International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2019; 5(4): 639-645

www.orthopaper.com
Received: 24-08-2019
Accepted: 28-09-2019

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Limb reconstruction system (LRS) in infected non union of femur: A case series

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DOI: https://doi.org/10.22271/ortho.2019.v5.i4k.1747

Abstract
Objective: To evaluate the clinical and functional outcomes of limb reconstruction system (LRS) in infected non union of femur.
Background: LRS is an effective alternative in treating the failed osteosynthesis in long bone fractures, due to infection, loosening of implant, non union, poor bone quality and bone loss associated with deformities, limb length discrepancy, soft tissue problems, and functional issues.
Methods: We did a prospective study of 30 cases of infected non union of femur (10 plating, 19 nailing & 1 k-wire with plaster) between April 2014 to November 2018 treated with LRS. Initially we managed by implant removal, freshening of fracture site or radical debridement followed by LRS application. In 13 cases corticotomy & lengthening was performed. Monofocal lengthening was done in 5 cases. Bifocal corticotomy done in 8 cases. Average duration of frame was 14 months (8-18 months).
Results: Bone united in 24 cases (80%), Number of cases underwent lengthening -14. Average lengthening achieved-5 cm (2-11 cm). We had 86% excellent and 10 % poor bony result. Functional result was excellent in 40%, good in 50% and failure in 10% cases according to ASAMI scoring system.
Conclusions: LRS is found to be effective in managing infected non union in long bones because of its simplicity, short learning curve, ease of use with better patient compliance and is an alternative to Ilizarov.

Keywords: infected non-union, limb reconstruction system (LRS), compression distraction

Introduction
In recent times, there is an increased incidence of compound femoral diaphyseal fracture due to RTA. In spite of adequate debridement and stabilization, a significant percentage of these cases land up with infection leading to non-unions. These cases are operated upon several times with an aim to eradicate the infection, which leads to scaring of sub adjacent soft tissue and devitalisation of the surviving bone. These infective non-union presents with not only with problem of indolent infection but also with associated deformity, limb length discrepancy, adjacent joint stiffness, disuse osteoporosis and soft tissue atrophy. As a consequence these cases will be a challenging for orthopaedic surgeons. Infected non-union of long bones can be managed by debridement, external fixation and bone transport. [1–2]. The Ilizarov principles are the basis for modern successful treatment [3]. However, when the principles are applied using the Ilizarov fixator with its transosseous tensioned wires, there are disadvantages: local anatomy is distorted; soft tissues are transfixed; there is a risk of neurovascular impingement; and the circumferential fixator is poorly tolerated [4, 5]. The circular fixator is cumbersome and interferes with conduct of personal hygiene, especially when rings are used in upper thigh [6]. To overcome these disadvantages, some modifications were introduced, e.g. use of half pins and femoral arches [7]. In contrast, a monolateral external fixator has advantages with being located to one side of the limb, is usually easier to apply and remove and has greater patient acceptance [8]. The limb reconstruction system is uniplanar and less bulky. It has the advantage of allowing distraction and compression at fracture site [9]. It also allows dynamisation of the fracture site which is the essential principle in the treatment of nonunions. This study evaluates the use of LRS for treating segmental defects after treatment of infected nonunions of the femur [10].

