Outcome of Ilizarov fixator for non union of femur and tibia in pediatrics and adolescents.

Karim Bakhsh,[1] Hamidullah Khan,[2] Eid Mohammad,[3] Attiq Ur Rehman,[4] Amanullah[5]

[1]Assistant Professor Department of Orthopedics, Bolan Medical Complex Hospital Quetta
[2,3,4,5] Department of Orthopedics, Bolan Medical Complex Hospital Quetta

Authorship and contribution Declaration:
[1]**Karim Bakhsh:** Conception and design of the study, acquisition of data, analysis of data
[2]**Hamidullah Khan:** Final approval of the version for publication
[3]**Eid Mohammed:** Revised the manuscript critically for important intellectual content
[4]**Attiq ur Rehman:** Drafted the manuscript
[5]**Amanullah:** interpreted the data

Correspondence Author:
Karim Bakhsh
Email: drkarimbakhsh71@gmail.com

ABSTRACT

Objective: To determine the functional and radiological outcome of Ilizarov ring fixator for nonunion of femur and tibia in pediatrics and adolescent.

Methods: This descriptive study was conducted in Bolan Medical Complex Hospital Quetta, from 3rd February 2016 to 24th February 2019.All paediatrics and adolescent patients with non union femur and tibia meeting the inclusion criteria were operated for Ilizarov ring fixator. Post operative functional and radiological outcome was assessed through AASAMI(Association For The Study And Application Of Methods Of Ilizarov) scoring system at final follow up and graded as Excellent, Good, Fair and Poor.

Results: We included 30 patients with mean age 12.7+ 2.16years(range 8 to 15 years).Male children were 25(83.33%) and female 5 (16.67%).Among the participants infected non-union of femur was present in 11 (36.7%), infected non union tibia in 8 (26.7 %), non union femur 9 (30.0 %) and non union tibia in 2 (6.7%).A total of 8 patients (26.7%) had no previous surgeries, 9 (30.0%) patients had only one surgery and 13 (43.3%) had two previous surgeries. Excellent results were achieved in 8(40%) good in 6(20%) and fair in 6(20%) patients with femur Ilizarov. Tibial Ilizarov produced excellent results in 8(80%) and good results in 2(20%) patients.

Conclusion: Non union femur and tibia in children and adolescent treated with Ilizarov produced excellent and good results in majority of patients. We therefore recommend Ilizarov ring fixator as a first line treatment modality to treat non union of femur and tibia in children.

Key Words: AASAMI, Bone graft, Ilizarov, Non union femur, Non union tibia.

This article may be cited as: Bakhsh K, Khan H, Muhammad E, Atiq ur Rehman, Amanullah. Outcome of Ilizarov fixator for non union of femur and tibia in pediatrics and adolescents. J Pak Orthop Assoc. 2019;31(4):163-168.

INTRODUCTION

Paediatric femur and tibia shaft fractures usually heal within 8 to 12 weeks in majority of patients.[1] However studies have reported 12% non union rates in femoral fractures and 60% non union in tibial shaft fractures in children.[2-4] A number of devices and techniques are available to treat paediatric non unions of femur and tibia. These include open reduction internal fixation and bone grafting, external fixation and bone grafting, the Masquelet technique of Induced-Membrane formation. Each procedure has merits and demerits. Distorted local anatomy, recipient site complication, graft failure, two stage surgery and re-fracture are the possible complications of Induced-Membrane technique.[5]

Ilizarov method has been reported in multiple studies to have been used successfully for the treatment of wide range of orthopaedic problems like congenital short stature, deformity correction caused by traumatic injuries, infections, metabolic bone diseases and limb length discrepancy, non unions and bone defects.[6]

The method of Ilizarov segmental bone transport has several advantages like limited surgical exposure and less blood loss. These factors make this approach especially applicable to patients with pre existing soft tissue and bone infections and poor skin condition. Femoral and tibial reconstructions using the ilizarov method offers the surgeon a comprehensive way to avoid a variety of complications and address many femoral pathologies to the ability to perform limb lengthening, deformity

correction and bone transport at the same time.[7] The technique of segmental bone transport with Ilizarov method offers a safe and effective method to combat one of the most difficult orthopaedic problems of non union long bones.

