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The use of ilizarov external fixator for open comminuted fractures in different parts of tibia

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ABSTRACT

Background: Open fracture of tibia is a common occurrence in the orthopedic treatment arena. Ilizarov technique is a popular technique of treating open tibial fracture after debridement and open reduction. It is comparatively a newer method and has many advantages.
Methods: This study was carried out in the department of orthopaedics, Centre for women and child health, Ashulia, Dhaka, Bangladesh during the period from January 2019 to June 2021. In total 30 patients with tibial fractures were selected as the study population. Before starting the intervention, the written consent of the participants was taken and this study was approved by the ethical committee of the respective medical college.
Results: Out of total 30 participants, 24 (80%) were males and 6 (30%) were female. In analyzing mode of injuries, we found highest (86.7%) participants were from road accidents followed by 10% from sports injury and the remaining 3.3% from general falls. The duration of treatment with the fixator was 12-23 weeks (average 16 weeks). Fourteen patients wore a PTB cast for an additional period of 4 weeks. In our study total 30 cases were debrided on the same day and stabilized with Ilizarov ring fixator after a period of 5 to 12 days from the date of injury. The operation time ranged from 90 minutes to 120 minutes (Mean 102±4 minutes).
Conclusions: No case developed deep infection, non-union or unacceptable mal-union. The construct is stable and enables the patient to bear weight on the affected limb a short time after the surgery, even in cases of comminuted fractures.

Keywords: Illizarov, Tibial, Fractures, Proximal, Distal, Fixator

INTRODUCTION

Depends on the size of the wound, Amount of soft tissue injury, Bone fracture type, velocity of injury, Contamination wound, open Fractures are divided into three major categories. They are type I, type II and type III respectively. Type I open fractures are defined by wound size <1 cm with minimal soft tissue injury, minor fracture, almost clean/minimum contamination low velocity trauma. Type II open fractures are defined by an open fracture with a laceration >1 cm (2-5 cm), moderate soft tissue injury, moderate contamination, no flaps, or avulsions. Type III open fractures are defined by an open fracture with a laceration >5 cm, heavy contamination, complex or segmental fracture. Type III open fracture can further be divided into three types, type III A, type III B, type III C. Type III A includes fractures with adequate bone covered in soft tissue. Type III B includes fractures with inadequate soft-tissue coverage with periosteal stripping, and the bone is exposed. Type III C includes fractures with vascular injury, arterial injury that necessitates repair, regardless of the degree of soft tissue injury.

Tibial fractures are one of the most frequent type of long bone fractures occurring in the body.[1] Open fractures are common in this bone.[2] Treatment of open tibial fractures has controversy among the orthopedic surgeons despite being very common.[3]

At present, mostly non-surgical procedures or interventional attempts are used for treatment of open tibial fractures.[4] Some of the non-surgical procedures include using casts or brace, and some of the interventional attempts include inserting of plate, intramedullary nailing and external fixators. Selection of any methods among these are reliant on the surgeon's decision and the financial status of the patients.

Reamed nailing for the treatment of open or closed tibial fractures is a common method among the North American doctors.[4] The selection of each method may differ in the developing and underdeveloped country, resulting from lack of medical instruments and low facilities.[5] A recent trend has been observed in the extensive use of external fixators like Ilizarov or AO external fixator in developing countries, but such methods have shown relatively high rates of infection and mal-union.[6] With AO external fixator, the efficacy of treatment in two studies were reported to be 20-31%.[7] Different methods for the treatment of open fracture shaft tibia (after debridement and open reduction) include POP cast immobilization, external fixation, open reduction and plating, locked intramedullary nailing.

According to Trafton, complications include deep infection, acute or chronic osteitis or osteomyelitis, delayed union, non-union, mal-union, loss of alignment in cast or brace, fixation problems.[11] Gavril A. Ilizarov, a Russian physician, devised this method of treatment of open fractures of tibia. The Ilizarov ring accepts trans-fixional K-wire or haft pins, which can be attached to the ring's numerous holes. It has two or more interconnected rings that make up the equipment' frame. The rings bear the additional parts of the frame essential for the dynamic bone treatment.[12] They are essentially elastic external fixators that allow axial micro-motion that is conducive to fracture healing and regeneration.

