Avoidance of amputation with the Masquelet technique in femur's chronic osteomyelitis. A case report
Evitación de amputación con técnica de Masquelet en osteomielitis crónica de fémur. Reporte de caso

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ABSTRACT

A case of a 21-year-old male patient with chronic osteomyelitis of the left femur following an open fracture secondary to a motor vehicle accident was presented. Eight months after internal medullary nailing, he developed pain, purulent discharge, and fever, which confirmed a multi-antibiotic-resistant osteomyelitis; therefore, the Masquelet technique was applied. The objective was to present the case of a patient with chronic osteomyelitis who underwent the Masquelet technique, resulting in resolution of the infection and adequate bone healing. Therefore, the option of amputation of the affected limb was discarded.

Keywords: Bone Regeneration; Induced Membrane; Masquelet Technique; Osteomyelitis

RESUMEN

Se presentó el caso de un paciente masculino de 21 años con osteomielitis crónica del fémur izquierdo tras fractura expuesta secundaria a accidente vehicular. Ocho meses después de la osteosíntesis con clavo

endomedular, desarrolló dolor, secreción purulenta y episodios febriles, que fue catalogada como osteomielitis multirresistente; por lo tanto, se aplicó la técnica de Masquelet. El objetivo fue presentar el caso de un paciente con osteomielitis crónica sometido a técnica Masquelet, el cual culminó con la resolución de la infección y consolidación ósea adecuada. Por lo tanto, se descartó la opción de amputación del miembro afectado.

Palabras clave: regeneración ósea; membrana inducida; técnica de Masquelet; osteomielitis

Introduction:

Osteomyelitis is a bone infection characterized by an inflammatory process that compromises bone tissue and its adjacent structures. It is caused by the invasion and proliferation of microorganisms, mainly pyogenic bacteria, although less frequently fungi and mycobacteria, which trigger a local immune response, necrosis of the cortical or cancellous bone, and possible extension to periosteal tissue and bone marrow.[1,2] Clinically and histologically, it is classified into acute, subacute, and chronic forms, the latter being the one that entails greater morbidity due to the formation of bone sequestrations, sinus tracts, and a worse response to systemic antibiotic treatment.[3]

Clinically, it usually presents with local pain, fever, and inflammatory signs, and, in chronic phases, it can be accompanied by fistulas or bone necrosis. Diagnostic confirmation requires imaging and medical history; however, microbiological isolation by bone biopsy remains the gold standard.[4]

Routes of infection for osteomyelitis include hematogenous spread, a contiguous focus (e.g., adjacent soft-tissue infection or a surgical wound), and direct inoculation after trauma or surgery.[4,5] In the lower limbs (femur, tibia and fibula), osteomyelitis is particularly frequent due to the high incidence of trauma, open fractures, orthopedic surgery and the presence of osteosynthesis material that favors bacterial colonization; poor vascularization of bone diastases, the presence of osteosynthesis material and contamination in high-energy lesions favor bacterial colonization and biofilm formation, making it difficult to eradicate the infection. This type of osteomyelitis is usually due to contiguity after an open wound or by implantation, although it can also have a hematogenic origin.[2,6]

From a global epidemiological perspective, recent estimates place the incidence of osteomyelitis between 11 and 24 per 100,000 person-years, with a predominance in men and a significant increase in older adults. In South America, data are scarce and heterogeneous: a Brazilian population-based study reported 71,817 hospitalizations for osteomyelitis during 2019–2023, with a higher prevalence in men aged 40–49 years and higher mortality in the Southeast region (50 % of deaths).[7] In Ecuador, specific records on osteomyelitis are scarce; however, infectious health indicators show that bone diseases remain relevant and that the prevalence of chronic infections in the lower extremities is high, emphasizing the need for systematic epidemiological studies in the country.[3]

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The treatment of infected bone defects has evolved toward reconstructive techniques that combine infection control and bone regeneration.[8] The Masquelet or induced membrane technique, described for the first time in 2000, is based on a two-phase approach: in the first, after aggressive debridement, a polymethylmethacrylate cement (PMMA) spacer with antibiotic is placed, which induces the formation of a periosteal pseudomembrane rich in osteogenic and angiogenic factors; In the second phase, typically performed 6 to 8 weeks later, the cement is removed and autologous bone graft is inserted within the protective membrane that promotes healing.[9,10] Current evidence supports that the rate of success is 82 % in 427 cases of chronic osteomyelitis and pseudo-malignancies, reporting good outcomes in terms of functionality. Sequeantial internal fixation and the Masquelet technique in a cohort study of 21 patients with femur osteomyelitis, adequate bone healing in all cases was reported, with an average of 7 months of consolidation.[9]

The Hospital General Docente Riobamba of the Ministry of Public Health receives a high influx of trauma patients, mainly with exposed fractures, which confers a risk of osteomyelitis. There is no research in this Health Unit regarding patients with osteomyelitis and their treatment; therefore, we present the case of a patient who underwent the Masquelet technique and thus avoided amputation of the affected limb.

