



Original article

Experience in fixation of infected non-union tibia by Ilizarov technique – a retrospective study of 42 cases[☆]



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ABSTRACT

Objective: The aim of the study is to evaluate the clinical and functional outcome in treatment of infected tibial nonunion by the Ilizarov method.

Methods: The authors retrospectively analyzed 42 patients with infected tibial nonunion with bone loss; shortening and deformity treated at this institution during the period of February 2012 to April 2015 were included in the study. The results were evaluated according to Association for the Study and Application of the Methods of Ilizarov (ASAMI) criteria. Pin tract infections were assessed by Moore and Dahl score.

Results: Bone results were excellent in 60% of patients ($n=25$), good in 15% ($n=6$), fair in 25% ($n=11$), and poor in none. The functional results were excellent in 55% of patients, good in 30%, fair in 5%, and poor in 10%. The most common complication found in this study was pin tract infection.

Conclusion: Ilizarov ring fixator still remains an excellent treatment modality for tibial nonunion, as it addresses the problems associated with the condition, although the procedure is cumbersome.

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Experiência na fixação de pseudartrose infectada da tíbia usando a técnica de Ilizarov – estudo retrospectivo de 42 casos

RESUMO

Objetivo: O objetivo do estudo é avaliar o desfecho clínico e funcional no tratamento da pseudartrose infectada da tíbia pelo método de Ilizarov.

Métodos: Os autores analisaram retrospectivamente 42 pacientes com pseudartrose infectada da tíbia com perda óssea. Os casos de encurtamento e deformidade tratados nesta instituição durante o período de fevereiro de 2012 a abril de 2015 foram incluídos no estudo.

Palavras-chave:

Tibia

Técnica de Ilizarov

Infecção

Fixador externo

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Os resultados foram avaliados de acordo com os critérios da Associação para o Estudo e Aplicação dos Métodos de Ilizarov (Association for the Study and Application of the Methods of Ilizarov [ASAMI]). As infecções no trajeto dos fios e pinos foram avaliadas pela classificação de Moore e Dahl.

Resultados: Os resultados ósseos foram excelentes em 60% dos pacientes (n = 25), bons em 15% (n = 6) e moderados em 25% (n = 11); nenhum paciente apresentou resultados ruins. Os resultados funcionais foram excelentes em 55% dos pacientes, bons em 30%, razoáveis em 5% e ruins em 10%. A complicação mais comum encontrada neste estudo foi infecção no trajeto dos fios e pinos.

Conclusão: Embora seja um procedimento complicado, a fixação de Ilizarov continua a ser uma modalidade de tratamento excelente para pseudartrose da tibia, uma vez que aborda os problemas associados à condição.

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Introduction

Tibia, as a subcutaneous bone which is vulnerable to trauma and its fractures are common which are mostly open and complex among the long bone fractures. Delayed union, non-union with associated infection are relatively common complications seen. The non-union ranges from 3 to 11% of all tibia fractures. Treatment of infected non-union of tibia is one of the perplexing dilemmas in orthopaedic surgery because of its delayed management after a high energy trauma, as it has thin soft tissue coverage with poor vascular supply and complex fracture patterns that result usually in an unfavourable outcome.

After multiple surgeries with huge burden of cost as well as prolonged period of immobilization makes the patient life miserable, even then the end results are unsatisfactory along with amputation may still be the outcome. To eradicate infection and to establish bony union with a good functional extremity often requires a courageous measure. The treatment of infected non-union of tibia by distraction osteosynthesis using ilizarov technique can also address a coinciding deformity, bone loss, shortening or infection.¹

According to Ilizarov, to eliminate infection and obtain bony union, concerned vascularity must be increased. In this technique, vascularity is increased by corticotomy and application of a circular external fixator. It also provides micro motion due to distraction and gives an excellent biological environment for fracture healing.² Ilizarov technique has the additional advantage of efficient fixation which allows early mobilization and maintains articular function, eliminates the need for bone grafting and has minimal complications.³

In our study, we analyzed the role of ilizarov fixation in infected non-union of tibia, we assessed for bony union, infection, functional outcome and to know the complications associated with it.

Materials and methods

Forty two patients with infected non-union of tibia for more than 6 months treated by ilizarov fixation method from February 2012 to April 2015 were retrospectively analyzed from

Table 1 – Non-union – GS Kulkarni's classification.