The circular fixator's forces act in a plane. It is a fixator with multiple levels and planes. The Ilizarov circumferential rings disseminate stresses more evenly across fracture or osteotomy sites. Therefore, three dimensional corrections become possible. Gradual mechanical techniques allow for axial distraction, compression, angular, and translational corrections. A circular fixator, on the other hand, is a stable and elastic fixator. These fixators enable immediate weight bearing and function. The holes are small since the wires are thin. Circular fixators can perform three-dimensional corrections.

The Ilizarov devices can control shear at the fracture site while also allowing for axial and bending flexibility, creating an ideal environment for bone healing. Wire stoppers increase the system's shear rigidity. Circular fixators are preferable to wire fixators for patients with osteoporosis. The purpose of this study was to assess the Ilizarov Technique in the treatment of open tibial fractures.

Objectives

General objective

The objective of the study was to evaluate the Ilizarov external fixator in the treatment for open comminuted fractures in different parts of tibia.

Specific objectives

The specific objectives of the study were (a) to assess the fracture patterns of tibial fractures; and (b) to assess the types and locations of tibial fractures.

METHODS

This was an observational prospective study. This study was carried out in the department of orthopaedics, Centre for women and child health, Ashulia, Dhaka, Bangladesh during the period from January 2019 to June 2021. In total 30 patients with tibial fractures were selected as the study population. Before starting the intervention, the written consent of the participants was taken and this study was approved by the ethical committee of the respective medical college. SPSS software was used to analysis data.

According to the exclusion criteria patients with closed fracture, pathological fractures and type IIIC fractures were rejected h. The fractures were assessed by AP and lateral X-ray. Fractures were classified according to Gustilo's fracture classification of open fractures. Patients with compound tibial fractures were taken to the operating room for debridement as soon as possible. These fractures were managed provisionally in long leg posterior slab or long leg posterior cast with a window for dressing changes. Necessary fluids and electrolytes replacement or whole blood transfusion were given as per requirement of each patient.

Definitive treatment of fracture was done as routine case usually in a week. Patients were operated under general or spinal anaesthesia as per need. Pre-assembly of the frame was done one day prior to surgery. Distance between the rings was adjusted according to the fracture anatomy. Fracture with minimal comminution and length loss less than 1cm was usually managed with a four-ring frame, more complex fracture needed more number of rings. Wires were fixed to the rings with ring fixator bolt after tensioning up to 90-110 kg using a dynamometer.

The rings were kept 2 finger breadths from skin all around. Reduction was checked with C-arm image intensifier on the table and adjustments done according at the same setting. The pin tract wounds were dressed by povidone

iodine solution (10%) and covered with pad. Pin site was cleaned everyday with spirit or povidone iodine (10% solution). When clot and crust was present, weak solution of hydrogen peroxide (H_2O_2) was applied to remove it. When pin tract wound was inflamed or discharge was present, oral antibiotics were given. Partial weight bearing with axillary crutch was allowed as soon as the patient could tolerate the pain. The frame and wire were checked whenever the patients complained of pain, stability. Tension of the wire was checked and tensioning was done as per need.

Check X-ray was taken on first or second postoperative day and reduction was checked. Equines deformity was prevented by active and passive movement of ankle. If ankle movement was painful, foot was supported with a slipper or boot cast tied to the last ring. The patients were followed up at an interval of 2 weeks for a minimum period of 8 weeks, thereafter every month for 3 months and subsequently 3 monthly till a period of 1 year. Check-radiographs were taken on the next day and then at 6th week, 12th week and 36th week.

The patients were assessed clinically for the range of movement of the knee and ankle respectively, pain at the fracture site, anterior knee pain, ankle joint symptoms, infection, muscular atrophy, clinical union, difficulty in walking and performing daily routine. Frames were removed after clinico-radiological union. The fracture was regarded to be united (1) if the patient could walk without support after loosening the frame crossing the fracture site and not tender at fracture site (2) if there was no mobility at fracture site after loosening the frame and (3) radiologically, if there was enough callus across the fracture site and obliteration of the fracture line. The frame was removed at the out-patient's department or in the operation theatre once the fracture was united. If the frame was removed before the union of fracture due to superficial infection or frame intolerance patellar tendon bearing POP cast was applied. At the end of follow-up period, the results were grouped into excellent (20), good (7), fair (2) and poor (1) using modified criteria of Karlstrom and Olerud.

