

Original Research Article

A comparative study of Ilizarov ring fixators and limb reconstruction system fixators in the treatment of compound tibial shaft fractures

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ABSTRACT

Background: Tibia is the most commonly fractured long bone, and the prevalence of compound fractures has risen due to an increase in high-energy traumatic incidents. In addressing challenging tibial fractures with significant soft tissue damage, infected tibial nonunion, and compound tibial fractures, medical professionals have turned to specialized treatments, such as Ilizarov ring fixators and limb reconstruction system fixators. These fractures typically cannot be managed effectively with traditional internal fixation methods. To facilitate early weight-bearing, limb lengthening, and efficient wound care, two minimally invasive fixation systems have been developed: the Limb Reconstruction System and the ring fixator.

Methods: The study was conducted on 40 patients with compound tibial shaft fractures treated by Ilizarov ring fixators and limb reconstruction system fixators with the aim to evaluate the functional outcome, union rate and amount of limb lengthening using Ring and ILRS fixators in compound tibial fixators.

Results: In our study, a significant portion of the participants fell within the age range of 28 to 37 years, comprising 45% of the total sample. Furthermore, the majority of the study subjects were male, constituting 65% of the participant pool. The primary mode of injury reported in our study was road traffic accidents, accounting for 77.5%.

Conclusions: The study concluded that LRS fixators show good and promising results like easy to apply, carry, compress, distract and clean while Ilizarov ring fixator is technically demanding, difficult to carry and cumbersome to the patient.

Keywords: LRS, Ilizarov, Tibia, ASAMI, Compound fracture

INTRODUCTION

Tibia is the most frequently broken long bone, accounts for 2% of all fractures and 36.7% of all long bone fractures in adults. Its documented incidence is 17-21 per 100,000 people. Open fractures account for 23.5% of all tibial shaft fractures, according to epidemiological studies. Road traffic accidents are the most prevalent reason for fractures (62.2%), followed by falls (18.7%), sports (7.4%), and direct blows (8.3%). Open tibial fractures are more prone to problems because there is no muscle protection over the

anteromedial portion of the tibia and because there is inadequate blood flow.¹⁻³ Compound fractures have become more common as a result of the rise in high-energy traumatic incidents. This fracture is frequently subjected to several environmental toxins, inadequate debridement, and occasionally poor judgement, which can result in cases of infected nonunion. These types of fracture are generally associated with infection and malunion as well as comminution, a bone gap, or a deformity can all further exacerbate the condition.⁴ Compound tibial fractures, infected tibial nonunion, and complex tibial fractures with

extensive soft tissue injuries have all been treated with the aid of Ilizarov ring fixators and limb reconstruction system (LRS) fixators when it was not possible to employ a traditional internal fixator. These external fixators enable early weight bearing by facilitating distraction osteogenesis and fracture union concurrently.⁵ Both the limb reconstruction system (LRS) and the ring fixator are minimally invasive fixators that support early weight bearing, limb lengthening, and successful wound management. They both operate on the compression distraction histogenesis principle. Thus, the present study was undertaken to evaluate the functional outcome, union rate and amount of limb lengthening using Ring and ILRS fixators in compound tibial fixators.

METHODS

This comparative study was conducted in post graduate department of orthopedics, SKIMS, MCH Bemina, Srinagar. A total 48 patients who had open tibial shaft fractures and were treated by Ilizarov ring fixators and limb reconstruction system fixators w.e.f. August 2019 to August 2022 out of 48 patients 8 were lost to follow up and final assessment was done on 40 patients only.

Inclusion criteria

Age >18 years and <65 years, open diaphyseal fractures of tibia type 2 and type 3a (Gustilo- Anderson classification).

Exclusion criteria

Type 1 and type 3c open diaphyseal tibial fractures (gustilo-anderson classification), pathological fractures, tibial fractures with intra-articular extension, polytrauma patient with multiple fractures and patients not fit for anaesthesia.

Procedure

A detailed history was collected and clinical examination was done. The patients were divided into two groups, i.e., Group A and Group B. Group A, consist total 20 patients who were operated with limb reconstruction system fixator (LRS) and Group B, also consist a total of 20 patients who were operated with Ilizarov ring fixators. The data (including demographic data, functional outcome, union rate and amount of limb lengthening) was collected with the help of a structure clinical proforma. All 40 patients were followed for one year and the results were compared and the functional outcome was measured with the help of ASAMI criteria.⁶

Each patient was thoroughly observed and followed up on during the study. The statistical package for social science software (SPSS), version 21, was used to organise, tabulate, analyse, and interpret the acquired data using frequency and percentage distribution, mean, and both descriptive and inferential statistics. Numbers and percentages were used to express categorical variables.

