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Complications with Ilizarov ring fixator in open tibial fracture

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Abstract
Introduction: The management of infected nonunion of the tibia is challenging, particularly with segmental bone loss, multiple draining sinuses, poor soft tissue cover, osteopenia, adjacent joint stiffness, limb deformity, or multidrug-resistant polymicrobial infection. The Ilizarov method permits early rehabilitation and addresses all the problems such as non-union, infection, shortening, soft tissue loss and deformity simultaneously at single stage. Ilizarov ring fixation technique has its own advantages as well as associated complications.
Methods: The present study was a prospective randomized open study in which aim was to evaluate Complications with Ilizarov ring fixator in open tibial fracture. The study was conducted in 30 skeletally mature patients in Department of Orthopaedics, SGRD University of health sciences, Amritsar from July 2017 to May 2019. The patients were assessed clinically based on history and physical examination. Radiological evaluation using plain antero-posterior and true lateral radiographs of the involved leg was done and evaluated by complications.
Results: Mean age was 37.7 years. Out of 30 cases 24(80%) were male and 6(20%) were female. Right tibia was involved in 24 cases out of 30 cases. 29 cases had history of road side accident and 1 had history of fall from height. In present study following complications were noted, limp in 12 cases(40%), ankle stiffness in 7 cases(23.33%), pin site infection in 9 cases(30%), limb oedema in 7 cases(23.33%), knee stiffness in 3 cases(10%), loosening of pins in 2 cases(6.67%), deformity in 2 cases(6.67%) and refracture in 1 case(3.33%). There was no complication of neurovascular injury, malunion, breakage of wires, axial deviation or limb length discrepancy
Conclusion: Limp and Pin tract infection were the most common complications. Most complications can be prevented by diligent post-operative care. Complications if diagnosed early can be managed effectively. As such advantages of Ilizarov ring fixator outweigh the associated complications.

Keywords: Ilizarov ring fixator, complications

Introduction
In the past, patients with open infected and non-union fractures had little treatment available to them and ultimately landed up in amputation. The treatment of such conditions was revolutionised by Dr. Gavril Ilizarov. The ilizarov frame takes its name from Dr Gavril Abramovich Ilizarov [1].
Ilizarov has been found to show encouraging results in infected nonunion of tibia as it can not only offer a one-stage solution to infection, shortening and deformity [2], but also produces regenerate without bone graft [3].
Ilizarov ring fixator are stable and elastic type of external fixator and allow axial micromotion allowing "trampoline effect" which are conductive to healing of fractures and regeneration [4].
The main disadvantage of fine-wires in diaphysis is the relatively narrow anatomic corridors in which they can be placed to minimize the risk of neurovascular damage. These wires often transfix muscle and irritate tendons, leading to pain, loss of mobility, and potentially increasing the risk of pin site infection and contracture of adjacent joints. Wires are more painful and their removal is difficult. Another disadvantage is increased frame complexity and construction. Reducing the number of wires decreases these problems, reduction in fixation time and lower risk of complications [5].
Hybrid assembly is an advancement of the original Ilizarov apparatus introduced by the Lecco group in Italy in 1986, where half pins were used diaphysis in place of wires [6].

Addition of half pins in diaphysis cause minimal transfixation of the surrounding soft tissues and due to its insertion in anatomically safe areas cause less morbidity, increased mobility and improved patient comfort and decreased postoperative pain [7]. Addition of half pins in metaphysis increases the stability of the construct thereby reduces the incidence of pin site infection, loosening, allows early mobilisation. The Hybrid frame is easy to apply, versatile, and less expensive than other commercially available adaptors and frames [8, 9]

Methods

The present study was a prospective randomized open study in which aim was to evaluate Complications with Ilizarov ring fixator in open tibial fracture .The study was conducted in 30 skeletally mature patients in Department of Orthopaedics, SGRD University of health sciences, Amritsar from July 2017 to May 2019. Patients with Infected nonunion with or without bone loss, Infected nonunion with or without previous history of internal fixation, Acute open grade III fracture tibia with bone loss >5cms were included in the study. Patients with significant medical comorbidities and uncorrected metabolic disorders, with significant smoking habits and with Irreparable damage to Tibial nerve were excluded from the study. Follow up was done at monthly interval until frame removal. The patients were assessed clinically based on history and physical examination. Radiological evaluation using plain antero-posterior and true lateral radiographs of the involved leg was done. External fixation time and following complications i.e, pin-track infection, axial deviation, loosening of wires, breakage of wires, mal-union, re-fracture, knee stiffness, ankle stiffness, limb edema and neurovascular injury were noted. Results were evaluated in%.

