RESEARCH PAPER | Medical Science | Volume : 6 | Issue : 2 | FEBRUARY 2016 | ISSN - 2249-555X

Treatment of Infected Non Union of Lower Limb Long Bones with Limb Reconstruction System (Lrs).

KEYWORDS: LRS, Infected Non-union, Long Bones, Ilizarov.

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ABSTRACT *Back ground: Infected nonunion of long bones is very big challenge to manage due to the presence of infection, deformities, shortening and multiple surgeries in the past. Open debridement of the non-union site, appropriate antibiotics and stabilization of fracture are the basic principles of treatment in an infected non-union. Internal fixation of such fracture is fraught with recurrence and or persistence of infection. Infected nonunions are traditionally managed by Ilizarov ring fixator. The disadvantages of Ilizarov are poor patient compliance, inconvenience of the frame and difficult frame construction. Limb reconstruction system provides single stage, easy to construct and less cumbersome option to the patient. We conducted a study on 21 infected nonunions of lower limb long bones treated by the limb reconstruction system (LRS).*

Materials and Methods: Between January 2011 and December 2015, we treated 21cases of infected nonunion of lower limb long bones with the LRS. 19 were male and 2 females. Average shortening was 4.3 cm and 8 cases presented with infected implants. The average age was 33 years (range 21-55 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. Initially we managed with implant removal, radical debridement followed by fixation with the LRS. In 16 cases, corticotomy and lengthening was done. The average duration of treatment was 7.6 months. We compressed the fracture site at the rate of 0.5 mm per day for 2 weeks and distracted the corticotomy at the rate of 1 mm/day till lengthening was achieved. 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 5.5 months (4-13 months). The mean follow up after LRS removal was 25.2 months (range 15-44 months). Two cases had angulation of upto 7 degrees (both femur) and remaining cases did not have any angulation. Using ASAMI scoring system functional outcome was excellent in 13(61.9%) patients, good in 6(28.57%) patients & fair & poor result in 1(4.76%) case each. Bone outcome was excellent 14(66.67%) patients, good in 6(28.57%) patients & fair in 1(4.76%) patient. The union occurred in all cases and eradication of infection in 95.35% cases. 3 case required bone grafting out of which 1 case wase initially treated by induced membrane technique. Average lengthening done was 3.6 cm.

CONCLUSION: "Best treatment for infection is Prevention". Treatment infected non-union is a long battle. It needs an aggressive approach and a lot of patience from the patient. LRS is an attractive alternative to the Ilizarov fixator in their management of complex nonunion of long bones. It is less cumbersome to the patient and more surgeon and patient friendly.

INTRODUCTION: Infected non-union has been defined as a state of failure of union and persistent infection at the fracture site for 6-8months[6] and union is not likely to occur without active intervention. Infected non-union of long bones poses a great functional and financial challenge to the patient. The treatment is usually prolonged and involves multiple surgeries, disability and social stigma[1]. With increase in open long bone fractures due to road traffic accidents, the incidence of complex non unions is on a high. In such cases the surgeon faces a formidable challenge[11] in planning the treatment, financial constraints and non-compliance. The issues complicating the treatment are devitalisation of bone, soft tissue scarring & atrophy, deformity, limb length discrepancy, joint stiffness and secondary osteoporosis.[2,6,10] The suffering for patient is so severe in some cases that ablation /amputation may be one of the treatment options to save the life of the patient.[7-9] 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] Internal fixation of such fracture is fraught with recurrence and or persistence of infection as the implant so placed will act as a foreign body. Colonization of bacteria on the implant cannot be eliminated as the antibiotics will not reach non vascular areas. The best way to stabilize such a fracture is with an external fixation. External fixation so used should not only stabilize the fracture but should also take the cyclical loading of day to day activities and also weight bearing. Ilizarov ring fixator, LRS and Orthofix are the implants that can serve the above purpose.[12,13] Ilizarov ring fixator and limb reconstruction system are popular modalities 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. Ilizarov fixator is cumbersome to the patient, painful and relative difficult to mount.[4,14] Limb reconstruction system is less bulky with better compliance, easy to apply and remove with advantage of being dynamic which is most important principle in treatment of non-union.[5,15] In this study, we assessed limb reconstruction system in management of infected non-union of long bones of lower limb in terms of union rates, control of infection and associated complications.

