

# Definitive Management of Open Tibia Fractures Using Limb Reconstruction System

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## ABSTRACT

**Introduction:** Open fractures are treated as surgical emergency and early administration of intravenous antibiotic coupled with early irrigation and debridement decreases the infection rate dramatically. Limb Reconstruction System (LRS) is a unilateral rail system which consists of Shanz pins, rail rods and sliding clamps. It is specifically designed to enable the surgeon to perform simple and effective surgery as it offers rigid fixation of fracture fragments, allowing early weight bearing and reduces economic burden.

**Aim:** To determine the efficacy of Limb Reconstruction System for treatment of compound tibia fractures.

**Materials and Methods:** A prospective study was carried out where in 54 cases out of 412 compound tibia fractures having Modified Gustilo Anderson Type IIIA and IIIB with a mean age of 42±5 years were treated using LRS over a period of 26 months. Limb reconstruction system was used in acute docking mode or with corticotomy and bone transport was done depending upon the bone loss. The soft tissue condition was assessed

and split thickness skin grafting and flap repairs were done as per the need. Clinical and radiological assessment was done at every follow-up. Bony and functional assessment was done by Association for the Study and Application of the Methods of Illizarov (ASAMI) criteria.

**Results:** Among 54 patients, bony results as per ASAMI score were excellent in 36, good in 14, fair in 2 and poor in 2 patients. Functional results were excellent in 43, good in 7, fair in 4 patients. The average fracture union time was 8 months. Post-surgery patient satisfaction was excellent since fixation allowed weight bearing immediately. Average hospital stay was 7 days and financial burden was reduced by 40% as compared to multi staged surgery. The average time of return to work was 20 days.

**Conclusion:** LRS is an easy, simple and definitive surgical procedure that allows immediate full weight bearing walking. It reduces hospital stay, is cost effective with excellent patient compliance and can also be used for bone lengthening/transportation.

**Keywords:** Bone loss, Bone transport, Compound tibia fracture, Corticotomy, External fixator, Pin tract infection

## INTRODUCTION

More than 4.5 million open fractures occur per year in India [1]. Open fractures have to be treated as surgical emergency after ruling out other life threatening conditions. Local treatment goals include prevention of infection, soft tissue coverage and fracture stabilisation. Early administration of intravenous antibiotic coupled with early irrigation and debridement decreases the infection rate dramatically in open fractures. Fracture stabilisation can be achieved with internal fixation and external fixation, ring fixators, free or vascularized bone grafting along with allografts or bone substitutes [2,3]. The usual protocol of treating compound fractures include initial debridement, external fixation, closure of wound and then, after the wound heals without any signs of infection intramedullary interlocking nail would be inserted [4]. The disadvantage of this technique is need for several operative procedures, longer period of hospital stay, increased chances of infection, financial burden and prolonged immobilization. To overcome these disadvantages Limb Reconstruction System (LRS) was considered as definitive management for open fractures. LRS is a unilateral rail system consisting of Shanz pins, rail rods and sliding clamps. With its modular attachments it is specifically designed to enable the surgeon to perform simple and effective surgery as it offers rigid fixation of fracture fragments, allows early weight bearing and reduces the economic burden [5]. As the ideal treatment for compound tibia fractures is still under debate, evaluation of the outcome of LRS as a definite mode of treatment to achieve union, as well as limb lengthening was done.

## AIM

To establish the efficacy of definitive fixation using Limb Reconstruction System.

## MATERIALS AND METHODS

Out of 412 compound tibia fractures, 54 cases having Modified Gustilo Anderson Type IIIA and IIIB [6] were included in this prospective study. The study was conducted from 1<sup>st</sup> June 2013 to 31<sup>st</sup> August 2015 at KLE'S Dr. Prabhakar Kore Hospital and Medical Research Centre, Belagavi after obtaining the necessary ethical clearance. These 54 patients have undergone fixation using LRS to achieve bony union. Both male and female patients between the age of 18-60 years were included in the study.

Patients with immediate life threatening conditions, closed fractures, osteoporotic fractures and Modified Gustilo Anderson Type I, II and IIIC were excluded from the study.

