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ORIGINAL ARTICLE

Frequency of complications of Bone transport technique using the ilizarov method in the lower extremity.

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ABSTRACT… Objectives: To evaluate the frequency of complications in patients treated with the Ilizarov bone transport technique for lower extremity reconstruction. **Study Design:** Prospective study. **Setting:** Ghurki Trust Teaching Hospital, Lahore. **Period:** October 25, 2024, to January 25, 2024. **Methods:** Including 75 patients meeting the inclusion criteria. Ethical approval was obtained, and informed consent was secured from all participants. Patient demographics, injury characteristics, and complication details were recorded. Data were analyzed using SPSS version 26, with chi-square tests for stratified comparisons. Statistical significance was set at $p \leq 0.05$. **Results:** Among the 75 patients (mean age 37.55±13.76 years), 64% were male, and 36% were female. The most common complication observed was pin tract infection, which occurred in 37.3% of patients. This was followed by joint stiffness in 21.3%, limb discrepancy in 17.3%, and malalignment in 12.0%. Refracture occurred in 4.0% of patients, while recurrent infection was not reported in any cases. Amputation was observed in 2.7% of patients. Age was significantly association with the rate of complications. **Conclusion:** For reconstructing the lower extremities, the Ilizarov bone transfer technique works well, although it has a significant risk of complications, especially pin-site infections. Preventive measures and careful observation are necessary to reduce these risks and enhance treatment results. Future research should concentrate on improving surgical methods and postoperative care to improve patient recovery.

Key words: Ilizarov Technique, Bone Transport, Lower Extremity Reconstruction, Complications, Pin-site Infection, Limb Salvage.

INTRODUCTION

Open and comminuted fractures of the lower limbs brought on by high-energy and severe trauma are examples of complex surgical situations. Necrosis and infection of the bone and soft tissues, as well as severe deformities or damage to the soft tissues in the periphery, are frequently present with these fractures. Amputation could be the only option for covering and reconstructing missing bone and soft tissue. Finding effective reconstructive techniques is, therefore, essential to save the limb. The basic concept of soft tissue covering with osseous repair requires surgeons to choose a limb-salvage strategy that might improve the patient's standard of life.[1]

Orthopaedic surgeons and patients have significant difficulty when treating extensive bone defects in the lower limbs that result from trauma, developmental abnormalities, tumor removal, or osteomyelitis.[2] Various surgical techniques have been offered to treat bone defects[3], and the Ilizarov method-based bone transfer technique is a commonly used approach in reconstructive surgery. The Ilizarov method is the primary treatment option for reconstructing bone defects because it is quick, easy, efficient, and minimally invasive, and it preserves the biomechanical microenvironment required for fracture healing. It focuses on the biology of the bone and the ability of the soft tissues around it to heal when under stress.[4]

Although the bone transfer technique has been

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widely utilized to cure bone defects, other treatments that are also commonly employed include joint contracture correction, misalignment correction, and rebuilding of the bone defect together with soft-tissue covering.[5] Numerous research has shown the inevitable challenges and consequences of the Ilizarov method of bone translocation. These complications remain a significant concern and could affect clinical outcomes.[6-7]

In a similar research, Liu et al.[8] found that the most common problems were delayed union of the docking site (13.48%), soft tissue imprisonment (22.34%), joint stiffness (23.76%), axial deviation (40.78%), and pin-site infection (65.96%).

According to the results of a related study by Aktuglu et al.[9], pin tract infection (PTI) was the most frequent consequence. It occurred 46.6% of the time. PTI was 25% more likely to be followed by joint stiffness. The corresponding rates for amputation, infectious recurrence, malunion, and fracture were 4%, 8.4%, 4.58%, and 1%.

In another study conducted by Xie et al.[10], the complications were seen as pin site infection (55.40%), refracture (2.53%), limb discrepancy (18.67%), malalignment (10.87%), joint stiffness (25.63%), recurrent infection (2.44%) and amputation (1.23%).

Due to the scarcity of literature and lack of local studies on this topic, this study will provide evidence to help us generate evidence-based medicine for our population. This study aims to fill the knowledge gap in the literature on the risks associated with the Ilizarov method of bone transfer for lower extremity repair. By focusing on the risks commonly associated with this procedure, such as pin-site infection, limb discrepancy, refracture, and joint stiffness, the study seeks to inform both medical professionals and patients. Understanding these risks enables more informed decision-making and enhances preoperative and postoperative protocols. This research highlights the importance of continuously refining surgical techniques and improving patient care.

