CASE REPORT

Management of Radial Shaft Nonunion with Fixation Failure Using the Masquelet Technique: A Case Report

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ABSTRACT

Nonunion represents a challenge for orthopedic surgeons, and although several treatment options exist, there is no clear consensus. We report the successful use of the Masquelet technique as an alternative approach. This technique, commonly used for the treatment of large bone defects in the extremities, has reported success rates ranging from 82% to 100%. Although it is widely used in the lower limbs, there is limited evidence regarding its application in the upper limbs. We present a case of radial shaft nonunion with fixation failure, successfully treated using this technique. **Conclusion:** Bone union was achieved at approximately 8 months, with symptom resolution and functional recovery, demonstrating the effectiveness of this therapeutic option.

Keywords: Bone graft; Masquelet technique; Nonunion.

Level of Evidence: IV

Manejo de la seudoartrosis diafisaria de radio con falla de síntesis mediante la técnica de Masquelet. Presentación de un caso

RESUMEN

La seudoartrosis representa un desafío para el cirujano y, aunque existen diferentes alternativas de tratamiento, no hay un consenso claro. Presentamos el uso exitoso de la técnica de Masquelet como alternativa. Esta técnica, conocida por tratar defectos óseos largos en las extremidades, tiene tasas de éxito del 82% al 100%. Aunque su uso es común en los miembros inferiores, hay poca evidencia sobre su aplicación en los miembros superiores. En este reporte, se presenta un caso de seudoartrosis en la diáfisis radial con falla del material de osteosíntesis, tratado exitosamente con esta técnica. **Conclusión:** La consolidación ósea ocurrió en aproximadamente 8 meses, los síntomas se aliviaron y se logró la recuperación funcional, lo que demuestra la eficacia de esta opción terapéutica.

Palabras clave: Injerto óseo; técnica de Masquelet; seudoartrosis.

Nivel de Evidencia: IV

INTRODUCTION

Forearm fractures affect upper limb function and require appropriate treatment to prevent complications such as nonunion, which represents a challenge for the surgeon. Nonunion is defined as the absence of bone healing within the expected timeframe, without the potential for spontaneous consolidation. In clinical practice, its diagnosis is complex and depends on factors such as fracture type, initial treatment, time elapsed, and bone condition; therefore, clinical and radiographic criteria are essential.[1]

The treatment of nonunion depends on its origin and characteristics, and proper classification is key. When biological potential is adequate, proper alignment and stable osteosynthesis are sufficient; in nonviable lesions, additional measures are required to promote bone healing.[2]

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Options for the treatment of large bone defects in the upper extremity include autografts, allografts, distraction osteogenesis, and bioactive materials. Each technique has specific indications and limitations: autografts require a well-vascularized bed and offer better integration in poorly vascularized areas, but they involve greater surgical complexity; allografts avoid donor-site morbidity, but may lead to complications such as infection and fracture.[3]

The Masquelet technique is based on the use of an autologous bone graft within an induced biological membrane and is an effective and relatively simple method for treating segmental bone defects in both the upper and lower extremities. It can be applied in aseptic or septic settings and does not require advanced microsurgical techniques.[4]

This technique is performed in two stages: first, debridement and bone stabilization are carried out with placement of a cement spacer and fixation material; approximately 4 weeks later, after formation of the induced membrane, the spacer is removed and the defect is filled with an autologous bone graft.[2]

This grafting approach is effective for treating bone defects of several centimeters in length in the extremities, with union rates ranging from 82% to 100%. Most currently published studies focus on bone defects in the lower extremities.[3] There are few reports on its use in the upper extremity, which underscores the relevance of the clinical case presented here: a radial diaphyseal nonunion successfully treated with this technique.

CLINICAL CASE

A 29-year-old man with no relevant past medical history sustained a fall from a motorcycle, resulting in trauma to the left upper limb. He presented with a diaphyseal fracture of the left radius classified as AO 2R2B2 (Figure 1). Initial management consisted of analgesia, immobilization, and hospital admission for surgical treatment. Two days after the injury, the fracture was treated with a dynamic compression plate through a volar approach.

Figure 1. Anteroposterior (**A**) and lateral (**B**) radiographs of the forearm showing an AO 2R2B2 radial diaphyseal fracture.

Two months after surgery, the patient returned for follow-up, and control radiographs showed delayed union (Figure 2).