Type I	Fragments in apposition with mild infection and with or without implant
Type II	Fragments in apposition with severe infection with large or small wound
Type III	Severe infection with a gap or deformity or shortening
IIIa	Defect with loss of full circumference
IIIb	Defect in >1/3rd of cortex
IIIc	Infected non-union with deformity

hospital records. There were 10 females and 32 males with an average age of 38 years (range, 26–64 years) at the initial operation. Majority were manual labourers and injuries were caused by road traffic accidents (n = 36) and by fall from height (n = 6). The right side was included in 24 cases (57%) and the left side in 18 cases (43%). Infected non-union was classified by G. S. Kulkarni classification (Table 1).³ Infected non-union of distal one third tibia constituted the most number of cases in our study.

Inclusion criteria

All infected non-union of tibia associated with:

1. Bone loss of less than 10 cm.
2. Varying degree of limb shortening of less than 2.5 cm and deformity less than 5 degrees.
3. Both male and female
4. Infected non-union tibia of more than 6 months duration.

Exclusion criteria

1. Congenital pseudoarthrosis of tibia.
2. Non-union tibia not associated with infection.
3. Fresh compound fractures.
4. Infected fractures less than 6 months.

Surgical technique

Depending upon the initial clinical assessment and radiographs, appropriate ilizarov frame was assembled prior to

surgery according to required length and width. Oblique incision was preferred to avoid wound closure problems. Initial hardware if present was removed and in patients who had previous intramedullary nail, reaming of tibia was done. The bone ends were thoroughly debrided and samples were taken for microbiology and histopathology analysis. Both ends of the bone, if needed were kept in alignment with plate and screws temporarily and then frame was applied with transosseous wires along with half pins to preserve the anatomical axis and avoid any additional soft tissue damage. If required, the frames were extended to the foot to minimize equinus deformity whenever necessary. Tourniquet was used until debridement and freshening of the edges. The wires introduced after removal of tourniquet and were tensioned up to 110kg using tensioner. If soft tissue coverage was required then this was done by plastic surgeons at the same sitting. Corticotomy was performed as second stage procedure in needed cases by wires using De Bastiani technique.⁴ Whenever union is delayed, we augmented non-union site with bone marrow injection or bone grafting.

Post operatively patient was on appropriate intravenous antibiotics and analgesics for a week with leg positioned over the pillow so that knee kept extended all the times, passive dorsiflexion splints for the ankle was given. To promote early bone healing immediate weight bearing was encouraged in most cases, intensive physiotherapy to maintain or to regain normal range of motion of the knee and ankle joints was considered an important part of the treatment.

After surgery there was no changes for initial 7 days; thereafter all manipulations were done by the patients themselves by turning nuts on the fixator of the apparatus four times a day, resulting in movement in the axis of the bone of 1 mm per day. In cases requiring internal bone transport, the bone segment between the non-union corticotomy site was moved distally and the bone segment reached the former non-union site eventually followed by docking.

Consequently we evaluated patients every two weeks clinically for pin tract infections, stability of frame and radiological assessment was done every four weeks for union at the non-union site and consolidation of the regenerate. Fixator was removed when the regenerate consolidated and the non-union was corticized on three of four sides as seen on the anteroposterior and lateral X-rays.^{5,6} We used protective casts for an additional 2 months because of our fear of refracture in all our cases.

Results

In our study of 42 patients, no patients were lost during follow up. At follow up examination 14 months (range 10–24 months) after frame removal the final outcome was evaluated by criteria laid down by Association for the Study and Application of the Methods of Ilizarov (ASAMI) for bone and functional results.⁷ In majority of the cases external fixator held for a time period of 8–10 months. Bone loss after initial debridement was 2.5–5.5 cm in most of our cases.

In our study, 85% of the patients were treated by bifocal osteosynthesis, which is acute docking of the non-union site followed by corticotomy and distraction at other site. Limb



Fig. 1 – Grade 4 pin site infection according to Moore and Dahl classification.

length discrepancy was assessed at the end of treatment after union. In 35% of cases there was no limb length discrepancy after treatment. In most cases the limb length discrepancy was 0.5–1.5 cm.

In terms of organism, 28 patients grew staphylococcus aureus, six patients grew pseudomonas, four patients grew coagulation negative staph, two grew streptococcus viridans and propionibacterium each, and two patients had negative culture as they were on antibiotics preoperatively.

Bone results were assessed by ASAMI scoring. An excellent bone result was one that had no evidence of infection, a deformity of 5 degree or less in any one plane, an limb length discrepancy (LLD) less than 2.5 cm and a bone union wide enough not to require long term bracing or protection.⁷ In our study, we had excellent results in 60% of cases ($n=25$), all 42 patients had successful union after ilizarov bone transport at the end of one year, and none required amputation.

Functional results were assessed by ASAMI scoring. An excellent functional result was one in which the patient had no pain or mild pain (not requiring narcotics), did not require a walking aid or brace, did not have joint contracture greater than 5 degree, did not lose more than 20 degree of ankle motion, and was able to perform all activities of daily living.⁷ In our study, functional results were excellent in 55% ($n=23$) of cases.

