old and without any signs of healing for 3 consecutive months.<sup>5</sup> Muller's definition is failure of a (tibia) fracture to unite after 8 months of non operative treatment.<sup>6</sup> These two definitions are widely utilized. For practical purposes non-union is a fracture that, in the opinion of the treating

physician, has no possibility of healing without a further intervention.

Infection in the zone of fracture increases the risk of non union.<sup>7</sup> Infection may result in instability at the fracture site as implants loosen in infected bone. Avascular, necrotic bone at the fracture (sequestrum) decreases potential of union. Infection also produces poor bony contact as osteolysis at the fracture site results from in growth of infected granulation tissue.<sup>8</sup>

Most common offending agent is *Staphylococcus aureus*.<sup>8</sup> Others being *Klebsiella*, *Streptococcus*, *Enterococcus*, and *pseudomonas* are other common gram negative bacteria responsible. In open fracture however majority of bacteria are nosocomial. So immediate culture of the wound may not prove fruitful. Several other problems occur in long standing infection such as chronic infection with discharging pus, fracture site indicating presence of sequestrum and cavity, Shortness of the bone, etc.

With the above background, the present study was conducted to assess the bony and functional outcome of non-union of tibia treated with Ilizarov ring fixators using Paley's Criteria and to Identify the problems, obstacle and complications during the course of treatment.<sup>9</sup>

## METHODS

The present cross sectional study was conducted on 20 patients attending the outpatient Department of Orthopedics, Government Medical College and Hospital, Ambikapur, Sarguja (C.G) India between September 2020 to February 2021. Patients within the age group of 18-60 years, having fracture of any duration with gap non union and those having duration of fracture more than 36 weeks without bony gap were included in the study. Patients who are not willing to undergo the surgical procedure after explaining the course and prognosis of treatment, patients with head injury and its residual morbidity and with neurological and vascular injuries were excluded. Ethical consideration was made through Institutional ethical committee and informed consent was taken from the subjects prior to study.

Investigations done were X-ray, CT scan, MRI, Radionuclide scanning. Also details of patient's characteristics concerning primary injury such as age, sex, limb affected, type of trauma, fracture type, type of fracture care after initial injury, etc and Ilizarov treatment parameters such as fracture age, type of non-union, infected or not, Length of bone loss, Corticotomy done or not, lengthening achieved, duration of fixator applied, complications occurring during and at the end of treatment were recorded and evaluation of results were based on Paley's criteria.<sup>9</sup> Data was recorded in MS excel and checked for its completeness and correctness then it was analysed by using suitable statistical software and  $p < 0.05$  was considered as a statistically significant.

## RESULTS

In our study, the age range of the patients was 32-60 years with a mean of 42.8 years and M:F ratio was 16:4. Out of total 20 patients, 14 (70%) patients had right leg involved. Out of total 20, 11 cases had non union site in distal 3<sup>rd</sup>, 6 cases in middle third and 3 cases in upper 3<sup>rd</sup>.

**Table 1: Patients demographic.**

Features	Variant
Age (range)	42.85 (32-60)
Gender (M:F)	16:4
Side of limb injured - Right/Left	14/6
Site of the tibia involved- upper third/middle third/lower third	3/6/11
Type of primary injury - closed/grade 1/grade 2/grade 3	2/2/6/10
Paleys type of non-union - C1/C2	13/7
Period of non union (in months), mean/median, (Range)	12.5/11.5, (9-23)
Amount of bone gap after debridement (in cm), mean, (Range)	3.125 (1-5)
Limb length discrepancy (in cm), mean, (Range)	0.82 (0-3)
Lengthening index, (in cm), mean, (Range)	2.265, (1.8-3)
Period of Ilizarov fixator (in months), mean/median, (Range)	5/5, (2 - 9)
Follow-up time (in months), mean/median, (Range)	6.45/6, (3-10)

13 cases belonged to Paley's type C1 and 7 cases belonged to Paley's type C2 of classification of infected non union. Based on the type of injury 2 (10%), 2 (10%), 6 (30%) and 10 (50%) were closed, grade 1, grade 2 and grade 3 compounding respectively. The mean time of non union was 12.5 months (range 9-23/median 11.5), average lengthening index was 2.265 months per cm and the mean period of Ilizarov fixator was 5 months (range 2-9 / median 5). The average follow up time was 6.45 months (range 3-10/median 6). The average limb length discrepancy was 0.82 cm (0-3) and amount of bone gap after debridement was 3.125(1-5) (Table 1).

