

ORIGINAL ARTICLE

Effectiveness of ilizarov frame fixation on functional outcome in aseptic tibial gap non-union

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Abstract

Objectives: The Objective of the study is to evaluate the effect of Ilizarov frame fixation on functional outcome in aseptic tibial gap non-union cases

Methods: In this clinical study, 15 cases of post-traumatic aseptic tibial gap non-union were selected in department of orthopedics, Allied Hospital Faisalabad, Punjab Pakistan, during years 2013-2014. After blood analysis and clinical assessment, the aseptic gap nonunion cases underwent ilizarov frame fixation for their problem. They were taught about care of ilizarov fixator and pin tract. They were called on regular basis and pre and post-surgery functional outcome was measured by modified functional evaluation system by Karlstrom-Olerud.

Results: Out of the 15 patients, 12 (80%) with road traffic accident, 2 (13.3 %) with gunshot injury and 1 (6.66%) with fall from height; 9 (60%) were treated by compression technique (fig.1,2,7,8,11), 4 (2.66%) with compression-distraction (fig.3,10) and 2 (13.3 %) were treated using distraction-compression technique (bone transport) (fig.4,5,6). Mean gap was 6.33cm (range 2-12cm). Duration of tibial gap union was average 10.60 months (minimum 8 months, maximum 15 months) and union was achieved in all the cases in mean time of 25.20 weeks (minimum 13 weeks, maximum 57 weeks). Patients remained in ilizarov fixator frame for average 6.80 months (range minimum 4, maximum 13 months). Pin tract infection and pain were common Complications. The functional outcome was measured by modified functional evaluation system by Karlstrom-Olerud 5 showed good, 4 satisfactory, 4 moderate and 2 poor results.

Conclusion: The Ilizarov technique is an effective method in treating the aseptic tibial gap non-union. Patient's motivation and co-operation played an important role in good to excellent outcomes.

Keywords: Aseptic, Functional, Ilizarov, Gap Nonunion, Tibial. (JPMA 65: S-179 (Suppl. 3); 2015)

Introduction

Tibial gap nonunions have been treated with a variety of surgical methods including plate osteosynthesis with bone graft,¹⁻³ intramedullary nailing,⁴⁻⁷ and external fixation.⁸⁻¹⁰ The complexity of a tibial gap nonunion can be variable and depends on several factors. The "personality of a fracture" is a term and concept introduced by Schatzker¹¹ and its use underscores the complexity of a particular problem and helps organize a treatment approach. We have found it helpful to apply this concept to gap nonunion. The personality of a tibial gap nonunion is determined by a number of factors including bone loss; radiographic appearance and stiffness as they relate to the nonunion biology; deformity; leg-length discrepancy (LLD); presence or history of infection; soft-tissue envelope; retained hardware; and patient factors including diabetes, smoking, and neuropathy. Although the use of internal fixation is effective in the treatment of selected tibial gap nonunions,

these techniques have their limitations. The Ilizarov method has gained many advocates for the treatment of tibial gap nonunions over the last 2 decades, particularly hypertrophic gap nonunions,¹² and gap nonunions associated with bone loss,¹³⁻¹⁶ infection^{17,18} and a poor soft-tissue envelope.^{13, 19} The classic Ilizarov frame has been used to correct all deformity,²⁰⁻²³ including lengthening and bone transport.^{13,15,19} However, deformity correction with components of angulation, translation, and rotation requires a staged correction and frame modifications.²⁴ The purpose of this study was to review the results of our experience with a consecutive series of complex tibial gap nonunion defects.

Materials and Methods

This prospective study was conducted in the Department of Orthopedic Surgery at Allied Hospital, Faisalabad, Punjab, Pakistan. The patients were selected and treated between years of 2013 to 2014. Patients having aseptic tibial gap nonunion with no signs of clinical, radiological and biomechanical evidence of infection were included in the study. Patients with history of other injuries, those aged above 50 or under 14, (SD 34.93±10.87) and those suffering from rheumatoid arthritis, diabetic mellitus, and fracture in the other limb were all excluded from the

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study. After fulfilling the inclusion and exclusion criteria, 15 Patients, aged between 14 and 50 were enrolled as study subjects based on clinical findings along with erythrocyte sedimentation rate, C-reactive protein levels and tissue culture reports. The patient's pre-operative X-rays and functional assessment were done using modified functional evaluation system by Karlstrom-Olerud.^{25,26}