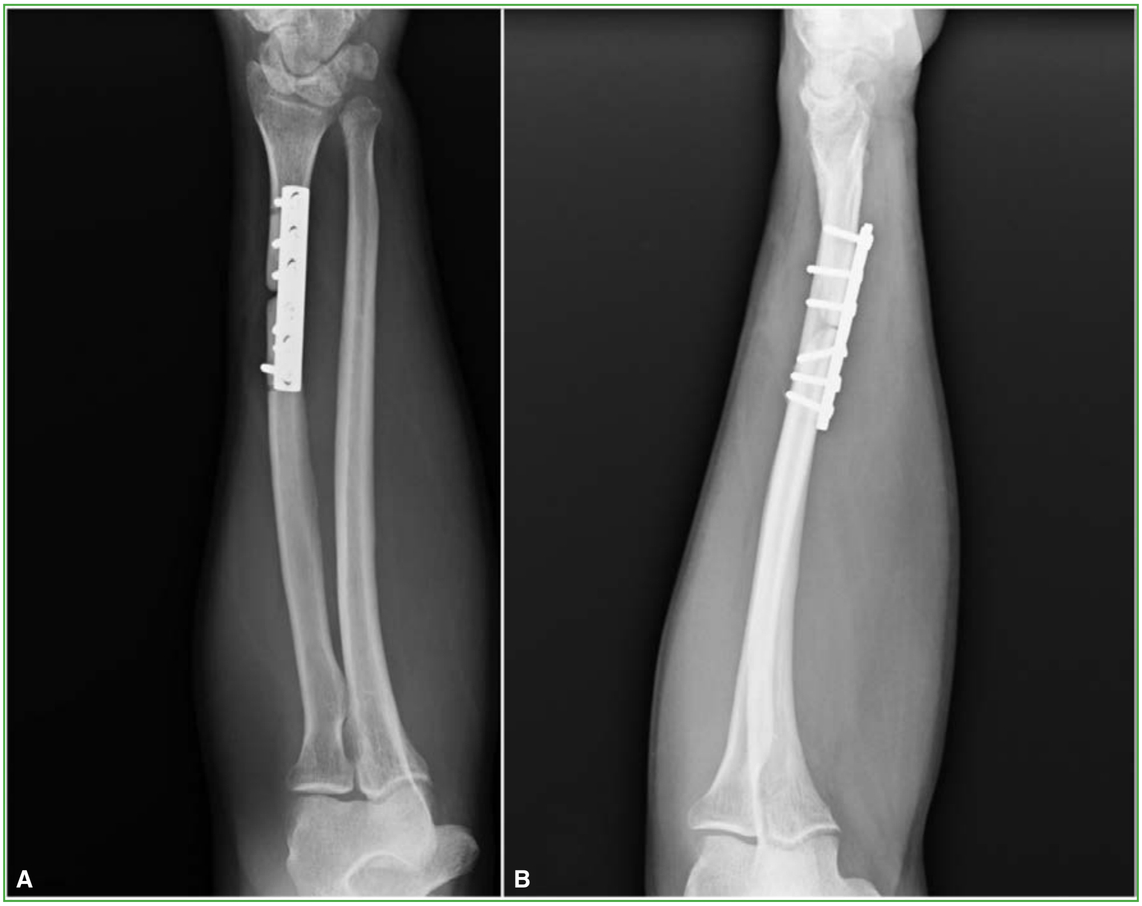

Figure 2. Anteroposterior (**A**) and lateral (**B**) radiographs of the forearm showing delayed union.

Eight months later, he presented to the emergency department with deformity of the left forearm. He denied recent trauma or fever, and the surgical wound was in good condition, without inflammatory changes or signs of infection. Radiographic evaluation revealed a radial diaphyseal nonunion associated with failure of the fixation hardware (Figure 3). Complete laboratory tests were requested, including erythrocyte sedimentation rate and C-reactive protein.

The patient underwent surgery consisting of resection of all nonviable bone and removal of the fixation hardware, through the previous volar approach, which was extended. During the procedure, no signs of infection were observed at the nonunion site. The residual bone defect after debridement measured approximately 10 cm. An antibiotic-free orthopedic bone cement spacer was placed in the defect. For stabilization, a Kirschner wire was inserted within the cement to function as an intramedullary support, and a second wire was used to perform temporary arthroereisis of the distal radioulnar joint (Figure 4).