Out of total 20 patients, 16 (80%) were due to road traffic accident and 4 (20%) patients fell from height. Prior to application of fixator there was external fixator in 13(65%) cases, intramedullary nail in 3 (15%) cases, Enders nail in 2 (10%) cases and 2 (10%) cases had no implant. Monofocal osteosynthesis was done in 19 (95%) cases and Accordion maneuver was carried out in 1 (5%) case. Problems encountered were poor quality of regenerate in 4 (20%) cases, delayed appearance of regenerate in 6 (30%) cases and pin tract infection in all the 20 (100%) cases. Wire infection was treated with wire change in 8 (40%) cases, wire breakage occurred in 3 (15%) cases, refracture during period of treatment in 1 (5%) case. At the end of treatment there was persistent non union in 1 (5%) case

and 1 (5%) case had infection. Eight had an appreciable ankle stiffness and eight had angular deformity more than 7 degree. Significant limb length discrepancy was seen in 3 cases. Reflex sympathetic dystrophy (RSD) in 5 cases. Pain after removal of fixator in 8 cases. Four had an obvious limp (Table 2).

**Table 2: Clinical data of the patients before the treatment.**

Features		N (%)
<b>Mode of injury</b>	Road traffic accident	16 (80)
	Fall from a height	4 (20)
<b>Implants prior to frame application</b>	External fixator	13 (65)
	Intramedullary nail	3 (15)
	Enders nail	2(10)
	No implant	2 (10)
<b>Type of osteosynthesis</b>	Monofocal osteosynthesis	19 (95)
	Accordion maneuver	1 (5)
<b>Problem</b>	Poor quality of regenerate	4 (20)
	Delayed appearance of regenerate	6 (30)
	Pin tract infection	20 (100)
<b>Obstacles</b>	Wire infection needing change of wire	8 (40)
	Breakage of wire needing change of wire	3 (15)
	Refracture after union	1 (5)
<b>Complications</b>	Persistent infection	1 (5)
	Persistent non union	1 (5)
	Ankle stiffness	8 (40)
	Angular deformity more than 7 degree	8 (40)
	Limb length discrepancy more than 2.5 cm	3 (15)
	Reflex sympathetic dystrophy	5 (25)
	Pain upon removal of fixator	8 (40)
	Limp	4 (20)

**Table 3: Bone and functional results.**

Results	Bone results score	Functional results score
<b>Excellent</b>	7	9
<b>Good</b>	11	9
<b>Fair</b>	1	1
<b>Poor</b>	1	1

Based on Paley's evaluation criteria, bony and functional results were assessed. In bone/radiological results, seven were classed as excellent, eleven as good with the remainder of 2 being fair and poor each. Functionally nine were graded as excellent, nine as good and two as fair and poor each (Table 3).

## DISCUSSION

Infected nonunion of a long bone remains a therapeutic challenge. Such patients usually have had numerous previous surgical interventions, resulting in bone defects and soft-tissue compromise. A vast majority of it 16 (80%) were males while 4 (20%) were females, this was comparable to study conducted by Cattaneo in which out of 28 people 22 were males and females were 6 (22%) whereas a study done by Hosny et al on 11 patients 8 (72%) patients were males and 3 (28%) were females. This occurrence may however occur due to generalized lower prevalence of fracture in females. The mean age of patients in our study was 43 years whereas Hosny et al reported mean be to be 27 years and Cattaneo et al in their study on 28 patients reported the mean age to be 34 years.<sup>10,11</sup>

The cause of initial trauma was road traffic accident in 16 (80%) patients while in 4 (20%) patients it was due to fall. Farmanullah et al in their study of 58 patients found motor vehicle accident injury to be major cause of trauma (46%) while fall from height or twisting injury of leg was found in 13% of the patients.<sup>12</sup> This was due to road traffic accident accounting for majority of fractures as is supported by the findings of Rastogi et al Most of them had injury to right limb in our study whereas in a study done by Farmanullah et al found equal incident of the occurrence in right and left side.<sup>13,12</sup>

