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Case report

Medial fibular transport with the Ilizarov apparatus in the treatment of infected tibial pseudarthrosis

Maksim Kovačević[1,2], Marijana Kovačević[1,2], Verica Ivanović Prodanović[1,2], Sanja Marić[1,2], Nada Avram[1,2], Aleksandar Tanović[2], Dražan Erić[2,3]

[1]University Hospital Foča, Republic of Srpska, Bosnia and Herzegovina

[2]University of East Sarajevo, Faculty of Medicine Foča, Republic of Srpska, Bosnia and Herzegovina

[3]Al Emadi Hospital, Department of Plastic and Reconstructive Surgery, Doha, Qatar

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Corresponding author:
Aleksandar Tanović, Student
Studentska bb, 73300 Foča
e-mail: acotanovic@gmail.com

Summary

Introduction. Tibial bone defects, particularly those caused by infections, represent one of the most complex challenges in orthopedics. Given the severity of complications such as limb function loss or even amputation, the need for innovative and reliable treatment methods is crucial. Medial fibular transport using the Ilizarov apparatus offers a successful solution to these problems, preserving limb functionality and integrity.

Case report. This paper presents the case of a 76-year-old patient with chronic osteomyelitis and infected tibial pseudarthrosis. Following radical debridement and sequestrum removal, a significant partial bone defect measuring 8 cm remained. Treatment was performed using medial fibular transport with the Ilizarov apparatus. The reconstruction process lasted eight months, after which complete bone consolidation, infection elimination, and restoration of limb function were achieved.

Conclusion. The medial fibular transport technique has proven to be an effective and safe method for treating large tibial defects associated with infection, enabling limb preservation and significantly improving patients' quality of life.

Keywords: fibular transport, Ilizarov, pseudarthrosis, osteomyelitis

Introduction

Pseudarthrosis of the tibia is one of the most complex conditions in the field of orthopedic surgery, especially when associated with infection. This complication is defined as the failure of bone healing within the expected time frame, typically six to nine months, resulting in permanent

instability, pain, and functional impairment. Infection further complicates the healing process by causing bone destruction, soft tissue damage, and significantly reducing the success of traditional treatment methods [1].

Tibial pseudarthrosis may arise from various factors, including:

- Inadequate fracture treatment (poor stabilization, insufficient immobilization).
- Biological factors, such as poor vascularization, the presence of infection, and decreased bone regenerative capacity.
- Systemic factors, including comorbidities such as diabetes, smoking, malnutrition, or other conditions negatively affecting bone healing [2].

When pseudarthrosis is accompanied by infection, it leads to a complex pathological condition known as infected pseudarthrosis or chronic osteomyelitis. These conditions require a multidisciplinary approach involving infection eradication, bone defect reconstruction, and restoration of the affected limb's functionality [1, 2].

Treating infected tibial pseudarthrosis presents unique challenges for several reasons:

1. The presence of infection hinders bone healing, increases the risk of infection spreading to surrounding tissues, and reduces the effectiveness of traditional treatment methods.

2. Large bone defects, often resulting from resection of infected tissue, require complex reconstruction techniques.

3. The need for bone stabilization: Achieving adequate stability in the presence of infection is crucial for treatment success but often difficult due to tissue damage and case complexity.

Traditional treatment approaches, such as internal fixation with bone grafts, are often inadequate for such cases, as infection increases the risk of graft rejection and further complications. In this context, the Ilizarov method of external fixation and distraction osteogenesis emerges as an effective solution [1, 2, 3].

Developed in the mid-20th century, the Ilizarov method represents a revolutionary approach in orthopedics, enabling simultaneous infection control and bone tissue regeneration. The fundamental principle of this technique is the gradual distraction of regenerative tissue, stimulating new bone formation. The external fixator facilitates:

- Stabilization of the affected segment.
- Removal of infected tissue through surgical debridement.
- Stimulation of bone regeneration, even in cases of large defects.

This method is particularly useful in cases of infected tibial pseudarthrosis, where classical methods often fail to achieve satisfactory results [2, 3, 4].

The aim of this study is to demonstrate the effectiveness of the Ilizarov method in treating infected tibial pseudarthrosis in patients with large bone defects. Special emphasis is placed on assessing:

- Achieving stability and eliminating infection.
- Bone regeneration and functional recovery of the limb.
- Avoiding complications typical of traditional methods.