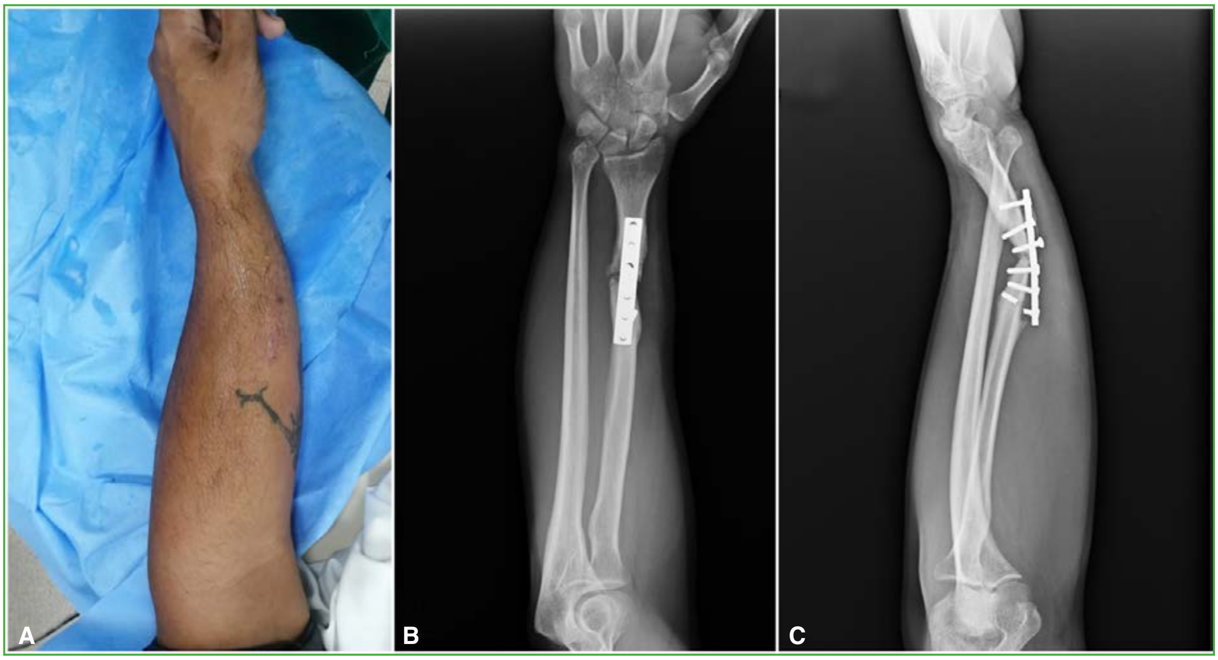

Figure 3. **A.** Obvious deformity of the forearm. Anteroposterior (**B**) and lateral (**C**) radiographs of the forearm showing a radial diaphyseal nonunion associated with failure of the fixation hardware.

