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Role of Ilizarov with Bifocal Distraction Osteogenesis in the Treatment of Grade III Open Tibia-Fibula Fracture with Bone and Soft Tissue Loss

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Abstract

Background: *Open tibia fractures with segmental bone and soft tissue loss pose significant treatment challenges due to high risks of infection, delayed healing, and nonunion. The purpose of the study was to evaluate the efficacy of Ilizarov with bifocal distraction osteogenesis in managing Grade III open tibia-fibula fractures accompanied by bone and soft tissue loss.*

Aim of the study: *The aim of the study was to evaluate the efficacy of Ilizarov with bifocal distraction osteogenesis in managing Grade III open tibia-fibula fractures accompanied by bone and soft tissue loss.*

Methods: *This retrospective study was conducted at the Department of Orthopaedics, NITOR, and BSOH, Dhaka, Bangladesh, between January 2022 and December 2023. A total of 34 patients with Grade IIIB/IIIC open tibia-fibula fractures and ≥3 cm bone loss were included. Patients underwent debridement, soft tissue coverage, and bifocal Ilizarov fixation (1.8mm wires, 1mm/day distraction). Outcomes included union, ASAMI scores, and complications, analyzed using SPSS v25.0.*

Results: *In 34 patients (mean age 37.1±14.0 years, 85.3% male) with severe open tibia-fibula fractures (82.4% IIIB, 17.6% IIIC), bifocal Ilizarov fixation achieved 100% union (mean fixation: 216.1±36.5 days). Functional outcomes were excellent/good in 91.2%, with complications limited to pin infections (41.2%), stiffness (35.3%), and refractures (23.5%). No deep infections or amputations occurred.*

Conclusion: *Ilizarov with bifocal distraction osteogenesis is a reliable and effective method for managing Grade III open tibia-fibula fractures with bone and soft tissue loss, ensuring complete union and favorable functional outcomes.*

Keywords: *Ilizarov Technique, Bifocal Distraction Osteogenesis, Grade III Open Fracture, Tibia-Fibula Fracture, Bone and Soft Tissue Loss*

1. Introduction

Open fractures of the tibia are a common injury, often leading to traumatic bone loss due to the tibia's subcutaneous location. [1]

These fractures can result in severe complications such as infection, delayed healing, and nonunion, particularly when accompanied by significant bone defects and soft tissue injury. Treating open distal tibia fractures becomes especially complex when segmental bone loss is involved, and defects exceed 4–6 cm, making conventional treatments like autografting less effective. [2] Large tibial bone defects, typically

caused by high-energy trauma, infection, or nonunion, pose a significant challenge to orthopedic surgeons.[3] Their management is further complicated by the increased risks of infection and delayed union, especially in open injuries.

Various methods have been proposed for treating complex tibial fractures with associated bone and soft tissue loss, including vascularized or non-vascularized fibular grafts, bone grafting, and internal transport using external fixators. For defects larger than 4–6 cm, internal transport via external fixation is often preferred over cancellous bone grafting due to better outcomes.[4] However, these techniques are not without limitations. High complication rates, prolonged treatment duration, technical difficulty, and a need for multiple procedures remain significant concerns.[5–10] Management of segmental tibial bone defects often requires a multidisciplinary approach, including acute shortening followed by bone lengthening,[11,12] vascularized fibular grafting, or flap transfer, tailored to the defect's size and the condition of the surrounding tissues.[13,14]

The Ilizarov technique, first developed by Gavriil Ilizarov [15] and later adopted globally, revolutionized the treatment of complex tibial fractures with bone loss.[16–18] Based on the principle of distraction osteogenesis, this method stimulates new bone formation through gradual mechanical tension. The Ilizarov approach allows simultaneous bone regeneration and soft tissue recovery, making it a valuable tool for limb salvage in severe cases. When applied after acute shortening, an Ilizarov-type circular fixator not only promotes union and realignment but also compensates for length discrepancies, all while maintaining biomechanical stability. It has proven especially effective in managing limb-threatening injuries that previously required amputation. [19]

Despite the availability of various treatment modalities, many remain limited by high complication rates and inconsistent outcomes, particularly in extensive Grade III open tibia-fibula fractures. Although the Ilizarov method has demonstrated promise, there is a lack of focused clinical evaluation on the specific role of bifocal distraction osteogenesis in this context. The aim of the study was to evaluate the efficacy of Ilizarov with bifocal distraction osteogenesis in managing Grade III open tibia-fibula fractures accompanied by bone and soft tissue loss.

