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Reconstruction of Lower Limbs After Osteomyelitis: Surgical Approaches and Clinical Challenges

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Abstract
The primary objective of this study is to evaluate the efficacy of a multidisciplinary, evidence-based approach in the treatment of osteomyelitis at the Hospital de Base of the Federal District. This complex bone infection demands a comprehensive management strategy that emphasizes the eradication of the infection and the functional restoration of the affected limb. The treatment protocol integrates advanced surgical techniques, such as the use of negative pressure therapy and antibiotic-impregnated biocomposites and considers patient-specific factors like severity of infection, tissue viability, and comorbid conditions. Special attention is given to the selection between pedicled and free microvascularized flaps for soft tissue reconstruction, based on the patient's vascular health and the presence of conditions such as diabetes and peripheral arterial disease. The efficacy of early and effective soft tissue coverage in reducing infection rates and hospitalization time is demonstrated, alongside tailored antibiotic therapy that targets specific pathogens identified through meticulous microbiological testing. Additionally, the study underscores the importance of a customized rehabilitation plan, involving physical and occupational therapy, to ensure optimal functional recovery. This protocol serves as a model for modern osteomyelitis management, combining innovative surgical and medical treatments to significantly improve patient outcomes.

Keywords: Osteomyelitis, Multidisciplinary Approach, Soft Tissue Reconstruction, Negative Pressure Therapy, Antibiotic-Impregnated Biocomposites

1. Introduction

Osteomyelitis is an inflammatory bone infection, frequently associated with orthopedic complications and requiring complex surgical interventions. In orthopedics, this pathology stands out due to its functional impact and the difficulty of completely eradicating the infection. The surgical approach in orthopedics and plastic surgery aims at eradicating the infection while preserving the affected limb and optimizing the patient's functionality. *Staphylococcus aureus* remains the main etiopathogenic agent (Mayberry-Carson *et al*., 1984) [26], making microbiological identification essential for effective treatment.

Osteomyelitis can occur through hematogenous dissemination or by contiguity, the latter being common in patients who have undergone orthopedic procedures or who have implants (Street *et al*., 2017). Lower limb involvement is particularly significant in cases of severe orthopedic trauma and post-surgical complications, making an integrated evaluation between orthopedic surgeons and plastic surgeons essential (Kremers *et al*., 2015) [22].

Clinical manifestations include localized pain, edema, and erythema, as well as fistulas with purulent drainage in chronic cases (Shintani *et al*., 2022). The progression of the infection can lead to bone tissue destruction and the need for complex reconstructive interventions, involving muscle and fasciocutaneous flaps for coverage (Ferguson *et al*., 2017) [13].

Effective diagnosis requires a combination of laboratory and imaging tests, such as magnetic resonance imaging and dual-energy computed tomography, which allow for an accurate characterization of the infection's extent (Foti *et al*., 2023) [14]. Microbiological detection through fluid sonication has been an innovative tool in diagnosing infections associated with orthopedic devices (Street *et al*., 2017).

The treatment of osteomyelitis in orthopedics involves prolonged antibiotic therapy and surgical intervention for the removal of infected tissue. Plastic surgery plays an essential role in reconstructing bone defects and covering exposed tissues using techniques such as free microvascular flaps (Olesen *et al*., 2015). The combination of bone grafts with local antibiotics has shown good results in infection eradication (Ferguson *et al*., 2017) [13].

Treatment failure can lead to infection recurrence, increased morbidity, and the need for reinterventions. Chronic osteomyelitis is associated with complications such as the selection of multidrug-resistant microorganisms and severe functional impairment, increasing the risk of amputation (Barshes *et al*., 2016) [6].

Soft tissue and bone reconstruction require the integration of orthopedic and plastic surgery techniques, utilizing muscle and fasciocutaneous flaps. The medial femoral condyle flap and the sural flap are widely used in the treatment of large post-osteomyelitis defects (Caterson *et al*., 2015; Luo *et al*., 2024) [9, 25]. The use of vacuum therapy has demonstrated efficacy in reducing bacterial load and accelerating healing (Diefenbeck *et al*., 2011) [12].

The prevention of osteomyelitis in orthopedic and reconstructive surgeries includes adequate control of hospital infections, antimicrobial prophylaxis, and strict surgical wound management (Bode *et al*., 2010) [7]. Patients with comorbidities such as diabetes should be closely monitored to prevent persistent infections (Ruan *et al*., 2021).

This article describes cases of patients who developed post-traumatic osteomyelitis in the lower limb and underwent reparative plastic surgery at the Hospital de Base do Distrito Federal, Federal District, Brazil.

