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**ORIGINAL RESEARCH**

# Analysis of functional and radiological outcome of application of Ilizarov ring fixator in the management of diaphyseal fractures of the Tibia

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## ABSTRACT

**Introduction:** The ideal management of open fractures remains controversial, especially in Gustilo Anderson type IIIA/IIIB/Complex articular fractures.Various studies have been published so far describing the outcome of Ilizarov fixator in management of open fractures, but very few have been published for diaphyseal tibial fractures. In this study we are looking at the role of early Ilizarov External Fixator as definitive management in open diaphyseal fractures of Tibia. **Study:** We conducted a Prospective observational study of 26 patientsdiaphyseal open fractures of Tibia treated with early Ilizarov External Fixator. **Results:** Average time for union was 27.3weeks Complications were non-union(11.5%), pin tract infection (30.8%), persistent pain (38.4%), knee stiffness (3.8%), ankle stiffness (26.9%), deformity (3.8%), limb length discrepancy (15.2%), reflex sympathetic dystrophy (15.2%), persistent limp (41.8%). None of the patients had infection at fracture site.Good and excellent ASAMI bone and functional results were seen in 92.3% and 76.9% respectively. **Conclusion:** Ilizarov is a very minimal invasive tool with very less secondary soft tissue damage and gives good results in managing open shaft fractures of tibia with early patient mobilization and very few complications.

**Key words:** Open fracture, tibia, diaphysis, Ilizarov ring fixator, ASAMI score.



## INTRODUCTION

The ideal management of open fractures remains controversial, especially in Gustilo Anderson type IIIA/IIIB/Complex articular fractures. Most of the times these fractures are managed with debridement and immediate bony stabilisation with external fixator with tissue cover to enable early mobilisation and restoration of optimum function[1]. External fixators can be conventional half pin mono rail fixators or tensioned wire with ring fixators. Plate fixation and the conventional half-pin fixators with rods and clamps are associated with high rates of non-union and the need for secondary procedures[2]. A lot of literature supports the importance of biology of healing[3,4,5,6,7]. Various studies have been published so far describing the outcome of Ilizarov in management of open fractures but very few for diaphyseal tibial fractures. In this study we are looking at the role of early Ilizarov External Fixator as definitive management in open diaphyseal fractures of the Tibia in our institution.

## MATERIALS AND METHODS

The study was conducted at Victoria hospital attached to Bangalore Medical College and Research Institute from January 2022 to September 2024 with the aim and objective of studying functional and radiological outcome of early Ilizarov External Fixator as definitive management in diaphyseal open fractures of Tibia. It is a Prospective observational study of 26 patients.

Inclusion criteria were, Patients aged between 18 to 80 years, both sexes, presenting with type IIIA/IIIB open fractures tibial shaft not amenable for internal fixation presenting within 30 days of injury were included in study after getting consent to participate in study. Exclusion criteria were, Simple fractures of long bones (Gustilo-Anderson type I, II) and simple

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periarticular fractures, Polytrauma patients or patients with fractures or injuries which precluded early mobilisation, Patients with haematological disorders / vascular pathologies like aneurysm/ Type IIIC open fractures, Patients with malignancies/ gangrene.

After Initial resuscitation, splintage and primary care for the wound was provided in the emergency room and swab was taken for culture. Any protruding bone fragments were covered with sterile dressing and obvious foreign material removed. The wound was copiously washed with normal saline (6 litres for types II & IIIA and about 10 litres for type IIIB), and thorough debridement of all devitalised bone and soft tissue was done under anaesthesia. Only stay sutures was applied with a view to cover the bone, if possible. In all cases, third-generation cephalosporins and aminoglycosides was administered in the emergency room and used until the culture reports returned. In fractures with gross contamination and farmyard injuries, metronidazole was added for 7 days. The culture sensitive antibiotics was continued for 7 days. Definite fixation with the Ilizarov frame was carried out at the earliest. The patients and their attendants were taught pin and ring care. On the first post-operative day, knee and ankle mobilisation was started within the limits of pain. All patients were allowed full weight bearing within the limits of pain. Regular follow upis done for pain, pin-tract infection, loss of alignment or any pin loosening at, 6 weeks and 3 months with the frame and to assess clinical and radiological union by ASAMI SCORE[17] at 6 months after frame removal.