Methods: This study was done for the evaluation of the efficacy, radiological and functional outcome by using limb reconstruction system (LRS) method in the treatment for the management of infected non-union of femur with or without segmental bone loss. Between April 2014 to November 2018, we treated 30 cases of infected non-union of femur with LRS at Dept. of Orthopaedics, Vydehi Institute of Medical Sciences & Research Centre, Bangalore. In these 23 were male with mean age-39 years (26-52 years) & 3 females with mean age 26.5 years (17-36 years) and 4 pediatric cases. Many of the cases were previously operated elsewhere. Initially we managed with implant removal, freshening of fracture site or radical debridement and fixed the nonunion with the LRS in operation theatre under all aseptic condition under guidence of an image intensifier. In 8 cases polymethyl methacrylate antibiotic cement beads were implanted. Commonly employed antibiotics were aminoglycosides (gentamicin), cephalosporins and vancomycin. Once there were no clinical signs of infection for 6-8 weeks, cement beads were removed. Most of the cases presented with shortening (2-12 cm). 13 cases underwent corticotomy & lengthening. Monofocal lengthening was done in 5 cases presenting with shortening ≥2 cm. Bifocal lengthening was done in 8 cases presenting with shortening ≥7 cm. Acute docking was done in 15 cases. We compressed the fracture site at the rate of 0.25 mm/day for 1-2 weeks and distracted corticotomy site at the rate of 1 mm/day, preferably in four increments a day. LRS was maintained till radiological sign of union was obtained. The limb was protected with POP cast for 3-4 weeks in most of the cases after LRS removal. In our study, bone grafting was not done in any of the cases. Active and passive mobilization of adjacent joint was encouraged the day following operation. Ambulation and partial weight bearing was started on second or third postoperative day depending on patient's compliance, pain, local soft tissue condition and quality of bone. Compression at fracture site was started as early as third postoperative day. Distraction at corticotomy site was started on the seventh postoperative day. Patients were discharged and asked to follow up regularly (6, 12, 20 weeks) on OPD basis. Patients were educated about pin tract hygiene, regular dressing, cleaning of external fixator and compression-distraction. At each follow up, problems of pin tract infection, loosening of pins, bolts, clamps were addressed. Check X-ray was taken at each follow up. Once radiological union of fracture site was visualized, at the same time the corticotomy site was assessed and double the duration of distraction given for the consolidation on an average for each patient before considering for the fixator removal. LRS was removed as office procedure in minor operation theatre under intravenous sedation. Average duration of treatment for femur was 8-16months (mean 12 months). Average duration of frame was 14 months (8-18 months). The details of treatments and nonunion are summarized as given in Table (2).

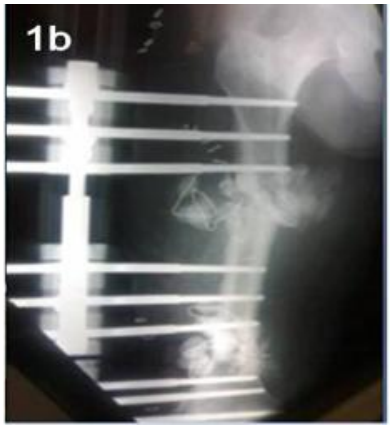
Results: Outcome was calculated in 30 cases for which final follow up was available. Out of 30 cases, complete union was attained in 84% and eradication of infection in 96.5% of cases. Two cases failed to unite and one lost to follow up. 18 cases underwent lengthening. Average lengthening achieved was 5 cm (range 3-11 cm). Finally there was no limb length discrepancy in 62% of cases, in 24% of cases it was 0.5-1 cm and in 14% of cases it was 1.1-2 cm. There was no significant difference in preoperative and post treatment joint movements (P >0.05). Results were calculated and graded as excellent, good, fair, poor and failure based on ASAMI Scoring System given in Table (4).

Discussion: In this prospective case series done between April 2014 to November 2018, we treated 30 cases presented with infected non-union of femur by the application of limb reconstruction system. The present study establishes the efficacy of the limb reconstruction system (LRS) in the treatment of these infected non-unions of femur. Infected non-union often arising from compound injury to the limb. It may have a devastating effect on patient's social and financial state. These patients are usually operated upon several times either to stabilize and healing or to eradicate infection, which in turn produces scarring of the soft tissues and devitalisation of bone. Traditionally, Ilizarov distraction osteogenesis is commonly used for managing complex non-union of long bone fractures associated with large defect and infection. But Ilizarov technique has its own complexity and technical difficulty, the commitment of time and resources required for good result and the potential for numerous complications. On the other hand LRS is uni planar dynamic external fixator which is light weight, has short learning curve and is based on same basic principle of Ilizarov. It provides stable external fixation with ability to do limb lengthening by bone transport. Major drawback is difficulty to correct three-dimensional deformities unlike Ilizarov fixator.

Kim N H *et al* conducted a study on 33 infected non union femur in which they achieved 69.6% union rate. Corticotomy was not done in any of the cases. Pin tract infections were encountered in 8 of the cases. Pin loosening and joint stiffness were noted in some cases. In a study conducted by Banks J V *et al* in 14 cases of infected non union of femur 93% of the cases of united. 2 – 5cm lengthening was achieved. Bifocal corticotomy was done in most of the cases. No pin tract problem was encountered.Hashmi *et al* conducted a study on 38 infected non union femur in which Monofocal corticotomy was done in 20 cases, and Bifocal in 18. They achieved 90% union rate, average lengthening- 4.5 cm & concluded that Monolateral external fixation can provide stable fixation for treatment of established nonunions.