Results

The medical records and serial radiographs of all 30 patients were reviewed.In our study mean age was 37.7 years. Out of 30 cases 24(80%) were male and 6(20%) were female. Right tibia was involved in 24 cases out of 30 cases. 29 cases had history of road side accident and 1 had history of fall from height. Proximal tibial shaft was affected in 4 cases (13.34%), middle and distal tibial shaft was affected in 16 (53.33%) and 10(33.33%) cases respectively. Out of 30 cases, 14 cases (46.66%) were of infected non-union with bone loss and 16 cases (53.34%) were of open fracture IIIB/IIIC with bone loss. The mean consolidation time was 8.2 months and mean bone lengthening achieved was 7.1cm. In present study following complications were noted, limp was present in 12 cases (40%), pin site infection in 9 cases (30%), ankle stiffness in 7 cases (23.33%), limb oedema in 7 cases (23.33%), pain was present in 5 cases (16.67%), knee stiffness in 3 cases (10%), loosening of pins in 2 cases (6.67%), deformity (>7 degree) in 2 cases (6.67%) and refracture in 1 case (3.33%). There was no complication of non union, neurovascular injury, malunion, breakage of wires, axial deviation, limb length discrepancy or reflex sympathetic dystrophy.

Table 3: Complications.

Complications	No. Of Cases	Percentage (%)
Knee Stiffness	3	10
Ankle Stifness	7	23.33
LIMP	12	40
Axial Deviation	0	0
N/V Injury	0	0
Pin Site Infection	9	30
Refracture	1	3.33
Malunion	0	0
Loosening Of Pin	2	6.66
Breakage Of Wires	0	0
Limb Oedema	7	23.33
Deformity	2	6.67
Limb Length Discrepancy	0	0

A

B

C D E

Fig A-Preoperative clinical picture. B-Preoperative X-Ray. C-X-Ray at 6 months. D- X-Ray after removal of fixator at 1 year. E- Clinical picture after removal of fixator.

Discussion

The management of infected non-union of the tibia is challenging, particularly with segmental bone loss, multiple draining sinuses, poor soft tissue coverage, osteopenia, adjacent joint stiffness, limb deformity, or multidrug-resistant polymicrobial infection. Permanent functional deficits, prolonged recovery times, and even amputation can result [8, 10].

Several methods have been applied successfully in the treatment of infected non-union of tibia including bone grafts, extensive debridement and local soft tissue rotational flaps, packing of the defects with Papineau-type open cancellous bone grafting, tibiofibular synostosis, free microvascular soft tissue and bone transplants and masquelet technique [11-16]. However these treatments have obvious limitations such as donor site morbidity, stress fracture, restriction of the size of bone defects, failure of flaps and skin grafts and multiple surgeries.

Ilizarov pioneered the theory of "tension stress" allowing bone and soft tissue generation to restore defects after excision of associated osteomyelitis [17, 18] and in non-union treatment [19, 20].

The Ilizarov method permits early rehabilitation and addresses all the problems such as non-union, infection, shortening, soft tissue loss and deformity simultaneously at single stage [21].

However Ilizarov ring fixator has certain disadvantages [2] such as Muscle and tendon transfixation which leads to pain and contracture of adjacent joints. Chances of neurovascular impalement are higher. Olive wires are more painful and their removal is difficult and 90-90 placement of wires is not always possible according to anatomical safe corridors compromising the stability of assembly.