A case report based on the comprehensive and descriptive care of a patient diagnosed with chronic osteomyelitis of the left femur, treated with the Masquelet surgical technique is presented. The case took place at the Provincial General Teaching Hospital of Riobamba, in the Traumatology and Orthopedics service.

For research and academic documentation, institutional authorization was obtained through a letter of endorsement issued by the highest authority of the health establishment, in accordance with the ethical principles established in the Declaration of Helsinki. Likewise, written informed consent was obtained from the patient, authorizing the use of clinical and surgical data for scientific purposes and the use of photographs without showing his face, guaranteeing respect for the privacy, anonymity, and confidentiality of personal and medical information.

Once the relevant ethical permissions were obtained, the patient's medical history was retrospectively reviewed, including records of medical evolution, surgical reports, complementary examinations (laboratory tests, microbiological cultures, and diagnostic images), and postoperative follow-up.

Objective: to present the case of a patient with chronic osteomyelitis who underwent the Masquelet technique.

In addition to present the clinical characteristics of the patient, to establish the patient's diagnostic process, to describe the treatment received based on the Masquelet technique, and the patient's clinical evolution.

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Case presentation
Anamnesis:
Filiation data:

A 21-year-old male patient, single, of mestizo ethnicity, with medium socioeconomic status, Catholic religion, pursuing university studies, born and resident in Guaranda, province of Bolívar, resides in a single-family house with complete basic services (drinking water, electricity, and internet), and lives with an indoor animal (canine).

Personal history: Left femur, diaphyseal (middle third) fracture exposed Gustillo-Anderson II resolved with surgical intervention by placement of endomedullary nailing after a high-energy trauma in a traffic accident that occurred approximately eight months ago. The patient does not report a relevant family history of pathology. As part of his lifestyle habits, he reports occasional consumption of alcohol and tobacco. The frequency of urination and defecation is within normal parameters, with a dietary pattern of three meals a day.

Reason for consultation: leg pain and discharge of pus from the wound

Current illness:

A 21-year-old male patient who consulted for burning, pulsating, continuous VAS 5/10 pain, without irradiation, of 3 months of evolution in the left thigh at the level of the surgical scar. He reports an increase in the intensity of the pain, VAS 8/10, and the presence of purulent discharge through the wound for one week of evolution. The clinical picture worsens with movements. In addition, he reports intermittent episodes of unquantified thermal rise and asthenia; and self-medication with paracetamol and naproxen in unspecified doses and frequency without showing improvement, for which he went to the Emergency Service at the Hospital Provincial General Docente, Riobamba.

Review of organ systems: No additional symptoms are reported

Physical examination:

General physical examination:

Upon admission, the patient was conscious and oriented in all spheres, with an asthenic attitude and fluent speech. He had normotypical facies, blood pressure of 118/72 mmHg, heart rate of 82 beats per minute, respiratory rate of 18 per minute, and axillary temperature of 38.4°C. He presented with an antalgic gait and was supported with crutches.

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Regional Physical Exam:

On inspection of the left lower limb, slight muscle atrophy of the thigh was observed, presence of an active fistula (2cm by 1 cm) with purulent exudate on the lateral aspect of the proximal third of the thigh and another active osteocutaneous fistula (2cm by 2 cm) with the presence of purulent exudate in the surgical scar of the middle third of the thigh; Discrete erythema and induration of adjacent soft tissues were also observed. On palpation, intense pain and local hyperemia were evident in the affected region; pedal and tibial pulses were present and symmetrical with the contralateral limb, capillary refill was less than 2 seconds, and there were no signs of ischemia or distal neurovascular compromise. The patient scored 3/5 on the Daniel scale and experienced limited active range of motion in the affected limb at the knee (flexion from 0° to 60°) due to pain. It retains intact superficial sensation in the territories of the femoral and sciatic nerves. Patellar and Achilles reflexes present.

