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Outcomes of Ilizarov Ring Fixator in Infected Nonunion of Tibia

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Objective: This study was designed to evaluate the effectiveness of Ilizarov. We aimed to explore the infection rate, bony union, and functional outcomes of Ilizarov fixators.
Methodology: This retrospective study was conducted in Orthopedic department of Bolan Medical Complex Hospital Quetta Pakistan from June 2020 to June 2021. In this timeframe total of fifty-five patients of infected nonunion tibia were enrolled for Ilizarov technique treatment. For surgical intervention, patients were placed in a supine position on a radiolucent table. Ilizarov fixator was prepared on the behalf of patient's limb length, infection site, and ankle and knee functional status. We applied assembled Ilizarov fixator at the tibial shaft while keeping in mind that the rings were positioned in on the proximal and distal fragments. The ring was placed parallel to the joints whereas pins were inserted perpendicular to the tibial mechanical axis.
Results: A total of 55 patients were recruited for this study. The mean age of the selected

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participants was 45.65±16.69 years. The overall successful bone results of the ASAMI score were observed as 80% whereas 88% functional outcomes were achieved. In bone results, we observed 28 (50.9%) cases with excellent results, 16 (29%) with good, 7 (12.7%) with fair, and 3 (5.4%) with poor outcomes. On the other hand, 25 (45.4%) cases observed excellent functional results, 25 (45.4%) with good, 4 (7.6%) with fair, and 2 (3.6%) with poor outcomes.

Conclusion: Our results show a high success ratio therefore we recommend Ilizarov external fixators for infected nonunion tibial fracture. This method helps to recover limbs without any amputations. However, the discomfort of patients is one of the main problems with this method of treatment.

Keywords: Ilizarov external fixators; tibial nonunion fracture; infection.

1. INTRODUCTION

Due to the increasing number of trauma high ratio of incidence related to long bone was reported in recent years [1]. Among these complex and compound fractures of a long bone, the tibia is most persistent due to its vulnerable subcutaneous location. Tibial infection can cause complications like nonunion and delayed union of bone [2]. Non-union is the most frequent complication of the tibia as compared to other body bones. Other coexisting problems also contribute to complications related to nonunion of the fracture. These problems include persistent infection, loss of soft tissues and bone [3]. Major complications like limb deformity and limb length discrepancy occurred due to nonunion of the tibia [3]. Despite the fact, a large variety of nonunion bony defect treatment is introduced still the management of nonunion bony defects is a challenging problem for many orthopedic surgeons [4]. Methods like soft-tissue rotational flaps, antibiotic cement beading, bone grafting, bone transplants, and Ilizarov are available for managing chronic diaphyseal infections associated with non-union [5]. Regardless of these methods, the Ilizarov fixator provides better outcomes for managing nonunion defects >4cm [6]. This method has an advantage over others in terms of compensation of bony defects, infection elimination, and achieved bony union through histogenesis [7].

This study was designed to evaluate the effectiveness of Ilizarov. We aimed to explore the infection rate, bony union, and functional outcomes of Ilizarov fixators.

2. METHODOLOGY

This retrospective study was conducted in Orthopedic department of Bolan Medical Complex Hospital Quetta Pakistan from June 2020 to June 2021. In this timeframe total of fifty-five patients with infected nonunion tibia were enrolled for Ilizarov technique treatment. Inclusion criteria were set before initiating the procedure. We only include those patients who had non-union tibial of a minimum of 6 months duration. We further assure that the recruited patients had infections at nonunion sites with 2.5 cm or more bone defects. Those patients who underwent unsuccessful procedures of nailing or bone grafting were also included. On the contrary patients with infection and fractures, less than 6 months were not part of this study. All the procedure of Ilizarov application was carried out by a senior surgeon. All the demographic details of patients, along with injury mechanism, history of previous interventions were noted. We further observed the detail of isolated organisms for evaluation. Nonunion of fractures was classified into three major categories: active infection, inactive infection, and extent of bone loss. Before surgery, clinical evaluation of patients was done to evaluate the pre-surgical complications. Observations revealed that 19 patients had initial treatment of open reduction and internal fixation, 14 had external fixations, 11 underwent through intramedullary nailing, and cast application was done in 7 patients as first-line treatment.

For surgical intervention, patients were placed in a supine position on a radiolucent table. Ilizarov fixator was prepared on the behalf of patient's limb length, infection site, and ankle and knee functional status. We marked the pre-selected osteotomy site and incision point for surgery preparations. We applied assembled Ilizarov fixator at the tibial shaft while keeping in mind that the rings were positioned in on the proximal and distal fragments. The ring was placed parallel to the joints whereas pins were inserted perpendicular to the tibial mechanical axis. All the procedure was done under the image intensifiers [8].

