MANAGEMENT OF INFECTED NON-UNION OF LONG BONES WITH LIMB RE-CONSTRUCTION SYSTEM

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ABSTRACT

BACKGROUND: CONTEXT:
Infected nonunion of long bones are a great challenge to treating surgeons. Various factors such as devitalisation of bone, soft tissue scarring, deformity, limb length discrepancy, joint stiffness and secondary osteoporosis need to be addressed along with financial constraints and compliance in management of such situations to choose appropriate treatment. Limb reconstruction system provides single stage, easy to construct and less cumbersome option to the patient.

PURPOSE
To evaluate safety and efficacy of limb reconstruction system in management of infected nonunion of long bones.

STUDY DESIGN/SETTING
Retrospective study.

METHODS
Thirteen patients with infected nonunion of long bones (tibia-8 cases and femur-5 cases) were operated using limb reconstruction system. There were 11 males and 2 females. The average age was 35 years (range 21-50 years). All cases had established nonunion for at least 6 months with evidence of infection. The infection was active in 8 patients and non-draining in 5 patients. Ilizarov study group ASAMI score was used for bone results and functional results. Complications assessed as per Paley classification.

RESULTS
The mean time for union was 9.8 months (7-12 months). The mean follow up after LRS removal was 35.2 months (range 24-44 months). Two cases had angulation of about 8 degrees (femur) and remaining cases did not have any angulation. Infection was eradicated in all cases. Functional outcome was excellent in five patients and eight good in patients. Bone outcome was excellent eleven patients and good in two patients.

CONCLUSIONS
Limb reconstruction system is a safe and effective tool for simultaneous correction of limb length discrepancy; achieve union and infection control in a single stage. It is easy to perform with reliable results and less complications.

KEYWORDS
Nonunion, Infection, Tibia, Femur, Limb Reconstruction System.

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INTRODUCTION: Infected non-union of long bones pose a great functional and financial challenge to the patient. The treatment is usually prolonged and involves multiple surgeries, disability and social stigma.[1] Financial burden is very high because of repeated hospitalization, expensive antibiotics and frequent OPD visits.

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Moreover, patient loses considerable amount of time in his work and is force to alter life in many ways. With increase in open long bone fractures due to road traffic accidents, the incidence of complex non unions is on a high. The surgeon faces a formidable problem in management of such cases in terms of planning the treatment, financial constraints and non-compliance. The issues complicating the treatment are devitalisation of bone, soft tissue scarring, deformity, limb length discrepancy, joint stiffness and secondary osteoporosis.[2]

Various modalities of treatment for infected non-union of long bones described are extensive debridement, micro vascular soft tissue flaps, external fixation with bone graft, Ilizarov ring fixator, bone transport through external fixator over nail and limb reconstruction system(LRS).[3] Ilizarov

ring fixator and limb reconstruction system are a popular modality as they are single staged procedure. It gives correction of deformity and limb length along with excellent infection control and facilitates bone union. Weight bearing can also be initiated simultaneously during treatment. Disadvantages of Ilizarov fixator are that it is cumbersome to the patient with difficulty in clothing, pain due to tensioned olive wires and relative difficulty due to extensive muscular envelope around femur and neurovascular structures. [4] Limb reconstruction system is less bulky with better compliance, easy to apply and remove with advantage of allowing dynamisation which is an important principle in treatment of non-union.[5]

In this study, we assess utility and efficacy of limb reconstruction system in management of infected non-union of long bones in terms of union rates, control of infection and associated complications.

MATERIALS AND METHODS: This is a retrospective study between the years 2008 to 2010. Thirteen cases of infected non-union of long bones (tibia-8 cases and femur-5 cases) were operated in our trauma unit using limb reconstruction system. There were 11 males and 2 females. The average age was 35 years (range 21-50 years). The causes of infected non-union were open fractures in 11 cases and infection post internal fixation in 2 cases. Of the eleven cases of open fracture, 9 were primarily treated with debridement followed by external fixator and 2 were treated with debridement followed by intramedullary nail. All cases had established nonunion for at least 6 months with evidence of infection. The infection was active in 8 patients and non-draining in 5 patients. Limb length discrepancy was 3.7 cm (range 3-5 cm). All patients had history of prior surgery 1.9 surgeries (range 1-3) either debridement or implant removal or fixation with either intramedullary nail or AO external fixator. Duration of non-union prior to LRS surgery was 11.8 months (range 7-20 months). The location of non-union was diaphyseal in 10 cases and metaphyseal in 3 cases. None of the patients were smoker. There were no associated comorbidities except one having diabetes mellitus.

