A prospective study on use of Ilizarov external fixator for open fractures of Tibia

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Abstract

Introduction: Open fractures are more commonly seen in tibia as compared to other bones because of subcutaneous location and the tenuous soft tissue cover. There has been rise in open tibia fractures with increased road traffic accidents. Management of open tibial fracture remains controversial. Ilizarov external fixator is a better option for the treatment of these fractures. This study was conducted to evaluate the clinical outcome of open tibial fractures managed with an Ilizarov external fixator.

Material & Methods: Twelve patients among those who presented to the emergency department with Type II, Type IIIA and Type IIIB Gustilo-Anderson type open tibial fracture were enrolled. All these cases were treated by Ilizarov external fixator and appropriate wound management. Active movements were started at the earliest after the surgery. Partial weight bearing with support was started from the second day after the surgery.

Results: Mean age of the study subjects was 37.66 ± 8.77 years. Half of the patients had Type IIIB Gustilo-Anderson type fractures. The mean duration of fracture union was 7.1 months. Pin tract infection of the wires was the more common among complications. Excellent to good outcome was seen in 90% of study subjects.

Conclusion: Ilizarov external fixator gives stable fixation of the open tibial fractures and allows better wound care. It also helps in early ambulation and rehabilitation of these patients.

Keywords: Open fracture, Ilizarov ring fixator, Tibia fracture, Road traffic accident, Delayed union

Introduction

Open fractures are frequently seen in Tibia because of its anatomical positioning and the fracture incidence ranges from 49.4% to 63.2%. [1] Open fractures are more common in the tibia as compared to other bones because of subcutaneous location and the less soft tissue cover. [2] There is a rise in open tibia fractures with the increase in road traffic accidents. With the development in road infrastructure of the country, the high-velocity road traffic accidents are increasing because of citizens driving at high speed. An associated vascular injury in open tibial fracture leads to poor treatment outcomes, prompting some surgeons to call for early amputation in selected cases.[3,4] Infection, malunion, delayed union, and nonunion are seen more commonly in these fractures. [5] Many studies have shown the high risk of nonunion and infection in high-velocity tibial injuries which were finally managed by Ilizarov fixator. [6-9,10]

Management of tibial open fracture remains controversial with orthopedic surgeons preferring different treatment modalities. The newer management protocol is focused on adequate debridement of the wound and tissue cover with stabilization of the bone.[11] Primary plate fixation and external fixators are associated with nonunion requiring a second surgery.[12] Ilizarov external fixation is a viable option for the treatment of these fractures. Fractures of the metaphyseal region extending into the shaft and with small periarticular fragments are frequently treated with the Ilizarov frame.[13] Ilizarov external fixator also gives freedom of early weight-bearing with frame. The purpose of this study was to evaluate the clinical outcome of open tibial fractures

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managed with an Ilizarov external fixator.

Materials and Methods:

This prospective study was carried out at a tertiary care medical college hospital from September 2011 to September 2013. Institutional ethical committee permission was taken before enrolling the patients in the study. Universal sampling technique was used and patients above 19 years, who presented to the emergency department with Type II, Type IIIA and Type IIIB Gustilo-Anderson type open tibial fracture were included in this study. Patients below 19 years of age, pathological fracture, and open fracture with vascular injury (Type IIIC) were not included in this study. Patients who fulfilled the inclusion criteria were enrolled after they signed informed consent and were willing to participate in the study.

Patients with open tibial fractures, when presented to the emergency department were initially managed by hemodynamic stabilization, intravenous antibiotics, wound wash, and removal of the devitalized tissue followed by a sterile dressing. The fracture was temporarily immobilized with an above-knee Plaster of Paris (POP) slab or Thomas splint. After a thorough examination of the wound and assessing the vascularity of the distal limb, the fracture was classified by Gustilo-Anderson classification.[14] All patients were sent for an X-ray of the lower limb and Pelvis. Standard blood investigations required before the surgery were done and the surgery was performed at the earliest.