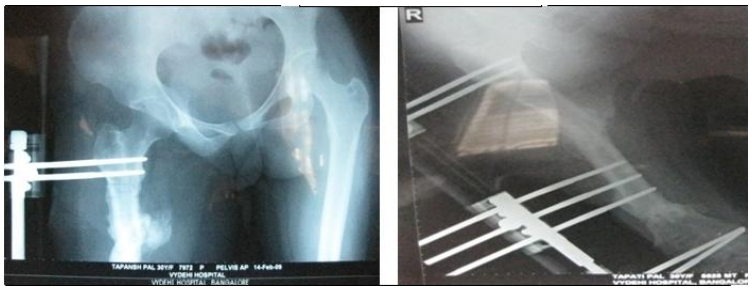
We classified the complications according to Paley classification as problem, obstacle or true complication. Problem were difficulties that required no operative intervention to resolve. Obstacles were difficulties that required an operative intervention. All intra operative injuries and difficulties during limb lengthening that were not resolved before the end of treatment were considered true complications. Pin tract infection (n = 22, 73%) was the most common problem, pin loosening (n = 8, 26%) was the most common obstacle and joint stiffness (n = 10, 33%) was most common true complication. Other complications were angulation (n = 2), premature union of corticotomy (n = 2), equinus (n = 7), persistent discharge (n = 3) and refracture (n = 2). Comparisons of present study with other studies in the literature are given in TABLE (3) below. Our study outcome was assessed with ASAMI scoring system – Table (1).

Case 1- Pre-op: failed osteosynthesis of right femur with infected nonunion associated with shortening of 10 cm.



immediate postop picture after removal of implant, radical debridement, placement of antibiotic cement beads & LRS fixation for femur**.**

Post operative clinical photograph

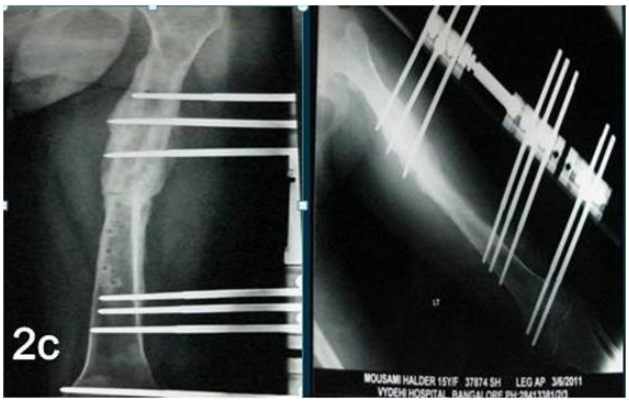


Bifocal corticotomy

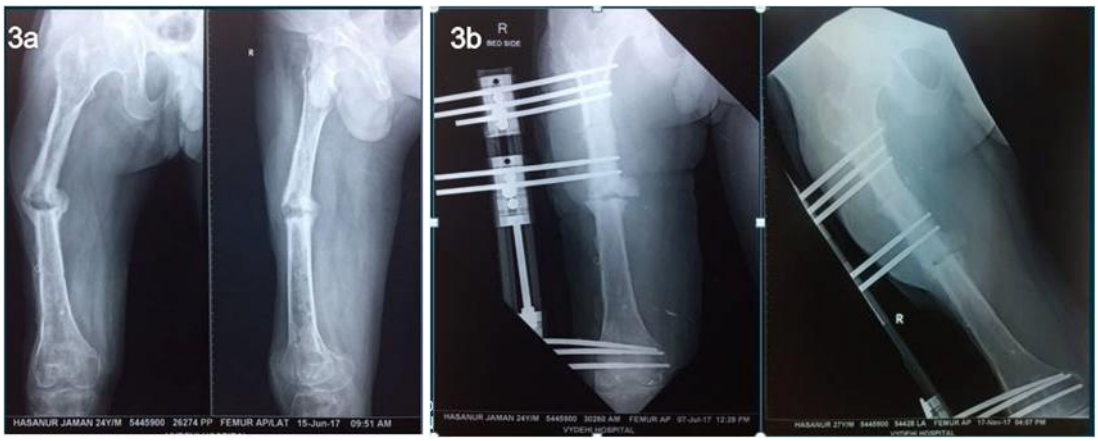
Removal of LRS & application of plaster after 18 months

