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Original Research Article

STUDY ON MANAGEMENT OF OPEN TIBIA FRACTURES WITH LRS AS PRIMARY & DEFINITIVE MODE OF FIXATION IN A RURAL BASED TERTIARY CARE CENTRE IN SOUTH INDIA

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ABSTRACT

Background: Open tibial fractures are challenging injuries because of soft-tissue damage, contamination, and the risk of delayed healing and complications. This study evaluated the outcomes of using the Limb Reconstruction System (LRS) as primary and definitive fixation in a rural tertiary-care setting. **Materials and Methods:** This retrospective study included 20 patients aged 20–70 years with Gustilo-Anderson Grade I–IIIB open tibial fractures treated with LRS at Government Medical College Hospital, Ariyalur, from August 2021 to July 2023. Clinical and radiological outcomes, rehabilitation, complications, and functional outcome using the ASAMI scoring system were assessed during follow-up. **Results:** The mean age was 43 years, with 16 (80%) males and 4 (20%) females. Grade II fractures were most common (10, 50%), followed by Grade I (5, 25%), Grade IIIA (3, 15%), and Grade IIIB (2, 10%). Partial weight bearing with walker support was achieved by 6 weeks in 14 (70%) patients. The mean time to full weight bearing was 12 ± 2 weeks. Hospital stay was less than 8 days in 16 (80%) patients. Radiological union occurred within 4–8 months, and 2 (10%) patients required additional procedures for soft-tissue coverage. ASAMI outcomes were excellent in 12 (60%), good in 5 (25%), fair in 2 (10%), and poor in 1 (5%). Complications documented during follow-up included pin-tract infection, pin loosening, delayed union, non-union, and joint stiffness. **Conclusion:** LRS was associated with favourable clinical, radiological, and functional outcomes in this retrospective cohort and may be a useful primary and definitive fixation option for open tibial fractures.

INTRODUCTION

Open tibial fractures remain among the most challenging injuries managed by orthopaedic surgeons. The tibia lies close to the skin along much of its length, with limited soft-tissue coverage, making it the long bone most commonly affected by open fractures.[1] These injuries commonly result from high-energy trauma, with road traffic accidents remaining the most common cause. In India, road traffic injuries cause approximately one death every four minutes, and government data from 2022 recorded more than 4.6 lakh accidents nationwide, with nearly 34% being fatal.[2] The burden is particularly high among young, economically active men, with many such injuries occurring in rural areas where trauma-care resources may be limited.[3]

The management of open tibial fractures is challenging because of the associated soft-tissue injury, muscle damage, wound contamination, and, in severe cases, bone loss. These factors increase the risk of infection, delayed healing, and non-union. A recent pooled analysis of published studies reported that infection occurs in a substantial proportion of open tibial fractures worldwide, with rates increasing with greater wound contamination and soft-tissue injury.[4] In low-resource settings, these challenges may be further increased by delayed presentation and limited access to definitive fixation. A study from Malawi reported persistent impairment in function and quality of life one year after open tibial fractures,

associated with delayed presentation, infection, and limited access to definitive fixation.[5] Similar challenges have been reported in sub-Saharan Africa, where treatment delays and limited access to appropriate fixation methods remain important barriers to favourable outcomes.[6]

External fixation therefore remains an important option in the management of open tibial fractures. Devices such as the Limb Reconstruction System (LRS) provide fracture stabilization while allowing access to the wound for repeated dressing and soft-tissue management, with early mobilization and weight bearing. A recent meta-analysis comparing external fixation with intramedullary nailing for open tibial fractures supports the continued role of external fixation, particularly when local wound conditions are unfavourable for internal fixation.[7] In addition, the Ganga Hospital Open Injury Severity Score and similar scoring systems have demonstrated value in predicting limb salvage and assisting surgeons in treatment decisions.[8]

In rural tertiary-care centres where patients may present late, resources may be limited, and repeated surgical procedures can be difficult to arrange, a fixation system capable of providing both primary and definitive stabilization may have practical advantages. However, evidence regarding the use of LRS as both primary and definitive fixation for open tibial fractures in resource-constrained rural tertiary-care settings remains limited. Therefore, this retrospective study was undertaken to evaluate the clinical and radiological outcomes, functional recovery using the ASAMI scoring system, and complications associated with LRS as the primary and definitive fixation method for open tibial fractures.