All patients were operated with spinal anesthesia and in the supine position. The limb was scrubbed with Povidone-Iodine scrub and washed with normal saline followed by painting and draping. Two folded drape sheets were kept beneath the involved limb supporting the distal and proximal fragments. The Ilizarov frame was constructed with appropriate size rings and placed around the limb. The folded drape sheets help in positioning the limb in the center of the Ilizarov frame and in reduction of the fracture. The frame was adjusted with the threaded rod to have two rings on either side of the fracture. K-wires with 1.5 mm to 1.8 mm diameter were used in a specified direction. The wire's entrance and exit sites were predetermined. While the surgeon was positioned at the wire entrance site, preparing to drill the wire through the opposite side of the frame. The Kirschner wires (K-wires) were positioned according to the ring plane, preferably across only one side of the ring wall (either proximal to proximal or distal to distal). The K-wires were introduced slowly following the "stop and go method" pausing several times during the procedure to avoid burning of tissues particularly bone and skin.

After confirming the satisfactory reduction of fracture, all the wires were bent and cut after appropriate tensioning. The soft tissue debridement was performed and saline wash was given. The soft tissue cover over the bone was achieved with local mobilization of the soft tissue. Wound and pin sites were covered with a sterile dressing. In the postoperative period, active and passive ankle and knee movements were started on the first postoperative day. Partial weight-bearing with crutches or walker support was started on the second day. Alignment of the fracture fragments was confirmed with post-op x-ray and compression or distraction of the fracture site was done accordingly. Antibiotics were continued for the postoperative period for a minimum of one week and then based on the wound status. Regular dressing of the wound and pin sites was done.

All the patients were called for follow up at monthly interval. Radiological assessment of the fracture union and clinical examination of the limb function was done and findings were recorded. Evaluation of final results was done based on Johner and Wruhs Criteria (Table 1). [15] During the subsequent follow-up visits at the hospital, the patients were assessed for the comfort level with the Ilizarov frame and appropriate rehabilitation advice was given to make the livelihood for their treatment expenses.

Table 1: Johner and Wruhs Criteria for evaluation of final results

Criteria	Excellent (Left = Right)	Good	Fair	Poor
Nonunion, osteitis, amputation	None	None	None	Yes
Neurovascular disturbances	None	Minimal	Moderate	Severe
Deformity				
Varus/valgus	None	20-50	60-100	> 100
Anteversion/recurvation	00-50	60-100	110-200	>200
Rotation	00-50	60-100	110-200	>200
Shortening	0-5 mm	6-10 mm	I 1-20 mm	>20 mm

Mobility				
Knee	Normal	>80%	>75%	<75%
Ankle	Normal	>75%	>50%	<50%
Subtalar joint	>75%	>50%	<50%	
Pain	None	Occasional	Moderate	Severe
Gait	Normal	Normal	Insignificant limp	Significant limp
Strenuous activities	Possible	Limited	Severely limited	Impossible

During the follow-up visit, the wires were checked to ensure that they remain tight. In case of wire site inflammation or early infection, antibiotics were given and regular dressing of the pin tract. Pin-tract infection was classified according to Paley as Grade 1: superficial soft tissue inflammation; Grade 2: deep soft tissue infection; Grade 3: osteomyelitis[16]. The apparatus was left in place until fracture consolidation was seen on X-ray. After confirming the formation of the callus on x-ray, nuts of the Ilizarov frame were unscrewed to make the rings free and patient was asked to walk around. The patient was sent home and asked to return after two weeks. The Ilizarov external fixator apparatus was removed after 2 weeks, if the patient had no discomfort with weight-bearing. The wires were cut several millimetres outside the skin and were removed. A patella tendon bearing (PTB) POP cast was applied and the patient was advised to continue walking. The PTB cast was removed after six weeks and patient was advised to keep walking. Patients were also advised to do active joint mobilisation exercises for knee and ankle. The fracture was considered united when the patient had no pain during walking and an X-ray in Anteroposterior (AP) and Lateral views showed bridging callus in the 3 cortexes.[17] If the fracture did not show any progress of bridging callus at the end of the sixth month was termed as delayed union and nonunion when fracture did not show further progress with intervention at nine months.[18] Bone deformity with shortening more than one centimeter, angulation more than five degrees and rotation more than 15 degrees was considered as malunion.[19] All the patients were called back at one year of treatment for final follow up. X-ray of the involved limb taken and final result of treatment recorded. The data was tabulated on an excel sheet for analysis. The data was presented as mean and standard deviation after analysis of the numerical variables.