### Intervention

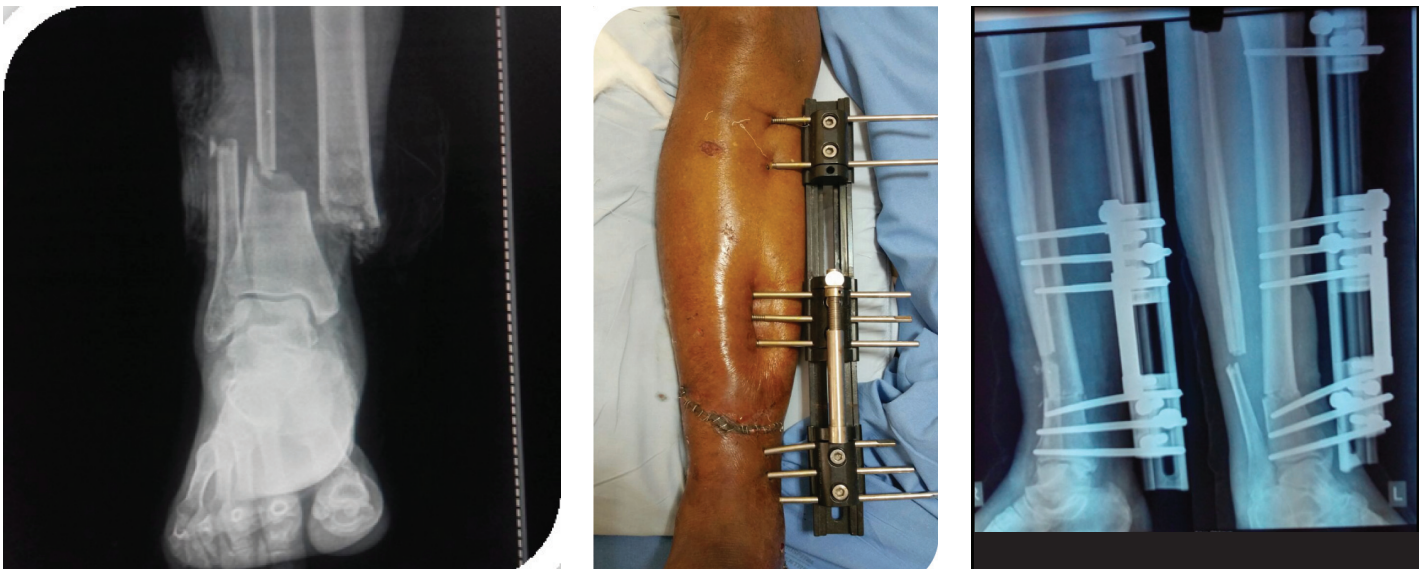
After primary survey and ruling out immediate life threatening conditions, patients were administered intravenous antibiotics and tetanus immunoglobulin. Preoperative work up included complete haemogram, renal profile, coagulation profile, viral markers and radiographs of the affected limbs in orthogonal planes.

Under spinal anaesthesia and with tourniquet in situ, thorough debridement of wound was performed which was followed by LRS application. Stab incisions were followed by blunt dissection until the bone was reached. Shanz pins were passed proximal and distal to fracture site followed by insertion of rail rods and clamps.

In simple fractures without bone loss, LRS was applied in acute docking mode and immediate weight bearing was advised. In those with bone loss, compression distraction technique was used at 1mm for every week alternatively in immediate



**[Table/Fig-1]:** Showing open distal tibia fracture; Showing open distal tibia fracture.



**[Table/Fig-2]:** X-ray showing distal tibia and fibula fracture AP view. **[Table/Fig-3]:** Showing LRS in situ. **[Table/Fig-4]:** Post op X-ray AP and lateral view showing LRS in situ.



