

INFECTED TIBIAL NONUNION TREATED BY ILIZAROV TECHNIQUE— A PROSPECTIVE STUDY OF FUNCTIONAL AND RADIOLOGICAL OUTCOME

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ABSTRACT

BACKGROUND

Tibial diaphyseal fractures commonly affect young males, and a severe fracture complicated by non-union or infection often results in employment loss or other social and economic problems. The goal of treatment should be a stable limb without deformation, of equal length, with functioning muscles, good range of joint motion, and free of pain. The Ilizarov external fixation technique is a valuable tool that enables achievement of these goals.

Aim of this study was to assess the functional and radiological outcome of Ilizarov technique for infected non-union of tibia.

MATERIALS AND METHODS

We selected 30 patients of infected nonunion tibia who presented to orthopaedic outpatient unit of Government Medical College, Kozhikode between 2011 July-2015 November. They were treated using Ilizarov technique and observed for a period of 2 years. Majority of cases in study group belongs to A and B-1 type of Paley's classification. Bony and functional results were evaluated as laid down by the ASAMI criteria.

RESULTS

The average duration of fixation (treatment) was 6.6 months [range 5-10 months], average duration of union was 6.5 months. In the study, 80% had excellent to good results. ASAMI bone score and functional score were better in non-smokers. Persistent bone infection despite bony union was evident in 5 patients. 10 patients had residual shortening of more than 2.5 cm. There was limb oedema in many patients despite fracture union. After treatment, 13 cases had more than seven degrees. Significant limp was seen in 9 patients [30%]. After surgery, 12 patients' [40%] stiffness persisted, with more than 15 degrees loss of range of movement. 5 patients got reflex sympathetic osteodystrophy or skin changes.

CONCLUSION

The Ilizarov technique with bone transport is the most versatile, adaptive and effective method of treatment of infected nonunion in tibia, and can very successfully deal with the associated large soft tissue and bony defects.

KEYWORDS

Infected Tibial Nonunion, Ilizarov Technique, ASAMI Score.

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BACKGROUND

In the 21st century, because the number and severity of road accidents have risen dramatically, and military and terrorist activities have led to an increase in serious injuries, acute trauma in orthopaedic surgery is more genuine today than ever.

Limb trauma is often accompanied by open injuries. The percentage of open fractures of the tibia is about 24%.¹ Soft tissue injury accompanying fracture may vary from an

insignificantly small scratch or abrasion to damage that may lead to loss of the limb. Tibial diaphyseal fractures commonly affect young males, and a severe fracture complicated by nonunion or infection often results in employment loss or other social and economic problems.

The goal of treatment should be a stable limb without deformation, of equal length, with functioning muscles, good range of joint motion, and free of pain. It is important to preserve normal innervation. Besides the obvious fact that all fractures must heal, additional key points of the treatment process are decreasing time of hospitalisation disability, minimising the number of surgical procedures, and lowering expenses. During the course of treatment, the life of the trauma patient should be as comfortable and dynamic as possible. The Ilizarov external fixation technique is a valuable tool that enables achievement of these goals.²

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AIM OF THE STUDY

To study the functional and radiological outcome of Ilizarov technique for infected nonunion of tibia in the Department of Orthopaedics, Medical College, Kozhikode, between July 2011 and November 2015.

MATERIALS AND METHODS

It was a prospective study. Study group consisted of 30 patients with infected nonunion/delayed union fracture of tibia in age group 20-60, both females and males who presented to Orthopaedic Outpatient Unit of Government Medical College, Kozhikode, between 2011 July-2015 November. Patients with associated fractures in same limb, pathological fractures, polytrauma and intra-articular fractures were excluded from the study.

SEX DISTRIBUTION

Sex	No.	Percentage
Male	23	76.3
Female	7	23.3

Table 1. Sex Distribution

Majority of patients are male.

Type of nonunion based on Paley's Classification

Type of Nonunion	No. of Patients	Percentage
A-1	8	26.7
A-2-1	7	23.3
A-2-2	6	20
B-1	7	23.3
B-2	1	3.3
B-3	1	3.3

Table 2. Paley's Classification

Majority of cases in study group belong to A and B 1 group.

LATERALITY

Side	No.	Percentage
Right	16	53.3
Left	14	46.7

Table 3. Laterality

After receiving institutional research committee approval and written informed consent, the patients are taken up for surgery. Preoperative antibiotics are given (usually 1 g cefazolin) 1 hour prior to surgery and continued for next 48 hours, a total of 6 doses will be given after which oral antibiotics will be continued for 10 days, which is based on culture and sensitivity. Usually, all the procedures will be done under spinal anaesthesia unless the indication for general anaesthesia was present.