All patients were operated under spinal anaesthesia. First step was to do thorough debridement and osteotomy (if required) at non-union site, this was followed by metaphyseal corticotomy (fibula was excised in cases of tibial non-union). Post operatively intravenous antibiotics were given for 6 weeks as per culture sensitivity from intraoperative samples. Patients were counselled regarding distraction. It was started after 7 days at the rate of 0.25 mm/day. Range of motion exercises were started in postoperative period. Weight bearing was started as tolerated. Patient was followed up at monthly interval and radiographs were taken to check for callus formation. Infection markers like c reactive protein and erythrocyte sedimentation rate were checked regularly. LRS was removed once union was achieved and functional brace given for 3 weeks. Table 1 shows details of patient.

Case	Age/sex (years)	Site	Infection	Bone loss(cm)	Duration of non-union (months)	Number of previous surgery	Union (months)	Follow up after frame removal (months)	ASAMI score	
									Bone results	Functional results
1	30/m	Femur	Draining	4	7	1	9	24		Good
2	41/m	Tibia	Non draining	5	12	2	10	36	Excellent	Excellent
3	33/m	Tibia	Draining	3	15	1	7	28	Excellent	Good
4	35/m	Tibia	Non draining	3	19	3	11	40	Excellent	Good
5	39/m	Femur	Draining	4	20	3	10	38	Excellent	Good
6	24/f	Tibia	Non draining	3	8	2	9	35	Excellent	Excellent
7	50/m	Tibia	Draining	5	9	1	8	29	Excellent	Good
8	44/m	Tibia	Non draining	3	11	3	12	27	Excellent	Excellent
9	45/f	Femur	Draining	4	14	2	11	38	Good	Good
10	38/m	Tibia	Draining	3	13	1	9	44	Excellent	Good
11	21/m	Tibia	Draining	3	7	3	10	38	Good	Excellent
12	26/m	Tibia	Draining	4	9	2	11	40	Excellent	Good
13	29/m	Femur	Non draining	4	10	1	11	41	Excellent	Excellent

Table 1

Bone Results	
Excellent	Union, no infection, deformity<7°,limb length discrepancy<2.5 cm
Good	Union + any two of the following: no infection, deformity<7°,limb length discrepancy<2.5 cm
Fair	Union +only one of the following: no infection, deformity<7°,limb length discrepancy<2.5 cm
Poor	Non-union / refracture / union + infection + deformity>7° + limb length discrepancy>2.5 cm

Functional Results	
Excellent	Active, no limp, minimum stiffness (loss of <15°knee extension/<15° dorsiflexion of ankle), no reflex sympathetic dystrophy, insignificant pain
Good	Active with one or two of the following: Limp, stiffness, RSD, significant pain.
Fair	Active with three or all of the following: Limp, stiffness, RSD, significant pain
Poor	Inactive (unemployment or inability to return to daily activities because of injury)
Failure	Amputation

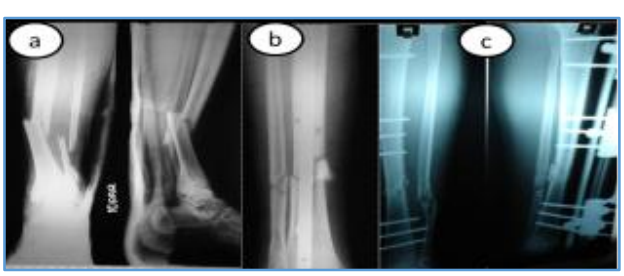
Table 2: ASAMI scoring system

All patients were evaluated using ASAMI scoring system [6] into bone results and functional results (Table 2). Complications were classified as per Paley classification. [7] Paley classified complications as problems, obstacles and true complications. Problems are difficulties which resolve with conservative management. Obstacles are difficulties which resolve with operative management. True complications are the one persist even after completion of treatment.