Final scoring system for Modified Functional Evaluation System by Karlstrom-Olerud

- ♦ Excellent 33 Points
- ♦ Good 32-30 Points
- ♦ Satisfactory 29-27 Points
- ♦ Moderate 26-24 Points
- ♦ Poor 23-21 Points

After anesthesia patients underwent standard method of Ilizarov frame application. After a latent period of 10-14 days, the lengthening was started. 1) Compression technique was used when there is hypertrophic gap nonunion with no shortening or shortening less than four centimeters. The compression of the fracture was done by moving the rings together and compressing the fracture site and maintaining the ring until radiological evidence of union is seen. 2) Compression and distraction technique was used when the hypertrophic gap nonunion showed bone shortening of more than four centimeters. In this method, we have compressed the both ends of the fracture for 10-14 days and then distracted the compressed site slowly at the rate of 0.25 mm every six hours or 1 mm per day. 3) Distraction-compression is used in cases of oligotrophic or atrophic gap nonunion with bone shortening of more than four centimeters. In this method, the patient will be kept on a circular frame and corticotomy is usually done in the metaphysis to ensure good regeneration. The aim is to mobilize the middle

segment, and lengthening will be done through the corticotomy site. Both ends of the fracture segment approximation are called docking. The frame would remain in this position until there is a radiological evidence of bone union. All patients were operated on by the same orthopedic surgeon using the hybrid Ilizarov fixator technique. Immediately after surgery, X-rays and clinical assessment were done. Physical Therapy was started as soon as the patient was comfortable, and gentle active assistive exercises and active exercises were done for ankle and knee within the pain free ranges. Weight bearing on affected leg was progressively increased from toe touching to full foot touching in the first week. After the first week walking was initiated with partial to full weight bearing as per patient tolerance. Isometric quadriceps exercise and gentle knee mobilization were started up to the available range within the first week. In the first few days after surgery, patients were on oral analgesics. Prophylactic antibiotics (3rd generation cephalosporin) and wound care (pin tract and corticotomy site) were strictly followed to prevent any further problems. Patients were educated and properly trained on how to wash fixator and pins and were discharged from the hospital ward when they started walking with partial weight bearing and were able to go to the toilet independently. They were then followed up in the outpatient department, first on a weekly basis and then twice a month. The fixators were removed by admitting the patients for day care surgery. After the removal of the fixators, patients received physical therapy and were dispensed above or below the knee braces to use for the duration of 4 weeks. The patients were allowed to walk with full weight bearing, and after 5 weeks of regular physical therapy, functional scoring with modified functional evaluation system by Karlstrom-Olerud was performed again.

Results

15 patients aged between 14 and 50 participated in this

Table-1: Modified Functional Evaluation System by Karlstrom-Olerud.

Sr No	Measurement	3 Points	2 Points	1 Point
1	Pain	No	Little	Severe
2	Difficulty in walking	No	Moderate	Severe Limp
3	Difficulty in stairs	No	Supported	Unable
4	Difficulty in previous sports	No	Some sports	Unable
5	Limitation at work	No	Moderate	Unable
6	Status of skin	Normal	Various colors	Ulcer/Fistula
7	Deformity	No	Little, up to 7o	Remarkable,>7o
8	Muscle atrophy	<1cm	1-2 cm	>2cm
9	Shorter lower extremity	<1cm	1-2 cm	>2cm
10	Loss of motion at knee joint	<10o	10-20o	>20o
11	Loss of motion at Subtalar motion	<10o	10-20o	>20o

Table-2:

Sr no	Characteristics	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	average	SD
1	Cause of injury	RTA	RTA	RTA	RTA	GS	RTA	RTA	RTA	FFH	RTA	RTA	RTA	GS	RTA	RTA		
2	Duration of non-union in months	8	11	14	9	14	9	10	9	8	15	10	9	10	9	14	10.60	±2.4
3	Average bone gap in cm	2	2	7	3	10	3	9	3	3	12	8	2	2	3	11	5.33	±3.72
4	Technique used	C	C	CD	C	CD	C	CD	C	C	CBT	CD	C	C	C	CBT		
5	Duration of frame in months	4	5	6.5	5	8	5.5	8.5	5	4.5	13	8.5	5	5.5	6	12	6.80	±2.71
6	Time of union in weeks	13	18	22	17	30	19	32	17	15	57	31	18	18	22	49	25.20	±12.77

RTA- road traffic accident, C-compression, CD-compression-distraction, CBT-compression-bone transport.