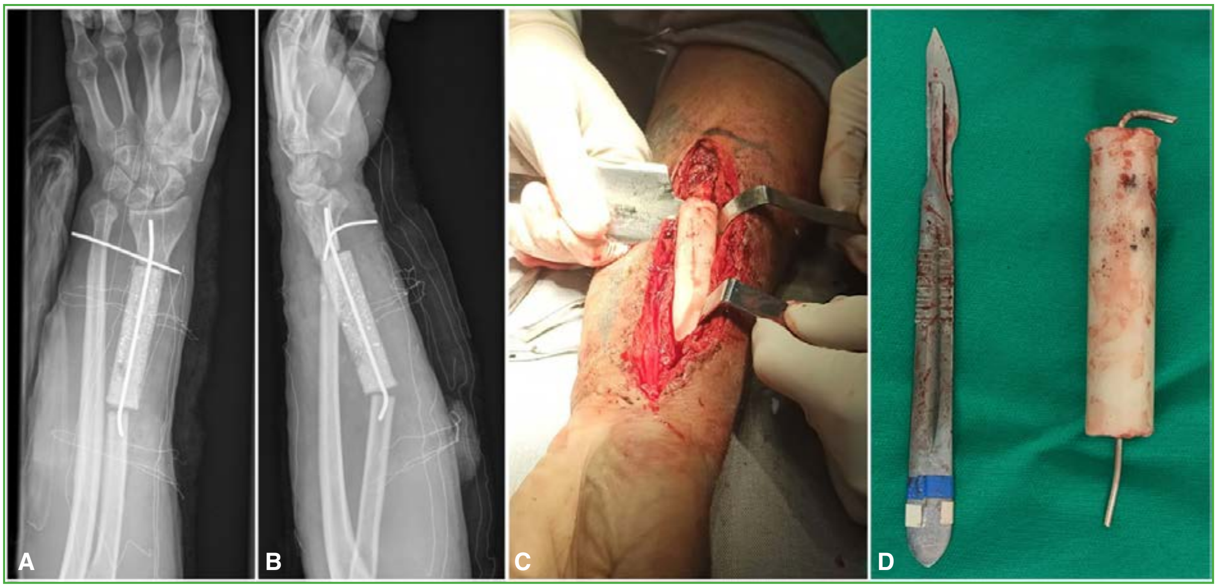

Figure 4. Anteroposterior (**A**) and lateral (**B**) radiographs of the forearm in the immediate postoperative period, showing orthopedic cement associated with Kirschner wires. **C and D.** Visualization and placement of orthopedic cement.

No postoperative complications were observed. Four weeks after cement placement, the patient underwent the second stage of the procedure. During this stage, the cement spacer was removed, and the formation of the induced membrane was confirmed intraoperatively. The bone defect was then filled with autologous cancellous bone graft harvested from the iliac crest. A locking dynamic compression plate was applied in neutralization mode, and an additional Kirschner wire was placed to maintain distal radioulnar joint arthroereisis (Figure 5).

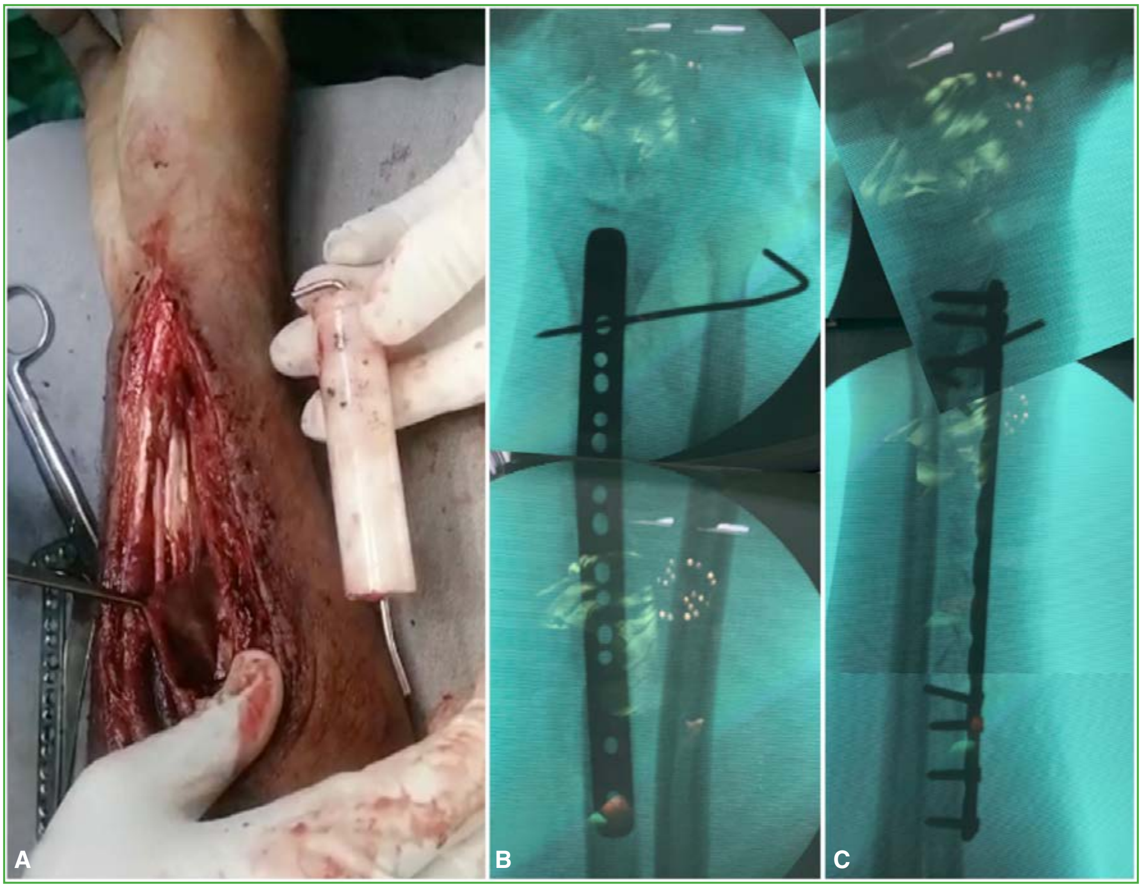

Figure 5. A. Removal of the orthopedic cement with visualization of the induced membrane (tip of the forceps). Anteroposterior (**B**) and lateral (**C**) radiographs of the forearm in the immediate postoperative period, showing the bone graft and fixation hardware.