2. Objective

The aim of the study was to evaluate the efficacy of Ilizarov with bifocal distraction osteogenesis in managing Grade III open tibia-fibula fractures accompanied by bone and soft tissue loss.

3. Methodology & Materials

This retrospective observational study was conducted at the Department of Orthopaedics, National Institute of Traumatology and Orthopaedic Rehabilitation (NITOR), and Bangladesh Spine & Orthopaedic Hospital (BSOH), Dhaka, Bangladesh, between January 2022 and December 2023. A total of 34 patients were included in the study, selected based on specific inclusion criteria to evaluate the role of Ilizarov fixation with bifocal distraction osteogenesis in the treatment of Grade III open tibia-fibula fractures with bone and soft tissue loss.

Inclusion Criteria

- Adults (>16 years) with Gustilo-Anderson Grade IIIB/IIIC fractures
- Bone loss ≥3 cm post-debridement
- Adequate neurovascular status (repaired if IIIC)

Exclusion Criteria

- Non-reconstructible vascular injuries (primary amputations)
- Pre-existing osteomyelitis or systemic infection
- Incomplete follow-up (<12 months)

All patients underwent radical debridement followed by early soft tissue coverage—local or free flap for Gustilo-Anderson Grade IIIB injuries and vascular repair for Grade IIIC. The Ilizarov frame was applied with proximal and distal rings using 1.8-mm tensioned wires, and metaphyseal corticotomy was performed after a latency period of 5–7 days. Distraction was initiated at a fixed rate of 1 mm/day (0.25 mm every 6 hours), and docking site compression was performed, with iliac crest bone grafting as required. Postoperative care included daily pin-site dressing, early physiotherapy to maintain joint mobility, and progressive weight-bearing from two weeks post-surgery. Clinical outcomes assessed included fracture union (radiological bridging and pain-free weight-bearing),

functional status based on ASAMI criteria, and postoperative complications such as pin tract infection, joint stiffness, and refracture. All data were recorded in a structured format and analyzed using SPSS version 25.0, with descriptive statistics (means, standard deviations, frequencies, and percentages) used to present the results.