Table-3: Patient characteristics.

Sr No.	Characteristics	Description
1	Cause of injury	12 Road traffic accident, 2 gun shoot injury, 1 fall from height,
2	Duration of non-union	Minimum 8 months, maximum 15 months, average 10.60 months
3	Average bone gap	Minimum 2 cm, maximum 12 cm, average 5.33 cm
4	Technique used	9 Compression, 4 compression-distraction, 2 compression+bone transport
5	Duration of frame	Minimum 4 months, maximum 13 months, average 6.80 months
6	Time of union in weeks	Minimum 13weeks, maximum 57, weeks, average 25.20 weeks



Figure-1: Patient of RTA with gap non union of tibia, treated with ilizarov fixator, compression applied.



Figure-2: Gap non union due to RTA, treated by compression by ilizarov fixator.



Figure-3: Ilizarov fixator on tibia with gap non union due to RTA, compression-distraction done.

study. They all suffered from an average duration of gap nonunion of 10.60 months, and the average nonunion gap was 5.33 cm and average duration in the frame was 6.80 months. Out of these 15 patients, nine were treated with compression, (bone shortening was less than 4cm that was covered by shoes) four with compression and distraction and two with distraction-compression. All the patients included in this study had a union of their gap

non-united fractures even though two patients had shown poor outcome on the functional scale. The duration of time the patients remain in the frame indicates the healing time of the patients because they were kept in the ring until complete union was seen radiographically. The minimum duration of frame on the patients was 6 months and maximum was 15 months. Out of the 15 patients, 13 patients showed moderate to good

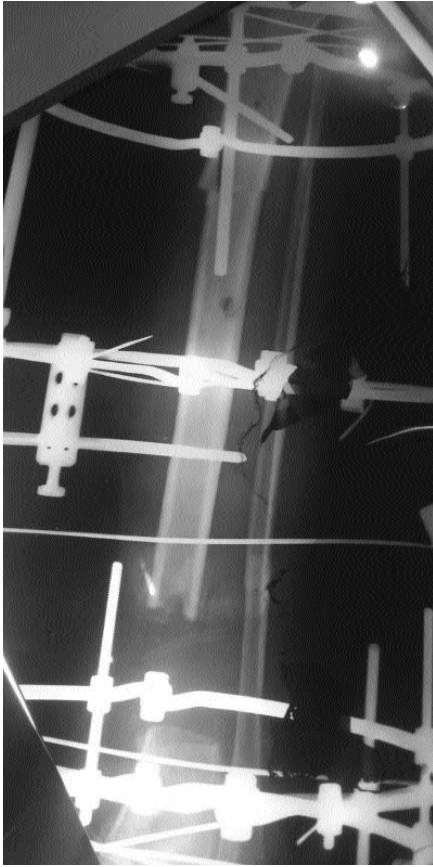


Figure-4: Gap non union tibia treated by compression-bone transport by ilizarov fixator.

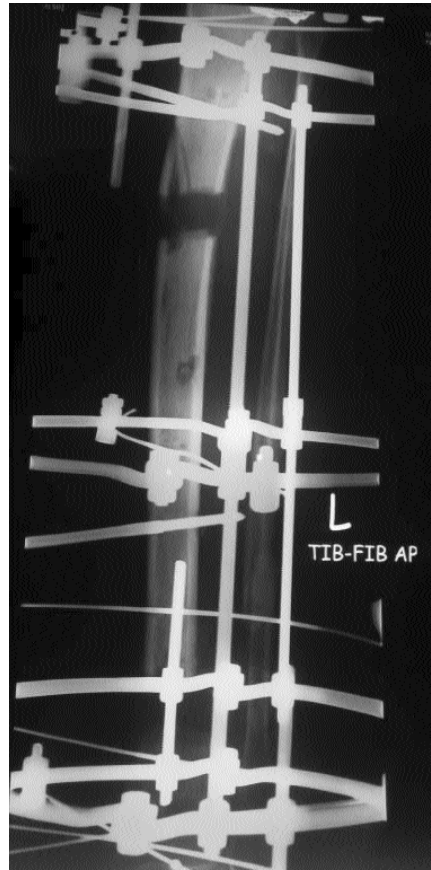


Figure-5: Follow up picture, bone transport being done and callus visible.