Hybrid assembly is an advancement of the original Ilizarov apparatus introduced by the Lecco group in Italy in 1986, where half pins were used diaphysis in place of wires [6]. Addition of half pins in diaphysis cause minimal transfixation of the surrounding soft tissues and due to its insertion in anatomically safe areas cause less morbidity, increased mobility and improved patient comfort and decreased postoperative pain [7]. Addition of half pins in metaphysis increases the stability of the construct thereby reduces the incidence of pin site infection, loosening, allows early mobilisation. The Hybrid frame is easy to apply, versatile, and less expensive than other commercially available adaptors and frames [8, 9].

The present study was a prospective randomized open study in which aim was to evaluate Complications with Ilizarov ring fixator in open tibial fracture. The study was conducted in 30 skeletally mature patients in Department of Orthopaedics, SGRD University of health sciences, Amritsar from July 2017 to May 2019. Patients with Infected nonunion with or without bone loss, Infected nonunion with or without previous history of internal fixation, Acute open grade III fracture tibia with bone loss >5cms were included in the study. Patients with significant medical comorbidities and uncorrected metabolic disorders, with significant smoking habits and with Irreparable damage to Tibial nerve were excluded from the study. Follow up was done at monthly interval until frame removal. The patients were assessed clinically based on history and physical examination. Radiological evaluation using plain antero-posterior and true lateral radiographs of the involved leg was done. External fixation time and following complications i.e, pin-track infection, axial deviation, loosening of wires, breakage of wires, mal-union, re-fracture, knee stiffness, ankle stiffness, limb edema and neurovascular injury were noted. Results were evaluated in%.

In present study union rate was 100%. This is comparable to studies conducted on ilizarov fixator by Menakaya CU *et al*. (2014), Peng Y *et al*. (2014), Ferreira N *et al* (2015) and Rohilla R *et al*. (2016) [22-24, 3] Pin site infection is one of the most common complications of ilizarov. In present study infection at pin site was present in 30% of cases. In studies conducted on ilizarov fixator by Elgazzar AS *et al* (2012), Peng Y *et al*. (2014), Rohilla R *et al* 2016 and Ali SK *et al*. (2017) infection at pin site was present in 36%, 60.6%, 68.5%and 45% of cases respectively [25, 23, 3, 26].

In present study deformity (>7 degree) was present in 6.67% of cases. In studies conducted on conventional ilizarov fixator by Rohilla R *et al* (2016) deformity >7 degree was present in 22.8% of cases [3]. In present study limb length discrepancy was absent in all cases. In studies conducted on ilizarov fixator by Farmanullah *et al*. (2007), Rohilla R *et al*. (2016) and Barawi OA *et al*. (2018) limb length discrepancy was present in 3.44%,11.4% and 5% of cases. Our results are

better than the above studies [27, 3, 28].

Post operative pain is a major complication of ilizarov fixator. Pain is due to muscle and tendon transfixation by the wires. In our study postoperative pain was present in 16.67% of cases and reflex sympathetic dystrophy was absent in all cases. In study conducted on ilizarov fixator by Wani N *et al* in 2011 and Elgazzar AS *et al* in 2012 postoperative pain was present in 25% and 20% of cases respectively [29, 25]. According to studies conducted on ilizarov fixator by Farmanullah *et al* (2007) and Barawi OA *et al* (2018) reflex sympathetic dystrophy was present in 6.89% and 10% of cases respectively. Post operative pain and reflex sympathetic dystrophy was less in our study as compared to above studies [27, 28].

Joint stiffness is a major drawback of ilizarov fixator. In our study done on hybrid ilizarov fixator ankle stiffness as a complication was present in 23.3% and knee stiffness was present in 10% of cases. In studies conducted on ilizarov fixator by Megas P *et al* in 2010, Gupta SK *et al* in 2014 and Rohilla R *et al* in 2016 ankle stiffness was present in 55%,25% and 51% of cases respectively [30, 31, 3]. In studies conducted by Elgazzar AS *et al* in 2012, Rohilla R *et al* in 2016 and Barawi OA *et al* 2018 knee stiffness was present in 8%,20% and 10% of cases respectively. Our studies showed decrease in incidence of knee stiffness and ankle stiffness [25, 3, 28].

Thus we conclude that though we have encountered complications of ilizarov ring fixator but most of the complications are avoidable or can be decreased by diligent postoperative care and physiotherapy.

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