METHODS

This prospective study was performed at the Department of Orthopaedics & Spine Centre, Ghurki Trust Teaching Hospital, Lahore, after obtaining Ethical approval from the Hospital Ethical Committee (No.2024/05/R-18-01-05-24) of Ghurki Trust Teaching Hospital. The study duration was October 25, 2024, to February 25, 2024. Seventy-five patients were enrolled in the study. Written informed consent was taken from each patient. A demographic profile, including registration number, age, gender, and place of residence, was recorded. The surgical procedure was carefully planned using standard anteroposterior (AP) and lateral radiographs of the affected limb. A comprehensive evaluation was performed to identify any surgical contraindications, and the wound was thoroughly debrided under either general or epidural anesthesia.

All existing hardware was extracted before initiating bone transport, and necrotic or infected bone and compromised soft tissue underwent extensive debridement. When required, an antibiotic-loaded cement spacer was placed to enhance structural stability. In infection cases, surface secretions and deep tissue samples were collected for bacterial culture and drug sensitivity analysis to guide subsequent antimicrobial therapy. Cortical bleeding was considered an indicator of bone viability. Minor soft tissue defects were managed with local tissue flaps or tension-free sutures, while more extensive wounds required flap transfers or free skin grafting. Bone transport only started once clinical signs and laboratory results confirmed the infection had resolved.

The choice of external fixator depended on the bone and soft tissue loss location, the surgeon's expertise, and patient preferences. To preserve the periosteum, a minimally invasive Gigli saw osteotomy was performed. A double-level bone transport procedure was implemented in cases where bone loss exceeded 8 cm or accounted for more than 40% of the original bone length. Strict pin-site care was maintained, and intravenous antibiotics were managed for at least six weeks until ESR and CRP levels were normal,

as determined by bacterial culture and drug sensitivity testing.

Early mobilization was encouraged, with passive knee and ankle exercises starting on the second postoperative day to facilitate partial weight-bearing. Bone transport was initiated within 7–10 days post-surgery. However, the procedure commenced only after complete healing for patients who underwent flap transfers, typically within 2–3 weeks. The bone fragment was advanced at 0.25 mm four times daily in single-level transport. For double-level transport, when both fragments moved in the same direction (proximal to distal), the fragment closer to the defect was transported at 0.5 mm four times daily, while the distant fragment moved at 0.25 mm per session. When fragments moved in opposite directions, each side of the defect was advanced at 0.25 mm four times daily. Adjustments to the transport rate were made based on a radiographic assessment of the newly forming bone. The external fixator was removed once radiographs confirmed union at the docking site and at least three continuous cortices at the lengthening site. To minimize the risk of refracture, all patients were fitted with a functional brace for 4–6 weeks after fixator removal.

All surgeries were performed by a single consultant orthopedic surgeon (≥15 years of experience), and all postoperative complications were observed by a single resident (the candidate himself) to eliminate bias. Exclusion criteria controlled confounding variables.

All data were using SPSS software version 26. Mean and standard deviation (±SD) were calculated for numerical variables such as age and duration of injury. Frequencies and percentages were used to represent qualitative variables such as gender, side, and complications. Data were stratified for age, gender, side, and duration of injury to assess effect modification. A chi-square test was applied. All p-values ≤ 0.05 were deemed statistically significant.

RESULTS

Characteristics	N(%)	Mean±SD Range
Gender		
Male	48(64.0)	
Female	27(36.0)	
Age(years)		37.55±13.76 (14-64)
Side		
Left	44(58.7)	
Right	31(41.3)	
Injury (days)		31.05±17.94 (1-60)

Table-I. Demographic characteristics of patients (n=75)

Complications	Yes	No
Pin Tract Infection	28(37.3)	47(62.7)
Refracture	3(4.0)	72(96.0)
Limb Discrepancy	13(17.3)	62(82.7)
Malalignment	9(12.0)	66(88.0)
Joint Stiffness	16(21.3)	59(78.7)
Recurrent Infection	-	75(100.0)
Amputation	2(2.7)	73(97.3)