**Figure – 1: a: Radiograph of the patient with Type IIIB open fracture distal shaft tibia, b: Intra operative c arm images of anatomical fracture reduction, c: Post-operative radiograph showing acceptable reduction and fixation and k wires in-situ. d: clinical picture of the wound after k wire removal healing with secondary intention, e: 24 weeks after frame removal radiograph showing complete union at fracture site, f: clinical picture of ambulating patient.**

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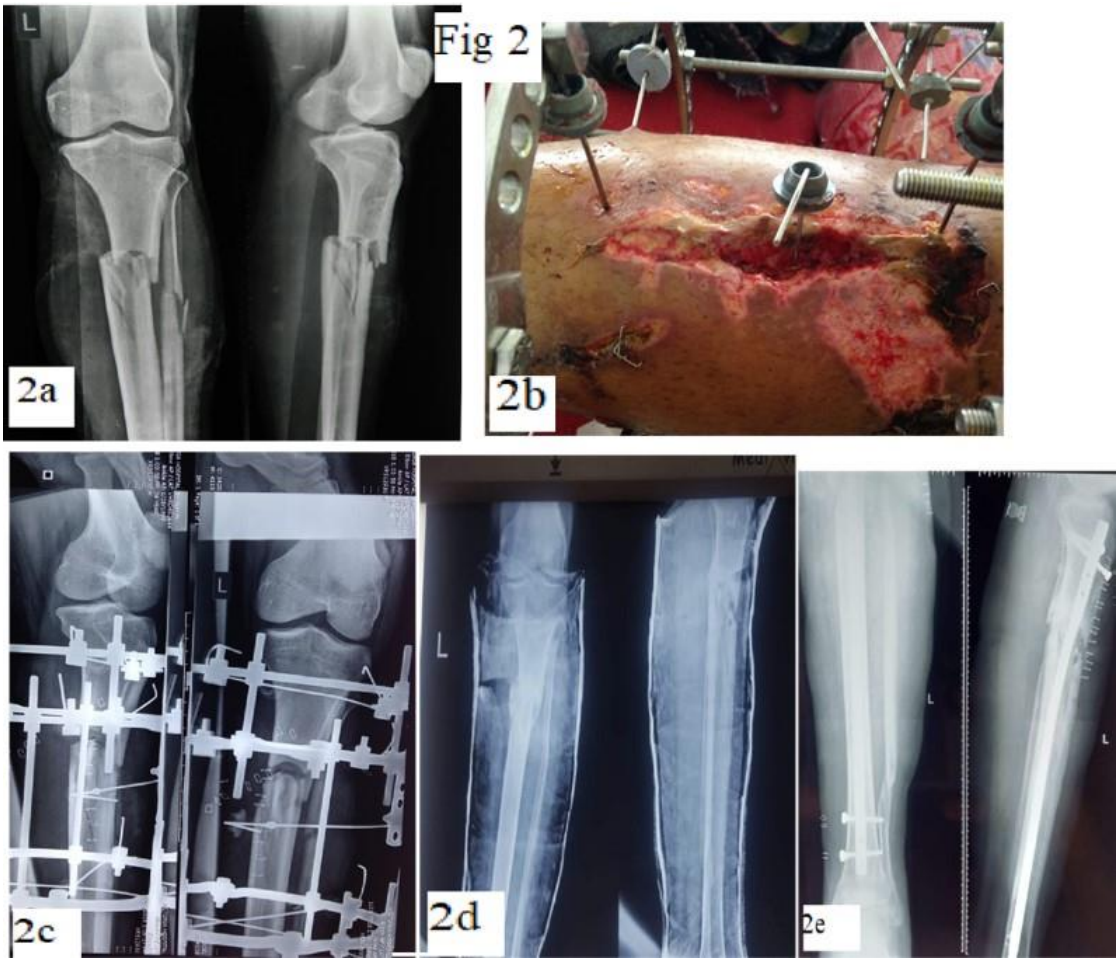
**Figure – 2: a: Radiograph of the patient with Type IIIB open fracture proximal shaft tibia, b: Intra operative wound approximation,c: Post-operative radiograph showing acceptable reduction and fixation. d: 24 weeks after frame removal radiograph showing persistentnon-union at fracture site, e: patient underwent internal fixation.**