Implant removed, Radical debridement done, LRS applied

Implant removed, Radical debridement done, LRS applied



3 months follow up- Infection controlled, fracture uniting



Case 3: Pre operative - Infected non union of shaft femur with implant insitu with 5 cm shortening

Post operative - Implant removed, debridement done, corticotomy and LRS applied

4 months follow up

6 months follow up – Fracture is uniting, 3 cm lenghtening

9 months follow up

12 months follow up – Fracture united | Consolidation of callus | 15 months follow up – Implant removal, 7cm lengthening achieved

Case 4: Pre op – Infected non union of left femur, 3 months follow up – Infection controlled, Bone uniting.

6 months follow up – Bone united, no joint stiffness, Knee ROM 0-100^0

Case 5: 6 year/ female – chronic | 3 months follow up – Infection controlled | 8 months follow up – Bone uniting

12 months follow up – Fracture uniting

18 months follow up – Fracture united, LRS removed

Case-6: 5 year/ female- Chronic osteomyelitis with

Post op – Debridement and LRS application

3 months follow up – Infection controlled

8 months follow up

12 months follow up

Clinical picture after slab removal

Table 1: Results based on asami score

Score	Bone results	Functional results
Excellent	26	12
Good	-	15
Fair	-	-
Poor	3	3
Failure	1 lost follow up	1 lost follow up

Table 2: Details of treatment

Mean time of union (months)	9.5 months(5-12)
Mean duration of frame (months)	13months (7-18)
Mode of treatment	
Compression	7 cases
Compression-distraction	8 cases
Compression + bone transport	15 cases

Table 3: Comparison of our study with other studies

Researcher	no of patients	long bones involved	Corticotomy	Duration of frame	Result	Conclusions
Kim NH *et al* [15]	33	Femur	-	- 8-14 months	Uncomplicated union-69.6%; 24.1% require further Rx	They recommend its use for the primary Rx of open and Segmental fractures,& for infected nonunion
Banks JV *et al*. [4]	14	Femur	Bifocal in all cases	9-13 months	13 cases united (93%), One follow up, 2-5 cm lengthening; no pintract problem	LRS to be a safe and effective technique to Rx femoral nonunions.
Hashmi MA *et al*	38	Femur	Monofocal-20 Bifocal-18	12-14 months	90% united, average lengthening- 4.5 cm,	Monolateral external fixation can provide stable fixation for Rx of established non unions.
Our study	30	Femur	Monofocal-13 Bifocal-8	8-18 months	Bone united -24 cases (80%) Number of cases underwent lengthening -14 Average lengthening achieved-5 cm(2-11 cm)	LRS is found to be effective in managing infected non union in long bones because of its simplicity short learning curve ease of use with better patient compliance an alternative to Ilizarov.

Table 4: ASAMI scoring system

Grading	Bone results	Functional results
Excellent	Union, no infection, deformity < 7 degree; Limb length discrepancy <2.5 cm	Active, no limp, minimum stiffness (loss of <15 degree knee extension/ <15 degree dorsiflexion of ankle), no RSD, insignificant pain
Good	Union+ any two of the following: Absence of infection; deformity <7 degree, Limb length inequality <2.5 cm	Active with one or two of the following Limp, stiffness, RSD, significant pain
Fair	Union+ only one of the following absence of infection, deformity <7 degree, Limb length inequality <2.5 cm	Active with three or all of the following limp, stiffness, RSD, significant pain
Poor	Nonunion/refracture /union+infection+de formity>7 Degree+limb length inequality >2.5cm	Inactive (unemployment or inability to return to daily activities because of injury)
Failures		Amputation

Conclusion: LRS is an excellent alternative to Ilizarov in the management of failed osteosynthesis with infected nonunion and shortening. Also LRS is both surgeon and patient friendly. It is easier to use and has a short learning curve compare to ilizarov.

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