The objective of our study was to determine the functional and radiological outcome of Ilizarov ring fixator for nonunion of femur and tibia in pediatrics and adolescent. Paediatric non unions referred to our center for treatment were managed with Ilizarov ring fixator. The publications of our results will gave confidence, trust and satisfaction not only to the referring doctors but to the parents as well that optimal treatment has been given to them. Moreover our results will help in the formulation of standard guidelines to treat these difficult non unions in our set up.

METHODS

We conducted this descriptive study at Bolan Medical Complex Hospital Quetta, from 3rd February 2016 to 24th February 2019.All non unions of femur and tibial shafts in pediatric and adolescents age group presented or referred to our department during the study period were included. Femur and tibial shaft fractures due to some pathological condition, like tumor, bone cyst or any metabolic bone condition and patients that were lost in follow up were excluded from our study. The Ethical Committee of our hospital approved our study protocols before the commencement of our study. Informed consents were taken from parents of children. In the included subjects history and clinical examination was done. Relevant radiological and serological investigations were done to classify the non union as infective or non infective and proper planning for surgery was done.

Surgical Technique

We operated on all patient in the supine position on radiolucent table. The entire lower limb for tibial fractures and entire lower limb and abdomen for femoral fractures was included in the sterile field. For femur fracture, the fracture non union site was opened and bone debridement was done up to the appearance of "Paprika sign." If the bone defect was less then 2cm, docking was done initially. For larger defects segmental bone transport was done. On average 2-3 arches were applied for the proximal femur. Complete rings were applied in the distal femur. In some cases arches were also used in the distal femur when needed. If the distal femoral segment was short a complete ring was applied on proximal metaphyseal area of the tibia and the knee joint was spanned. About 2-3 half pins were used in each arch. In each Ilizarov ring 2-3 wires were used.

Similarly for non union of the tibia fracture site was opened and bone debridement was done upto the appearance of "Paprika sign". If the bone defect was less than 2cm, docking was done initially. For larger bone defects segmental bone transport was done. Two complete rings were applied in the proximal fragment and two complete rings were applied in the distal fragment, with two to four Ilizarov wires in each rings. If the distal fragment was very short and stability was not achieved with one ring in the distal fragment, the ankle was spanned and a half ring was applied in the foot which was removed after docking was achieved.

Patients were encouraged partial weight bearing with assistive devices on the next day of operation. Physiotherapy was advised for knee, hip and ankle (range of motion exercises).Patients were instructed to clean the pin sites with a mixture of Pyodine and hydrogen peroxide solution daily. Intravenous antibiotics were given according to the culture and sensitivity tests in infected non union.

Bone transport was started on the 7th post-operative day. The rate was 1mm per day and the rhythm was 0.25mm 4 times a day. If early consolidation was suspected on the radiographs the distraction rate was increased accordingly. When the docking was achieved compression was done (0.25 twice weekly until union was achieved or patient observed pain).

Patients were followed fortnightly initially in the distraction phase and then monthly in the consolidation phase. When radiological union was achieved the frame was dynamized. The fixator was removed under anaesthesia when xray AP and lateral view revealed callous on three cortices at regenerator and solid union at the docking site. Functional and radiological results were assessed according AASAMI(Association For The Study And Application Of Methods Of Ilizarov).[8]

Data was stored and analysed using IBM-SPSS version 23-0. Descriptive anlaysis was done using count, percentages of base line characteristics, diagnosis, clinical characteristics, outcome and complications. Data presented in table where necessary.

RESULTS

In our study 30 patients with mean age 12.7+ 2.16years(range 8 to 15 years) were included.