RESULTS

The (Table 1) depicted that the majority of the study subjects were in the age group of 28 to 37 years (45%), followed by 38-47 years (20%), 18-27 years (15%), 48-57 years (12.5%) and 58-60 years (7.5%).

Table 1: Age.

Age (years)	N	%
18-27	6	15
28-37	18	45
38-47	8	20
48-57	5	12.5
58-60	3	7.5

Table 2: Gender.

Gender	N	%
Male	26	65
Female	14	35

Table 3: Mode of injury.

Mode of injury	N	%
Road traffic accident	31	77.5
Fall from height	9	22.5

Table 4: Side of fracture.

Side	N	%
Right	29	72.5
Left	11	27.5

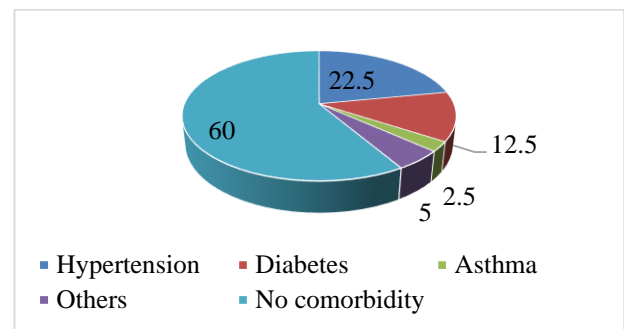


Figure 1: Associated comorbidities.

It is observed that the most of the study subjects were males (65%) and 35% were females as shown in (Table 2). In most of the cases the most common mode of injury was road traffic accident (77.5%) and among 22.5% cases the mode of injury was fall from height as presented in (Table 3). It was reported that the most of the study subjects had fracture to right side (72.5%) and 27.5% study subjects had fracture on left side as shown in (Table 4).

Figure 1 shows that most common associated comorbidity was hypertension (22.5%) followed by diabetes (12.5%),

asthma (2.5%), others (5%) and no associated comorbidity was reported among 57.5% study subjects. It is observed that in both groups the fixators were applied within 2 to 7 days as presented in (Figure 2). The (Figure 3), showed that the majority of subjects in LRS group stayed in hospital for 3 to 5 days. Whereas in ilizarov ring fixator group stayed for 3 to 5 and 6 to 8 days (45% respectively).

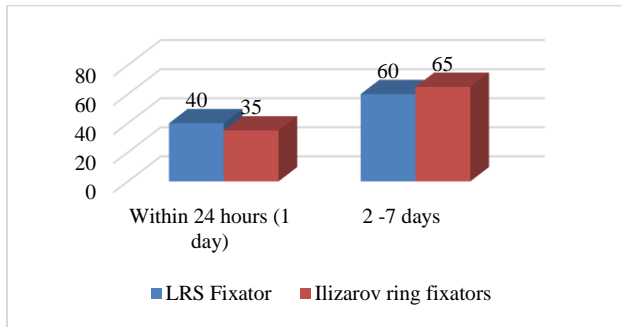


Figure 2: Time of application of LRS and Ilizarov ring fixator.

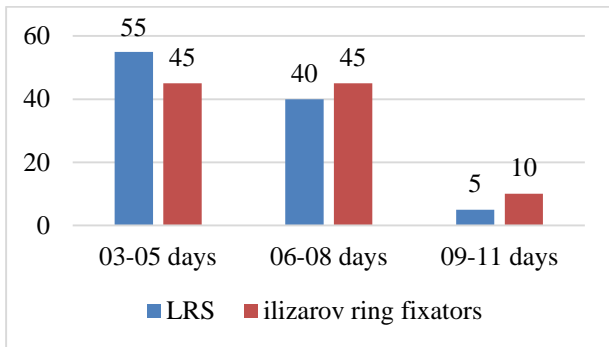


Figure 3: Duration of hospital stay.

Table 5: Duration of postoperative ambulation

Weeks	LRS		Ilizarov ring					
	Partial weight bearing		Full weight bearing		Partial weight bearing		Full weight bearing	
	N	%	N	%	N	%	N	%
<1	2	10	0	0	0	0	0	0
1-2	12	60	0	0	5	25	0	0
3-4	6	30	0	0	12	60	0	0
5-6	0	0	14	70	3	15	9	45
7-8	0	0	5	25	0	0	7	35
9-10	0	0	1	5	0	0	4	20
>10	0	0	0	0	0	0	0	0

The (Table 5), depicted the duration of postoperative ambulation in both groups. It was observed that in both groups, partial weight bearing was permitted as soon as the patient's general health permitted. 60% of individuals in the LRS group and 25% of those in the ilizarov ring fixator group with joint mobilisation exercises were permitted to bear some weight in 1-2 weeks.