RESULTS

In our study among total 30 participants 80% were male and 30% were female. So male dominance was observed in this study. In age distribution, we found 43.3% form 18-30 years' age group, which was the highest number. This ratio was followed by 36.7% in the 31-40 years' age group, 10% from 41-50 years' age group, 6.7% from 51-60 years' age group and rest 3.3% from over 6o year of age group. According to the data, highest (46.7%) participants had type II open fracture followed by 36.7% with type I open fracture and remaining 16.7% with type III A open fracture.

On the other hand, among total 30 participants, highest number of patients (66.7%) had middle location fractures followed by 20% who had proximal location and rest 13.3% who had distal location fracture. Among total study population highest 56.7% patients had right side open fracture whereas 43.3% had left side open fractures. In analyzing mode of injuries, we found highest 86.7% participants had injuries from road accidents, followed by 10% from sports injury and rest only 3.3% from general falls. The duration of treatment with the fixator was 12-23 weeks (average 16 weeks). Fourteen patients wore a PTB cast for an additional period of 4 weeks. In our study total 30 cases were debrided on the same day and stabilized with Ilizarov ring fixator after a period of 5 to 12 days from the date of injury. The operation time ranged from 90 minutes to 120 minutes (mean 102±4 minutes).

The Ilizarov external fixator was withdrawn when there was clinico-radiological union. The duration of treatment with the fixator ranged from 12 to 22 weeks (Mean 16±3 weeks). The time to union varied from 21 to 28 weeks (average 24.5 weeks). The average time of union was 21 weeks for type I open fractures, 22.5 weeks for type II open fractures and 27 weeks for type IIIA open fractures. The complications of compound fracture of tibia with Ilizarov ring fixator were broadly divided into intra-operative, post-operative and delayed complications. There was no intraoperative complication.

As for the postoperative complications, local pain with motion and local oedema were seen in 4 cases (13.3%) and painful tenting of skin in 6 cases (20%). Delayed complications included pin tract infection in 7 (23.3%) patients, loss of 80 ankle dorsiflexion in 3 (10%) cases, shortening of 1 cm was seen in 2 case (6.7%), 2 cases (6.7%) of united in 70 recurvatum as calculated radiologically, 1 case (3.3%) of muscle wasting of the leg from 0.4 to 1.5 cm. No case developed deep infection, non-union or unacceptable malunion. Only one patient got 2 weeks more treatment than all the others patients.

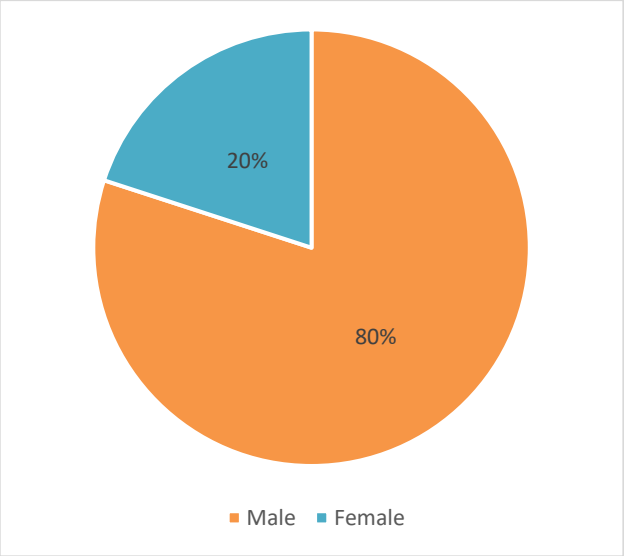

Figure 1: Gender distribution of participants, N=30.

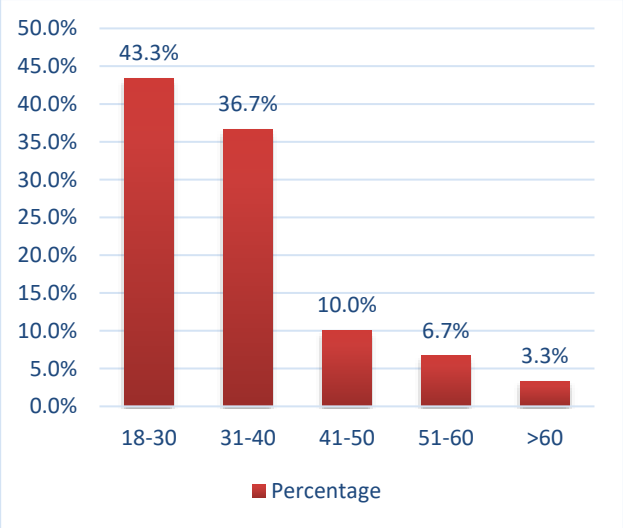

Figure 2: Age distribution of participants, N=30.