Results

Twelve patients with open tibial fractures treated with the Ilizarov external fixator were followed up for one year. The majority of patients in this study were males and the cause of injury in all the patients was road traffic accident. The left leg was involved more commonly than the right. Half of the patients had Type IIIB Gustilo-Anderson type fractures (Table 2).

Table 2: Demographic data of the patients

Variables	Number (percent) (n=12)
Mean Age ± SD	37.66 ± 8.77 year
Sex of the patients	
Male	10 (83.33%)
Female	02 (16.67%)
Fractures operated	
Right side	5 (54.54%)
Left side	7 (45.45%)
Mode of injury	
Road traffic accident	12 (100%)
Fall from height	00 (0%)
Fracture type (Gustilo-Anderson classification)	
Type II	3 (25%)
Type IIIA	3 (25%)
Type IIIB	6 (50%)

All the fractures were extraarticular with seven patients having open fracture in diaphyseal region and other five patients having fracture in the proximal metaphysis of the tibia. Two patients had associated injuries. One patient had a head injury and the other patient had associated pelvic injury which was managed accordingly. All the patients achieved fracture union at an average duration of 7.1 months. All Type II and Type IIIA fracture wounds were managed with thorough debridement and primary closure. Type IIIB wounds were managed with repeat debridement and secondary wound healing in five patients and skin grafting in one patient.

Pin tract infection occurred in 2 cases (16.6%, n=12) of which, one case was treated by systemic antibiotics for 5 days. The second case of pin tract infection was managed by soft tissue release around the infected wire, systemic antibiotics, and regular dressing. One patient (8.3%, n=12) had malunion with valgus angulation of 10 degrees at the fracture site which was accepted by the patient. One (8.3%, n=12) patient had shortening of about 7mm of the fractured leg for which no intervention was needed. All patients had satisfactory ankle and knee joint movements. Fibular osteotomy was done for one case to augment

the healing process which showed signs of the union at 8 months (Fig 1). Post Ilizarov fixator removal half of the patients were put on PTB cast for 4 weeks and another half for six weeks. In this study, two-third of fractures united between 7 to 8 months (Fig 2). According to Johner and Wruh's Criteria 75% of the study subjects had excellent outcomes and another 16.67% had good outcome at one year of follow-up (Fig 3).