Table 6: Timing of fixator removal (weeks).

Weeks	LRS		Ilizarov ring	
	N	%	N	%
16-20	8	40	5	25
21-25	10	50	7	35
26-30	2	10	8	40
31-35	0	0	0	0

Table 7: Bony and functional outcome according to ASAMI score

Parameters	LRS		Ilizarov ring	
	N	%	N	%
Bony outcome				
Excellent	15	75	11	55
Good	2	10	4	20
Fair	2	10	3	15
Poor	1	5	2	10
Functional outcome				
Excellent	12	60	9	45
Good	4	20	3	15
Fair	2	10	4	20
Poor	2	10	4	20

Table 8: Postoperative complications.

Complications	LRS		Ilizarov ring	
	N	%	N	%
Ring Sequestrum	0	0	1	5
Refraction	1	5	1	5
Wound dehiscence	1	5	2	10
Non Union	1	5	2	10
Pin tract infection	1	5	3	15
Shortening	1	5	1	5
No Complications	15	75	10	50

Compared to the LRS group, patients in the Ilizarov fixator group reported higher postoperative pain. Further, it was found that patients in the LRS fixator group were more at ease and experienced less postoperative pain than those in the Ilizarov group. 70% of individuals in the LRS group and 45% of cases in the ring fixator group were able to resume full weight bearing after 5-6 weeks. In most of the fixator was removed at 21-25 weeks (50%) in LRS fixator group and in Ilizarov ring fixator group the fixator was removed at 26-30 weeks (40%) as shown in (Table 6). The (Table 7) shows the comparison of bony and functional outcome according to ASAMI score. It was found that most of the patients in LRS group has achieved excellent bony and functional outcome that Ilizarov ring fixator group. The Ilizarov ring fixator group had more postoperative complications than LRS group. The most common complication was pin tract infection (15%) as shown in (Table 8).



Figure 4: Radiograph showing pre-op fracture Tibia.

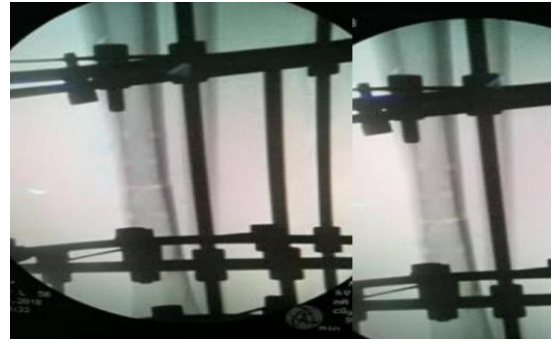


Figure 8: Post-op image showing ring fixator.

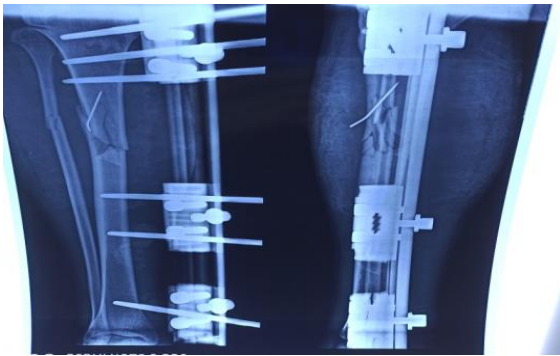


Figure 5: Immediate Post-op radiograph showing LRS Fixator in place.



Figure 9: Clinical image of ring fixator.



Figure 6: ROM at final follow-up of same patient treated with LRS.



Figure 7: Pre-op images of fracture Tibia.

DISCUSSION

Open tibia fractures have become increasingly prevalent in the contemporary world due to high-velocity trauma and road traffic accidents. These fractures persist as significant challenges within the realm of orthopedic trauma care.

Multiple treatment options are at hand for managing compound tibial fractures, including minimal osteosynthesis, biological fixation, and internal fixation utilizing intramedullary nailing, as well as external fixation employing various types of fixators. Regardless of the chosen treatment approach, the surgical objective should revolve around restoring the highest possible functionality to the injured limb while safeguarding the patient's overall quality of life, all while minimizing the risk of damage or complications.⁷⁻⁹

The use of external fixators is now commonly accepted for the management of complex open fractures, such as Gustilo-Anderson types IIIB and IIIC, which involve comminution, bone defects, and contamination.^{10,11} According to Yokoyama K, the use of intramedullary nailing to treat grade IIIB and IIIC fractures was associated with a notable risk, as it resulted in deep infection and nonunion in approximately 20.3% of cases.¹² Hence, external fixators emerge as the preferred treatment option due to their user-friendly nature and capacity to facilitate soft tissue management. Nonetheless, they present challenges, notably prolonged immobilization and the potential need for later-stage revision surgery to attain

definitive fixation. In light of these concerns, we opted for the Limb Reconstruction System (LRS), which distinguishes itself from standard external fixators by enabling immediate postoperative full weight-bearing, akin to intramedullary fixation. The LRS fixation method also boasts the distinct advantage of limb preservation, mitigating the need for amputation. Conversely, it carries its own set of complications, including pin loosening and pin tract infections.