Aim

To evaluate the clinical, radiological, functional outcomes and complications of LRS as primary and definitive fixation for open tibial fractures.

Objectives

1. To assess clinical and radiological outcomes following LRS fixation.
2. To evaluate functional outcome using the ASAMI scoring system.
3. To assess fracture union and postoperative rehabilitation.
4. To document complications and the need for additional procedures.

MATERIALS AND METHODS

This retrospective study was conducted at a rural-based tertiary care centre in South India. Patients with open tibial fractures who presented to the Emergency Department of Government Medical College Hospital, Ariyalur, between August 2021 and July 2023 were included in the study. The study was conducted from December 2024 to November 2025. Institutional Ethics Committee approval was obtained.

Inclusion & Exclusion Criteria

Patients aged 20–70 years with open tibial fractures classified as Gustilo-Anderson Grade I, Grade II, Grade IIIA, or Grade IIIB were included in the study. Patients with Gustilo-Anderson Grade IIIC open tibial fractures, pathological fractures, associated head injury, closed tibial fractures, open tibial fractures with bone loss, associated upper-limb fractures, pre-existing neurological conditions, or those unfit for anaesthesia were excluded from the study.

Sample size

A total of 20 eligible patients were included during the study period. As this was a retrospective study, all patients meeting the predefined eligibility criteria during the study period were included. The sample size was therefore based on the available eligible cases rather than a formal prospective sample size calculation.

Initial Clinical and Radiological Assessment

All patients underwent complete clinical assessment, including a detailed history of the mode and place of injury to assess the severity of violence and field contamination. Clinical examination was performed to rule out other associated injuries. Radiological assessment was performed to evaluate the fracture pattern, severity of comminution, and presence of bone loss. Demographic and treatment-related data, including age, sex, mechanism of injury, Gustilo-Anderson grade, surgical response time, operative duration, hospital stay, weight-bearing status, follow-up duration, radiological union, and additional procedures were recorded.

Emergency Management

Tetanus toxoid, tetanus immunoglobulin, and prophylactic parenteral antibiotics consisting of cephalosporins and aminoglycosides were administered to all patients. Metronidazole was administered in patients with field contamination.

After haemodynamic stabilization, thorough wound lavage with copious amounts of normal saline was performed. Loose stay suturing was done, and the limb was splinted in an above-knee plaster.

Fracture Classification and Surgical Management

All injuries were classified according to the modified Gustilo-Anderson classification. Patients with Grade IIIC injuries were excluded.

Once the patient was fit for anaesthesia, LRS was applied under spinal anaesthesia. The wound was extended proximally and distally, followed by thorough wound debridement. The fracture was reduced and held using clamps or K-wires and stabilized with the LRS, with at least three pins in the proximal and three pins in the distal fragment.

The wound was closed carefully without tension, or only stay suturing was performed so that the wound could heal by secondary intention.

Postoperative Management and Rehabilitation

Postoperative parenteral antibiotics were continued for 5 days, followed by oral antibiotics until suture removal. Knee and ankle mobilization was started on the first postoperative day. Quadriceps strengthening

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exercises were started on the third or fourth postoperative day.

Toe-touch weight bearing was started on the third or fourth postoperative day if there was no fracture comminution. Partial weight bearing as tolerated with walker support was started once early radiological evidence of union was present.

Patients were reviewed once a month until fracture union was achieved. The duration of follow-up was recorded for each patient.

Clinical and Radiological Assessment During Follow-up

Patients were reviewed monthly until fracture union. Clinical assessment included wound healing status, pin-site infection, pin-site loosening, delayed union, non-union, and joint-related complications. Radiological assessment included pin loosening, fracture-site union, delayed union, non-union, and sequestrum formation. The duration of follow-up was recorded for each patient.

Final Outcome Assessment

Functional outcome was assessed using the functional component of the Association for the Study and Application of Methods of Ilizarov (ASAMI) scoring system and categorized as excellent, good, fair, or poor.

Statistical Analysis

Data were analysed using descriptive statistics. Continuous variables are presented as mean ± standard deviation or range, as appropriate, and categorical variables are presented as frequencies and percentages.