SURGICAL APPROACH

Patients were operated under spinal anaesthesia and a wedge placed below trochanter to make patella anterior, pillow kept below thigh and heel so that leg hangs. Existing implants were removed with lazy S incision. All patients will undergo complete resection of the infected/necrotic bone, debridement of the soft tissue, and lavage. The medullary canal is opened on both sides and reamed. Punctate cortical bleeding (paprika sign) is used to determine the completeness of bone debridement. To attain gradual simultaneous limb lengthening and to restore loss of length at the defect, acute compression of the site is followed by diaphyseal or metaphyseal corticotomy. The preconstructed sterilised Ilizarov frame is applied after debridement. Rings were fixed to the bone proximally, parallel to the joint then distally. Full rings are reinforced with tensioned 1.8-mm olive wires through the rings; Schanz screws are applied for additional stability if required, especially in osteoporotic bone. To avoid damage to vital structures, K wires are inserted according to the level of the tibia. On postoperative day 8, the corticotomy site is distracted at a rate of 0.25 mm 4 times a day. The rate of distraction is modified according to the quality of the regenerate formed.³ All patients undergo active physiotherapy of the knee and ankle. Weight bearing is permitted with a quadrangular walker. The time taken to accomplish radiographic and clinical union is recorded and all difficulties (such as pin tract infections, wound infections, and malalignment) are noted. The frames were removed once full healing was achieved, and the limbs immobilised in a patellar tendon-bearing cast for 6 weeks.



Photo 1. Surgical Procedure

ASSESSMENT

Bone healing, and the functional result are assessed according to ASAMI.⁴ The patient is followed up in every 6 week till 24 months. Bone healing is evaluated based on union, infection, deformity, and limb length discrepancy

Functional results are based on 5 criteria: significant limp, equines rigidity of the ankle, soft tissue dystrophy (skin hypersensitivity, insensitivity of sole decubitus or pressure sores), pain, and inactivity.



Photo 2. Case 1 Preop and Postop

RESULTS

The study group consisted of 30 patients in the age group of 20–60 years with mean follow up of 13 months. There were 23 male and 7 female patients. In 16 patients right and in 14 patients left tibia was involved.

Fracture union was achieved in 30 patients without the need for bone grafting. Bony and functional results were evaluated as laid down by the ASAMI Criteria. Of 30 patients in the study, an average duration of fixation (treatment) of 6.6 months [range 5-10 months] was noted. There were 9 [30%] excellent, 15 [50%] good, 6 [20%] fair and functional results; and 8 [26.6%] excellent, 19 [63.3%] good, 3 [10%] fair and bony union results. In our study at the time of presentation, all patients had clinical and radiological features of chronic osteomyelitis. According to the Cierny clinical staging of adult osteomyelitis, 12 [40%] patients had type III-A and 18 [60%] had type IV-A lesions.

There were no intraoperative complications. Despite being advised about proper pin site care, few patients strictly adhered to the instructions. The pre-existing bone infection and insufficient pin care probably account for the incidence of pin tract infections in this study. There were multiple episodes of pin tract infection majority of which were subsided by pin tract cleaning, 5 cases (16.6%) of which intravenous antibiotic and surgical intervention were needed. During the postoperative period, some patients presented with minor complications. Persistent bone infection despite bony union was evident in 5 patients. 10

patients had residual shortening of more than 2.5 cm. There was limb oedema in many patients despite fracture union. Majority of patients belong to 40 to 60 years group - 19 (63.3%). No neurovascular complications were encountered.

In functional outcome - pain; need for walking aids or braces; foot, ankle, or knee deformity or contracture and ability to return to normal activities of daily living (ADL) and/or work accessed. All patients could walk well without support, three patients felt pain (requiring narcotics) after they walked a long distance.

Majority of cases in study group belong to A and B-1 type of Paley's classification. Type of nonunion does not have statistically significant relationship with functional outcome (p value 0.72) or bony result (p value 0.43).