**[Table/Fig-5]:** Follow up X-ray AP view with LRS in situ. **[Table/Fig-6]:** Showing X-ray AP and lateral view after LRS removal with good union. **[Table/Fig-7]:** LRS applied to bilateral lower limbs.

postoperative period. Patients and their relatives were explained and taught about the technique of compression distraction at a cyclical rate of 1mm per day or on alternate basis. When required, skin grafting and flap surgeries were carried out within 3-4 weeks. Patients were asked to come for follow-up at every 4 weeks interval and weekly dressings were advised to prevent pin tract infection. Clinical and radiological assessment was done at every follow-up to check for pin tract infection and presence of

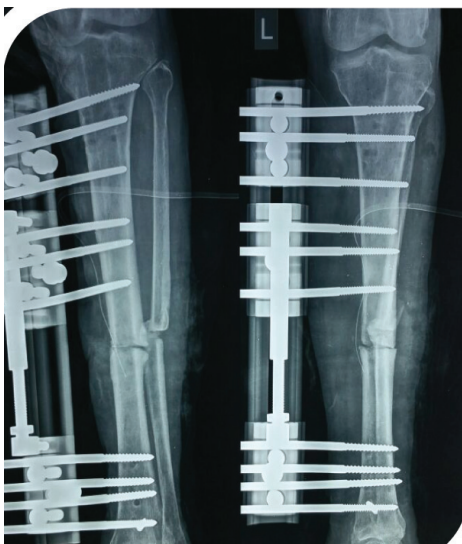
callus. Bony and functional assessment was done by Association for the Study and Application of the Methods of Illizarov (ASAMI) criteria [7].

## RESULTS

In this study, LRS was performed in 54 cases of open fracture tibia (type IIIA and type IIIB). The patients were between 18-60 years of age with a mean age of 42± 5years. A total of 49 patients were



[Table/Fig-8]: X-ray AP and lateral view right leg.



[Table/Fig-9]: X-ray AP and lateral view left leg.



[Table/Fig-10]: Xray showing bone transport.

male and 5 patients were female and road traffic accident being the most common cause of injury. Forty patients had fractures in middle one-third tibia shaft. Acute docking was done in 47 patients [Table/Fig-1-6] and 1 patient underwent LRS fixation for bilateral tibia fractures [Table/Fig-7-9], 7 patients with bone loss underwent bone transport [Table/Fig-10,11] and 8 patients underwent split thickness skin grafting and flap repair. One patient with type IIIB fracture developed deep infection with pin loosening which warranted fixator removal, it was reapplied after the infection was under control. In 3 patients with type IIIA fracture, fibular osteotomy was done [Table/Fig-9,10], as intact fibula was not allowing compression at the fracture site. The most common complication encountered in this study was pin tract infection, which was treated with suitable antibiotics postculture and sensitivity testing. All patients achieved good range of movements in the follow-up period. Among 54 patients, bony results as per ASAMI score were excellent in 67% ( $n = 36$ ), good in 25% ( $n = 14$ ), fair in 4% ( $n = 2$ ) and poor in 4% ( $n = 2$ ). Functional results were excellent in 80% ( $n = 43$ ), good in 13% ( $n = 7$ ), fair in 7% ( $n = 4$ ) [Table/Fig-12]. All the 54 cases of type IIIA and IIIB were kept on LRS external fixator for a period of 5-6 months on an average depending on the rate of union, after which the fixator was removed and limb immobilized with Patella Tendon Bearing cast for another 3-4 weeks. In most cases union was complete by 7-8 months, the least being 5 months for a tibia shaft fracture. In cases with acute docking [Table/Fig-13], patient satisfaction post-surgery was excellent because fixation allowed them to start immediate weight bearing. Patient satisfaction was assessed using a questionnaire wherein majority of patients expressed high satisfaction in terms of early mobilization. The average hospital stay for the patients was 7 days and as compared to multi staged surgery financial burden was reduced by 40%. The average time of return to work for the patients was 20 days.

## DISCUSSION

Open fractures of tibia are very common in this modern world because of high velocity road traffic accidents. Although newer and better treatment approaches for the management of open fractures are available, open fractures remain to be one of the important challenges in orthopaedic trauma. Because the study has been done in a tertiary care centre, a lot of compound fractures were encountered. According to Behrens and Searls [8], every year two cases out of 1000 injuries were compound tibial fractures and this rate was even greater than 0.2% in developing countries. The various modalities of treatment available for tibial compound fractures are minimal osteosynthesis, biological fixation and internal fixation with intramedullary nailing or external fixation with different



[Table/Fig-11]: Xray showing AP and Lateral views post bone transport.

types of fixators. Irrespective of which treatment method is used, the aim of the surgery should be to obtain maximum functionality to the fractured extremity and to maintain patient's life quality with minimum damage or complication [9-11].