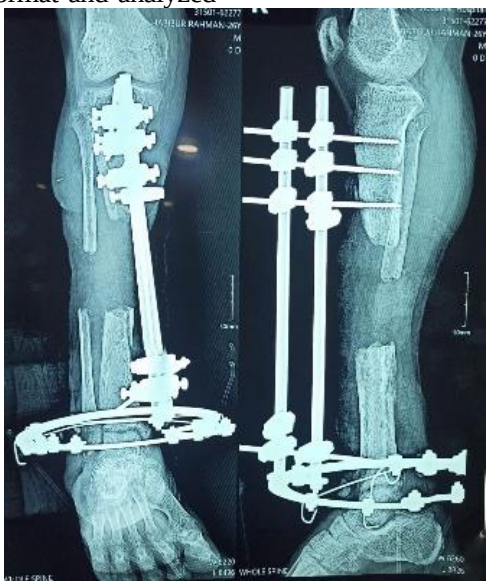

Figure 1. *Preoperative X-ray following flap coverage*

Figure 2. *Immediate postoperative X-ray after planned bifocal corticotomy*

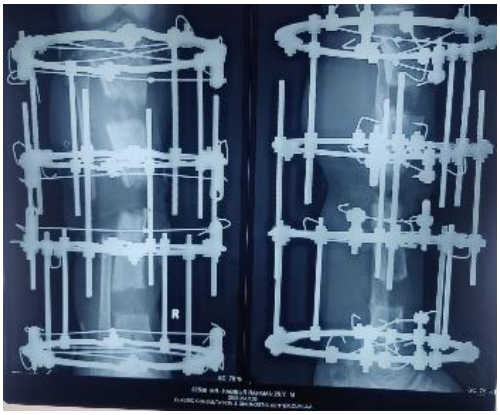

Figure 3. *Illustration of Bifocal Corticotomy Followed by Distraction Osteosynthesis Using the Ilizarov Technique*

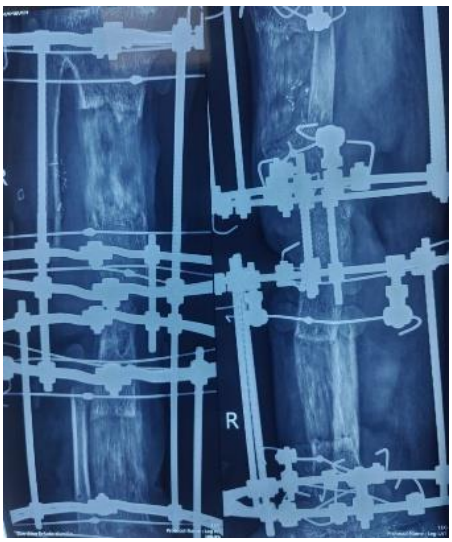

Figure 4. *X-ray Showing Bone Lengthening by Bifocal Corticotomy and Distraction Osteogenesis*

Figure 5. *X-ray Showing After Union of Fracture*

4. RESULTS

Table 1. *Demographic and Injury Characteristics of the Study Population (n = 34)*

Variable		Frequency (n)	Percentage (%)
Age Group (years)	16–25	8	23.5
	26–35	10	29.4
	36–45	7	20.6
	46–55	5	14.7
	56–65	3	8.8
	66–83	1	2.9
	Mean ± SD	37.1±14.0	
Sex	Male	29	85.3
	Female	5	14.7
Mechanism of Injury	Road Traffic Accident	29	85.3
	Fall from Height	3	8.8
	Industrial Accident	2	5.9
Fracture Grade	IIIB	28	82.4
	IIIC	6	17.6
Side injured	Right	13	38.2
	Left	21	61.8
Soft Tissue Loss	Present	28	82.4
	Absent	6	17.6

Table 1 presents data from 34 patients with a mean age of 37.1 ± 14.0 years. The majority of patients were aged 26–35 years (10 patients, 29.4%), followed by 16–25 years (8 patients, 23.5%), 36–45 years (7 patients, 20.6%), 46–55 years (5 patients, 14.7%), 56–65 years (3 patients, 8.8 marked male predominance with 29 male patients (85.3%) and 5 female patients (14.7%). Road traffic accidents were the leading mechanism of injury, accounting for 29 cases (85.3%), followed by falls from height (3 cases, 8.8%) and industrial accidents (2 cases, 5.9%). Most patients sustained Gustilo-Anderson Grade IIIB fractures (28 cases, 82.4%), while 6 patients (17.6%) had Grade IIIC fractures. The left side was more commonly affected (21 patients, 61.8%) compared to the right (13 patients, 38.2%). Soft tissue loss was present in 28 cases (82.4%), while 6 patients (17.6%) had no soft tissue loss.