The data we obtained was analyzed and discussed with previously available literature. In our study the majority of the study subjects were in the age group of 28 to 37 years (45%), most of the study subjects were males (65%), the commonest mode of injury was road traffic accident (77.5%) and the most common affected side was right side (72.5%). These findings are correlated with the study conducted by Dwivedi et al reported that the mean age of the study subjects was 37 years, majority of the subjects were males and the commonest cause of injury was road traffic accident.¹³ In another study performed by Hussain et al found that there were malepredominance, the mean age of study subjects was 27 years. Right limb fracture was observed in 62.5% patients and the most common mode of injury was road accident (75%).¹⁴ The present study showed that the commonest associated comorbidity was hypertension (22.5%) and the majority of subjects in LRS group stayed in hospital for 3 to 5 days. Whereas in ilizarov ring fixator group stayed for 3 to 5 and 6 to 8 days (45% respectively). These findings are comparable with the study done by Dwivedi et al observed that the average duration of hospital stay was 5.38 days.¹³

In both groups the fixators were applied within 2 to 7 days. 60% of individuals in the LRS group and 25% of those in the ilizarov ring fixator group with joint mobilisation exercises were permitted to bear some weight in 1-2 weeks. Compared to the LRS group, patients in the Ilizarov fixator group reported higher postoperative pain. In the LRS fixator group patients experienced were less postoperative pain than those in the Ilizarov group.

70% of individuals in the LRS group and 45% of cases in the ring fixator group were able to resume full weight bearing after 5-6 weeks. These results are correlated with the study carried out by Arora et al reported that the fixators were applied within 24 hours in majority of the cases.¹⁵ In similar study performed by Pal et al found that with joint mobilisation exercises, partial weight bearing was permitted in 1-2 weeks in 62.50% of cases for LRS and 6.25% of cases for ring fixators.

Patients in the Ilizarov fixator group had more postoperative pain than those in the rail fixator group. The various sites where bone and soft tissue were pricked were most likely what caused the agony. Rail fixator group had less postoperative pain than those in the Ilizarov group. In 87.5% of cases in the LRS group and in 62.50% of cases in the ring fixator group, full weight bearing was permitted at 5-6 weeks.³

In most of the fixator was removed at 21-25 weeks (50%) in LRS fixator group and in Ilizarov ring fixator group the fixator was removed at 26-30 weeks (40%). The comparison of bony and functional outcome according to ASAMI score showed that most of the patients in LRS group has achieved excellent bony and functional outcome that Ilizarov ring fixator group. The ilizarov ring fixator group had more postoperative complications than LRS group.

Similarly, Pal et al observed that in majority of cases the fixator was removed at 21-28 weeks (50%) in LRS fixator group and in Ilizarov ring fixator group the fixator was removed at 29-36 weeks (50%). The comparison of bony outcome showed that most of the patients in LRS group has achieved excellent bony and functional outcome that Ilizarov ring fixator group.³

In other similar study conducted by Bhardwaj et al reported the excellent result in 28% and 32%, good in 32% and 52%, and fair in 40% and 16% cases in Ilizarov ring fixator group and LRS fixator group, respectively.¹⁶ The Ilizarov ring fixator represents a viable treatment modality; however, it can pose challenges for patients due to its cumbersome nature and for surgeons due to its technical intricacies when compared to the Limb Reconstruction System (LRS). A study conducted by Ajmera et al. demonstrated that the LRS proved to be an effective treatment modality for cases involving open tibia fractures with bone loss. It serves as a definitive approach for both damage control and the attainment of union and limb lengthening.¹⁷

Limitations

Limitations of the study were small sample size, short time period and our study coincided with global pandemic of covid-19 and there was nationwide lockdown due to which sample size was affected. Further multicenter studies with larger sample size and randomized controlled trials are recommended before firmly establishing it as an effective treatment modality for open tibia fractures.

CONCLUSION

The study's conclusion highlights that LRS fixators yield favorable and promising outcomes, characterized by ease of application, portability, compression, distraction capabilities, and cleanliness. In contrast, the Ilizarov ring fixator was found to be technically demanding, challenging to transport, and burdensome for the patient. LRS group has achieved excellent bony and functional outcome than Ilizarov ring fixator group. The ilizarov ring fixator group had more postoperative complications than LRS group.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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