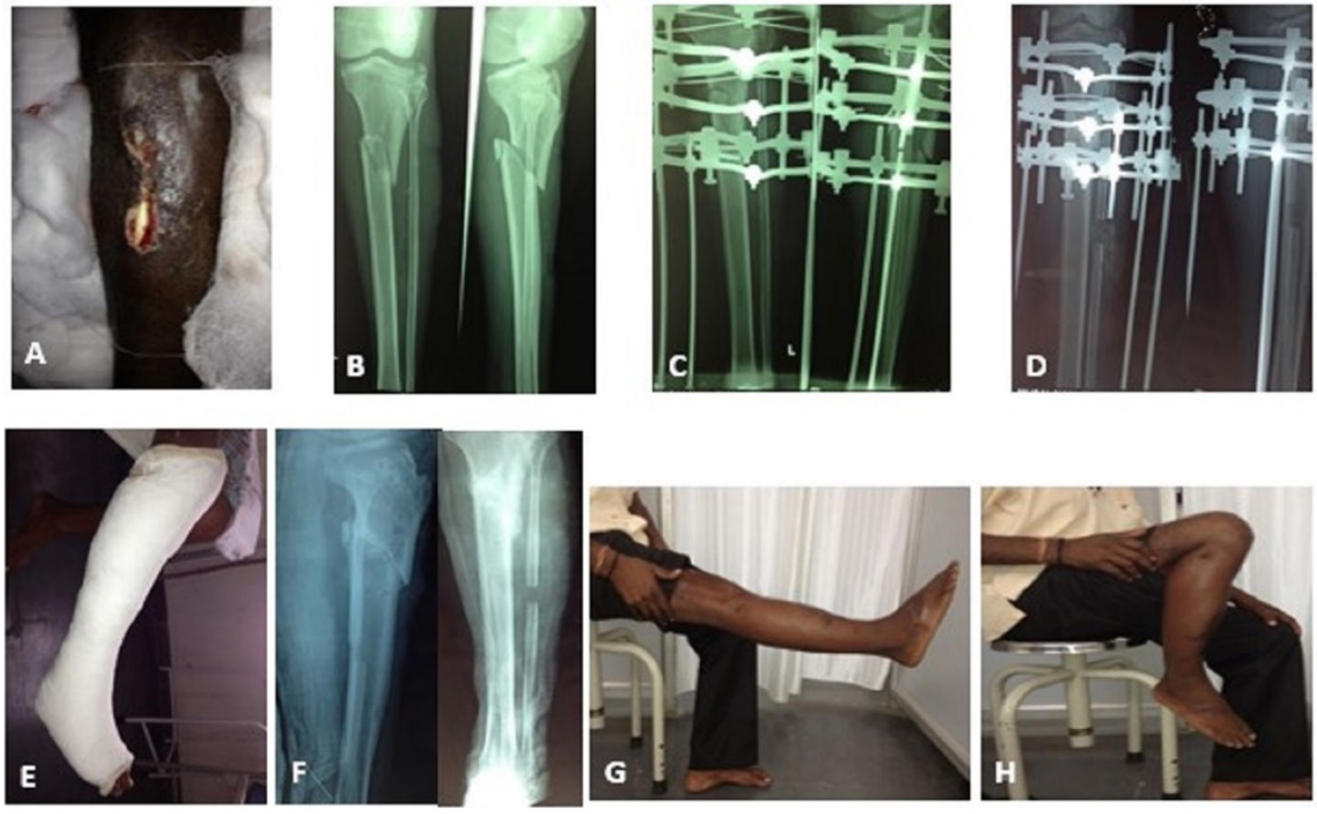

Fig. 1: Patient with open fracture of the Tibia (A, B), managed with Ilizarov external fixator (C, D) and PTB (E) showing union of the fracture on X-Ray (F) with good range of movements of knee and ankle (G, H).

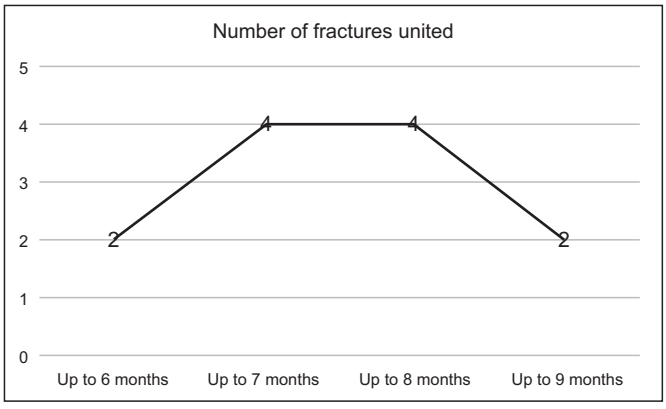

Fig. 2: Duration of fracture healing

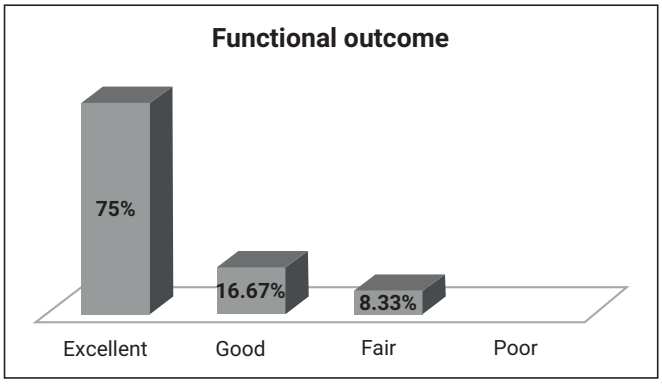

Fig. 3: Final results according to Johner and Wruh's Criteria

Discussion

Open fractures of the tibia pose a difficult situation to the treating surgeon in deciding the treatment plan which is acceptable by the patient. These fractures are more prone to non-union and infection because of precarious blood supply and lack of soft tissue cover over the shaft of the tibia.[20] Severe osteomyelitis has been seen in up to 19% of the cases treated by plate