Case Report

A 76-year-old patient was admitted to the University Hospital Foča with a history of repeated surgical interventions for osteomyelitis of the left tibia, which developed following a severe injury sustained in a traffic accident. The patient had undergone several previous operations, including debridement and grafting, but the infection persisted, leading to the development of infected pseudoarthrosis. The most recent surgical intervention aimed at eliminating the infectious focus resulted in a partial bone defect measuring 8 cm, the presence of a fistulous tract, and persistent pain (Figure 1).

The patient reported severe pulsating pain along the entire left leg, with pronounced worsening in the tibial region. Those symptoms

Figure 1. X-ray on admission to our Hospital. Signs of osteomyelitis are recorded along with signs of nonunion.

were accompanied by chronic swelling, further impairing leg functionality. The patient exhibited limited mobility, particularly in the knee joint, and experienced walking difficulty. There was also continuous drainage of seropurulent discharge through the fistulous tract at the wound site.

Laboratory findings indicated acute infection, with elevated levels of C-reactive protein (CRP) and leukocytes, suggesting an active bacterial infection. Radiographic evaluations confirmed the presence of bony sequestra, with significantly compromised stability of the bone ends, resulting in further tibial deformity and instability.

Before surgery, a comprehensive evaluation of the patient's condition was performed. The infection was clinically assessed, and laboratory tests included blood counts and cultures from fistulous tract samples to identify the pathogen and determine appropriate antibiotic therapy. Radiological assessments included X-rays and CT scans to precisely delineate the extent of bone loss and the presence of sequestra.

The preoperative plan included radical debridement of infected and necrotic tissue as the primary step to eliminate the infection and prepare for bone reconstruction. The use of the Ilizarov apparatus was planned as the reconstruction method, along with fibular transport, aiming to restore stability and preserve limb function.

Antibiotic therapy, guided by antibiogram results, was initiated preoperatively and continued throughout the postoperative period to ensure optimal infection control.

The surgical treatment was conducted in two stages:

1. Stage One – Radical debridement

In the first stage, thorough debridement was performed. All necrotic and infected tissues, including sequestrated portions of the tibia, were removed, allowing the healthy bone ends to come into contact and prepare for subsequent consolidation. After removing the devitalized tissue, the bone ends were carefully prepared.

2. Stage Two – Installation of Ilizarov apparatus and fibular transport

In the second stage, the Ilizarov apparatus was installed. The device was assembled with four rings connected by rods, ensuring stabilization of the bone fragments. After an initial period of 10 days, the process of medial fibular transport began, progressing at a rate of 1 mm per day. This facilitated the filling of the bone defect, with periosteal and endosteal layers contributing to osteogenesis. Throughout the transport process, the patient was closely monitored to prevent complications (Figure 2).

The postoperative period was challenging but successful. Over eight months, the patient achieved fracture healing with continuous monitoring. Regular radiographic evaluations tracked the progress of bone transport and regeneration.

Physiotherapy began shortly after surgery, focusing on maintaining mobility in the knee and ankle joints to prevent contractures and ensure optimal leg functionality following bone transport.

