



E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2023; 9(3): 24-28
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<https://www.orthopaper.com>
Received: 05-04-2023
Accepted: 07-05-2023

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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

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DOI: <https://doi.org/10.22271/ortho.2023.v9.i3a.3401>

Abstract

Introduction: Infected tibial non-union has always posed a challenge for orthopaedic surgeons. The primary aim of our study is to analyze the role of Ilizarov circular ring fixation in infected non-union tibia, to assess osteogenesis, infection rates, bony union, and limb lengthening along with functional outcomes and associated complications.

Materials and Methods: This observational study was conducted at the Department of Orthopedics in Tertiary Care Centre of western India. A total 20 cases of infected non-union of diaphyseal # of Tibia with chronic discharging sinus of at least 3 months duration were included in our study. All procedures were performed after the patients had signed a written consent and after approval by the institutional ethical committee.

Results: In our 20 cases, union was achieved in 19 cases. One patient required bone grafting and one patient had refracture. Union time ranged between 3 to 7 months. Smoking, persistent infection, patient himself not able to walk, these factors affect the union. Early docking of the non-union site was observed to shorten the union time.

Keywords: Ilizarov ring fixation is the safest, simplest, most economical and most effective method for the management of infected non-union tibia

Introduction

The incidence of complex and compound fractures of long bones is on an increasing trend due to increasing number of high-energy trauma events in recent times [1]. Tibia is the most common long bone fracture due to its vulnerable subcutaneous location. Delayed union and non-union due to infection are some of the commonly acquired complications [2]. Non-union is more common in tibia fractures compared to other bones of the body.

Additionally, non-union of fracture is often complicated by other coexisting problems, such as persistent infection, loss of soft tissues and bone, limb length discrepancy and limb deformity [3]. Infected tibial non-union has always posed a challenge for orthopaedic surgeons [4]. There are different options available for the management of chronic diaphyseal infections associated with non-union which include extensive debridement with local soft-tissue rotational flaps [5], packing the defect with antibiotic cement beads, Papineau-type open cancellous bone grafting [6], tibiofibular synostosis, free microvascular soft-tissue and bone transplants and the Ilizarov method. The Ilizarov method has certain advantages as it can overcome most of the difficulties of infected Non-union fractures. It is a miracle for bony defects, simultaneously allow in for bony union through neo- histogenesis and eliminate the infection [7].

The Ilizarov Circular Ring Fixator allow immediate weight bearing, thereby can prevent regional osteoporosis, sympathetic dystrophy of adjacent joint, complex regional pain syndrome and DVT.

The primary aim of our study is to analyse the role of Ilizarov circular ring fixation in infected non-union tibia, to assess osteogenesis, infection rates, bony union, limb lengthening along with functional outcomes and associated complications.

Materials and Methods

This observational study was conducted at Department of Orthopaedics in Tertiary Care Centre

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of western India. A total 20 cases of infected non-union of diaphyseal # of Tibia with chronic discharging sinus of at least 3 months duration were included in our study. Exclusion criteria were Acute fracture, patient with Pathological fracture and intra-articular fracture. There were 17 men and 3 women. The average age at the time of surgery was 36 (range 18–65) years. The mode of injury was RTA in 85% of patient. The left side was affected in 6 cases while right leg was involved in 14 patients. 14 patients were injured while participating in sports. All procedures were performed after the patients had signed a written consent and after approval by the institutional ethical committee.

Surgical technique

In the preoperative period, all the patients were examined clinically and radiologically. Pus from discharging sinus sent with deep tissue culture and sensitivity, for Gram staining. In case of a Chronic Discharging sinus, a sinogram was done to determine the trajectory/track of infected sinus. X-ray of the affected leg – anteroposterior view and lateral view including knee and ankle joint taken in all the patients. Pre-operative templating is made by using X-ray. Opposite extremity length is important for limb length and selection of ring size.

After administration of spinal anaesthesia, patient placed in supine position on a radiolucent table with sandbag under the thigh and another under the heel. The affected limb painted and draped from mid-thigh to foot.

Infected non-union site exposed. Debridement done from the skin, fascia and muscles. Sequestrum removed. In case of previous implants inside were removed, non-union site bone ends excised till punctuate cortical or cancellous bleeding visible (Paprika sign). If gap found to be less than 2cm acute docking done.

First ring is placed below the knee joint and parallel to the joint line. First K-wire is passed through the head of fibula and fixed with ring using wire fixation bolt. Second K-wire is passed anterolateral to posteromedial, both K-wires are tensioned before fixing the ring. Whenever necessary additional schanz pins are used.

The distal ring is fixed just above the ankle joint. The intermittent rings are fixed with K-wires or olive wires. In our study whenever required, corticotomy/fibula osteotomy done as per fracture configuration and non-union site. Using c-arm, the position of K-wires and non-union site are checked and compression is given at the non-union site if required. To avoid pin tract infection, we use betadine dressing for each pin tract.