Most commonly affected part of tibia was distal third as against to proximal and middle third. This was similar to the findings reported by Mehtab et al in their study on 16 patients. The cause of this was due to poor vascularization of lower third of tibia and poor protection of lower third of tibia.<sup>14</sup> Majority of the cases were infected hypertrophic non union (C1) as per the Paley's classification. These findings were against to those found by Schwartzman in his study. He reported that the majority of the cases in his study were atrophic infected non union (Paley's type C2).<sup>15</sup>

The average period of non union was 12.5 months whereas almost double findings were seen in the study done by Schwartzman et al on patients with average duration of non union as 29 months and Toh et al studies patients with average duration of non union as 9 months.<sup>15,16</sup> The average bone gap in our study after debridement as found to be 3.125 cm with range 1 cm to 5 cm whereas Schwartzman in his study found average bone gap to be 2 cm with range 1 cm to 10 cm. it was seen that bone gap correlated with the severity of primary injury, higher the grading of primary injury (as per Gustillo Anderson Classification) higher was the bone gap after debridement.<sup>15</sup>

Monofocal osteosynthesis was used in all except one case. This was done even in case where bone defect as 5 cm to avoid difficulties and make the method of distraction simpler. In one case Accordion maneuver as reported by Baruah et al was used to achieve union.<sup>17</sup>

Average duration for which fixator was applied was 5 months whereas in a study done by Madhusudan et al average duration to be 8 months. This however stems from higher average bone gap. Similar to our study, Mehtab et al reported this duration to be 5 months. In our study average lengthening index was 2.265 months per cm while lengthening index found by Garcia was 1.02 months per cm.<sup>18,14,19</sup>

In our study, all 20 patients have superficial wire tract infection treated with dressing and oral antibiotics followed by delayed appearance of regenerate. Eight patients had deep wire tract infection with frank purulent discharge. Green et al in his study found that the largest number of problem are associated with wire tract infection whereas the second biggest difficulty was wire loosening associated with infection or Osteomyelitis.<sup>20</sup> For this reason, controlling wire-site sepsis is a principal objective to the management of a patient with an Ilizarov ring fixator for the purpose of bone transport. Limb length discrepancy was significant in 3 patients (more than or equal to 2.5) which was similar to the study done by Dendrinis et al.<sup>21</sup>

Stiffness of ankle (more than 15 degrees loss of movement) at the end of treatment was present in 8 case. This was in great contrast to the finding of Maini et al who reported the overall incidence of stiffness to be less than 3%. Angular deformity more than 7 degrees were found in 8 cases. These patients did not want any further intervention to correct the deformity. Pain was present in many patients (8 patients) which gradually subsided with analgesic and vigorous physiotherapy. Reflex sympathetic dystrophy was found in 5 patients. There was limp in 4 cases. One of the patient suffered refracture while he was in patellar tendon bearing cast. He was treated conservatively.<sup>22</sup>

The results were evaluated using Paleys criteria for bony and functional result. Bony results were excellent in 35%, good in 55%, fair in 5% and poor in 5%. This was different from the findings of Paley who reported excellent result in 59%, good in 27% fair in 9% and poor in 4%. The functional results were excellent in 45%, good in 45%, fair in 5% and poor in 5%. This results were different from those found by Dr Paley who reported excellent outcome in 64% good in 28% fair in 4% and poor in 4%. Functional outcome also varied widely in previously done studies. Dendrinis et al reported results to be excellent, good, fair, poor in 25%, 39%, 14% and 2% respectively.

## CONCLUSION

It was found that Ilizarov ring fixator is an excellent treatment modality for tibial non-union with infection. It helps in two ways. Firstly the fixator stabilizes the fracture firmly and makes it stable. Secondly the corticotomy done to fill the gap greatly increases local blood flow which helps to combat infection. It helps in infection eradication, limb-length achievement and limb function optimization. Apart from this it also helps to correct the deformity which

arises during the course of treatment or occurs preoperatively. However the technique requires long treatment follow up. Multiple interventions may be necessary to overcome the difficulties which come across the treatment. It is therefore very important that the patient be counseled beforehand regarding the possible outcomes and difficulty. Proper follow up is more important than anything else. Taken care of this issue Ilizarov is a wonderful treatment for infected non union of tibia, especially those who have undergone multiple prior surgical procedures to achieve union.