MATERIALS AND METHODS: Between January 2011 and December 2015, 21 cases of infected non-union of long bones (femur- 9 cases, tibia-12 cases) were operated in our trauma

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unit using limb reconstruction system. There were 19 males and 2 females. The average age was 33 years (range 21-55 years). The causes of infected non-union were open fractures in 17 cases and infection following internal fixation in 4 cases. Of the 17 cases of open fracture, 13 were primarily treated with debridement with external fixation and 4 were treated with debridement with internal fixation. 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. Average limb length discrepancy was 4.3 cm (range 2-6.5 cm). All patients had history of prior 1.7 surgeries (range 1- 4) either debridement or implant removal or fixation with either intramedullary nail or AO external fixator. Duration of non-union prior to LRS surgery was 13.9 months (range 9-34 months). The location of non-union was diaphyseal in 16 cases and metaphyseal in 5 cases. 4 patients were smoker. There were no associated co-morbidities except in 3 patients having diabetes mellitus. Debridement, implant removal, antibiotics according to culture & sensitivity, stabilization of fracture, restoration of gunction of limb & adjacent joints are the basic principles to be followed in infected non union management. All patients were operated under all aseptic condition under suitable anesthesia under facility of an image intensifier. First step was to do thorough debridement and sequestractomy (if required) at non-union site; this was followed by corticotomy (fibulectomy in cases of tibial non-union). Post operatively antibiotics were given for 6 weeks as per culture sensitivity from intraoperative samples. In 7 cases polymethyl methacrylate antibiotic cement beads were implanted. Commonly employed antibiotics were aminoglycosides , cephalosporins and vancomycin. Once there were no clinical signs of infection for 6-8 weeks, cement beads were removed. Patients were counseled regarding compression-distraction. Distraction at corticotomy was started after 7 days at the rate of 1 mm/day. We compressed the fracture site at the rate of 0.5 mm/day for 1-2 weeks. Range of motion exercises were started in immediate postoperative period after adequate analgesia. Weight bearing was started as tolerated. Patients were educated about pin tract dressing, cleaning of fixator and compression–distraction. At each monthly followup appointment, problems of pin tract infection, loosening of pins, bolts, clamps were addressed. Radiographs were taken on each monthly follow up to check for callus formation. LRS was maintained till radiological sign of union was obtained (at least three out of four cortices united). Infection markers like C - reactive protein and erythrocyte sedimentation rate were also checked regularly. LRS was removed once union was achieved and functional brace given for 4 weeks. All patients were evaluated using ASAMI scoring system[18] into bone results and functional results (Table 1). Complications were classified as per Paley classification [14] into 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.

Table 1.1 ASAMI scoring system

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

Case 1: Mr.Chandrabhan 35 year old man with infected non union of tibia with 8 cm bone loss

post op picture

pre op picture showing hybrid fixator applied else where

2 month follow up after distraction

6 month followup showing consolidation of regenerate

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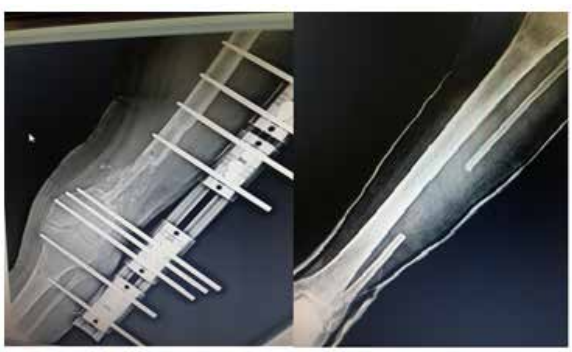
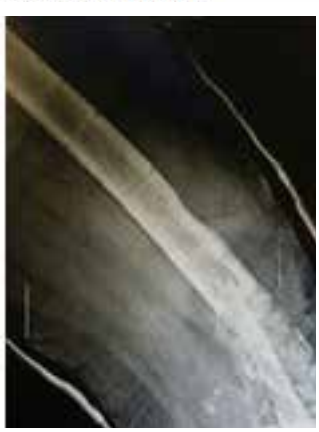
comlete eradication of infection and solidification of regenerate following 8 months post op



Free fibula taken from contralateral limb and along with cancellous bone graft it was grafted at non union site after clearance of infection