Syndromic Summary

a. **Infectious syndrome:** fever, asthenia, and persistent purulent discharge through fistulas.
b. **Osteoarticular pain syndrome:** constant pain in the left thigh, predominantly mechanical, pain on regional palpation, and antalgic claudication.
c. **Fistulous syndrome:** presence of fistulas with purulent discharge
d. **Complicated post-traumatic/post-surgical syndrome:** Derived from a history of fracture of the left femur treated by osteosynthesis, which evolved with infection of the surgical site.

Differential Diagnosis

1. **Localized necrotizing cellulitis**, related to infectious syndrome, osteoarticular pain syndrome, and fistulous syndrome.
2. **Infected pseudoarthrosis secondary to open fracture**, related to osteoarticular pain syndrome, complicated post-traumatic/post-surgical syndrome, and fistulous syndrome.
3. **Osteosarcoma with a fistulate component** related to osteoarticular pain syndrome, fistulous syndrome, and partially infectious syndrome.

Presumptive diagnosis:

Chronic osteomyelitis of the left femur: It includes localised, persistent, mechanical pain, with progressive functional limitation, and antalgic gait. Additionally, it presented chronic purulent discharge through cutaneous fistulas in the leg.

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Complementary exams:

During the patient's clinical course, multiple complementary tests were requested to support diagnosis and guide therapeutic management.

Blood tests

In the first controls, marked leukocytosis (up to 16,580/µL) and significant neutrophilia (85%) were observed, compatible with an acute systemic inflammatory response. The patient persistently presented elevated C-reactive protein (CRP) levels, reaching up to 129 mg/L, further reinforcing the suspicion of an active infection. Similarly, mild normochromic normocytic anemia (hemoglobin between 9–11 g/dL), related to chronic inflammation, was observed in several feedings.

Follow-up revealed a lack of response according to CRP levels, suggesting the need for a more aggressive approach. The fluctuating leukocytosis, relative lymphopenia, and intermittent neutrophilia were consistent with the chronic phase of the infection.

Cultures

Microbiological cultures of secretion and bone tissue yielded significant results: in the first instance, Enterobacter cloacae complex, resistant to cefoxitin, was identified. In subsequent cultures, multidrug-resistant Staphylococcus epidermidis was isolated, showing resistance to beta-lactams, fluoroquinolones, macrolides, and lincosamides, with intermediate sensitivity to moxifloxacin and ciprofloxacin. These microbiological findings confirmed the presence of a chronic bone infection with resistant germs associated with osteosynthetic material.

Image tests

Among the imaging studies, the ultrasound of the left thigh on admission to the emergency room stands out, showing increased soft-tissue volume and subcutaneous echogenicity, as well as multiple encapsulated hypoechoic collections. The most significant collection was located 20 mm from the skin in the middle third of the thigh, with an estimated volume of 10 cc. Additionally, deeper collections were identified in the lower third of the thigh (3.8 cc) and in the gluteal region (4.8 cc), in direct contact with the muscular plane and bone tissue. These findings were suggestive of organized abscesses and possible bone infiltration, which supported the clinical suspicion of chronic osteomyelitis.

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Blood chemistry

Finally, coagulation values (PT, TTP), renal function (urea, creatinine), and metabolic profile were maintained within normal parameters, allowing the safe scheduling of the required surgical procedures.

Definitive diagnosis:

Chronic osteomyelitis of the left femur due to infection of the osteosynthesis material.

Treatment and timeline of interventions:

Approximately three months after the initial osteosynthesis with an endomedullary nail, the patient presented with purulent discharge from the left thigh and visited this health clinic on August 8, 2021.

Upon admission due to the suspicion of deep infection, surgical cleaning was performed using 7000 ml of saline solution with chlorhexidine, debridement of glera, sampling for microbiological culture, and wound closure. Simultaneously, empirical intravenous antibiotic therapy with cefazolin (1 g) was initiated. An X-ray of the left femur was performed (Figure 1).

Masquelet Technique

Two weeks later, given the persistence of the infectious condition, the surgical approach was decided upon using the Masquelet technique; during each surgical cleaning, samples were taken for culture and antibiogram.