RESULTS: All cases achieved union. The mean time for union was 9.8 months (7-12 months). The mean follow-up after LRS removal was 35.2 months (range 24-44 months). The residual limb length discrepancy was 0.5-1 cm. There was no significant angulation more than 15 degrees in any cases, two cases had angulation of about 8 degrees (femur) and remaining cases did not have any angulation. Infection was eradicated in all cases.

There were few problems like pin tract infection in 6 patients which became better with regular dressing. Two patients had an obstacle in the form of pin loosening which needed the pin to be exchanged. Other had early consolidation at corticotomy site due to delayed distraction in a non-compliant patient, in this case re-corticotomy was done and distraction was started. Three patients had true complications like knee stiffness which persisted. There were no patients with re-fracture through pin tracts or regenerate. None had neurovascular complications or joint subluxations.

Functional outcome was excellent in five patients and eight good in patients. Bone outcome was excellent eleven patients and good in two patients. Figure 1 shows patient operated with LRS for infected non-union tibia.



a) Radiograph showing fracture tibia and fibula
b) Radiograph showing nonunion tibia fibula with nail in situ at 8 months.
c) Implant removal and LRS applied

d) Union at 9 months
e) Clinical photo showing patient walking full weight bearing at union.

DISCUSSION: The limb reconstruction system was primarily devised to correct the limb length discrepancy caused due to bone loss secondary to trauma or sequesterectomy following osteomyelitis surgery. This system uses techniques of bone transport, compression-distraction and bifocal lengthening for correction. [8] The only issue is difficulty in correction of three dimensional deformities unlike ring fixator. [9]

Limb reconstruction system is a uniplanar external fixator allowing dynamisation if required. It is based on principle of distraction histogenesis same as Ilizarov ring fixator. It is less bulky. It is easy to construct and the learning curve is short. It provides stable fixation which is mechanically strong. The spread of fixation using sliding clamps allow change in stiffness of fixation thus fracture can be controlled precisely. [2,9] Hence we commonly use this system especially for non-union of long bones.

In our study, none of our cases had soft tissue interposition and required re-surgery. [3] Our union rates were comparable to various studies with Ilizarov and limb reconstruction system. Patil et al [12] had 95% union rate using Ilizarov ring fixator and Hashmi et al [13] had 90 % union rates with limb reconstruction system. Seenappa et al [2] had 89.2% union with limb reconstruction system, In all our cases union was achieved.

As monorail fixator is uniplanar, there are chances of malalignment. This is particularly common in femur. Few authors have suggested use of intramedullary nail over

limb reconstruction system to prevent this and shorten treatment duration. [3,12,14] We believe that in the presence of infection, intramedullary device would exacerbate infection. Also the cost of intramedullary nail, cement and antibiotic beads may increase in previously multiply operated patients. [3] Therefore we did not use intramedullary nail with LRS in our study. We did not encounter any issues of significant malalignment in our study. Precise technique and watchful regular follow up can prevent significant malalignment.

Infection was controlled in all cases and there were no reactivations at average follow up of 35.2 months (range 24-44 months) after frame removal. The bony outcome was excellent since all patients achieved union with no or minimal angulation (two cases) and some amount of limb length discrepancy. The functional outcome was however less as compared to bony outcome because of persistent knee stiffness and limp due to muscular weakness. These results were comparable to other studies published in the literature. [2]

Key to successful outcome is proper compliance of patient with regular follow up, appropriate wound care, patient counselling and physiotherapist to prevent adjacent joint stiffness and mobilization. This is considered as a crucial part of treatment. [3] Our study has few limitations. The sample size is small. There is no control group or comparable treatment group.

In conclusion, limb reconstruction system is a safe and effective tool for simultaneous correction of limb length discrepancy; achieve union and infection control in a single stage. It is easy to perform with reliable results and less complications.

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