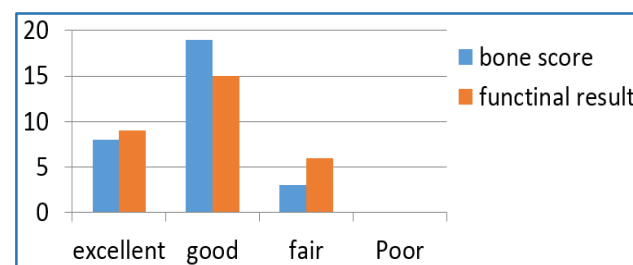


Figure 1. ASAMI Bone Score and Functional Score

Regarding ASAMI bone score and functional score in study, 80% had excellent to good result.

ASAMI Bone Score and Functional Score and Type of Nonunion

Score		A-1	A-2-1	A-2-2	B-1	B-2	B-3	Total
Excellent	ABS	1	1	3	2	0	1	8
	AFS	2	2	3	2	0	0	9
Good	ABS	6	4	3	5	1	0	19
	AFS	4	3	3	4	0	0	15
Fair	ABS	1	2	0	0	0	0	3
	AFS	2	2	0	1	1	1	6
Poor	ABS	0	0	0	0	0	0	0
	AFS	0	0	0	0	0	0	0
Total		8	7	6	7	1	1	30

Table 4. ASAMI Score and Type of Nonunion

ABS - ASAMI bone score, AFS - ASAMI functional score.

Type of nonunion does not have statistically significant relationship with functional outcome (p value 0.72) or bony result (p value 0.43).

Duration of treatment

Mean Duration of Treatment	6.6 months
In smokers	7.3 months
In non-smokers	6 months
Table 5. Duration of Treatment	

Mean duration of treatment is 6.6 months [range 5 to 10 months]. Duration is from 1st day of Ilizarov application to ring removal after bony union. Smokers took more time [average 7.7 months] for bony union than nonsmokers [average 6.6 months], which is statistically significant (p value 0.014)

Association of ASAMI bone score & functional score with smoking

Smoking	ASAMI Bone Score			ASAMI Functional Score		
	Excellent	Good	Fair	Excellent	Good	Fair
Non-smoker	5 (29.4%)	10 (58.8%)	2 (11.7%)	7 (41.2%)	9 (52.9%)	1 (5.9%)
Smoker	3 (23%)	9 (69.2%)	1 (7.8%)	2 (15.4%)	6 (46.2%)	5 (38.4%)
Total	8 (26.6%)	19 (63.3%)	3 (10%)	9 (30%)	15 (50%)	6 (20%)
Table 6. ASAMI Bone and Functional Score and Smoking						

Analysis shows that results are better in non-smokers.

patients were able to walk comfortably without pain, 10% had pain on prolonged standing or walking.

Bony Outcome

Outcome	Yes	No
Union	30 [100%]	0 [0%]
Infection	3 [10%]	27 [90%]
Deformity	13 [43.3%]	17 [56.7%]
LLD	10 [33.3%]	20 [66.6%]
Table 7. Bony Outcome		

In all the cases, fracture united. After Ilizarov treatment in 27 patients, infection was controlled. Although bone is united, 10% cases remained infected with recurrent discharge. After treatment, in 17 cases deformity was less than seven degrees if there is any, 13 cases had more than seven degrees. Limb length discrepancy was less than 2.5 cm in 20 cases, more than 2.5 in 10 cases.

Age Distribution and Union Time

Age	Number	Percentage	Union Time
20-40	11	36.7	6.54 months
40-60	19	63.3	6.63 months
Table 9. Age Distribution and Union Time			

Majority of patients belong to 40 to 60 years group. The union time is longer in older patients, but it is not statistically significant (p value).

Functional Outcome

Outcome	Yes	No
Activity	30 [100%]	0 [0%]
Limping	9 [30%]	21 [70%]
Stiffness	12 [40%]	18 [60%]
RSD	5 [16.7%]	25 [83.3%]
Pain	3 [10%]	27 [90%]
Table 8. Functional Outcome		

All the patients were active after Ilizarov ring removal. 9 patients [30%] had significant limp. Preoperatively, majority of patients had knee and ankle stiffness due to immobilisation, chronic infection and recurrent surgeries. After surgery, in 12 patients [40%] stiffness persisted, with more than 15 degrees loss of range of movement. 5 patients got reflex sympathetic dystrophy or skin changes. 27

Type of Injury and Union Time

Type of Injury	No.	%	Union Time
High velocity	19	63.3	6.63 months
Low velocity	11	36.7	6.54 months
Table 10. Type of Injury and Union Time			

Out of 30 patients studied, 19 cases of infected nonunion are because of high velocity injury. Union time not having statistically significant association.