Complications were sub classified according to Paley in “problems” solved during treatment without operative intervention, “obstacles” that requires an operative intervention and true “complications” that were not resolved before the end of treatment.⁸ The true complications were considered minor if they did not interfere with achieving the original goal. We recorded 38 problems in 42 patients; the problems consisted mainly of pin tract problems of which 30 patients with pin site inflammation which subsided with regular dressings and oral antibiotics. Five patients with pin site soft tissue infection were resolved by intravenous antibiotics (Fig. 1). Three patient had transient paresthesia which resolved by itself.

We recorded 20 obstacles in 18 patients. Seven patients required one additional procedure each. Four patients required two additional procedures each. Two required three additional procedures. Additional procedures included

revision for drifting transport fragment ($n=4$), debridement and grafting at docking site ($n=11$), repeat osteotomy ($n=2$), iliac bone graft to regenerate ($n=2$), and foot plate addition for equinus contracture ($n=1$). There were no major complications in our study.

Discussion

The ilizarov technique offers an effective and reliable treatment for some of the most challenging conditions in orthopaedic practice such as infected non-union of tibia. It was initially developed in Kurgan, Russia in 1950 by Prof. Gavril A. Ilizarov. Infected tibial non-unions are a complicated problem requiring complex time consuming surgery. Our study has demonstrated, good function can be achieved in terms of union, infection, pain relief and activities of daily living. Present study, using ASAMI criteria, where on par with other studies.

A diagnosis of non-union can be made when at least 6 months have elapsed with no evidence of progression of healing after the time of fracture, at this point, if there is an infection then it tends to be chronic and organism tends to be resistant to most antibiotics.^{9,10} Radical wound debridement with all necrotic bone should be completely removed together with problems like leg length discrepancy, deformity, joint stiffness; diffuse osteoporosis should be addressed.¹¹ In our study, 100% eradication of infection was noted which is

Table 2 – Bony results comparison.

Results	Excellent	Good	Fair	Poor
Paley ¹⁵	60.87%	26.09%	8.7%	4.35%
Madhusudhan et al. ¹⁶	22%	36.34%	22%	18.18%
Dendrinovs et al. ¹¹	50%	29%	3.6%	17.4%
Lalit et al. ¹⁷	70%	10%	0%	20%
Present study	60%	15%	25%	0%

comparable to other studies.^{11,12} Though ilizarov had not used antibiotics, we have used both appropriate oral and intravenous antibiotics depending upon the culture report for 4–6 weeks.

In our study duration of external fixation was 8–10 months in most cases which is comparable to other studies.¹³ In our study we noted bone lengthening index i.e. duration required for formation of 1 cm of new bone was 1.48. Studies has shown smoking has a poor statically outcome on duration of external fixator and bone lengthening index.¹⁴ Our patients were strictly advised to stop smoking during the course of treatment.

In our study, bone results were excellent in 60% of cases (Fig. 2), good in 15% of cases (Fig. 3), fair in 25% of cases and did not have any poor results making it superior to other studies (Table 2).^{15,16,11,17} In our current study though bone results were better than functional results. It shows excellent bone does not guarantee good function outcome. The