The patient showed favorable progression, with the surgical wound in good condition and no signs of infection or pain. Follow-up radiographs at 1 month (Figures 6A and B) and 3 months (Figures 6C and D) demonstrated good progression of bone healing. The Kirschner wire was removed, and rehabilitation was initiated.

One year after surgery, complete bone union was observed on radiographs (Figures 7A and B). The patient reported no pain, had no neurovascular deficits or signs of infection, and maintained range of motion, with pronation of 60° and supination of approximately 70° (Figures 7C and D).

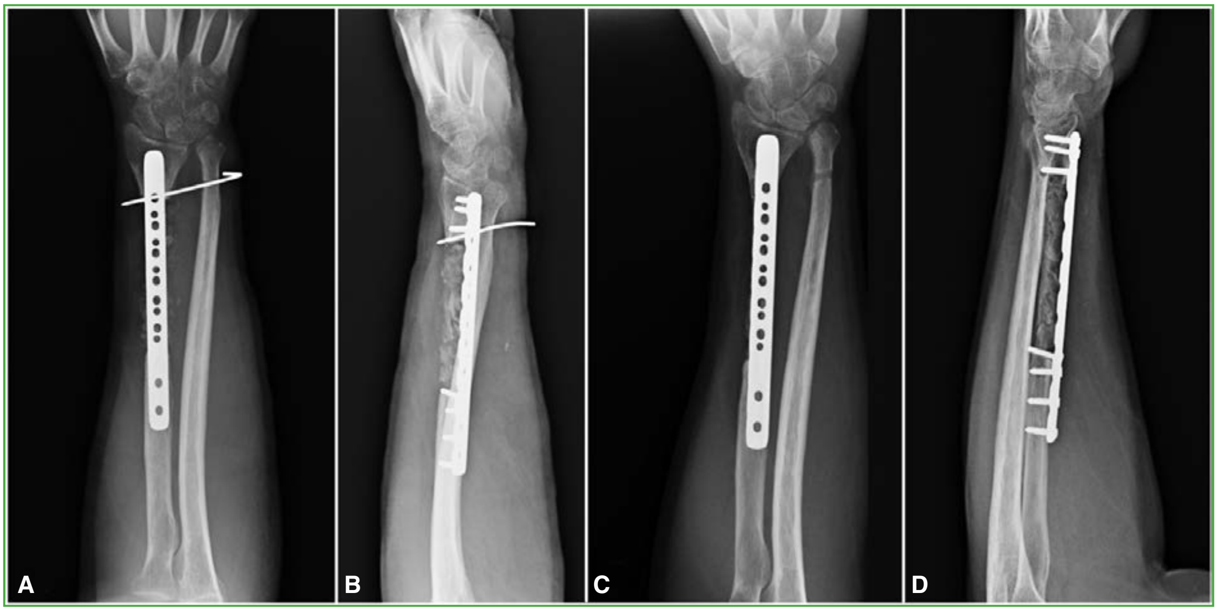

Figure 6. Anteroposterior (**A**) and lateral (**B**) radiographs of the forearm at 1 month and 3 months after surgery (**C and D**).