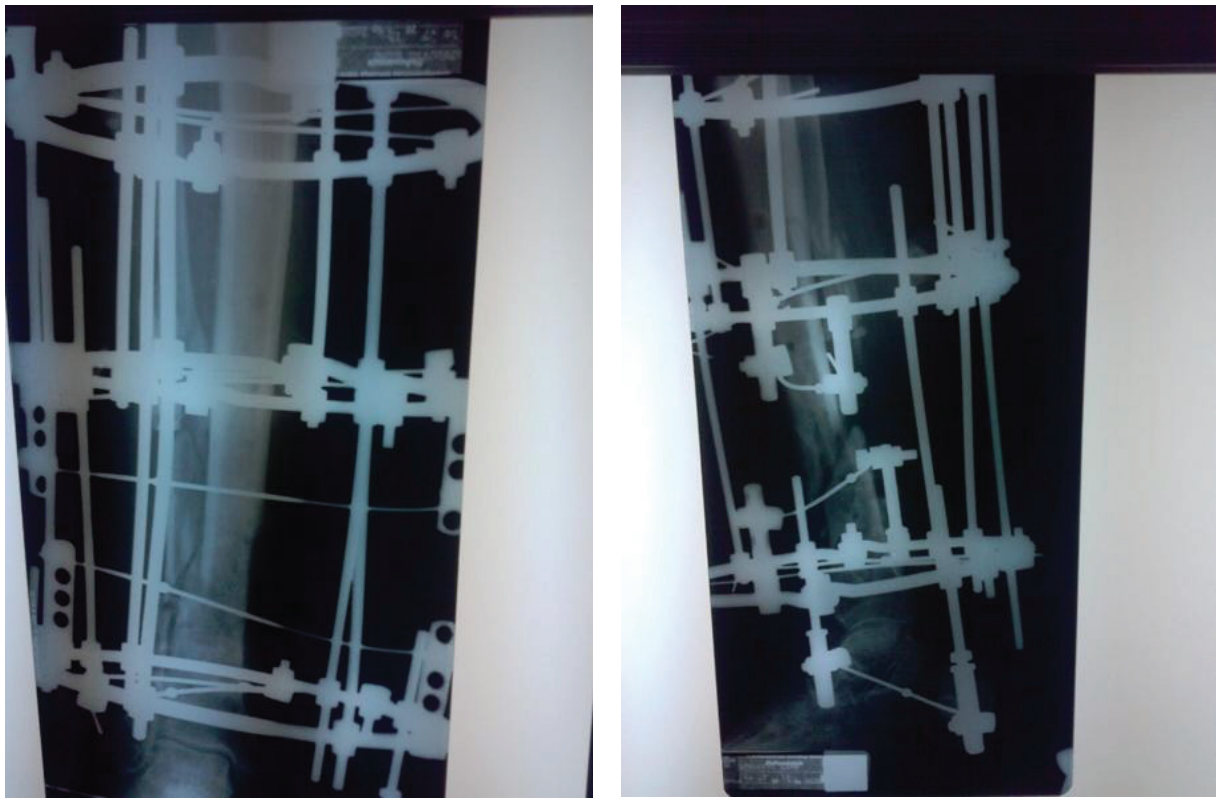

Figure 2. X-ray image two months after operation

After eight months, full bone consolidation was achieved, the Ilizarov apparatus was removed, and the patient continued rehabilitation.

Radiographs confirmed complete filling of the bone defect at the pseudoarthrosis site. Follow-up assessments six months after apparatus removal showed no signs of refracture or instability.

After the initial debridement and extended antibiotic therapy, laboratory findings demonstrated a gradual reduction in infection markers. CRP normalized within four weeks, and leukocyte counts returned to reference ranges within six weeks.

Clinically, the fistulous tract was fully closed by the third month of treatment, with no recurrence observed during one year of follow-up. Microbiological analysis of wound discharge post-intervention detected no pathogenic microorganisms.

Intensive physiotherapy preserved joint mobility in the knee and ankle. After apparatus removal, the patient was able to bear weight on the operated leg using crutches. By the sixth month post-treatment, the patient regained the ability to walk independently (Figure 3).

The AOFAS (American Orthopaedic Foot & Ankle Society) functional score of 85/100 indicated good functional outcomes with minimal limitations in daily activities. The patient reported no significant pain or need for analgesics during long-term follow-up.

The treatment course was free of major complications. Specific areas of concern included:

- Secondary infection: No secondary infections occurred throughout the treatment. Antibiotic therapy, adjusted according to antibiogram results, included broad-spectrum antibiotics followed by targeted therapy.
- Joint contractures: Physiotherapy successfully prevented joint stiffness. Full range of motion was maintained in the knee and ankle.

Figure 3. X-ray image one year after operation. Consolidation was radiographically and clinically complete. The fibula successfully replaced the tibial bone loss.

- Soft tissue issues: Minor skin irritation at pin sites was resolved with local care and adjustments to the apparatus.
- Refracture or instability: No tibial instability or refractures were observed during follow-up after apparatus removal.

The patient expressed a high degree of satisfaction with the results, citing significant improvements in stability and mobility after years of limitations and unsuccessful interventions. The ability to move independently markedly enhanced the patient's quality of life.

Follow-up radiographs after apparatus removal showed:

1. Complete filling of the bone defect,
2. Continuous and homogenous tibial structure without deformities,
3. Minimal fibular hypertrophy at the reconstruction site, which did not impair function (Figure 4).

Figure 4. Photographs taken after fracture healing

Discussion

The treatment of infected tibial pseudoarthrosis represents a significant challenge in orthopedic surgery, especially when large bone defects and chronic infections are present. This study analyzes the effectiveness of the Ilizarov method in addressing these complex issues, focusing on filling the bone defect, eliminating infection, and achieving functional recovery.