Initial Fracture and Union

Initial Fracture	No.	%	Union Time
Closed	10	33.3	6.5
Open	20	66.7	6.7
Table 11. Initial Fracture and Union			

Out of 30 patients, 20 [66.7%] are with open fracture initially, remaining became infected nonunion later due to surgical site infection. Union time not having statistically significant association with initial fracture.



Photo 3. Case 2 Preop, Perop and Postop



Photo 4. Case 2 Followup



Photo 5. Case 3 Preop, Postop and Followup

COMPLICATIONS

	Yes	No
Significant Pin Tract Infection	5 [16.7%]	25 [83.3%]
Pin Loosening	1 [3.3%]	29 [97.7%]

Table 12. Complications

Majority of patients had inflammation at pin skin junction which subsided by daily cleaning. 5 patients had significant pin tract infection which needed antibiotic or surgical intervention. One patient had pin loosening due to pin tract infection, which was subsequently removed.

DISCUSSION

Infected nonunion used to remain as an unsolved problem in the past. Persistence of infection, instability, multiplanar deformity, shortening, prolonged immobilisation, disuse atrophy of muscles are the difficulties faced by surgeons with Ilizarov. In our study, all cases were united and were walking comfortably, happy with the results. Although laborious, the Ilizarov method is of dramatic benefit to the patient. For example, patients with limb length discrepancies or limb deformities can find life very difficult, and may end

up with detrimental consequences on other parts of the body, especially joints.⁵

For other patients, the Ilizarov method offers an alternative to amputation. In the past, patients with osteomyelitis where large segments of bone had to be removed had no option other than amputation, but thanks to the Ilizarov method and bone transport techniques, amputation is now usually only a last resort and these patients can live normal lives without hindrance.⁶

Corticotomy creates an important effect, vascularisation of the whole bone segment increases greatly, enabling a good quality of regenerating bone (even in elderly patients) at the distraction site, and the development of bone callus at the previous nonunion site.⁷ Moreover, it has a stimulating effect on the surrounding soft tissues, MicroStrain causes an additive effect with enhancement of osteogenesis and mineralisation, provided that, the change in strain is the most effective kind of stimulation for bone formation.⁸ Hence, early mobilisation and corticotomy are important in ilizarov.⁹ A fracture nonunion with infection is a significant problem to the patient and the surgeon. In many instances, the patient has undergone one or more surgical procedures, has lost considerable time from his/her job or lifestyle, and has been forced to alter his/her lifestyle.

In many instances, consolidation of the non-union must be achieved with correction of axial and rotational mal-alignment. This method produces stability between the bone ends and the fixator, which offloads the fixator and reduces

the likelihood of fixation failure. Considerable physiotherapy is required to prevent permanent joint stiffness, which relies on patient compliance. Pin site infection is common and so patients must be diligent in their pin site care.

Comparison of Functional results with other studies

Functional Result	Excellent	Good	Fair	Poor	Union Time
GK Dendrinios et al ¹⁰	7 (26%)	11 (41%)	4 (15%)	5 (18%)	6 months
Ebrahim Hasankhani et al ¹¹	18 (56%)	4 (12.5%)	3 (9.5%)	7 (22%)	5.8 months
Marko Bumbaširević et al ¹²	19 (63%)	10 (33%)	1 (4%)	0	4.5 months
MP Magadum et al ¹³	15 (60%)	8 (32%)	1 (4%)	1 (4%)	6.3 months
Our study	9 (30%)	15 (50%)	6 (20%)	0	6.6 months

Table 13. Comparison of Functional Results with Other Studies

We have compared our results of functional outcome with results available in literature. Our study got comparatively less cases with excellent result and 50% got good result which is superior. There was no nonunion or failure in our study, but nonunion and poor result seen in other studies. Mean duration taken for bony union at nonunion site in months is at longer side in our study.

CONCLUSION

The Ilizarov technique with bone transport is the most versatile, adaptive and effective method of treatment in complex cases with infected nonunion, and can very successfully deal with the associated large soft-tissue and bony defects without the use of routine bone-grafting, by corticotomy, compression distraction technique.

The Ilizarov technique is highly demanding and requires a great deal of expertise to perform successfully. Extensive knowledge of human anatomy is essential in order to reduce the risk of nerve or vascular damage. A vast majority of patients were depressed mainly due to the multiple failed attempts at union, pain, and financial and social constraints. Hence, patient selection and education regarding the duration of treatment, emotional, financial and social support are absolutely essential.

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