First phase (induction): surgical cleaning, bone biopsy, and placement of cement nail impregnated with antibiotics were performed; this intervention sought to induce the formation of a biologically active periosteal pseudomembrane in the affected bone bed. During the surgical act, an abscess of approximately 4×4 cm was identified on the lateral aspect of the proximal third of the left thigh. with an estimated purulent content of 50 cc. Additionally, an active fistula was noted in the middle third of the left thigh, with purulent secretions of approximately 5 cc, as well as the presence of low blood clots. Two incisions were made: one of 5 cm at the level of the lateral aspect of the right thigh (proximal third) and another of 4 cm in the middle third of the thigh, allowing drainage of the purulent collections.

Four weeks later, a new surgical procedure was performed with removal of stitches, deepening of the wound, washing with 1000 ml of saline solution and taking samples for culture and histopathology, in this approach devitalized tissue of bad appearance was identified, glera in abundant quantity, pus in the endomedullary canal, presence of clots in moderate quantity and presence of bone callus in small quantity at the level of the fracture focus. Therefore, an ostectomy of 2 cm at the distal level and 4 cm at the proximal level of the femur

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was performed, until bleeding bone (paprika sign) was obtained, eliminating bone compromised by the infectious process. A polymethylmethacrylate (PMMA) spacer was placed, then a control X-ray was performed (Figure 1).

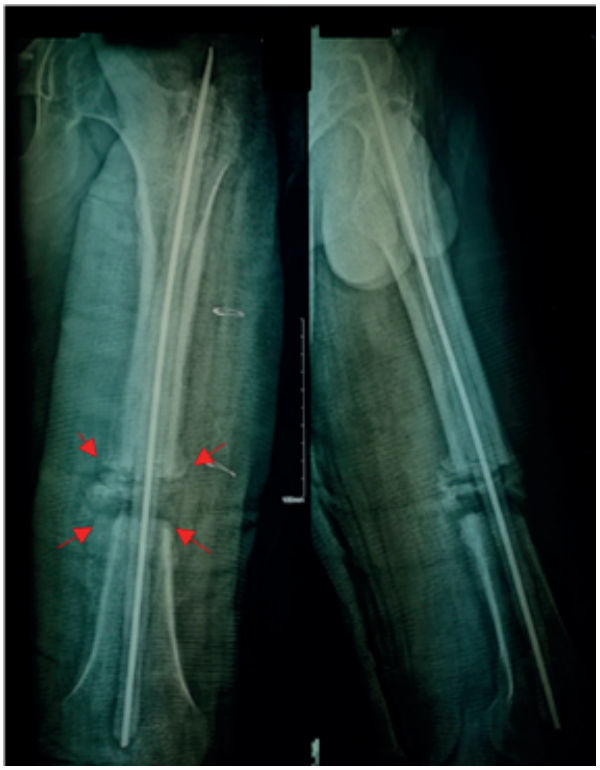

Figure 1. Membrane induction phase after debridement of the infectious focus

Source: Medical history.

This X-ray of the left femur in anteroposterior and oblique projections shows the placement of a PMMA spacer in the midfemoral third (area indicated by the red arrows), in the context of the first phase of the Masquelet technique. A long endomedullary nail is also observed as a means of temporary stabilization without signs of bone healing, which is expected in this stage.

Two weeks later, after observing a favorable clinical evolution, the fourth surgical intervention was performed, with no evidence of pus or active abscesses; only fibrin sclera in small quantities and blood clots were found. A new surgical cleaning was performed with 600 ml of saline solution, followed by the application of Prontosan for 20 minutes. The cultures obtained in this last intervention were negative, so it was considered appropriate to discharge the patient from the hospital with immobilization of the left lower limb and a handmade TEN nail with cement impregnated with antibiotics, left as a transitory measure to maintain mechanical stability and local control of the infection.

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The second part of the Masquelet technique was performed eight weeks later. The spacer cement was removed, an intramedullary nail was placed, and osteosynthesis was performed using an eight-hole plate (with two proximal and two distal cortical screws). A cancellous bone graft derived from two femoral heads, impregnated with vancomycin, was then placed to achieve definitive bone reconstruction. Additionally, a surgical lavage was performed with 100 mL of saline solution to verify hemostasis and stability.

Pain control was well achieved, and there were no postoperative complications. The patient was discharged 48 hours later with instructions for partial weight-bearing on crutches and outpatient follow-up.

Follow-up and results:

Exhaustive and systematic follow-up was conducted to evaluate bone consolidation and resolution of the infection.

No complications (active infection and/or purulent drainage) were observed during the 3 months of follow-up after the second phase of the procedure.