Majority (83.3%,n=25)of children were male while 5(16.6%) patients were female. Patients were presented to us as infected non-union of femur in 11 (36.7%), infected non union tibia in 8 (26.7 %), non union femur in 9 (30.0 %) and non union tibia in 2 (6.7%) patients. Previous record of the patients revealed that total of 8 patients (26.7%) had no previous surgeries, 9 (30.0%) patients had only one surgery and 13 (43.3%) had two previous surgeries. The types of surgeries are shown in table I. Post operatively union had been achieved in all patients. Excellent results were achieved in 8(40%) good in 6(20%) and fair in 6(20%) patients with femur Ilizarov.

Table I: Demographi and Clinical Characteristics of our study participants.

Variables	**Number of patients (%)**
Type of Previous Fixation	
Ex Fix(External Fixator)	7(23.3)
Ex Fix/ Ex Fix	1(3.3)
I/M Nail	1(3.3)
NA(Naseer Awais) Fixator	8 (26.7)
ORIF(open reduction & Internal fixation) with LCP/ Ex Fix	8 (26.7)
ORIF with NDCP/Ex Fix	2(6.7)
Rush Pin	1(3.3)
Rush Pin / Ex Fix	2(6.6)
Bone Defect	
Yes	30(100.0)
Bone debridement and excision of scleroses bone	
Yes	30(100.0)
Length of Bone defect	
1 cm	4(13.3)
2 cm	7(23.3)
3 cm	9(30.0)
4 cm	6(20.0)
5 cm	4(13.3)
Time frame in days	Mean ± S.D 165.0 ± 52.5
Infection Eradicated	
Yes	29(96.7)
Union achieved	
Yes	30(100)
Operative time(minutes)	Mean ± S.D 116.50(20.13)

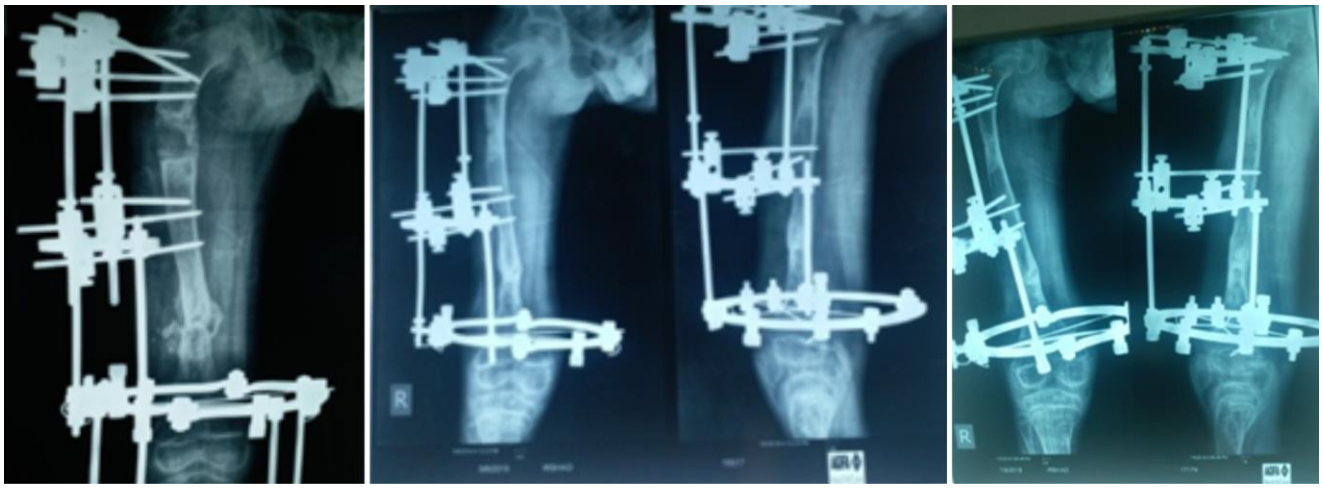

Fig IA: Ilizarove applied to femur nonunion. **Fig IB:** Followup Xray. **Fig IC:** Follow up xray with union