## OBSERVATION AND RESULTS

Average age of patients was 42.8yrs, 22 were males and four were females, all fractures were due to Road traffic accident, all patients had type IIIB Gustilo Anderson type of open tibial shaft fracture, one patient had renal failure, one had diabetes and one had cardiac problem and pulmonary artery hypertension, only two patients underwent flap surgery and one skin grafting, average total fixator duration was 38.4 weeks (shortest was 30 and longest was 52weeks), average time for union was 27.3weeks (shortest was 21 and longest was 46 weeks), Average range of movements at follow-up were as in Table 1, ASAMI SCORES at 6months Follow-up after frame removal was as in table 2. Complications were non-union in three cases(11.5%) two had comorbidity, pin tract infection in eight (30.8%), pain in 10(38.4%), knee stiffness in one(3.8%), ankle stiffness in seven(26.9%), deformity in one(3.8%), limb length discrepancy in four(15.2%), reflex sympathetic dystrophy four(15.2%), persistent limp in eleven patients(41.8%). None of the patients had infection at fracture site.

**Table 1:**

| **Average knee flexion in degrees** | | | **Knee extension lag** | | | **Average Ankle dorsiflexionin degrees** | | | **AverageAnkleplantar flexionin degrees** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 wks | 12wks | 24wks after framerem oval | 6 wks. | 12wks. | 24wks.afte r frame removal | 6wks. | 12wk s. | 24wks. after frame removal | 6wks. | 12wk s. | 24wks after frame removal |
| 106.9 | 113.8 | 120 | 3 patien ts | 3 patients | 2 patients | 14.8 | 13.8 | 14.8 | 30.8 | 26.9 | 26.9 |

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**Table 2: ASAMI SCORES at 24 weeks after frame removal**

| ASAMI BONE SCORE | | ASAMI FUNCTIONAL SCORE | |
|---|---|---|---|
| Excellent | 16 (61.5%) | Excellent | 14 (53.8%) |
| Good | 08 (30.8%) | Good | 06 (23.1%) |
| Fair | 00 (00.0%) | Fair | 04 (15.3%) |
| Poor | 02 (07.7%) | Poor | 02 (7.7%) |