## ACKNOWLEDGEMENTS

Authors acknowledge the immense help received from the scholars whose articles are cited and included in references of this manuscript. The authors are also grateful to authors/ editors/ publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

*Funding: No funding sources*

*Conflict of interest: None declared*

*Ethical approval: The study was approved by the institutional ethics committee*

## REFERENCES

1. Lerner RK, Esterhai JL, Jr, Polomano RC. Quality of life assessment of patients with posttraumatic fracture nonunion, chronic refractory osteomyelitis, and lower-extremity amputation. *Clinical Orthop Relat Res.* 1993;295:28-36.
2. Lawlis GF, McCoy CE. Psychological evaluation: Patients with chronic pain. *Orthop Clin North Am.* 1983;14:527-38.
3. Praemer A, Furner S, Rice DP. Musculoskeletal Conditions in the United States. Park Ridge, IL, American Academy of Orthopaedic Surgeons. 1992;83-124.
4. Terry CS, James B. Tibial shaft fractures. In: Campbell's Operative Orthopaedics. Eleventh edition. Mosby Elsevier. 2008;3118.
5. Zura R et al. Treatment of chronic (>1 year) fracture nonunion: Heal rate in a cohort of 767 patients treated with low-intensity pulsed ultrasound (LIPUS). *Injury, Int. J. Care Injured* 46 (2015) 2036-2041.
6. Müller ME, Allgöwer M, Schneider R. Manual of Internal Fixation: Techniques Recommended by the AO Group. Berlin, Springer-Verlag. 1979;299.
7. Effect of time to definitive treatment on the rate of 86 SECTION 1 \_ Section Title nonunion and infection in open fractures. *J Orthop Trauma.* 2002;16:484-90.
8. Gustillo RB. Management infected fractures. *Surgery of musculoskeletal system.* C McCollister Evart 2nd editon. 1990;5:4429.
9. Paley D. Current techniques of limb lengthening. *J Pediatr Orthop.* 1998;8;7-92.
10. Cattaneo R. The treatment of infected nonunions and segmental defects of the tibia by the methods of



- Ilizarov. *Clinical Orthopaedics and Related Research*. 1991;280:143-52.
11. Hosny G, Shawky MS. The treatment of infected non-union of the tibia by compression-distraction techniques using the Ilizarov external fixator. *International Orthopaedics (SICOT)* (1998) 22:298–302.
12. Farmanullah, Khan MS, Awais SM. Evaluation of management of tibial non-union defect with Ilizarov fixator. *J Ayub Med Coll Abbottabad*. Jul-Sep 2007;19(3):34-6.
13. Rastogi D, Meena S, Sharma V, Singh GK. Epidemiology of patients admitted to a major trauma centre in northern India. *Chinese Journal of Traumatology*. 2014;17(2):103-7.
14. Piwani, Mehtab, et al. "Evaluation of AO external fixator in the management of open diaphysial fracture of tibia gustilo type IIIA and IIIB." *Gomal J Medical Sciences*. 2015;13:1.
15. Schwartzman V, Schwartzman R. Corticotomy. *Clinical Orthopaedics and Related Research*. 1991;280:37-47.
16. Toh CL, Jupiter JB. The infected nonunion of the tibia. *Clin Orthop Relat Res* 1995;315:176–91.
17. Baruah R. Accordion Manoeuvre with Ilizarov Frame over Nail in Situ in a Case of Infected Non-Union of Femur: Discussion on Strategies: A Case Report. *Open Journal of Orthopedics*. 2014;4:183-8
18. Madhusudhan TR, Ramesh B. Outcomes of Ilizarov ring fixation in recalcitrant infected tibial non-unions – a prospective study. *Journal of Trauma Management and outcomes*. 2008;2(6):1-9.
19. Garcia E. Circular External Fixation in Tibial Nonunions. *Clinical Orthopaedics and Related Research*. 1991;283:116–22.
20. Green SA, Jackson JM, Wall DM, Marinaw H, Ishkanian J. Management of segmental defects by the Ilizarov intercalary bone transport method. *Clin Orthop*. 1992;280:136 .
21. Dendrinis GK, Kontos S, Katsenis D, Dalas A. Treatment of high-energy tibial plateau fractures by the ilizarov circular fixator. *J Bone Joint Surg [Br]* 1996;78-B:710-7
22. Maini L. The Ilizarov method in infected nonunion of fractures. *Injury*. 2000;31(7):509-17.

**Cite this article as:** Dubey A, Ragase AK. Ilizarov's technique outcome in non-union tibial fracture. *Int J Res Orthop* 2021;7:745-9.