Table-II. Complications in our study

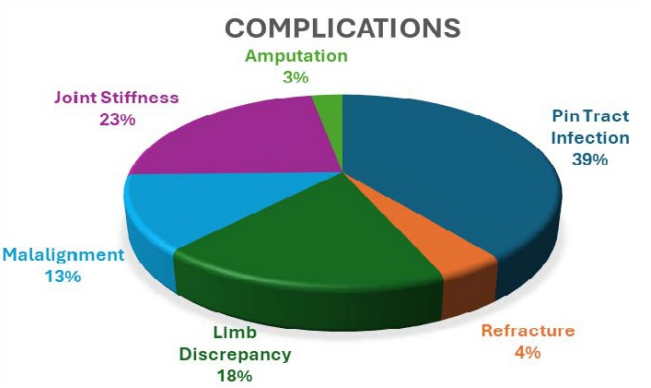

Figure-1: Frequency of complicaiton of Bone transport

The study included 75 patients, with a predominance of males (64%, n=48) and females (36%, n=27). The mean age of the patients was 37.55±13.76 years, with ages ranging from 14 to 64 years. The left side was affected in 58.7% (n=44) of cases, while the right side was involved in 41.3% (n=31). The average time from injury to treatment was 31.05±17.94 days, with a range of 1 to 60 days (Table-I).

Gender	Male		Female		P-Value
	Yes	No	Yes	No	
Pin Tract Infection	18(37.5)	30(62.5)	10(37.0)	17(63.0)	.968
Refracture	3(6.3)	45(93.8)	-	27(100)	.549
Limb Discrepancy	10(20.8)	38(79.2)	3(11.1)	24(88.9)	.355
Malalignment	7(14.6)	41(85.4)	2(7.4)	25(92.6)	.475
Joint Stiffness	11(22.9)	37(77.1)	5(18.5)	22(81.5)	.655
Amputation	2(4.2)	46(95.8)	-	27(100.0)	.533
Age(years)	14-35		36-64		
Pin Tract Infection	7 (18.9%)	30 (81.1%)	21 (55.3%)	17 (44.7%)	.001
Refracture	-	37(100.0)	3(7.9)	35 (92.1%)	.081
Limb Discrepancy	4(10.8)	33(89.2)	9(23.7)	29 (76.3%)	.141
Malalignment	1 (2.7%)	36 (97.3%)	8 (21.1%)	30 (78.9%)	.014
Joint Stiffness	6 (16.2%)	31 (83.8%)	10 (26.3%)	28 (73.7%)	.286
Amputation	-	37(100.0)	2(5.3)	36(94.7)	.493
Side	Right		Left		
Pin Tract Infection	19(43.2)	25(56.8)	9(29.0)	22(71.0)	.212
Refracture	1(2.3)	43(97.7)	2(6.5)	29(93.5)	.566
Limb Discrepancy	10(22.7)	34(77.3)	3(9.7)	28(90.3)	.142
Malalignment	5(11.4)	39(88.6)	4(12.9)	27(87.1)	1.000
Joint Stiffness	9(20.5)	35(79.5)	7(29.0)	24(77.4)	1.000
Amputation	1(2.3)	43(97.7)	1(3.2)	30(96.8)	1.000
Injury (days)	1-30		>30		
Pin Tract Infection	15(38.5)	24(61.5)	13(36.1)	23(63.9)	.833
Refracture	3(7.7)	36(92.3)	-	36(100.0)	.241
Limb Discrepancy	5(12.8)	34(87.2)	8(22.2)	28(77.8)	.283
Malalignment	6(15.4)	33(84.6)	3(8.3)	33(91.7)	.483
Joint Stiffness	10(25.6)	29(74.4)	6(16.7)	30(83.3)	.343
Amputation	2(5.1)	37(94.9)	-	36(100.0)	.494

Table-III. Comparison of complications concerning the demographic profile of patients

Complications observed in the study included pin tract infection (37.3%, n=28), refracture (4%, n=3), limb discrepancy (17.3%, n=13), malalignment (12%, n=9), joint stiffness (21.3%, n=16), and amputation (2.7%, n=2). Notably, no recurrent infections were recorded (Table-II).

When comparing complications based on demographic factors, no statistically significant differences were found between males and females, as all p-values were greater than 0.05. However, there was a significant relationship between age and pin tract infection (p=0.001), with patients aged 36-64 years showing a higher prevalence of disease compared to those aged 14-35 years. Additionally, malalignment was more frequent in older patients (21.1%) than in younger patients (2.7%), with a statistically significant p-value of 0.014. Other complications, such as refracture, limb discrepancy, joint stiffness, and amputation, did not exhibit substantial differences across age groups.

Regarding the side of injury, while more cases of pin tract infection occurred in patients with right-sided injuries (43.2%) compared to those with left-sided injuries (29.0%), this difference was not statistically significant (p=0.212). Other complications, did not show significant associations with the affected side of the injury.