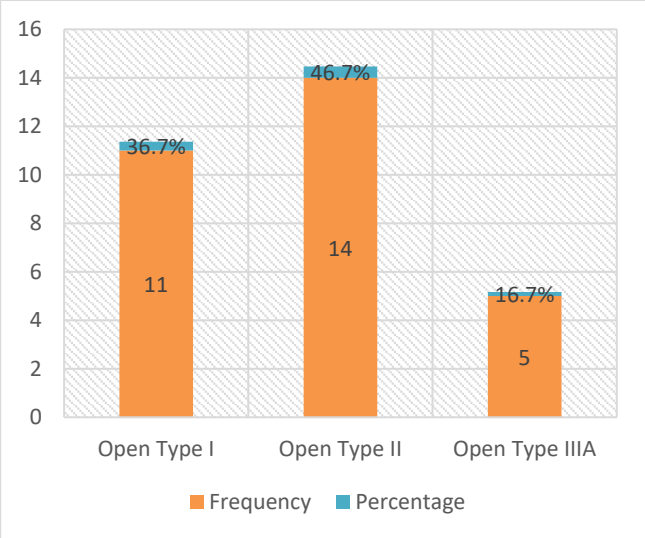

Figure 3: Distribution of types of open fractures, N=30.

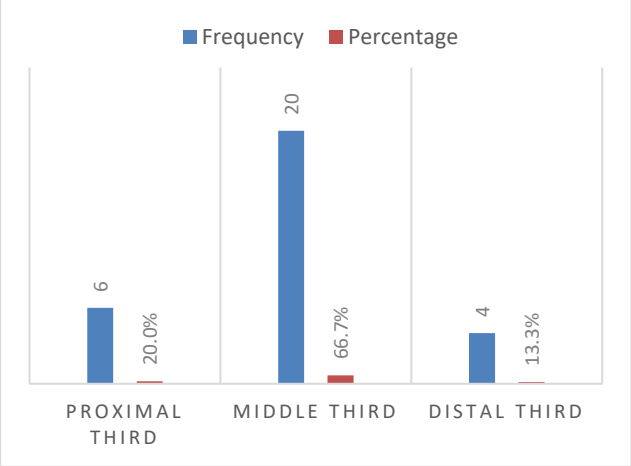

Figure 4: Distribution of locations of open fractures, N=30.

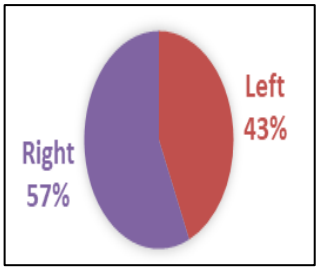

Figure 5: Distribution of sides of open fractures, N=30.