fixation.[6] In the literature, the reported rate of revision surgery ranges from 8%-69% in patients with open tibial fracture treated by plating.[7] Intramedullary nailing of these high injury fractures have shown to interfere in the blood circulation to the diaphyseal cortex.[8,9] The decreased blood supply contributes to the complications like delayed union or nonunion of these fractures. Intramedullary nailing is not recommended in type III fractures. [21] Use of Ilizarov fixator in these cases gives primary definitive fixation of fracture and also facilitates wound cover and access for wound care. [22] The treatment of these fractures should include anatomical reduction of segments, stable fixation, early ambulation, and appropriate management of the wound.

In this study, all the patients had trauma due to road traffic accidents. Ilizarov fixator with primary wound closure requires a smaller number of repeat surgeries and shorter time to recovery than secondary wound closure and Ilizarov fixation.[23] Our patients were not affordable to repeat surgeries in the future so, we decided to manage these patients with an Ilizarov external fixator. Most of the patients were young with a mean age of 37.66 ± 8.77 years. Male predominance was seen as they are more involved in outdoor activities. Half of the patients had Type IIIB fractures as they were involved in road traffic accidents on highways. The sample size was small as the patients with open tibial fracture managed with other methods were excluded from this study.

Ilizarov method gives the benefit of surgery without the much blood loss and requirement for blood transfusion. It serves the purpose of fracture fixation and wound care in these groups of patients. Ilizarov fixator has better efficacy as compared to other external fixators in open tibial fracture.[19] The mean duration for fracture union has been found to range from 5.6 to 7.5 months in different studies.[24-26] In our study the mean duration for fracture union was 7.1 months. All the patients in this study had fracture union. The delayed and nonunion were related to the more severe soft tissue damage.[27] Pin site infection was seen in 27.4% of patients with Ilizarov fixator in two studies.[24,28] In our study the rate of pin site infection was 16.6% (n=12), which less than the other studies.

The Ilizarov external fixator is found to have a stable structure and it also enables the patient to bear weight on the affected limb even in highly comminuted fractures.[29] In this study the patients were encouraged weight bearing form 2nd postoperative day and they were comfortable in walking indoor. Ilizarov fixator is a safe and versatile device, which provides stability and allows early ambulation.[30]

It has been shown that the Quality of life after use of the Ilizarov external fixator in these patients is better in comparison with other treatment options. [31] Another study on post-treatment survey about the patient satisfaction with Ilizarov external fixator showed that about 96.8% of the respondents were satisfied with the treatment and 91.7% said that they would opt for Ilizarov fixator again under the same circumstances [32].

The malunion rate reported in the literature for fractures treated with Ilizarov external fixator is 10% which is comparable to our study finding of 8%.[19,24] Application of Ilizarov external fixator in Type II, IIIA, and IIIB fractures allows excellent management of these open fractures.[24] It is a better option when internal fixation is contraindicated due to severe soft tissue injury.[33] In this study excellent to good outcome was seen in 91.67% of study subjects, which is comparable to other studies.[25,34] Ilizarov external fixator offers a minimally invasive way to manage tibial fractures and associated wound.[34] Ilizarov external fixator has been recommended for the definitive primary fixation of type II, IIIA, and IIIB fractures of the tibia.[24]

The Ilizarov external fixator has been in use for a long time for the management of open tibial fractures with consistent good clinical outcomes. The overall satisfaction of patients was better and patients were happy with early rehabilitation. Though, it requires a good pre-operative planning, frame designing, and appears cumbersome for the patient after application, the end results are promising in open tibial fractures. Limitations of this study are the small sample size and no other comparative group. The sample size was small as the patients with open tibial fracture managed with other methods were excluded from this study. Further studies with large sample size and longer follow up are required to assess the long-term outcome of this procedure.

Conclusion

Ilizarov external fixator gives stable fixation of the open tibial fractures and allows better wound care. Healing of bone and soft tissue is better with this apparatus in open tibial fractures. It also helps in early ambulation and rehabilitation of these patients.

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