Post-Operative Follow Up

All the patients are taught about pin site care and physiotherapy. In patients whom corticotomy done, distraction started on 7th to 10th day at the rate of 1mm/day – 0.25mm in 4 sitting. Once pain subsides, patient mobilized with the help of a walker. All patients discharged at a period of 2 weeks. In the patients whom corticotomy done, they discharged once they start to do distraction on their own. All our patients reviewed every 2 weeks and following parameters are reviewed – X-ray, joint stiffness, pain on walking, pin site infection, distal neurovascular deficit. The ring was removed after consolidation.

Results

In our study 20 patients were followed up. Outcome was analysed based on:

Union

In our 20 cases, union was achieved in 19 cases. One patient required bone grafting and one patient had refracture. Union time ranged between 3 to 7 months. Smoking, persistent infection, patient himself not able to walk, these factors affect the union. Early docking of the non-union site was observed to shorten the union time.

External fixation index (EFI)

The EFI is defined as duration of external fixation in days per amount of length gained (in cm.). In our 20 patients, distractive osteogenesis was done in 8 patients. In our study, external fixation index was 98 days/cm.

EFI in smokers	111 days/cm
EFI in non-smokers	88 days/cm

Radiological consolidation index (RCI):

Radiological consolidation index is defined as appearance of consolidation of at least 3 cortex in anteroposterior and lateral views in days/length in cm. in our study radiological consolidation index was 33 days/cm.

RCI in smokers	38/cm
RCI in non-smokers	27/cm

Bone results:

13 patients (65%) had excellent, 6 patients (30%) had good and 1 patient (5%) had poor results. Union was achieved in all 20 patients. Out of 20 patients 6 had infection and none had deformity >7 degree and none Limb length discrepancy >2.5cm.

Functional results:

6 patients (35%) had excellent, 11 patients (55%) had good, 1 patient (5%) had fair and 1 patient (5%) had poor results. The problems observed after functional assessment were:

1. Noticeable limping - 5 patients
2. Joint stiffness - 6 patients

Complications

1. Refracture – one patient
2. Nonunion - one patient
3. Pin site infection – six patients
4. Joint stiffness – six patients
5. Infection at the non-union site – six patients superficial infections one had a deep infection

Infections were controlled by suitable antibiotics as per culture sensitivity and regular dressing.

Statistical Analysis

Crosstabs

Table 1: Bone Result Gustilo Anderson

		Gustilo Anderson				Total
		I	II	IIIA	IIIB	
Bone Result	1	3	0	5	5	13
	2	0	1	0	5	6
	4	0	1	0	0	1
Total		3	2	5	10	20

Table 2: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.154 ^a	6	.013
Likelihood Ratio	15.004	6	.020
N of Valid Cases	20		

a. 11 cells (91.7%) have expected count less than 5. The minimum expected count is .10.

Table 3: Functional Result * Gustilo Anderson

		Gustilo Anderson				
		I	II	IIIA	IIB	Total
Functional result	1	1	1	2	3	7
	2	2	1	3	5	11
	3	0	0	0	1	1
	4	0	0	0	1	1
Total		3	2	5	10	20

Table 4: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.294 ^a	6	.972
Likelihood Ratio	1.668	6	.948
N of Valid Cases	20		

a. 11 cells (91.7%) have expected count less than 5. The minimum expected count is .10.

Crosstabs

Union Time * Diagnosis Cross tabulation

Table 5: Count

		Diagnosis		Total
		INU-D3	INU-M3	
Union Time	3m	1	1	2
	4m	3	5	8
	5m	2	5	7
	6m	0	2	2
	7m	0	1	1
TOTAL		6	14	20

Table 6: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.888 ^a	4	.756
Likelihood Ratio	2.701	4	.609
N of Valid Cases	20		

a. 9 cells (90.0%) have expected count less than 5. The minimum expected count is .30.

Cross tabs

Union Time * Comorbidity Cross tabulation

Table 7: Count

		Comorbidity					Total
		1.	2.	3,4	3.	4.	
Union Time	3m	1	1	0	0	0	2
	4m	5	0	0	2	1	8
	5m	4	1	0	2	0	7
	6m	2	0	0	0	0	2
	7m	0	0	1	0	0	1
TOTAL		12	2	1	4	1	20

Table 8: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	27.470 ^a	16	.037
Likelihood Ratio	15.772	16	.469
N of Valid Cases	20		

a. 25 cells (100.0%) have expected count less than 5. The minimum expected count is .05.

Crosstabs

Union Time * Smoking Cross tabulation

Table 9: Count

		Smoking		Total
		1	2	
Union Time	3m	0	2	2
	4m	4	4	8
	5m	4	3	7
	6m	0	2	2
	7m	1	0	1
Total		9	11	20

Table 10: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.993 ^a	4	.288
Likelihood Ratio	6.874	4	.143
N of Valid Cases	20		

a. 10 cells (100.0%) have expected count less than 5. The minimum expected count is .45.