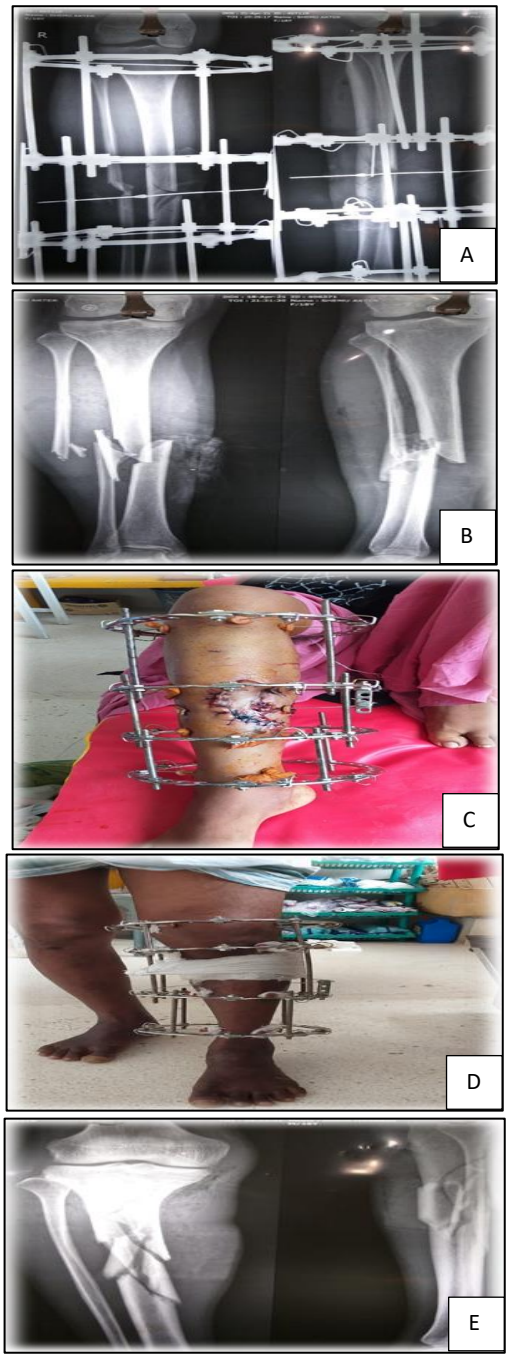

Figure 6: (A) Post-operative X-ray, (B) pre-operative X-ray, (C & D) post-operative pictures; and (E) pre-operative X-ray.

Table 1: Distribution of 'mode of injuries' of open fractures, N=30.

Mode of injury	Frequency	Percentage (%)
Road traffic accident	26	86.7
Sports injury	3	10
Falls	1	3.3
Total	30	100

DISCUSSION

There are many methods for stabilizing open tibial fractures. The problems are attributable mainly to the injury of skin, soft tissues and severity of the bone damage. In this study, the age of the patients ranged from 18 years to >65 years with mean age of 31±3 years. In our study, there were 24 (80%) males and 6 (20%) females. The sex incidence was similar to that of Tucker, Shtarker et al also reported male preponderance over female in their study.[13,14] In our study we found 66.7% had fractures in the middle third, 20% in the proximal third and 13.3% in the lower third. This finding was similar to that of Shtarker et al who reported 81.3% middle third, 15.7% proximal third and 3.1% lower third.[14] In this study out of 30 participants, there were 11 (36.7%) open type I, 46.7% open type II and 16.7% open type III A which was comparable with that of Shtarker et al.[14]

The period between admission and Ilizarov ring fixation varied from 2 to 12 days with the average of 7 days in generally. It is generally agreed that Ilizarov ring should be applied as soon as the general physical condition allowed. However, in this study Ilizarov ring fixation had to be delayed from 2 to 12 days from the date of injury because of insufficient operating days and facilities for emergency Ilizarov ring fixation. Th e average operating time varied from 90 minutes to 120 minutes. The finding was slightly lesser than that of Tucker who reported that the operating time varied from 120 minutes to 210 minutes, though later it was reduced from 1 to 1.5 hours.[13] The partial weight bearing on crutches was started on the very next day or on the 3rd day and full weight bearing after 2 to 3 weeks. This is comparable to that of Dagher and Ronkoz who reported that partial weight bearing had begun within 1st week of operation and full weight bearing after 2 to 3 weeks.[9] When using a uniplanar external fixator, Court-Brown et al postponed weight bearing until the fixator was removed.[10]

In our study, the patients were discharged from the hospital on an average on the 5th post-operative day. The average duration of hospital stay in this intervention was 12 days. Split thickness skin grafting was done in 5 cases in those who failed to heal spontaneously. In this study, the Ilizarov external fixator was removed after an average of 17 weeks (ranging from 12 to 22 weeks) which is in line with that of Shtarker et al who removed the fixators on an average of 16 weeks (ranging from 11-21 weeks).[14] In our series, the average time of clinic-radiological union was 24.5 weeks (ranging from 21 to 28 weeks). The average time of union was 21 weeks for type I open fractures, 25.5 weeks for type II open fractures and 25 weeks for type IIIA open fractures. Tucker reported the range of time to union as 12 to 47 weeks, with an average of 24.5 weeks.[13] Shtarker et al reported that the time to union was 21.5 weeks (ranging from 17.5 to 25.5 weeks).[14] Keating reported that the average time to union in reamed and unreamed locking intramedullary nailing in a series was 28 and 21 weeks for type I open fractures, respectively; 28 and 27 weeks for type II open fractures; 34 and 31 weeks for type IIIA open fractures.[15] Weight bearing, to some degree, stimulates bone healing.