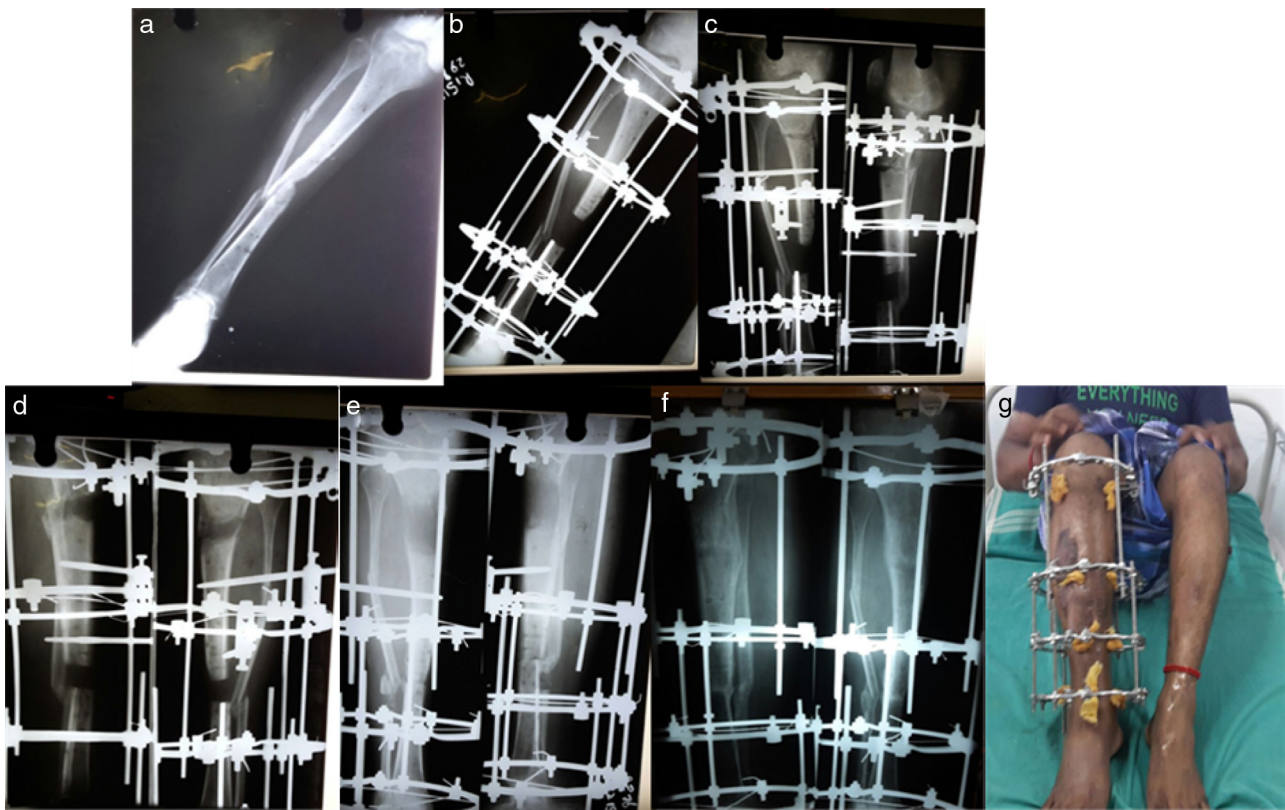


Fig. 2 – (a) 36 year old male with infected non-union right tibia type IIIc of Kulkarni's classification. (b) Post-op Xray showing radical debridement and preliminary ilizarov ring fixation. (c) X-ray showing post corticotomy status. (d, e) X-ray showing bone transport, (f) fracture united, (g) ilizarov fixator in situ after 8 months of union with excellent union and excellent functional outcome.



Fig. 3 – (a) A 40 year old male with infected non-union left tibia type IIc of Kulkarni’s classification. (b) Immediate post-op X-ray showing radical debridement and preliminary ilizarov ring fixation. (c) 1 month X-ray showing corticotomy done. (d) X-ray showing ongoing bone transport and docking. (e) United fracture with Ilizarov ring removed (f) Ilizarov fixator removed after 7 months of union with excellent union and good functional outcome.

functional result is affected by the soft tissue and neurovascular structures.⁸ Our functional results were better as compared to other studies (Table 3).

In our study, of 42 patients we had 50 complications at the rate of 1.6 complications per patient which was comparable to other studies. In that, there were 38 problems and 20 obstacles, among 38 problems 30 were due to pin tract infections assessed by Moore and Dahl grading (Table 4). Among which 16 patients had Grade II infection, 12 patients had grade III infection and two had Grade IV infection for which the pin

was removed and re-applied. The high rate of pin tract infection was due to low socio economical status and residence at villages where facilities for regular dressing were also less. Soft tissue complications including wound breakdown, invagination and significant joint contractures were not very common in our study as compared to other studies. We also found that multidisciplinary approach was very much helpful to our successful outcomes.¹⁸

Table 3 – Functional results comparison.

Results	Excellent	Good	Fair	Poor
Paley ¹⁵	64%	28%	4%	4%
Madhusudhan et al. ¹⁶	5.56%	22.22%	33.33%	38.89%
Dendrinios et al. ¹¹	25%	39.2%	14.3%	2.15%
Lalit et al. ¹⁷	26.7%	40%	10%	28.3%
Present study	55%	30%	5%	10%

Table 4 – Moore and Dahl pin site classification.

Grade	Inflammation
0	None or marginal
1	Marginal inflammation
2	Inflamed – serous
3	Inflamed – purulent
4	Inflamed with induration – seropurulent
5	Inflamed with induration, tenderness, surrounding erythema – gross purulent

Conclusion

Overall ilizarov bone transport is an effective salvage tool in obtaining union in patients with an infected non-union associated with bone loss. The lengthy treatment time and considerable number of complications must be fully understood both by the surgeon and the patient before undertaking this unique treatment process. In order to obtain faster union rate patient should be a non-smoker and smokers should be strictly advised cessation of smoking. This technique also gives better results in concern to bone healing and also gives an opportunity for correction of deformities and shortening at the same time.

Conflict of interest

The authors declare no conflicts of interest.

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