In terms of the time between injury and treatment, patients who received treatment within 30 days had a significantly higher rate of pin tract infection (55.3%) compared to those treated after 30 days (18.9%) (p=0.001). However, other complications such as refracture, limb discrepancy, malalignment, joint stiffness, and

amputation did not demonstrate statistically significant associations with injury treatment duration (p-values >0.05).

DISCUSSION

The results of this study provide good insight into the incidence of complications and types related to bone transport in lower limb reconstruction through the Ilizarov method. Results were aligned with previous studies indicating inherent challenges in this procedure, but on the other hand, offered a local perspective that contributes to existing evidence.

The study's results, which showed a lower incidence of 37.3% of pin-site infections, are consistent with previous research showing that pin-site infection is the most common complication following Ilizarov surgeries. According to research, the three most common problems were delayed union in 50 instances (25.13%), axial deviation in 86 cases (43.2%), and pin tract infection in 48 cases (61.3%).[2] The necessity of strict postoperative care and monitoring, together with the application of preventative measures to reduce this risk, is highlighted by this high infection rate.[11,12]

The study also found that 21.3% of patients experienced joint stiffness, a problem described in earlier studies with rates ranging from 23.76% to 60%. According to different research, the top five issues were delayed union of the docking site (13.48%), soft tissue imprisonment (22.34%), joint stiffness (23.76%), axial deviation (40.78%), and pin-site infection (65.96%).[8,10] Because joint stiffness can seriously delay functional recovery and quality of life, early mobilization and rehabilitation regimens after surgery are crucial.[13] Further complicating the clinical picture are limb length disparity (18.7%) and malalignment (12.0%), which might result in long-term functional impairments and require further surgical procedures. In contrast to earlier studies showing refracture rates as high as 4% to 8.4%, the reported refracture rate of 1.3% is minimal.[1,8] This implies that reducing these problems requires careful surgical planning and patient selection, even if the Ilizarov procedure works.

The duration of injury and the incidence of pin-site infections were not significantly correlated (p >.05). This result does not align with other studies showing that postponing treatment might increase the risk of infection and other consequences.[14] To maximize results and limit complication rates, the implications of this connection underscore the need for prompt intervention in managing severe lower extremity injuries.

The complication rates in this study are within the predicted range compared to previous studies. This supports the idea that although the Ilizarov procedure is a valuable tool for limb salvage, it is not without difficulties. The results of this investigation are similar to those of a large cohort in which Liu et al. reported a pin-site infection rate of 65.96%.[8] Joint stiffness and malalignment rates are comparable to those described in the literature, suggesting that these issues are prevalent in many patient groups and environments.[15]

The findings of this study demonstrated that younger individuals experienced fewer issues than older people; these findings are consistent with a study by Lui et al.[8] that found younger patients with smaller tibial defects experienced fewer pin tract problems.

May et al. found that there was a 59% incidence of complications, 5% malunion, 1.3% deep infection, and 6.5% persistent pin-site infection after frame removal.[16] With a rate ranging from 10% to 100% across the studies examined in a recent comprehensive review, pin-track infection is the most frequent side effect of utilizing Ilizarov techniques.[17] Our experience.[18,19] leads us to assume that this complication is so prevalent in Ilizarov bone transport that it may be regarded as an inevitable aspect of the procedure. We, therefore, decided to exclude it from the list of sequelae noted during the lengthy follow-up.

Numerous factors, including the sample size, systemic aspects of patients, and individualized therapies, influence this study. To more accurately assess the clinical efficacy, a longer follow-up period is required. Neither a comparison study

with other surgical techniques nor a thorough discussion of the pertinent influencing factors were included in this early examination of the treatment outcomes. Therefore, to further validate the results, large, high-quality multicenter randomized controlled trials are required.

CONCLUSION

Ultimately, the Ilizarov method of bone transfer is a successful strategy for reconstructing the lower extremities, according to our results. Still, it has several drawbacks, including delayed union, axial deviation, pin-site infection, and joint stiffness. Our results highlight how crucial careful surgical planning, strict postoperative care, and patient education are to achieving the best possible results. Clinicians may improve the technique's safety and effectiveness and, in turn, the quality of life for patients with complicated lower extremity abnormalities by addressing these problems.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Ziarmal Khan:** Complication & framework of study.
2	**Syed Kashif Shah Bukhari:** Write drafting of paper.
3	**Bilal ud Din:** Data collection.
4	**Haseeb Elahi:** Data collection.
5	**Atif Ali:** Critical review.
6	**Berkha Rani:** Supervisor of study.