Table 2. *Treatment Parameters and Outcomes of Ilizarov with Bifocal Distraction Osteogenesis (n = 34)*

Variable		Frequency (n)	Percentage (%)
Latency Period	≤ 7 days	20	58.8
	> 7 days	14	41.2
Docking Site Bone Grafting	Required	11	32.4
	Not required	23	67.6
Distraction Rate	1 mm/day (fixed)	34	100.0
Duration of External Fixation		216.1 ± 36.5 days	
Duration of Distraction Phase		52.1 ± 8.5 days	
Outcome	Fracture Union Achieved	34	100.0
	Refracture Post Frame Removal	1	2.9
	Nonunion/Amputation	0	0.0

Table 2 presents treatment parameters and outcomes for 34 patients who underwent Ilizarov fixation with bifocal distraction osteogenesis for Grade III open tibia-fibula fractures with bone and soft tissue loss. A latency period of ≤7 days was observed in 20 patients (58.8%), while 14 patients (41.2%) had a latency period >7 days. Docking site bone grafting was required in 11 cases (32.4%), while 23 patients (67.6%) did not require grafting. All patients followed a fixed distraction rate of 1 mm/day. The mean duration of the distraction phase was 52.1 ± 8.5 days, and the average duration of external fixation was 216.1 ± 36.5 days. Regarding outcomes, fracture union was achieved in all patients (100%). Refracture post-frame removal occurred in one patient (2.9%), and there were no instances of nonunion or amputation.

Table 3. *Functional Outcomes According to ASAMI Criteria (n = 34)*

Outcome Category	Frequency (n)	Percentage (%)
Excellent	27	79.4
Good	4	11.8
Fair	3	8.8
Poor	0	0.0

Table 3 presents the functional outcomes of patients assessed using the Association for the Study and Application of the Method of Ilizarov (ASAMI) criteria. Among the 34 patients treated with Ilizarov fixation and bifocal distraction osteogenesis for Grade III open tibia-fibula fractures, 27 patients (79.4%) achieved excellent functional outcomes. Good outcomes were observed in 4 patients (11.8%), while 3 patients (8.8%) had fair outcomes. Importantly, no patients were classified under the poor outcome category.

Table 4. *Postoperative Complications Observed in the Study Population (n = 34)*

Complication	Frequency (n)	Percentage (%)
Pin Tract Infection	14	41.2
Joint Stiffness	12	35.3
Refracture	8	23.5
Deep Infection	0	0.0

This table summarizes the complications encountered among 34 patients treated with the Ilizarov method and bifocal distraction osteogenesis for Grade III open tibia-fibula fractures. Pin tract infection was the most common complication, affecting 14 patients (41.2%), followed by joint stiffness in 12 patients (35.3%) and refracture in 8 patients (23.5%). Notably, no cases of deep infection were reported in the study population, indicating effective perioperative infection control measures.

5. Discussion

This study explores the efficacy of Ilizarov fixation with bifocal distraction osteogenesis in managing Grade III open tibia-fibula fractures accompanied by bone and soft tissue loss at tertiary care centers in Bangladesh. These complex injuries, often resulting from high-energy trauma, pose significant challenges due to extensive bone loss, soft tissue compromise, and elevated risks of infection and nonunion. The findings demonstrate promising outcomes with the Ilizarov method, including a 100% union rate, acceptable complication profiles, and predominantly excellent to good functional recovery, supporting its role as a reliable limb-salvage strategy in resource-limited settings.

In our study, the mean age of participants was 37.1 ± 14.0 years, with the majority belonging to the 26–35 years age group (29.4%). These findings are consistent with those reported by Chua et al.[20], who documented a mean age of 36.5 years (range 16.4–83.4), and Jaña et al.[21], who found a similar mean age of 32.3 ± 15.7 years, reflecting the common occurrence of high-energy trauma among young adults. The gender distribution in our study showed a marked male predominance (85.3%), which aligns with previous studies such as Chua et al.[20] (91.3% male), Jaña et al. (85% male), Ibeanusi et al.[22] (male-to-female ratio of 2.5:1), and Natalwala et al.[23], all of which reported higher rates of injury among males. This trend may be attributed to greater male involvement in outdoor activities, high-risk occupations, and road traffic exposure. In terms of injury mechanism, road traffic accidents accounted for the majority of cases (85.3%) in our cohort, which corresponds closely with Jaña et al., where traffic accidents were the cause in 84% of patients. The left limb was more commonly involved (61.8%) in our study, also observed in both Chua et al.[20] and Jaña et al.[21], possibly due to common pedestrian or vehicular impact patterns. Furthermore, most of our cases were classified as Gustilo-Anderson Grade IIIB (82.4%), with soft tissue loss present in 82.4%—a typical finding in such severe open fractures. The similarity of our demographic and clinical data with those in previous literature supports the external validity of our findings and reinforces the representativeness of our sample in evaluating the role of Ilizarov with bifocal distraction osteogenesis in managing complex Grade III tibia-fibula fractures.