## DISCUSSION

In most of the conventional methods of the treatment, initially open fractures are managed by external fixators and after soft tissue coverage procedures are done, they are managed by internal fixation. The time duration from injury to recovery is more and patient must undergo multiple surgeries, with high chances of infection and non-union, which can have negative impact on patient financial, physical (causing disability) and mental condition (depression and anxiety). High rate of failure associated with rod and pin fixator alone or internal fixation. The compromised soft tissue gave us an insight to investigate the advantages of Ilizarov external fixator especially when considered for the definitive treatment. Ilizarov ring fixators have an external apparatus connected to trans osseus tensioned wires passed in safe zones of the limb. Depending on the position of fracture full ring / $5/8^{th}$ ring or arches connected with rods are used. Decision to span the joint depends on the location of fracture. Most of the general orthopaedic surgeons are not exposed to the basic principles of Ilizarov ring fixators and hence follow conventional rod and pin fixator fixation. Ilizarov ring fixator needs some basic training related to wire placement and the apparatus components. These cases can be very well managed by a trained Ilizarov surgeon in such cases giving good outcomes. It is considered as one of the standard treatment modalities in managing such cases. This has many advantages: In cases who present late, have bone loss, with infection, it is minimally invasive method, which shall not affect the already compromised soft tissue, permits effective wound management, bone lengthening, early weight bearing and hence return to his activities of daily living at the earliest. Importance of biology of healing[3,4,5,6] in literature says that the biomechanical environment of the fracture site will influence both the pattern and rate of fracture healing. It is influenced by the mechanical properties of the external fixator, and can be reported in terms of axial stiffness, translational stiffness, and resistance to bending and torsion at the fracture site. Axial micromotion promotes bone regeneration while translational shear leads to the formation of fibrocartilage and predisposes to non-union. Bending micromotion can stimulate callus formation, but is more likely to lead to shear if the centre of rotation is not exactly at the centre of the fracture site. The optimal external fixator would therefore promote a degree of axial micromotion while preventing excessive bending and translational shear, which is very difficult to get with monolateral fixator. Circular external fixators use of tensioned fine wires as fixation elements, as opposed to half-pins, ring fixators are imparted with elastic properties and a low axial stiffness, while simultaneously preventing excessive bending and translational shear through high bending and translational rigidity. Tensioned fine wires also contribute to the circular external fixator's ability to exhibit increased axial stiffness with higher loads. This non-linear, load-dependent axial stiffness is like the viscoelastic properties of tendons and ligaments and this biomechanical attribute has led to fine wire circular external fixators being described as the only form of 'true biological fixation.' This biomechanical superiority along with their modularity and minimally invasive application make circular external fixators ideal treatment for the management of complex fractures of long bones, which is approved by AO foundation[7]. In this study we are looking at the role of early Ilizarov External Fixator as definitive management in open diaphyseal fractures of Tibia.

Many articles have been studied for ring fixators in various bones like Dunning et al[8],K. N. Subramanyam et al[13] for distal radius fractures, Shuichi Chida et al[9] for distal humerus fractures, Mohammed Anter Meselhy et al[10] for proximal humerus fractures, Łukasz Szelerski et al[11], Abdel-Salam et al[12] for distal femur fractures. In this study we wanted to see the role of early Ilizarov External Fixator as definitive management in open diaphyseal fractures of Tibia.

We found very few articles who have studied outcome of open shaft fractures of tibia managed with ring fixator. The results are similar with the following literature. Rasmus Elsoe et al[14] studied Fifty-six patients in their study. During treatment, the function and QOL increased with time. Wani N et al[15]evaluated the results of patients with Gustilo types II, IIIA and IIIB open tibial fractures managed early with the Ilizarov external fixator and concluded that early application of the Ilizarov fixator gives good functional and radiological results in types II, IIIA and IIIB. Ganji et al[16] in comparative study of 60patients with open tibial fractures had nonunion in 10% and malunion in 6% in Ilizarov patients. Nesari et al[17] in their study of tibia fractures managed with Ilizarov had 68.4% excellent, 15.8% good, 5.3% fair, and 10.5% poor result. They concluded that Ilizarov fixator astool for fractures when extensive dissection and internal fixation are contraindicated. Krishna K et al[18] in their comparative study of management of open tibial fractures primary by Ilizarov fixator and AO external fixator observed both ASAMI bone & functional results to be excellent (65%),good (30%) &poor (5%) and concluded Ilizarov fixator to

beminimally invasive, enables early weight bearingand high union rates.

**Drawbacks** of the study were small sample size, inclusion of assessment of quality of life was not there in the study and patients who needed plastic surgery intention were also included in the study which might affect the outcome in patients.

## CONCLUSION

Ilizarov is a very minimal invasive tool with very less secondary soft tissue damage and gives good results in managing open shaft fractures of tibia with early patient mobilization and very few complications but prognosis in patients with comorbidities should be guarded.

Ethical clearance has been taken from the institute for the study.

Conflict of Interest: There are no conflict of interest

Informed Consent was taken from all patients who were included in the study.

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