RESULTS: All cases achieved union. The mean time for union was 5.5 months (4-13 months). Femur took the shortest mean time of 4.6 months to unite and tibia took 9 months. 3 case required bone grafting (2 tibia & 1 femur). In 1 case of infected non union of proximal tibial metaphysis, we used antibiotic cement spacer for 6 weeks & then after infection control & membrane induction fibular strut grafting was done. Shortest time taken by femur to unite was thought to be due to better vascularity & better soft tissue envelope. The mean follow-up after LRS removal was 25.2 months (15-44 months). Average lengthening achieved was 4 cm (range 1.5-6 cm). Mean residual limb length discrepancy was 1.1 cm (0.5-1.5 cm). Finally there was no limb length discrepancy in 70% of cases, in 16.5% of cases it was 0.1-1 cm and in 13.5% of cases it was 1.1-2 cm. 2 cases had angulation about 7 degrees (both femur) and remaining cases did not have any angulation. Mean time taken to control the infection was 3.5 weeks (2-11 weeks). Infection was eradicated in 95.35% cases. There were few problems like pin tract infection in 13 patients which healed with regular dressing. 3 patients had pin loosening which needed the pin to be exchanged. 1 patient 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. 5 patients had knee stiffness which persisted. There were no patients with refracture through pin tracts or regenerate. None had neurovascular complications or joint subluxations. Functional outcome was excellent in 13 patients and good in 6 patients. Bone outcome was excellent 14 patients and good in 6 patients.

DISCUSSION: Non-union of fracture is itself very difficult situation in orthopaedics & when associated with infection it becomes the worst thing. Prevention of infection in any orthopaedic surgery is the most important tool. Once infected the treatment must be aggressive. Thorough debridement, implant removal & antibiotics are important. This reduces the load of infection[23-28]. Antibiotics should be used according to culture and sensitivity. 6 weeks of antibiotics of which 3-4 weeks intravenous and remaining oral antibiotics occasionally a longer duration is required[26]. Repeated debridement may be required in few infected non-unions. Stabilization of fracture with either internal or through external devices is very important for control of infection. Infection is better with external stabilization than internal fixation. Persistent infection is noted with internal fixation because of colonization of organisms on implant[6, 27]. So we recommend external fixation over internal fixation [27, 29, 30]. External fixators span the infected area giving stability to the fracture but without any contact with the already infected area. Only drawback if discomfort for the patient as there is an implant on the limb. With a well counseled patient it is not a major problem. Full weight bearing walking is encouraged to help in healing the fracture. Early return to full function will also improve the morale of the patient. Patient is encouraged to walk full weight bearing and also advised to move all the joints to full range of motion. The goal of treatment in infected non-unions is a patient with full functional limb with no deformities, healed fracture having no residual infection[25]. Traditionally, Ilizarov ring fixator is commonly used for managing complex non-union of long bone fractures associated with large defect and infection[4, 10, 31, 32]. But Ilizarov technique is complex, technically difficult, time consuming and potential for numerous complications is there[18]. As an alternative to ring fixator LRS was made for correction of limb length discrepancy due to bone loss caused by trauma or sequesterectomy following infection. Like ilizarov this system uses principles of bone transport, compression-distraction and bifocal lengthening[19]. Unlike ring fixator, correction of three dimensional deformities is very difficult with LRS[20]. Limb reconstruction system is a uniplanar external fixator which is dynamic, less bulky, easy to construct and the learning curve is short. It provides strong & stable fixation. The spread of fixation using sliding clamps allow change in stiffness of fixation thus fracture can be controlled precisely [2, 20]. In our study, none of our cases had soft tissue interposition and required re-surgery[3]. Our un-

Volume : 6 | Issue : 2 | FEBRUARY 2016 | ISSN - 2249-555X

ion rates were comparable to various studies with Ilizarov and limb reconstruction system. In this study all cases achieved union. Among them, 24.09% were by primary union, 14.28% cases required bone grafting, 52.38% by bone transport and 9.52% by callus distraction. It is in contrast of study done by Patil et al. (95%) [16] and Hashmi et al. (90%) [21] where bone grafting was done to achieve union. As LRS is uniplanar, there are chances of malalignment particularly in femur. Few authors have suggested use of intramedullary nail over limb reconstruction system to prevent this and shorten treatment duration [3, 16, 22]. 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 intra-medullary nail with LRS in our study. We did not encounter any issues of significant mal-alignment in our study. Precise technique and watchful regular follow up can prevent significant mal-alignment. Infection was controlled in 95.35% cases and there were no reactivations at average follow up of 25.2 months (range 15-44 months) after fixator removal. These results were comparable to other studies published in the literature [2]. Successful outcome mostly depend on compliance of patient with regular follow up, appropriate care of pins & fixator, patient counselling and physiotherapy to prevent joint stiffness and mobilization. This is considered as a crucial part of treatment [3].

CONCLUSION: "Best treatment for infection is Prevention". Treatment of infected non-union is a marathon task. It needs an aggressive approach from surgeon and a lot of patience from the patient. Basic treatment protocol for infected non-union is thorough debridement, removal of all infected material including the internal fixation devices & long duration antibiotics according to culture & sensitivity. Fracture stabilized with LRS is equally effective and a good modality of treatment in infected non-union of long bone fractures as compared to traditional ilizarov ring fixator. LRS is 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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