Hulth reported that the current concept of fracture healing was based on two variables namely blood supply and stability.[16] In the present study, there were 8 cases (26.67%) of pin tract infection, manifested by pain, erythema and small purulent discharge around the pin sites which was controlled by oral antibiotic within 10 days. There was no case of deep infection in this study. Tuker reported approximately 10% of pin tract infection.[13] Holbrook et al evaluated 28 open tibial fractures treated with external fixation and found a 14% rate of deep infection.[17] Keating et al reported a rate of 3.3% in his series of open tibial fractures treated with locking intramedullary nailing.[15] The aim of this study was to evaluate the Ilizarov technique in the treatment of open comminuted fractures of tibia. We found some positive features of Ilizarov in treating open comminuted fractures through this study.

Limitations

It was a single centered study with a small sized sample. So, the findings of this study may not reflect the exact scenario of the whole country.

CONCLUSION

Treat the cases of open comminuted fracture is a difficult task for the physicians. In our study we found some good features of using Ilizarov induced method in the treatment of open comminuted fractures.

Recommendations

This is to recommend for conducting more studies in several places in similar arena of the treatment procedure.

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Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Cannada LK, Anglen JO, Archdeacon MT, Herscovici D, Ostrum RF. Avoiding complications in the care of

fractures of the tibia. Instr Course Lect. 2009;58:27-36.
2. Whittle AP, Wood II GW. Fractures of lower extremity. In: Canale ST, eds. Campbell's operative orthopaedics. 10th ed. Philadelphia: Campbell; 2003: 2754-2773.
3. Webb LX, Bosse MJ, Castillo RC, MacKenzie EJ. LEAP Study Group. Analysis of surgeon-controlled variables in the treatment of limb threatening type-III open tibial diaphyseal fractures. J Bone Joint Surg. 2007; 89: 923-28.
4. Petrisor BA, Bhandari M, Schmitsch E. Tibia and fibula fractures. In: Bucholz RW, Court-Brown CM, Heckman JD, Tornetta III P. Rockwood and Green's fractures in adults. 7th ed. Philadelphia: Lippincott Williams and Wilikins; 2010: 1867-1923.
5. Wani N, Baba A, Kangoo K, Mir M. Role of early Ilizarov ring fixator in the definitive management of type II, IIIA and IIIB open tibial shaft fractures. Int Orthop. 2011;35:915-23.
6. Hasankhani E, Payvandi MT, Birjandinejad A. The Ilizarov ring external fixator in complex open fractures of the tibia. Eur J Trauma. 2006;32:63-8.
7. Papaioannou N, Mastrokalos D, Papagelopoulos PJ, Tyllianaksi M, Athanassopoulos J, Nikiforidis PA. Nonunion after primary treatment of the tibia fractures with external fixator. Eur J Orthop Surg Traumatol. 2001;11:231-5.
8. Gustilo RB. Management of open fractures. In: Gustilo RB, eds. Orthopaedic Infection, diagnosis and treatment. 1st ed. Philadelphia: WB Saunders Company; 1989: 87-89.
9. Kim PH, Leopold SS. Gustilo-Anderson Classification. Clin Orthop Related Res. 2012;470(11):3270-4.
10. Ovid. Ovid: Externer Link, 2017. Available at: Ovidsp.tx.ovid.com. Accessed on 10 October 2021.
11. Trafton PG. Tibial shaft fractures. In: Browner BD, Jupiter JB, Levine AM, Krettek C, eds. Skeletal trauma: basic science, management and reconstruction. 4th ed. Philadelphia: Saunders; 1998: 2319-2451.
12. Golyakhovsky V, Frankel VH. Operative manual of Ilizarov techniques. New Delhi: Jaypee Brothers; 1986.
13. Tucker HL, Kendra JC, KInnebrew TE. Management of unstable open and closed tibial fractures using Ilizarov method. Clin Orthop Rel Res. 1992;280:125-35.
14. Shtarker H, David R, Stolero J, Grimberg B, Soundry M. Treatment of open tibial fractures with primary suture and Ilizarov fixation. Clin Orthop Rel Res. 1997;335:268-74.
15. Keating JF, Obrier PF, Blachut PA, Meck RN, Broekhuse HM. Locking intramedullary nailing with and without reaming for open fracture of the tibial shaft. J Bone Joint Surg. 1987;79:334-41.
16. Hulth A. Basic science and pathology, current concept of fracture healing. Clin Orthop Rel Res. 1989;249:265-85.
17. Holbrook JL, Swiontkowski MF, Roy S. Treatment of open fractures of tibial shaft: Ender nailing versus external fixation A randomized prospective comparison. J Bone Joint Surg. 1989;71(A):1231-38.

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