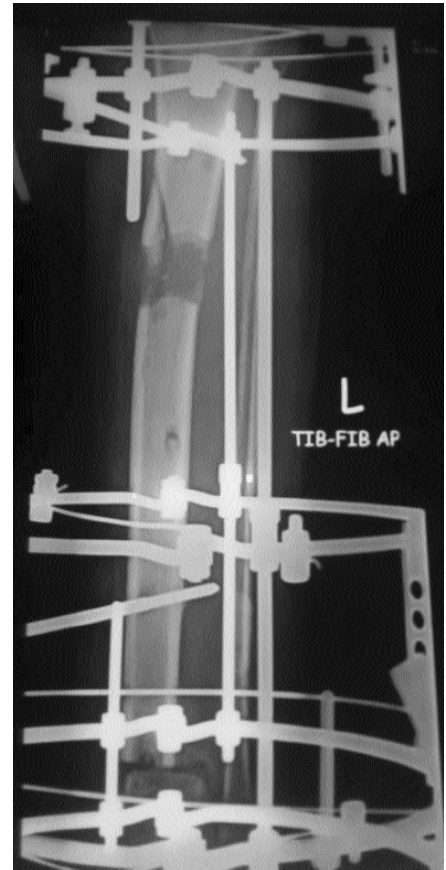


Figure-6: 12 weeks post OP case after ilizarov fixator, CBT done, callus visible.

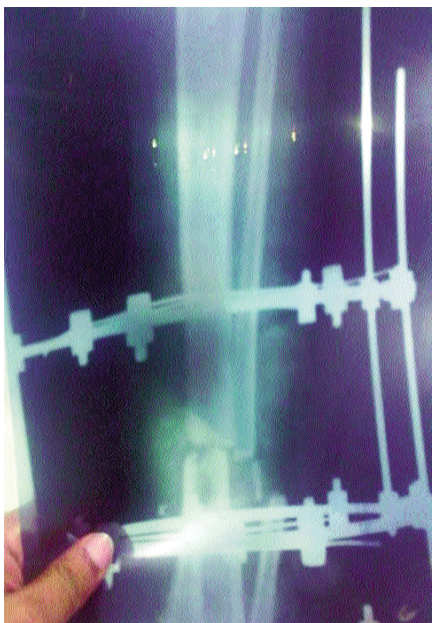


Figure-7: Gap non union distal third tibia due to RTA, compression provided by ilizarov fixator.



Figure-8: Gap non union of Rt tibia due to RTA treated by ilizarov fixator.



Figure-9: Tibial gap non union due to FAI, compression provided by ilizarov fixator.



Figure-10: Gap non union right tibia due to fall from height, CD provided by ilizarov fixator.