In our study, a latency period of ≤7 days was observed in 58.8% of patients, while 41.2% had a longer delay before distraction was initiated. This contrasts slightly with the findings of Sen et al. [24], who reported a fixed latency period of 10 days in their series of bifocal distraction osteogenesis for Grade III open tibial fractures. Docking site bone grafting was required in 32.4% of cases in our cohort, reflecting the variable need for additional surgical intervention to achieve union at the docking site. A fixed distraction rate of 1 mm/day was maintained uniformly across all patients, consistent with the standard Ilizarov protocol employed by Sen et al. [24] The mean duration of the distraction phase in our study was 52.1 ± 8.5 days, while the average duration of external fixation was 216.1 ± 36.5 days (approximately 7.1 months), closely mirroring the 7.1-month fixation period reported by their study. These results underscore the effectiveness and consistency of the Ilizarov method with bifocal distraction in addressing extensive bone and soft tissue deficits associated with high-grade open tibia-fibula fractures.

Fracture union was successfully achieved in all 34 patients (100%). This outcome is in agreement with the findings of Sen et al.[24], who also reported complete union in their series using bifocal compression-distraction osteogenesis for similarly severe tibial injuries. The use of the Ilizarov technique in our study not only ensured effective management of large bone defects but also minimized complications, with only one patient (2.9%) experiencing a refracture post frame removal. Importantly, there were no cases of nonunion or amputation, further supporting the efficacy of this limb salvage approach in high-grade open fractures. These findings reinforce the consistency and reliability of the Ilizarov method in achieving favorable bone healing outcomes in challenging clinical scenarios.

In our study, functional outcomes assessed using the ASAMI criteria revealed that 27 patients

(79.4%) achieved excellent results, 4 (11.8%) had good outcomes, and 3 (8.8%) were categorized as fair, with no patients falling into the poor outcome category. These findings are comparable to those reported by Patil et al.[25], who documented excellent outcomes in the majority of their cohort (43 patients), followed by 7 good and 4 fair results, and no poor outcomes—closely mirroring the distribution observed in our study. Similarly, Sharma et al. [26] reported 62.5% excellent, 25.0% good, and 12.5% fair outcomes, reflecting a comparable trend of favorable functional recovery following Ilizarov treatment. Zhang et al. [27] also demonstrated similar results with 15 excellent, 10 good, 4 fair, and only 1 poor outcome. The high rate of excellent outcomes in our series reinforces the effectiveness of the Ilizarov technique with bifocal distraction osteogenesis in managing complex Grade III open tibia-fibula fractures, supporting its role as a reliable limb-salvage option in cases with significant bone and soft tissue loss.

In our study, the most common complication was pin tract infection, observed in 41.2% of cases, followed by joint stiffness in 35.3% and refracture in 23.5% of patients. Notably, no cases of deep infection were recorded. The incidence of pin tract infection in our cohort is slightly higher than that reported by Wadi et al.[28], who documented it in 30% of their cases, highlighting the persistent challenge of managing this known complication of the Ilizarov technique. Similarly, joint stiffness, particularly involving the ankle, was observed in 23.33% of cases in Wadi et al.'s [28] series, comparable to our finding of 35.3%. The refracture rate in our study (23.5%) was notably higher than the 3.33% reported by Wadi et al.[28] and the 16% noted by Nieuwoudt et al.[29], which may reflect variations in patient compliance, severity of initial injury, or differences in frame removal protocols. Despite these complications, the absence of deep infection in our study is encouraging and may be attributed to rigorous aseptic technique and vigilant postoperative care.