The incision was made by the incision marked beforehand. We used radical debridement for the infected soft tissue and necrotic bone. The consideration as the vital bone was dependent on the bleeding margin ends of the bone. With the help of transverse osteotomy resection of the fibula segment was done. After the surgery antibiotics were recommended to patients for two weeks. The antibiotics were selected according to culture and sensitivity. Patients with negative cultures were treated with antibiotics containing both gram-positive and negative cover. From the first post-operative day, we encouraged patients for full weight-bearing and isometric exercises. The latency period before bone transport was observed as 5-7 days. On the other hand, the distraction rate was observed as 0.25mm per 6 hours. After the bone transport, the ends of the tibia docks were compressed by 0.2mm per day and this procedure was continued until the patient felt pain. Patients were examined until bone transport was achieved. We further observed post-operative complications. Ilizarov fixators were removed after the evidence of three complete cortices. Association for the Study and Application of the Method of Ilizarov (ASAMI) classification was used to evaluate the bone and functional status [9].

Bone results	Criteria
Excellent	Union, no infection, deformity < 7°, limb-length discrepancy < 2.5 cm
Good	Union + any two of the following: absence of infection, < 7° deformity and limb-length inequality of < 2.5 cm
Fair	Union + only one of the following: absence of infection, deformity < 7° and limb-length inequality < 2.5 cm
Poor	Nonunion/re-fracture/union + infection + deformity > 7° + limb-length inequality > 2.5 cm
Functional results	**Criteria**
Excellent	Active, no limp, minimum stiffness (loss of < 15° knee extension/< 15° dorsiflexion of ankle), no reflex sympathetic dystrophy (RSD), insignificant pain
Good	Active, with one or two of the following: limp, stiffness, RSD, significant pain
Fair	Active, with three or all of the following: limp, stiffness, RSD, significant pain
Poor	Inactive (unemployment or inability to return to daily activities because of injury)

Chart 1. ASAMI criteria of bone and functional outcomes

3. RESULTS

A total of 55 patients were recruited for this study. The mean age of the selected participants was 45.65±16.69 years. Forty-one patients were male (74.5%) whereas only 15 females (27.2%) were recruited. The mean follow-up duration was 6.84 months ranging from 3 to 12 months whereas the average Ilizarov fixator period was 10 months. Road traffic accidents were the major mechanism of injury with a high frequency of 63.6%. Fall from height was observed as the second major reason for nonunion tibial fracture (23.6%). The mean bone defect was reported as 3.5 cm while the average extended index was of 60 days. The average surgery time was observed as 180 minutes. Eight patients reported soft-tissue defects while 30 cases of preoperative limb discrepancy were reported.

A total of 27 patients had positive culture and the majority of them had isolated staphylococcus aureus organism (27.27%). Fifty-three patients were able to bear weight at the same time two patients had difficulty in weight-bearing. Postoperative complaints of pin track infection were highly reported. A total of 11 (20%) cases had pin track infection, 10 (18.1%) had limb length discrepancy, 2 (3.6%) cases of nonunion, 2 (3.6%) cases of wire breakage, and single (1.8%) case of reinfection appeared. The overall successful bone results of the ASAMI score were observed as 80% whereas 88% functional outcomes were achieved. In bone results, we observed 28 (50.9%) cases with excellent results, 16 (29%) with good, 7 (12.7%) with fair, and 3 (5.4%) with poor outcomes. On the other hand, 25 (45.4%) cases observed excellent functional results, 25 (45.4%) with good, 4 (7.6%) with fair, and 2 (3.6%) with poor outcomes.

Table 1. Demographic information of patients

Variables	
Mean Age	45.65±16.69
Male	41 (74.5%)
Female	15 (27.2%)
Mean follow up period in months	6.84 (range 3-12)
Mean ilazarov fixator time in months	10
Injury mechanism	
Fall from height	13 (23.6%)
Blast injury	3 (5.45%)
Road traffic accidents	35 (63.6%)
Gun shots	6 (10.9%)
Mean bone defect range	3.5 (2-5 cm)
Mean external index in days	60 (45-120 days)
Mean surgical time in minutes	180 (120-300)
Soft tissue defect	8 (14.5%)
Pre-operative limb length discrepancy	30 (54.5%)