The Ilizarov method allows for bone tissue transport even in cases of large defects. In this case, a partial bone defect of 8 cm was successfully filled within eight months, aligning with existing literature. The application of the Ilizarov apparatus ensured stability, which is crucial for the bone consolidation process.

One of the main advantages of the Ilizarov method is its ability to address multiple issues simultaneously:

1. Bone transport and regeneration: Bone transport enables the filling of bone defects without the need for bone grafts, reducing risks associated with donor sites.

2. Infection elimination: By removing devitalized tissue and creating new vascular structures, distraction osteogenesis contributes to infection elimination. This case demonstrates successful infection control through targeted antibiotic use.

3. Functional rehabilitation: Thanks to the apparatus' stability, the patient could begin early mobilization, preventing joint stiffness and muscle loss [3, 4, 5, 6].

Control of chronic osteomyelitis in this case was achieved through a combination of radical debridement and extended antibiotic therapy. Clinical and laboratory findings indicated complete eradication of the infection, confirming the effectiveness of this approach. Microbiological analysis of secretions post-treatment detected no bacterial presence, a critical indicator of success. This strategy aligns with literature recommendations emphasizing the removal of all infectious agents before initiating bone defect repair [7].

While the Ilizarov method carries certain risks, complications in this case were minimal and effectively managed:

- Pin-Site infections: Local skin irritation was resolved with proper hygiene and localized antibiotic treatment. Such complications are relatively common but rarely affect the overall outcome.
- Joint stiffness: Intensive physiotherapy played a key role in maintaining full joint mobility, essential for functional recovery.
- Pain and discomfort: Although the patient reported minor discomfort during the distraction period, pain was adequately controlled with analgesics [7, 8].

The results of this case demonstrate significant functional recovery, with the patient regaining the ability to walk unaided. The AOFAS score of 85/100 indicates a high level of functionality, confirming that the Ilizarov method not only resolves pseudoarthrosis but also enables quality functional outcomes [9].

Compared to other studies, the results of this case confirm the high success rate of the Ilizarov method. Studies report success rates exceeding 90% in cases of infected pseudoarthrosis. The specificity of this case lies in the large defect length, which was successfully filled in a relatively short period.

The literature also highlights the importance of a multidisciplinary approach, including orthopedists, infectious disease specialists, and physiatrists. This case underscores the value of integrating various medical disciplines to achieve optimal outcomes [10, 11].

The main limitation of this study is its focus on a single case, which restricts the generalizability of the findings. Future studies should include larger patient cohorts and longer follow-up periods to further evaluate the durability of results and potential late complications. Additionally, the development of new biomaterials and advanced antibiotic therapies could further improve treatment outcomes [12, 13, 14, 15].

Conclusion

Medial fibular transport using the Ilizarov apparatus is an effective solution for large tibial defects caused by infections. This technique preserves the limb, eliminates the need for amputation, and significantly improves patients' quality of life. Long-term results

confirm the stability of the reconstructed segment and the absence of recurrence, establishing this method as the gold standard for reconstructing complex tibial defects.

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Ethical approval. The Ethics Committee of the University Hospital Foča, Republic of Srpska, Bosnia and Herzegovina, approved the study and informed consent was obtained from all individual respondents. The research was conducted according to the Declaration of Helsinki.

Conflicts of interest. The authors declare no conflict of interest.

References:

1. Ilizarov GA. The Tension-Stress Effect on the Genesis and Growth of Tissues. Clin Orthop Relat Res 1989;(238):249–81.
2. Paley D. Problems, Obstacles, and Complications of Limb Lengthening by the Ilizarov Technique. Clin Orthop Relat Res 1990;(250):81–104.
3. McNally M, Ferguson J, Kugan R, Stubbs D. Ilizarov Treatment Protocols in the Management of Infected Nonunion of the Tibia. J Orthop Trauma 2017;31(Suppl 5):S47–S54.
4. Sangkaew C. Distraction osteogenesis for the treatment of post traumatic complications using a conventional external fixator. A novel technique. Injury 2005;36(1):185–93.
5. Shastov AL, Mikhailov AG, Kliushin NM, Malkova TA. Limb salvage and functional recovery in infected nonunion of the distal tibia treated with the Ilizarov techniques. J Clin Orthop Trauma 2023;44:102255.
6. Motsitsi NS. Management of Infected Nonunion of Long Bones: The Last Decade (1996–2006). Injury 2008;39(2):155–60.
7. DeCoster TA, Gehlert RJ, Mikola EA, Pirela-Cruz MA. Management of Chronic Osteomyelitis and Infected Nonunion. J Am Acad Orthop Surg 2004;12(1):28–38.
8. Iacobellis C, Berizzi A, Aldegheri R. Bone transport using the Ilizarov method: a review of complications in 100 consecutive cases. Strategies Trauma Limb Reconstr 2010;5(1):17–22.
9. Schottel PC, O'Connor DP, Brinker MR. Time Trade-Off as a Measure of Health-Related Quality of Life: Long-Term Results in Patients with Infected Nonunions of the Tibia. J Bone and Joint Surg 2015;97(17):1406–10.
10. Aktuglu K, Erol K, Vahabi A. Ilizarov bone transport and treatment of critical-sized tibial bone defects: a narrative review. J Orthop Traumatol 2019;20(1):22.
11. Feltri P, Solaro L, Di Martino A, Candrian C, Errani C, Filardo G. Union, complication, reintervention and failure rates of surgical techniques for large diaphyseal defects: a systematic review and meta-analysis. Sci Rep 2022;12(1):9098.
12. Dumlao III PE, Balce GCE. Utility of Ipsilateral Medial Fibular Transport Using the Ilizarov Frame in the Treatment for Non-elderly Patients Sustaining Massive Tibial Bone Defects as a Sequela of Trauma and Infection: A Systematic Review. Acta Med Philipp 2021;55(3):328–32.
13. Szelerski Ł, Żarek S, Górski R, Mochocki K, Górski R, Morasiewicz P, et al. Surgical treatment outcomes of the Ilizarov and internal osteosynthesis methods in posttraumatic pseudarthrosis of the tibia-a retrospective comparative analysis. J Orthop Surg Res 2020;15(1):179.
14. Dhaniwala N, Jadhav S, Chirayath A, Saoji A. Ilizarov Ring Fixator in the Lower Limb for 2000 Days: A Case Report. Cureus 2023;15(8):e43891.
15. Ferreira WQ, Ferreira DJ, Fontoura RS, Peres JV, Rocha DS, Lima JPL. Treatment of Infected Pseudarthrosis of the Tibia Using the Ilizarov Method and the Orr Dressing. Rev Bras Ortop (Sao Paulo) 2023;58(4):e571–e9.

Medijalni fibularni transport sa Ilizarovljevim aparatom u liječenju inficirane pseudartroze tibije

Maksim Kovačević[1,2], Marijana Kovačević[1,2], Verica Ivanović Prodanović[1,2], Sanja Marić[1,2], Nada Avram[1,2], Aleksandar Tanović[2], Dražan Erić[2,3]

[1]Univerzitetska bolnica Foča, Republika Srpska, Bosna i Hercegovina
[2]Univerzitet u Istočnom Sarajevu, Medicinski fakultet Foča, Republika Srpska, Bosna i Hercegovina
[3]Bolnica "Al Emadi", Odjeljenje plastične i rekonstruktivne hirurgije, Doha, Katar

Uvod. Defekti tibijalne kosti, naročito oni uzrokovani infekcijama, predstavljaju jedan od najsloženijih izazova u ortopediji. S obzirom na ozbiljnost komplikacija kao što su gubitak funkcije ekstremiteta ili čak amputacija, potreba za inovativnim i pouzdanim metodama liječenja je od ključnog značaja. Medijalni transport fibule korišćenjem Ilizarov aparata nudi uspješno rješenje za ove probleme, čuvajući funkcionalnost i integritet ekstremiteta.

Prikaz bolesnika. Ovaj rad prikazuje slučaj 76-godišnjeg pacijenta sa hroničnim osteomijelitisom i inficiranom pseudartrozom tibije. Nakon radikalnog debridmana i uklanjanja sekvestra, ostao je značajan djelimičan koštani defekt veličine 8 cm. Liječenje je sprovedeno primjenom medijalnog transporta fibule pomoću Ilizarov aparata. Rekonstrukcioni proces trajao je osam mjeseci, nakon čega su postignuti potpuna konsolidacija kosti, eliminacija infekcije i obnova funkcije ekstremiteta.

Zaključak. Tehnika medijalnog transporta fibule pokazala se kao efikasna i sigurna metoda za liječenje velikih defekata tibije povezanih s infekcijom, omogućavajući očuvanje ekstremiteta i značajno poboljšanje kvaliteta života pacijenata.

Ključne riječi: fibularni transport, Ilizarov, pseudartroza, osteomijelitis