6. Limitations Of The Study

This study had some limitations:

- The sample was not randomly selected.
- The study's limited geographic scope may introduce sample bias, potentially affecting the broader applicability of the findings.

7. Conclusion

Ilizarov fixation with bifocal distraction osteogenesis was found to be highly effective in treating Grade III open tibia-fibula fractures with bone and soft tissue loss. All patients achieved fracture union, with the majority showing excellent functional recovery. Although some experienced complications such as pin tract infections, joint stiffness, and refractures, there were no cases of deep infection, nonunion, or amputation. Overall, the technique demonstrated reliable outcomes in both bone healing and limb function.

References

[1] Keating JF, Simpson AH, Robinson CM. The management of fractures with bone loss. The Journal of Bone & Joint Surgery British Volume. 2005 Feb 1; 87(2):142-50.

[2] Robinson CM, McLauchlan G, Christie J, McQueen MM. Tibial fractures with bone loss treated by primary reamed intramedullary nailing. The Journal of Bone & Joint Surgery British Volume. 1995 Nov 1;77(6):906-13.

[3] Lasanianos NG, Kanakaris NK, Giannoudis PV. Current management of long bone large segmental defects. Orthopaedics and Trauma. 2010 Apr 1; 24(2):149-63.

[4] Dagher F, Roukoz S. Compound tibial fractures with bone loss treated by the Ilizarov technique. The Journal of Bone & Joint Surgery British Volume. 1991 Mar 1; 73(2):316-21.

[5] Atkins RM, Madhavan P, Sudhakar J, Whitwell D. Ipsilateral vascularised fibular transport for massive defects of the tibia. The Journal of Bone & Joint Surgery British Volume. 1999 Nov 1; 81(6):1035-40.

[6] Gordon L, Chiu EJ. Treatment of infected non-unions and segmental defects of the tibia with staged microvascular muscle transplantation and bone-grafting. JBJS. 1988 Mar 1; 70(3):377-86.

[7] Shepherd LE, Costigan WM, Gardocki RJ, Ghiassi AD, Patzakis MJ, Stevanovic MV. Local or free muscle flaps and unreamed interlocked nails for open tibial fractures. Clinical Orthopaedics and Related Research®. 1998 May 1; 350:90-6.

[8] Lenoble E, Lewertowski JM, Goutallier D. Reconstruction of compound tibial and soft tissue loss using a traction histogenesis technique. Journal of Trauma and Acute Care Surgery. 1995 Aug 1; 39(2):356-60.

[9] Aronson J. Current concepts review-limb-lengthening, skeletal reconstruction, and bone transport with the Ilizarov method. JBJS. 1997 Aug 1; 79(8):1243-58.

[10] Shtarker H, David R, Stolero J, Grimberg B, Soudry M. Treatment of open tibial fractures

with primary suture and Ilizarov fixation. Clinical Orthopaedics and Related Research®. 1997 Feb 1; 335:268-74.

[11] Donnan LT, Saleh M, Rigby AS. Acute correction of lower limb deformity and simultaneous lengthening with a monolateral fixator. The Journal of Bone & Joint Surgery British Volume. 2003 Mar 1; 85(2):254-60.

[12] Rozbruch SR, Weitzman AM, Watson JT, Freudigman P, Katz HV, Ilizarov S. Simultaneous treatment of tibial bone and soft-tissue defects with the Ilizarov method. Journal of orthopaedic trauma. 2006 Mar 1; 20(3):194-202.

[13] Lin KC, Tarng YW, Hsu CJ, Renn JH. Free non-vascularized fibular strut bone graft for treatment of post-traumatic lower extremity large bone loss. European Journal of Orthopaedic Surgery & Traumatology. 2014 May; 24:599-605.