RESULTS

A total of 20 patients were included in the study. The age ranged from 20–70 years, with a mean age of 43 years. There were 16 (80%) male and 4 (20%) female patients. [Table 1]

Table 1: Demographic characteristics of the study participants

Parameter	Finding
Total number of patients	20
Age range (years)	20–70
Mean age (years)	43
Male, n (%)	16 (80%)
Female, n (%)	4 (20

Road traffic accidents were the most common cause of injury. According to the Gustilo-Anderson classification, 5 (25%) patients had Grade I, 10 (50%) had Grade II, 3 (15%) had Grade IIIA, and 2 (10%) had Grade IIIB fractures. Surgical response occurred within 12–24 hours in 12 (60%) patients and after 24 hours in 8 (40%). The operative time was 60 minutes in 15 (75%) patients and 80 minutes in 5 (25%). [Table 2]

Table 2: Fracture characteristics and surgical parameters

	Parameter	Number of patients, n (%)
Gustilo-Anderson classification	Grade I	5 (25%)
	Grade II	10 (50%)
	Grade IIIA	3 (15%)
	Grade IIIB	2 (10%)
Surgical response time	12–24 hours	12 (60%)
	>24 hours	8 (40%)
Operative time	60 minutes	15 (75%)
	80 minutes	5 (25%)

Partial weight bearing with walker support was achieved by 6 weeks in 14 (70%) patients. The mean time to full weight bearing was 12 ± 2 weeks. Postoperative hospital stay was less than 8 days in 16 (80%) patients. Radiological union occurred within 4–8 months, and 2 (10%) patients required additional procedures for soft-tissue coverage. The follow-up period ranged from 6–24 months. [Table 3]

Table 3: Postoperative rehabilitation and clinical outcomes

Parameter	Finding
Partial weight bearing with walker support by 6 weeks, n (%)	14 (70%)
Mean time to full weight bearing (weeks)	12 ± 2
Postoperative hospital stay <8 days, n (%)	16 (80%)
Radiological union	4–8 months
Additional procedure for soft-tissue cover, n (%)	2 (10%)
Follow-up duration	6–24 months

According to the ASAMI functional outcome score, 12 (60%) patients had an excellent outcome, 5 (25%) had a good outcome, 2 (10%) had a fair outcome, and 1 (5%) had a poor outcome. [Table 4, Figure 1] The complications observed during follow-up included pin-tract infection, pin loosening, delayed union, non-union, and joint stiffness.

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Table 4: Functional outcome according to ASAMI score

ASAMI outcome	n (%)
Excellent	12 (60%)
Good	5 (25%)
Fair	2 (10%)
Poor	1 (5%)

Figure 1: Preoperative

Figure 2: Post op X-ray After reduction

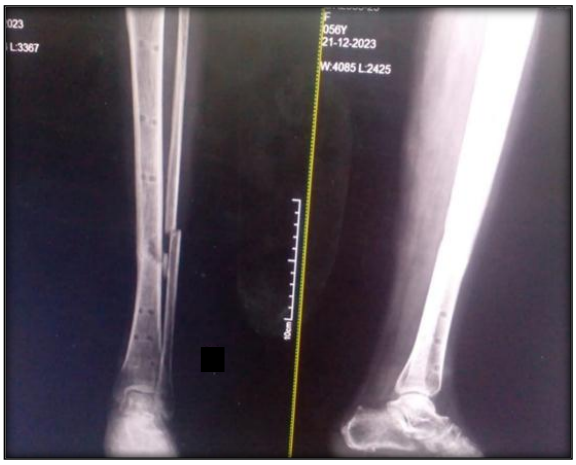

Figure 3: After fracture union and LRS exit

DISCUSSION

Open tibial fractures are challenging injuries because of soft-tissue damage, contamination, and the risk of delayed healing and complications. This retrospective study evaluated the clinical, radiological, functional outcomes and complications of LRS used as primary and definitive fixation. The study showed favourable functional outcomes, progressive weight bearing and fracture union, with manageable complications during follow-up.

In our study, the participants were adults across a broad age range, with a higher proportion of males than females. Similarly, Ramesh et al. reported a mean age of 42 ± 5 years among 20 patients with open lower-third tibial fractures treated with LRS.[9] Kwizera et al. evaluated 111 patients with open tibial fractures and reported a mean age of 34 years (range, 18–80) with a male-to-female ratio of 3.44:1.[10] These findings suggest that open tibial fractures were more frequently observed among males in our retrospective cohort, while age distribution varied across the different study populations.