The patient reported pain relief, progressive improvement in gait, increased joint mobility, preservation of reflexes and sensation, and no signs of neurovascular compromise.

Figure 2 shows the progressive formation of bone callus at the fracture site and the correct integration of the placed bone allograft.

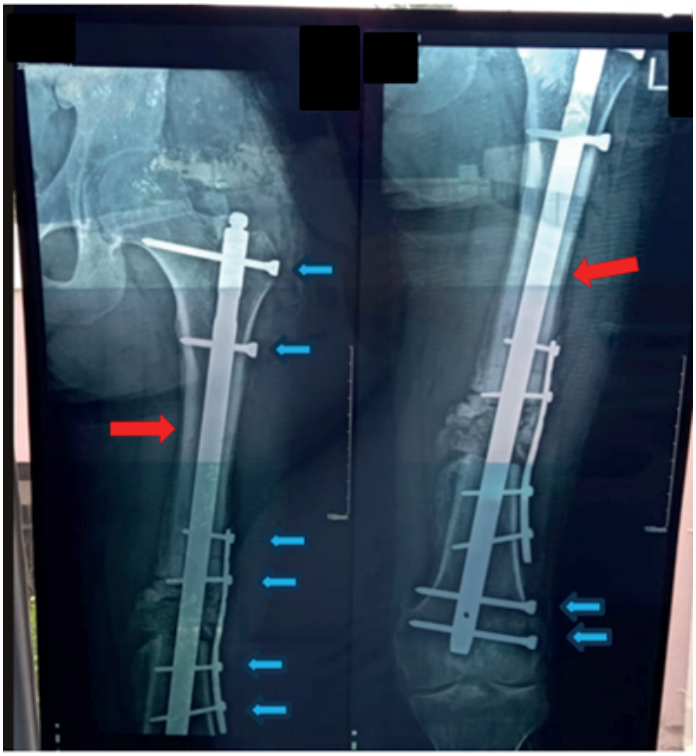

Figure 2: X-rays of the left femur in AP and oblique projections.

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Source: Medical history.

Figure 2 shows the long intramedullary nail (red arrows) and the proximal and distal fixation screws (blue arrows). Adequate consolidation was observed in the mid-femur due to the Masquelet technique. The correct positioning of the osteosynthesis material is evident, with no signs of loosening or displacement, and favorable peripheral remodeling consistent with the consolidation process was achieved.

Follow-up was performed at 6 and 9 months. Bone healing was achieved 9 months after the first Masquelet intervention, a period consistent with the literature (7 to 12 months) and within the acceptable range, according to recent systematic reviews reporting success rates of 82 to 100 % in infected bone defects.[11]

The functional clinical outcome was equally satisfactory. The patient returned to his daily activities, including prolonged walks and academic work, without significant limitations or residual pain. It was possible to avoid amputation of the left lower limb, which would have been the only viable therapeutic alternative in the absence of an effective reconstructive approach (Figure 3).

Figure 3: Clinical images of follow-up at 9 months postoperatively. A: Surgical wounds in good condition (red arrow). B: Hip and knee mobility (red circles).
Source: Medical History

DISCUSSION.

In the present clinical case, a systematic semiological examination was highlighted to identify the cardinal signs of osteomyelitis: localized bone pain (at the tip of the finger), fistula with persistent purulent discharge, antalgic gait, and general symptoms (asthenia, subjective thermal elevation). According to the Medical Semiology, intense focal pain and chronic discharge are key indicators to suspect a deep bone infection; in

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the anamnesis, signs of erythema, local heat, or active limitation of the joint range are documented, enriching the characterization of the inflammatory process and differentiating it from soft entities such as joint fasciitis or arthritis.[12,13]

Regarding treatment with the Masquelet technique, it is a bone reconstruction technique performed in two stages, regardless of the length used to rebuild bones after osteomyelitis. However, studies report defects up to 25 cm reconstructed.[14]

In the first phase, the infected osteosynthesis material was removed and with several surgical cleanings, a spacer with gentamicin was placed in addition to antibiotic therapy aimed at the isolated germs; the essential principle of Masquelet technique lies in the induction of a pseudomembrane through physiological responses to a foreign body around the polymethylmethacrylate (PMMA) spacer, said polymethylmethacrylate cement spacer has two functions: the first function is mechanical, structural support, maintaining the continuity and length of the skeletal segment in turn avoiding tissue invagination and the second function is biological, based on the rich vascular content and its bioactive role.[9,14,15]