[14] Yokoyama K, Itoman M, Nakamura K, Tsukamoto T, Saita Y, Aoki S. Free vascularized fibular graft vs. Ilizarov method for post-traumatic tibial bone defect. Journal of reconstructive microsurgery. 2001; 17(01):017-26.

[15] Ilizarov GA. Clinical application of the tension-stress effect for limb lengthening. Clinical Orthopaedics and Related Research (1976-2007). 1990 Jan 1; 250:8-26.

[16] El-Gammal TA, El-Sayed AM, Kotb MM. Hypertrophy after free vascularized fibular transfer to the lower limb. Microsurgery. 2002; 22(8):367-70.

[17] Jordan DJ, Malahias M, Khan W, Hindocha S. The ortho-plastic approach to soft tissue management in trauma. The open orthopaedics journal. 2014 Oct 31; 8:399.

[18] Wu Y, Yin Q, Rui Y, Sun Z, Gu S. Ilizarov technique: bone transport versus bone shortening-lengthening for tibial bone and soft-tissue defects. Journal of Orthopaedic Science. 2018 Mar 1; 23(2):341-5.

[19] Biz C, Crimì A, Fantoni I, Vigo M, Iacobellis C, Ruggieri P. Functional outcome and complications after treatment of comminuted tibial fractures or deformities using Ilizarov bone transport: a single-center study at 15-to 30-year follow-up. Archives of Orthopaedic and Trauma Surgery. 2021 Nov; 141:1825-33.

[20] Chua W, Murphy D, Siow W, Kagda F, Thambiah J. Epidemiological analysis of outcomes in 323 open tibial diaphyseal fractures: a nine-year experience. Singapore Med J. 2012 Jun 1; 53(6):385-9.

[21] Jaña Neto FC, Canal MD, Alves BA, Ferreira PM, Ayres JC, Alves R. Analysis of the characteristics of patients with open tibial fractures of Gustilo and Anderson type III. Revista Brasileira De Ortopedia. 2016 Mar; 51:143-9.

[22] Ibeanusi SE, Ekere AU. Epidemiology of open tibial fractures in a teaching hospital. Port Harcourt Med J. 2007 Aug 16;3(1):156-60.

[23] Natalwala I, Chuo CB, Shariatmadari I, Barlow G, Moulder E, Bates J, Sharma H. Outcomes and incidence of deep bone infection in grade III diaphyseal open tibial fractures: circular fixator vs intramedullary nail. Strategies in trauma and limb reconstruction. 2021 Sep;16(3):161.

[24] Sen C, Kocaoglu M, Eralp L, Gulsen M, Cinar M. Bifocal compression-distraction in the acute treatment of grade III open tibia fractures with bone and soft-tissue loss: a report of 24 cases. Journal of orthopaedic trauma. 2004 Mar 1;18(3):150-7.

[25] Patil MY, Gupta SM, KuruPati SK, Agarwal S, Chandarana V. Definitive management of open tibia fractures using limb reconstruction system. Journal of clinical and diagnostic research: JCDR. 2016 Jul 1;10(7):RC01.

[26] Sharma AK, Sharma J. Role of distraction compression Osteogenesis by Ilizarov ring fixator in complex non-union of long bones. Indian Journal of Orthopaedics Surgery. 2017; 3(1):1-5.

[27] Zhang Y, Wang J, Jiao B, Feng D, Li Z. Analysis of functional outcomes and complications of tibial bone defects treated with Ilizarov bone transport technique. BMC Musculoskeletal Disorders. 2025 Feb 25;26(1):198.

[28] Wadi DMKS, Garg DS, Singh DL, Ramneet D. Complications with Ilizarov ring fixator in open tibial fracture. Int J Orthop Sci. 2021;7(2):359–63.

[29] Nieuwoudt L, Ferreira N, Marais LC. Short-term results of grade III open tibia fractures treated with circular fixators. SA Orthopaedic Journal. 2016 Sep;15(3):20-6

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