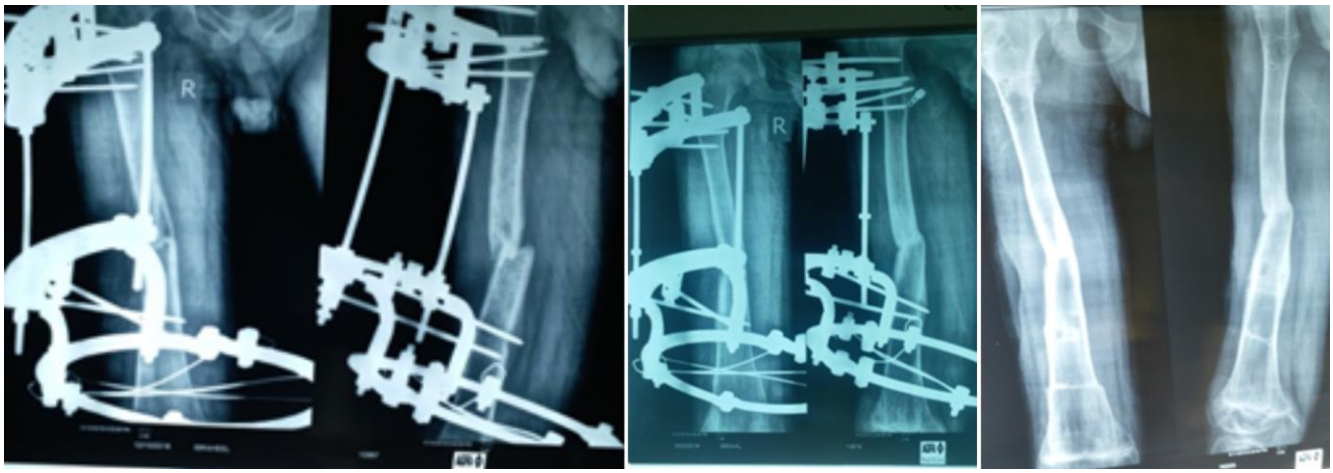

Fig IIA: Ilizarove applied to infected nonunion femur. **Fig IIB:** Follow up Xray. **Fig IIC:** Xray after union and Ilizarov removal

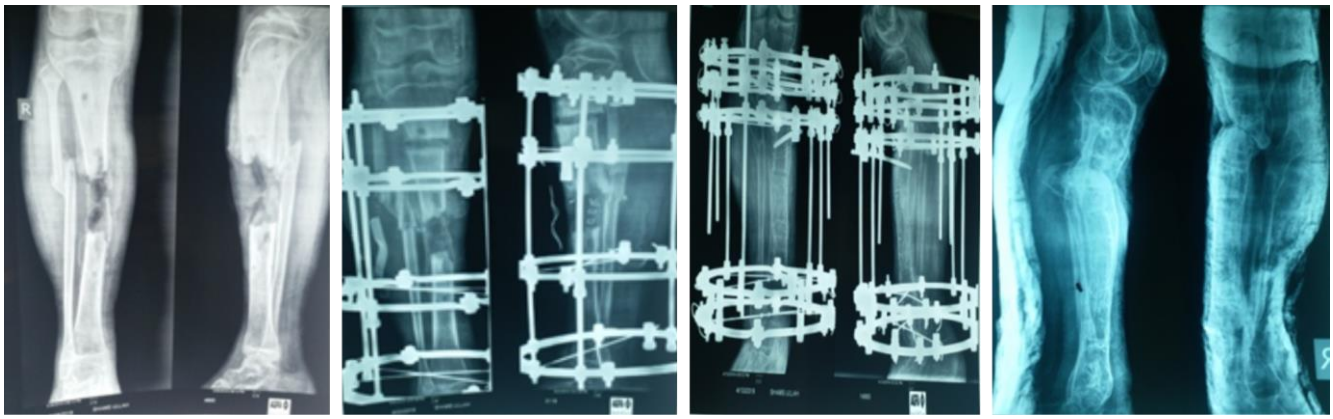

Fig IIIA: Infected gap non union tibia. **Fig IIIB:** Ilizarov applied. **Fig IIIC:** Follow up Xray. **Fig IIID:** Xray after Ilizarov removal and fracture union.