Crosstabs

Bone Result * Corticotomy Cross tabulation

Table 11: Count

		Corticotomy		Total
		No	Yes	
Bone Result	1	8	5	13
	2	3	3	6
	4	1	0	1
Total		12	8	20

Table 12: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.929 ^a	2	.628
Likelihood Ratio	1.279	2	.527
N of Valid Cases	20		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .40.

Bone Result * Corticotomy

Crosstabs

Table 13: Count

		Corticotomy		Total
		No	Yes	
Bone Result	1	8	5	13
	2	3	3	6
	4	1	0	1
Total		12	8	20

Table 14: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.929 ^a	2	.628
Likelihood Ratio	1.279	2	.527
N of Valid Cases	20		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .40.

Functional Result * Corticotomy Crosstabs

Table 15: Count

		No	Yes	Total
Functional Result	1	4	3	7
	2	8	3	11
	3	0	1	1
	4	0	1	1
Total		12	8	20

Table 16: Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.746 ^a	2	.418
Likelihood Ratio	2.083	2	.353
N of Valid Cases	20		

a. 5 cells (83.3%) have expected count less than 5. The minimum expected count is .40.

Discussion

Infected non-union is a challenging clinical problem even after decades of orthopaedic advancement in terms of fracture fixation, soft tissue management and antibiotic therapy. Infection of the fracture site hinders the process of fracture healing.

Hence effective control of the infection is warranted.

Debridement plays the first definitive step in the control of infection fixation of the fracture is then planned using an ilizarov external fixator.

This study is about infected non-union of tibia managed by the Ilizarov ring fixator. We have analysed the outcome by

1. Union time
2. Complications
3. External fixation index

4. Radiological consolidation index
5. Bone and functional results

Union time:

Union time ranged between 3-7 months. The mean union time of non-union tibia by using an ilizarov external fixator was nearly six months in a study by G.K. Dendrinios *et al.* [12] in 1995. Smoking is the main modifiable factor that mainly affects union rates, so all my patients were advised to quit smoking.

Complications:

Infection is one of the major complications in our study. Six patients had either pin tract infection or non-union site infection or both. Infection were controlled by suitable antibiotics as per culture sensitivity and regular dressing. Limb edema was controlled by proper limb elevation. In patients who underwent distraction osteosynthesis distal joint stiffness were noticed because muscle responds poorly to distraction rate. Joint stiffness was observed in 6 cases which was improved by suitable physiotherapy. One patients had refracture. No serious vascular or neurological complications were noted. 28 infected non-union of tibia studied by G.K. Dendrinios *et al.* [8] had 3 non-union 1 re-fracture, 13 joint stiffness, 11 axial deviations.

External fixation index

In our study external fixation index was 98 days/cm, it was longer in smokers because smoking cause the vasoconstrictive effect of nicotine that inhibits tissue differentiation, angiogenic response which is necessary for early stages of healing. Osteoblast function is inhibited by nicotine. Smoking affects union time and radiological consolidation index and external fixation index. In a study by Bobroff *et al.* [13] in the treatment of large bone defects in tibia, 2 months/cm is the mean, 1.45 months/cm in non-smokers and 2.6month /cm in smokers.

Radiological consolidation index

Corticotomy was done for 8 patients. Radiological consolidation index is influenced by smoking. In our study RCI was 32 days per cm in smokers 38 days per cm and non smokers 27 days per cm.

Bone and functional results

Table 17: According to ASAMI score

Results	Our results 20 patients		Dendrinios <i>et al.</i> [28] PTS		Lalit <i>et al.</i> [23] pts	
	Bone	Functional result	Bone	Functional result	Bone	Functional Result
Excellent	65%	35%	50%	25%	66.7%	26.7%
Good	30%	55%	28.5%	47%	13.3%	40%
Fair	-	5%	3.5%	14%	-	10%
Poor	5%	5%	18%	14%	20%	23.3%

Conclusion

- Ilizarov system allows early ambulant thus decreasing chances of osteoporosis and soft tissue dystrophy.
- The average union rate was found to be 4.6 months and was influenced by communication, infection, non-union type, smoking and fracture pattern.
- In our case, Ilizarov fixator provides 95% union rate.
- Compliance of the patients is the major factor that influences the result of the study.
- Even though ilizarov ring fixator is an external fixator

still it can be concealed by proper dressing so that patient can continue his / her regular day-to-day activity.

- Ilizarov ring fixation is the safest, simplest, most economical and effective method for management of infected non-union tibia.

Conflict of Interest

Not available

Financial Support

Not available

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How to Cite This Article

N Gaurav. 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. *International Journal of Orthopaedics Sciences.* 2023;9(3):24-28.

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