In our study, road traffic accidents were the predominant mode of injury. Most fractures were Gustilo-Anderson Grade II, followed by Grade I, Grade IIIA, and Grade IIIB injuries. Surgical response occurred within 12–24 hours in 60% of patients, while 40% underwent surgical management after 24 hours. The operative duration was 60 minutes in 75% of patients and 80 minutes in 25% of patients. Similarly, Kwizera et al. enrolled patients with Gustilo-Anderson Grade IIIA and IIIB open tibial fractures, reporting Grade IIIA in 58.6% (65/111) and Grade IIIB in 41.4% (46/111) of cases.10 Similarly, Sharma et al. reported road traffic accidents as the cause of injury in 80% of their 15 patients with open tibial diaphyseal fractures with bone loss managed by LRS.[11] These findings suggest that road traffic accidents remain a major mechanism of open tibial fractures, while fracture severity varies according to the studied population.

In the present study, most patients progressed to partial weight bearing with walker support by 6 weeks, with a mean time to full weight bearing of 12 ± 2 weeks. Radiological union occurred within 4–8 months, and a small proportion required additional procedures for soft-tissue coverage. The follow-up duration ranged from 6–24 months. Similarly, Uikey et al. studied 26 patients with complicated lower-extremity trauma managed by LRS, reported an average hospital stay of 7 days, with union achieved within 7–8 months in most cases and an average frame-removal time of 28 weeks.[12] In contrast, Dake et al. reported an average union time of 44 weeks and fixation time of 46 weeks in 30 patients with infected nonunion of lower-limb long bones managed with LRS.[13] Similarly, Bishnoi et al., in a comparative study of 64 patients treated with LRS or Ilizarov ring fixators, reported that weight bearing was initiated on postoperative day 2 in both groups, with distraction commenced on day 7.[14] Lone et al. reported less postoperative pain in the LRS group, with 60% of patients achieving partial weight bearing within 1–2

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weeks.[15] These findings suggest that LRS was associated with early weight bearing and progressive fracture healing, although the time to union may vary according to fracture severity and the clinical characteristics of the treated population.

With regard to functional outcome, the majority of patients achieved excellent or good results according to the ASAMI scoring system, while fewer patients had fair or poor outcomes. Similarly, Uikey et al. reported excellent functional outcomes in 84.7% and good outcomes in 11.5% of patients, giving an overall excellent-to-good rate of 96.2%, higher than that observed in our study.[12] Ramesh et al. reported excellent-to-good functional outcomes in 85% of patients based on both objective and subjective Olerud and Molander assessments.[9] In contrast, Bishnoi et al. reported excellent functional outcomes in 28.1% of the LRS group compared with 37.5% of the Ilizarov group at final follow-up, with statistically significant differences in functional outcomes at early follow-up.[14] Similarly, Khan et al., in a study of 26 patients with complex long-bone nonunion managed with a monorail (LRS) fixator, reported excellent bone results in 76% and good results in 12% of cases.[16] These findings suggest that LRS was associated with favourable functional and bone outcomes, although reported outcomes may vary according to fracture characteristics, severity, and the clinical population studied.

During follow-up, the complications documented in our study included pin-tract infection, pin loosening, delayed union, non-union, and joint stiffness. Similarly, Ramesh et al. reported pin-tract infection, joint stiffness, delayed union, and non-union among patients treated with LRS.[9] Similarly, Sharma et al. reported pin-tract infection in 13.33% and ankle stiffness in 6.67% of their 15 patients.[11] In contrast, Bishnoi et al. reported pin-site infection in 6 of 64 patients, with five cases in the Ilizarov group and one in the LRS group.[14] These findings suggest that pin-related complications, delayed union, non-union, and joint stiffness may occur following external fixation, with the pattern of complications differing across study populations.

Overall, the findings indicate favourable clinical, radiological, and functional outcomes with LRS, while highlighting the occurrence of pin-related and fracture-healing complications during follow-up.

CONCLUSION

LRS was associated with favourable clinical, radiological, and functional outcomes in open tibial fractures. Most patients achieved early weight bearing, satisfactory fracture union, and excellent or good ASAMI outcomes. Pin-related complications, delayed union, non-union, and joint stiffness were documented during follow-up. These findings suggest that LRS may be a useful primary and definitive fixation option for open tibial fractures in this setting.

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