Tibial Ilizarov gave excellent results in 8(80%) and good results in 2(20%) patients. Pin tract infection was the most common complication noted in 16(43.4%) with 5 patients (16.7%) had superficial pin tract infection and 11 (36.7%) deep pin tract infection. Loosening of wires were noted in 3 patients (10.0%),loosening of Schanz screws in 6 patient (20.0%). The loose wires and Schanz screws were removed and replaced by new ones in 5 patients (16.7.0%).No neurological injury was reported.

DISCUSSION

Based on the review of our 30 such cases we were able to show that Ilizarov fixator yields good to excellent functional and radiological results with a minimal rate of complications. (Fig.I to III) This conclusion is also supported by literature showing successful results in other centers.[7,9-11]Radical debridement including excision of necrotic soft tissue and sequestractomy usually results in bone and soft tissue defects which increase the complexity of the subsequent reconstruction. Several methods can be adopted for the management of bone defects, such as corticocancellous bone graft, vasucularised autogenous bone graft, Masquelet-induced membrane technique and Ilizarov bone transport. Corticocancellous bone graft is ideal for patient with a small defect and having no infection but there are limited options for autogenous bone graft in pediatrics and adolescents patients. Vascularized autogenous bone graft (usually vascularized fibular graft) is associated with high rate of refracture, donor site morbidity, and complexity of the operation and usually is not a good option for femoral and tibial defects because of its thinner size.[11] Masquelet-induced membrane technique needs a large amount of bone graft with consequent donor site morbidity and at least 2 operating procedures are required for a successful surgery. The other option to take a large

amount of bone graft for Masquelet-induced membrane technique is Reamer–Irrigator-Aspirator but which is usually not available in most centers including our center. Furthermore no recommendations of reamer – irrigator-aspirator in pediatrics and adolescents can be found in literature as very few studies are available on Masquelet-induced membrane technique in pediatrics and adolescents patients.[12]Moreover in complex cases the compromised soft tissues around the non union usually do not allow these procedures without risking infection and devascularization.[13]

Ilizarov method has gained popularity for the treating non-union femur and tibia because it can be applied in cases where other techniques are contraindicated. The technique involves gradual and controlled distraction from an osteotomy site either proximal or distal to the non union site with simultaneous closing of the gap at the nonunion site.[14] During the whole process of osteogenesis the deformity is corrected, limb is lengthened to an appropriate size with patient fully mobilized during the procedure.[15,16]

The Ilizarov ring fixator respects soft tissues, involves less blood loss during application and do not require routine post operative intensive care support.[15-18] In our study, the patients that were included had multiple previous failed surgeries and mostly complicated by non-union or infection. But we achieved an overall excellent and good outcome in most of our patients. Our results of tibial Ilizarov are more encouraging and the probable reason being the subcutaneous location of tibia and better compliance of children to tibial Ilizarov than femur Ilizarov. However the most frequent complication in our series was pin tract infection(43.4%) but somewhat higher infection rate has been reported in previous studied.[9,10-14,19]

Our study had a small sample size and descriptive design. We recommend randomized trials with larger sample size to confirm our results.

CONCLUSION

Non union femur and tibia in children and adolescent treated with Ilizarov produced excellent and good results in majority of patients. We therefore recommend Ilizarov ring fixator as a first line treatment modality to treat non union of femur and tibia in children. It is a safe technique with low complication rate.