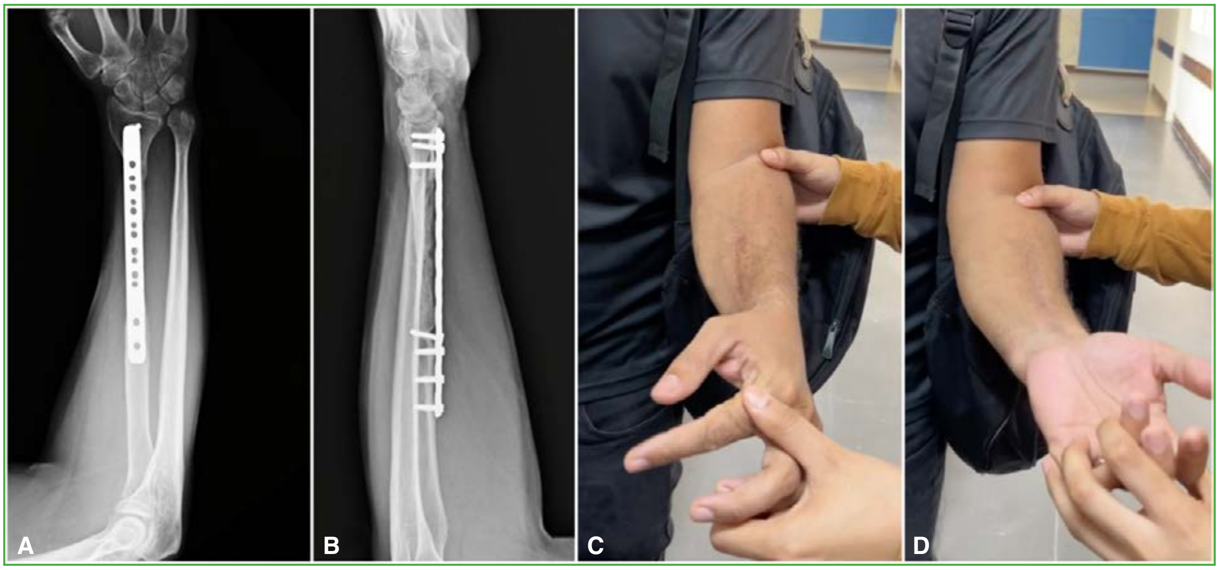

Figure 7. Anteroposterior (**A**) and lateral (**B**) radiographs of the forearm 1 year after surgery, showing bone union. **C and D.** Range of motion: pronation and supination, respectively.

DISCUSSION

The induced membrane technique described by Masquelet has consistently established itself as an effective and reliable method for the treatment of segmental bone defects. Although its initial applications were limited, its use has progressively expanded to include the long bones of the upper extremity.

In a review of this technique for fractures with segmental bone loss in the upper extremity, Braswell et al.[5] reported favorable outcomes, with an overall union rate of 91.3% and a mean time to union of 20 weeks. Similarly, Pederiva et al.[6] reported a union rate of 96%, with a mean time to union of 5.5 months and an average defect length of 4.5 cm. In a case report of an infected radial diaphyseal nonunion treated with this technique, Nitai et al.[7] reported favorable outcomes, with complete graft ossification at 10 months.

Micev et al.[3] proposed an optimal interval of 4 weeks for bone grafting within the induced membrane. In a randomized group of 14 patients treated with the Masquelet technique, membrane vascularization peaked at 1 month and decreased to less than 60% in samples obtained at 3 months. One-month samples showed the highest levels of vascular endothelial growth factor, interleukin-6, and type I collagen, whereas 2-month membranes exhibited less than 40% of the levels observed at 1 month.

Compared with data from oncologic reconstruction of the upper extremity, O'Connor et al.[8] concluded that the induced membrane technique compares favorably. They also reported no significant clinical differences compared with free bone grafting, despite the latter demonstrating shorter time to union. Furthermore, the Masquelet technique allows limb salvage in cases where microvascular bone flaps are not feasible.

In a comparative study of this technique and vascularized fibular grafting in open forearm fractures with segmental bone defects, Zhou et al.[9] concluded that clinical and radiographic outcomes are similar; however, with the Masquelet technique, operative time, hospital stay, and intraoperative blood loss were reduced. A military study reported a high success rate with this technique for the management of open fractures, bone loss, or infections (common complications in combat settings) since, in the military environment, there are limitations to other procedures, such as bone transport or vascularized bone grafting.[10]

Rohilla et al.[11] compared the Masquelet technique with bone transport in a prospective study of 25 patients with infected tibial nonunion and bone loss of up to approximately 6 cm. The authors reported that both techniques achieved functional outcomes, but bone transport was superior in terms of bone healing.

Among the main complications of this technique, some studies report nonunion requiring unplanned reoperations,[5] while others identify infection as one of the most frequent complications.[8] Pederiva et al.[6] reported a complication rate of 21% and failure in only 6 of 156 patients.

This technique yields good functional outcomes but requires strong commitment from both the patient and the surgeon, as well as effective communication, with patients being informed of the possibility that multiple procedures may be required until bone union is achieved.[12]

CONCLUSIONS

The Masquelet technique proved to be an effective option for the treatment of a radial diaphyseal nonunion with significant bone loss, achieving complete bone union and satisfactory functional recovery. This outcome supports the use of the Masquelet technique as a safe and viable alternative for bone reconstruction in the upper extremity, provided that appropriate surgical timing is respected and good adherence to treatment is ensured.

Conflicts of interest: The authors declare no conflicts of interest.

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