Use of external fixators in comminuted, defective, and contaminated open fractures like Gustilo-Anderson types IIIB and IIIC open fractures, is routinely accepted these days [12,13]. According to Yokoyama K, treatment of grade IIIB and IIIC with intramedullary nailing was risky as it lead to deep infection and nonunion in 20.3% cases [14]. Therefore, external fixators are preferred modality because they are easy to use and allow soft tissue treatment. But the problems associated are prolonged immobilization and need for revision surgery for definitive fixation at a later stage. Therefore, LRS, which is different from the simple external fixators in allowing full weight bearing immediate postoperatively like an intramedullary fixation was used. LRS fixation technique also has an added advantage of salvaging the limb and preventing amputation. On other side, it has its own complications like pin loosening and pin tract infection. In this case series of 54 cases, pin loosening was noted and pin replacement was required only in 1.85% cases and moreover, in 92.59% cases, complete union was achieved within 8 months.

The complications of nailing or fixators with acute docking are shortening, soft tissue healing problems, increased morbidity, multiple surgeries, prolonged hospital stay and its consequences like deep vein thrombosis, bed sores, nosocomial infection which

Bony Results		Number of patients
Excellent	Union, no infection, deformity<7°, limb length discrepancy <2.5 cms	36
Good	Union + any two of the following: No infection, deformity<7°, limb length discrepancy <2.5 cms	14
Fair	Union + any one of the following: No infection, deformity<7°, limb length discrepancy <2.5 cms	2
Poor	Nonunion/refracture/union+infection+deformity>7° + limb length discrepancy > 2.5 cm	2
Functional Results		
Excellent	Active, no limp, minimum stiffness (loss of <15 knee extension/< 15 dorsiflexion of the ankle), no reflex sympathetic dystrophy, insignificant pain	43
Good	Active with one or two of the following: Limp, stiffness, RSD, significant pain	7
Fair	Active with three or all of the following: Limp, stiffness, RSD, Significant pain	4
Poor	Inactive (unemployment or inability to return to daily activities because of injury)	0
Failure	Amputation	0

[Table/Fig-12]: Bony and Functional results as per ASAMI criteria.

Criteria	Number of patients
Acute Docking Mode	47
Bone transport	7
Split thickness skin grafting and flap	8
Fibular osteotomy	3
Resuturing	4
Pin reapplication	1
Average time of union	28 weeks
Average time of implant removal	30 weeks

[Table/Fig-13]: Results of open tibia fractures fixed using LRS.

eventually leads to increased chances of mal union and non-union and increased financial burden [15]. In a study conducted by Edward in 1988, Grade III open tibial fractures were treated with external fixator, where in 93% of the fractures united well and 89% patients had satisfactory clinical function [16]. Even in patients treated with secondary nailing after primary external fixator or after delayed primary nailing there are more chances of infection [4]. Ilizarov ring fixator is a good modality of treatment but is cumbersome for the patient and difficult to master by the surgeon as compared to LRS. According to a study done by Ajmera et al., LRS proved to be an effective modality of treatment in cases of open fractures tibia with bone loss as definite modality of treatment for damage control as well as for achieving union and lengthening [17].

LRS fixator provides immediate stability to fracture fragments and allows immediate weight bearing which ultimately promotes early fracture healing and reduced financial burden.

## LIMITATION

Limitations of this study were a lack of comparison group or a control group and less sample size. Considering the optimistic results of the study, further multicentric studies and randomized control trials are suggested before establishing it as an effective modality of treatment in cases of open fractures tibia with bone loss.

## CONCLUSION

LRS is a simple and easy system which can be used for all open fractures. Fixation with LRS is a single definitive surgery. It is a cost-effective mode of treatment. Patient is independent and walks full weight bearing without walking aids. It saves time for the patient by reducing hospital stay and is a simple technique compared to Ilizarov ring fixator. Patient compliance is excellent. It can also be used for bone lengthening / transportation, deformity correction, in patients with infective non-union and osteomyelitis. Implant can be reused which brings down the cost of surgery considerably.

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