Conflicts of Interests: None
Grants/Funding: None

REFERENCES

1. Zeckey C, Mommsen P, Andruszkow H, Macke C, Frink M, Stubig T et al. The asceptic femoral and tibial shaft non union in healthy patients-An analysis of the health-related quality of life and the socioeconomic outcome. Open Orthop J. 2011;5:193-197.
2. Zelle BA, Gruen GS, Klatt B, Haemmerle MJ, Rosenblum WJ, Prayson MJ. Exchange reamed nailing for aseptic nonunion of the tibia. J Trauma. 2004; 57 (5): 1053-9.
3. Alonso J, Geissler W, Hughes JL. External fixation of femoralfractures. Indications and limitations. Clin Orthop Relat Res. 1989;(241):83-8.
4. Sanders R, Jersinovich I, Anglen J, DiPasquale T, Herscovici D.The treatment of open tibial shaft fractures using an interlocked intramedullary nail without reaming. J Orthop Trauma. 1994;8(6):504-10.
5. Ghaffar KA, Ramy D, Ahmed K. Management of infected nonunited femoral fracture with large bone Defects: A Technique. Techniques in Orthopaedics, 2019;34: 30-34.
6. Dhar SA, Mir MR, Ahmed MS, Afzal S, Butt FM , Badoo AR, *et al*. Acute peg in hole docking in the in the management of infected non union of long bones. International Orthopedics. 2008;32(4):559-66.
7. Gosny GA, Ahmed AA. Infected tibial non union in children: Is redical debridement mendatory? Injury. 2018:590-597
8. Paley D, Catagni MA, Argnani F, Villa A, Benedetti GB, Cattaneo R, *et al.* Ilizarov treatment of tibial nonunions with bone loss. Clin Orthop Relat Res. 1989;241:146-65.
9. Sabharvar S. Role of Ilizarov external fixator in management of proximal/distal metadiaphyseal paeditric femur fracture. J Orthop Trauma. 2005;19:563-569
10. Kong H, Sbharwal S. External Fixation for Closed Paeditric Femural Shaft Frectures; Where Are We Now? Clin Orthop Relat Res. 2014;472;3814-3822.
11. Peng J, Min L ,Xiang Z , Huang F , Tu C, Zhang H. Ilizarov bone transport combined with antibiotic cement spacer for infected tibial non union. International journal of Clinical and Experimental Medicine. 2015;8(6):10058-65.
12. Blasier RD, Aronson J, Tursky EA. External Fixation of Paeditric Femur Fractures. J Pediatr Orthop. 199717(3);342-6.

13. Al Sayyad MJ. Taylor Spatial Frame in the treatment of paediatric and adolescent tibial shaft fractures. Jounal Pediatr Orthop. 2006 ;26(2):164-71.
14. Dror Paley. Problems, Obstacles,and Complications of Limb Lengthening by The Ilizarov Technique. Clin Orthop Relat Res. 1990;81-104.
15. Arora S, Batra S, Gupta V, Goyal A. Distraction Osteogensis using a mono lateral external fixator for infected non-union of the femur with bone loss. J Orthop Surg. 2012;209(2);185-90.
16. Magadum MP, Yadav CM, Phanssesha MS,Ramesh LJ. Acute compression and lengthening by the Ilizarov technique for infected non-union of the tibia with large bone defects. J Orthop Surg. 2006;14(3)273-9.
17. Mikhail AO, Abraham E, Gruber B, Gonzalez M. Bone transport in the management of posttraumatic bone defects in the lower extremity. J Trauma. 2004; 56(2):368-378.
18. Arslan H, Subasy M, Kesemenly C, Ersuz H. Occurrence and treatmet of Nonunion in long bone fractures in children. Archives of Orthopaedic and Trauma Surgery. 2002; 122;494-498.
19. Kazmers NH, Fragomen AT, Rozbruch SR. Prevention of Pin Sight Infection in External Fixator:A review of the litrature. Strategies in Trauma and Limb Reconstruction. 2016;(11):75-85.