Table 2. Information of Organism isolated from culture

Organism	Frequency
Proteus mirabilis	2 (3.63%)
Staphylococcus aureus	15 (27.27%)
Pseudomonas aeruginosa	7 (12.7%)
Escherichia coli	3 (5.45%)

Table 3. Postoperative complications

Complications	Frequency
Limb length discrepancy	10 (18.1%)
Septic arthritis	1 (1.8%)
Pin track infection	11 (20%)
Reinfection	1 (1.8%)
Non union	2 (3.6%)

Complications	Frequency
Wire breakage	2 (3.6%)
Schanz screw broken	1 (1.8%)
Leg abscess	1 (1.8%)

Table 4. ASAMI score of bone and functional outcomes

ASAMI score	Bone results	Functional results
Excellent	28 (50.9%)	25 (45.4%)
Good	16 (29%)	25 (45.4%)
Fair	7 (12.7%)	4 (7.2%)
Poor	3 (5.4%)	2 (3.6%)

4. DISCUSSION

Despite the fact, a large variety of nonunion bony defect treatment is introduced still the management of nonunion bony defects is a challenging problem for many orthopedic surgeons. These methods include ring fixators, modified Arbeitsgemeinschaft für osteosynthesefragen (AO) fixators, or specialized intramedullary nails [10]. Regardless of these methods, the Ilizarov fixator provides better outcomes for managing nonunion defects >4cm [6]. This retrospective study was aimed to evaluate the effectiveness of the Ilizarov fixator in infected tibial patients of ..... city by using the ASAMI score. We observed 80% bone results via ASAMI score whereas functional outcomes were observed as 88%. These results are comparable with the previous study of Yin et al [11]. Comparing the ASAMI score of bone and functional outcomes we observed better functional outcomes. These results are in contradiction to the previous studies of Farmanullah [12] and Magadum et al [13], both of these studies observed better outcomes of bone as compared to functional outcomes 58.9%>56.9% and (76%>60% respectively). However, a study conducted in 1989 had similar results as ours. They observed a better functional score (64%) than bone score (60.8%) [14]. The variations in results may occur due to factors including pain, and condition of muscles, joints, and bones of targeted population [10]. Though the reoccurrence of infection is the major postoperative complication of Ilizarov fixators, however, in the study we achieved 90% bone reunion with only one case of infection reoccurrence was observed. These results following the previous study of Xu et al [15], in which they observed a 100% rate of reunion without any single case of infection reoccurrence.

Our study observed less favorable outcomes in patients who already underwent multiple procedures before Ilizarov application. Thus, our results demonstrate that the higher the time between initial trauma and Ilizarov application fewer outcomes would be observed. Those patients who underwent a single procedure before the application had less time duration between the initial injury and Ilizarov application. Study of Kindsfater [16] also revealed that the chances of infection increase when prolonged interval occurs between injury and surgical intervention. However, there is a contradiction in our results systematic review of Crowley et al [17]. They recommended evaluation regarding the 6-hour rule of injury and surgical intervention [17]. High-stress areas and greater motion rate encouraged the formation of pin site infection. A recent study by Ceroni et al [18] observed pin site infection and irritation after excessive movement at the fixator pin-bone interface. We observed nine cases of pin site infection which were managed by regular dressing. Daily pin site care can help in the management of pin site infections [19].

Many researchers recommended that the usage of 4 wires with a diameter of 2mm and tension between 1,000-2,000 N gave rigid fixation and endorse the bone formation and bone union. However, the incidents of wire breakage can be observed in middle later stages of bone transport due to excessive fatigue [15]. In our study, we observed two cases of wire breakage during the late mineralization phase.

We observed two cases of nonunion. These two patients underwent multiple surgical procedures which results in amputation in one case. Thus the overall Ilizarov failure was observed as 3.6%. These results are comparable with the previous study of Yin et al [11] in which he observed 7% failure with a 4% rate of amputation. One case of reinfection was observed which was treated with antibiotics whereas one case of knee septic arthritis was observed which was managed with

arthrotomy. A clinical trial conducted in 2016 claimed that arthrotomy is the best effective method for septic arthritis [20].

5. CONCLUSION

Ilizarov external fixators provide better outcomes in the form of bone transport and resolve deformities. During the treatment, it enables patients to bear weight. Our results show a high success ratio therefore we recommend Ilizarov external fixators for infected nonunion tibial fracture. This method helps to recover limbs without any amputations. However, the discomfort of patients is one of the cons of this method.

CONSENT AND ETHICAL APPROVAL

As per international standard or university standard guideline Patient's consent and ethical approval has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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