In the second phase, after eight weeks, the spacer was removed with cement, and the allograft of two femoral heads was placed under an induced membrane. This strategy meets the pillars described in the recent reviews by Ren C. et al., Rojas M. et al., and Neupane B. et al. that highlight the need for a well-vascularized membrane and stimulatory membrane as keys to achieving microvascular consolidation and eradication of the infection niche, along with a stable mechanical environment.[14,16,17]

Recent studies confirm an 82-100 % healing rate in osteomyelitis bone defects using the Masquelet technique, with union times between 7 and 12 months.[18] In this case, consolidation occurred at 9 months, within the accepted range and comparable to the additional findings, which highlight that the mean time to union is usually 5.6 months, with a 95 % success rate in infectious cases.[17]

The incorporation of combined internal fixation (nail and plate) in the second phase coincides with the recommendation of He J. et al. to provide biomechanical stability without compromising the osteogenic process.[15] In addition, recent meta-analyses show that Masquelet allows for an earlier functional load of 7.7 months.[19] When rotational instability exists, the best treatment is considered to be augmentation with an anti-rotational plate and bone grafts, a treatment that achieves consolidation of up to 94 %.[20]

The technique demonstrated effectiveness in eradicating the infection, consistent with systematic studies reporting high success rates even in defects greater than 20 cm, and reported the absence of major complications such as graft recurrence or failure, unlike reports describing a 17 % need for additional procedures.[11]

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Clinical follow-up was comprehensive, with emphasis on periodic semiological evaluations to determine the absence of secretion, disappearance of focal pain, improvement of gait, and functional return. According to Argente and Suros, this confirms the restitution of the skeletal and functional environment.[12,13]

A significant limitation is recognizing that the use of artisanal bone cement nail can be replaced by better options available on the market and in healthcare institutions with more advanced settings, such as nails locked with bone cement plus antibiotics; however, in public hospitals like the HPGDR and where most patients are low-income, it is not possible to acquire these supplies; therefore arstisanal bone cement becomes an option by combining its action with the core of a TEN (Titanium Elastic Nail) despite not being locked. In this way, the antibiotic's functionality is replaced during the Masquelet time without maintaining the blocked construct, so the affected limb cannot be discharged during this period while the treatment lasts.

Patient Perspective:

The patient reports that at the beginning of treatment, he experienced nervousness, which was overcome thanks to the detailed explanation and accompaniment provided by the specialist, which generated confidence. He experienced pain relief during the sessions, and when the pain returned, it was tolerable; progressive improvement in mobility, which gave him hope and allowed him to resume daily tasks such as lifting objects and exercising, leading to a better quality of life with a positive personal and family impact. At the end of the therapeutic process, he expressed satisfaction with the results and the care received, and recommended the Masquelet technique to other patients with similar conditions.

CONCLUSIONS:

The Masquelet technique proved to be an effective and safe alternative in the treatment of chronic osteomyelitis of the femur, allowing not only the eradication of the infection, but also the functional reconstruction of the affected bone. In the present case, meticulous execution of each surgical phase, along with rigorous clinical follow-up and multidisciplinary management, led to a successful outcome without major complications or infectious recurrences.

This therapeutic approach not only avoided amputation of the affected limb, but also achieved favorable results in terms of mobility and functionality, establishing a benchmark for managing patients with similar conditions.

The key factors for therapeutic success were aggressive and systematic debridement, culture-directed antibiotics, stable mechanical fixation, and a biologically active pseudomembrane that promoted bone graft integration; all of this, combined with the patient's adherence to the appropriate treatment, active participation in postoperative recovery, and institutional support from the HPGDR.

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The experience gained in performing this technique confirms the feasibility of carrying out these types of advanced procedures in hospital settings that lack the medical resources and supplies of developed countries. The primary objective is to offer patients treatment options and improve their quality of life. The use of readily available halografts, homemade antibiotic cements, and conventional surgical resources allowed for the effective application of the original protocol, achieving results comparable to those reported in international referral centers.

It is essential to strengthen the capacity for early diagnosis of complications, particularly osteomyelitis, at the primary care level. Once identified, patients should be promptly referred for multidisciplinary management.

Research should be promoted through case studies and even more rigorous scientific studies that further reinforce the positive results achieved by combining experience and technical knowledge in the management of orthopedic conditions.

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