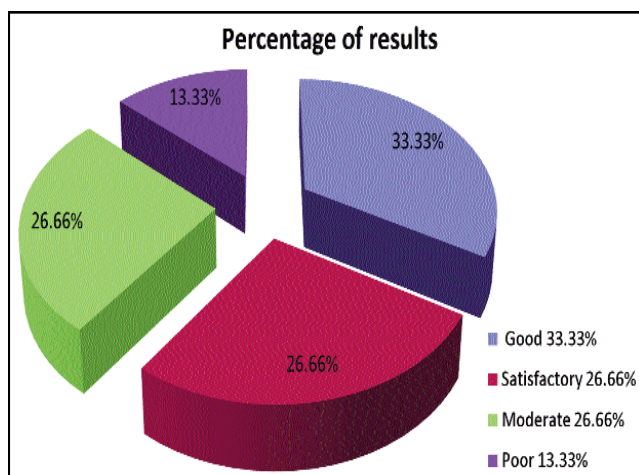


Figure-12: Percentage of results

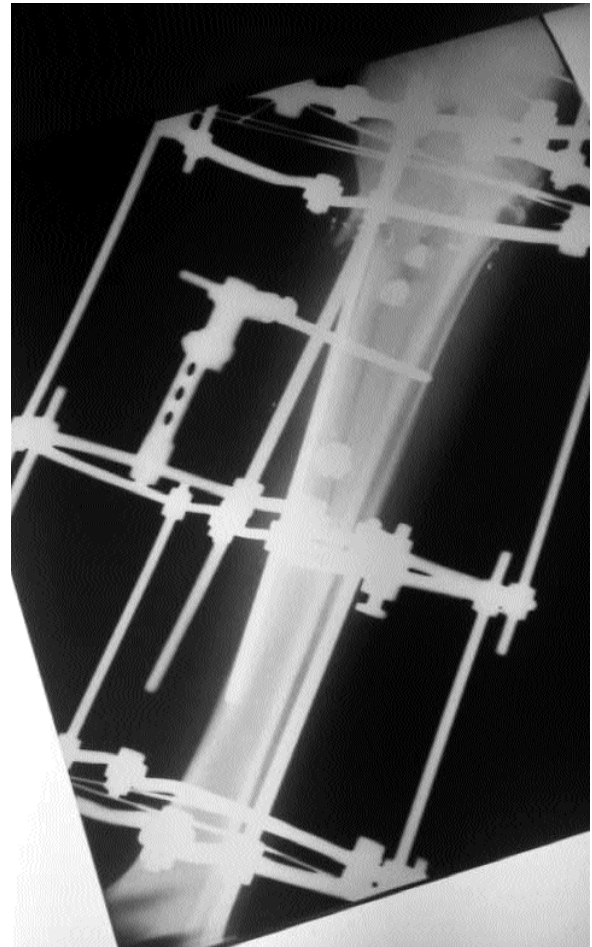


Figure-11: Gap non union due to FAI, treated by ilizarov fixator, compression provided.

functional recovery on modified functional evaluation system by Karlstrom-Olerud.

Discussion

Long standing gap non-union is difficult to treat and is a challenging problem for the orthopedicians. It, usually, leads to residual deformity, persistent infection, and contracture in the affected limb. Different methods have been employed to treat this situation e.g., radical debridement, local flaps, muscle flaps, bone grafting, tibiofibular synostosis, cancellous allograft, fibrin mixed with antibiotics, micro-vascular flaps and vascularized bone transplants.²⁷ All have improved results, but none has been able to solve this clinical situation fully. The Ilizarov ring fixator gives an option of compression, distraction and bone transport, and is effective in the treatment of gap non-union of the tibia where other types of treatment have failed. Weight bearing and the functioning of the joints while on the treatment is an advantage that cannot be matched by any other

technique.²⁸ The Ilizarov apparatus is axially elastic and as the weight bearing forces are directly applied to the bone ends, maintaining the weight bearing function of the extremity actually becomes one of the prerequisites for the success of the method. The cyclic axial telescoping mobility, not rigidity, at the non-union or fracture site is an important requirement for the formation of a reparative callus. Ilizarov experimentally showed that when gradual distraction tension stress is applied to the corticotomy site, the vascularity of the entire limb is increased, which in turn enhances the ability of the bone ends to unite.²⁹ In a study performed by Tranquilli Leali et al.³⁰ in Italy on 20 patients with gap non-union of the tibia, the result was union in all the cases; mean time of union being 4.5 months. In another study Marsh et al.³¹ showed gap union in 40 out of 46 non-union cases treated with Ilizarov method, with a high level of patient satisfaction. Menon et al.³² also concluded in their study that there is a role of Ilizarov ring fixator with nail retention in resistant long bone diaphyseal non-union and that this method could achieve high union rates where other methods failed. Several modifications have been undertaken to increase the efficacy of treatment with Ilizarov method and patient's acceptability, e.g., Rozbruch et al.³³ used a Taylor spatial frame in two cases of hypertrophic gap non-union of the tibia with deformity for which distraction was utilized, yielding noticeable results. The duration of frame application is a disadvantage but when all other treatment modalities have failed, this technique is probably the only alternative and the only hope for many suffering patients, though the patient's compliance is important for a successful outcome.

Conclusion

We conclude that in patients with aseptic tibial nonunion, the Ilizarov technique is a safe and effective technique to improve their functional capacity and to promote complete union.

Recommendations

According to this study, we have seen good healing of gap nonunion in aseptic tibial nonunion by using Ilizarov fixation along with improvements in the daily activities. We highly recommend Ilizarov fixation procedure in aseptic tibial gap nonunion cases to increase chances of bony union leading to improve functional capacity of the patients.

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