2. Analysis of the Surgical Approach in Osteomyelitis

Osteomyelitis is a bone infection triggered by pathogenic microorganisms that reach the bone either through hematogenous routes or by contiguity. Hematogenous spread primarily affects immunocompromised individuals and those at extremes of age, such as children and the elderly. In these cases, clinical management is predominantly conducted with antibiotic therapy, since the infection often responds well to drug treatment without the need for surgical intervention (Lew; Waldvogel, 2004). However, if there is therapeutic failure or the presence of intraosseous abscesses, surgical drainage becomes necessary.

Conversely, osteomyelitis by contiguity poses a significant therapeutic challenge as it arises from the bacterial spread from contaminated adjacent tissues. This form of the disease is commonly observed in patients who have suffered from complex traumas, open fractures, previous orthopedic surgeries, and those with infected orthopedic implants. These scenarios require a combination of prolonged systemic antibiotic therapy and surgical removal of the necrotic and devitalized bone tissue to eradicate the infection (Mayberry-Carson *et al*., 1984) [26].

The presence of devitalized material, such as bone necrosis, fibrosis, or foreign bodies at the infection site, contributes to the persistence of the infection and hinders the efficacy of antimicrobials. The bacterial biofilm, a major treatment challenge, consists of an extracellular polymeric matrix that protects the bacteria against antibiotics and immune system cells (Barker *et al*., 2017) [5]. This biofilm can render bacteria up to a thousand times more resistant to conventional therapies, making surgical resection of the infected tissue crucial for effective treatment (Sendi *et al*., 2014).

Additionally, the ability of microorganisms to enter a state of latency within the biofilm complicates treatment further. In this state, bacteria reduce their metabolic rate, which makes them less susceptible to antibiotics, potentially leading to infection recurrence after prolonged antimicrobial treatment (Libraty; Patkar; Torres, 2012) [24]. Thus, the surgical removal of the infected tissue is vital for the treatment of chronic osteomyelitis, ensuring the eradication of the infectious focus and preventing recurrences (Sendi *et al*., 2014; Ziran; Rao; Hall, 2003).

Surgical interventions in osteomyelitis may include extensive debridement of the affected bone, removal of contaminated implants, and bone reconstruction with grafts or bone substitutes impregnated with antibiotics. Advanced reconstruction techniques, such as muscular and fasciocutaneous flaps, have demonstrated significant efficacy in healing chronic wounds and restoring limb functionality (Ferguson; Diefenbeck; Mcnally, 2017) [13]. The use of antibiotic-impregnated biocomposites allows for controlled medication release directly at the infection site, minimizing systemic side effects (Mcnally; Nagarajah, 2010) [27].

In addition to surgical debridement, complementary approaches like vacuum-assisted closure (VAC) therapy have been effective in reducing bacterial load and stimulating angiogenesis, thus facilitating tissue regeneration and improving clinical outcomes (Diefenbeck *et al*., 2011) [12]. This technique is frequently used alongside microsurgical flaps to optimize tissue coverage and prevent reinfections.

Failure in osteomyelitis treatment can lead to infection progression, resulting in severe outcomes such as bone deformities, functional impairment, and, in extreme cases, limb amputation. The presence of multi-resistant microorganisms further complicates therapy, underscoring the need for rational antimicrobial use and appropriate microbiological monitoring throughout treatment (Sheehy *et al*., 2010).

Given the complexity of osteomyelitis management, a multidisciplinary therapeutic approach is required, involving orthopedists, plastic surgeons, infectious disease specialists, and microbiologists to ensure effective treatment. Integrating advanced surgical techniques with targeted antibiotic therapy and continuous microbiological monitoring is fundamental to improving prognoses and reducing complication rates (Mcnally; Nagarajah, 2010) [27].

In summary, successful osteomyelitis treatment hinges on complete surgical removal of infected tissue, appropriate antibiotic therapy, and the use of suitable reconstructive techniques. Advances in management strategies have enabled more effective recovery and limb preservation in most patients, enhancing their quality of life and reducing the socioeconomic impact of the disease (Ferguson; Diefenbeck; Mcnally, 2017) [13].

3. Microorganisms and Antibiotic Therapy in Osteomyelitis

Osteomyelitis is a complex bone infection that can be caused by a wide variety of pathogenic microorganisms. The most frequently isolated etiological agent in cultures of infected tissues is Staphylococcus aureus, due to its high capacity to adhere to bone surfaces and to form biofilms, making it highly resistant to host defense mechanisms and conventional antimicrobials (Mayberry-Carson *et al*., 1984) [26]. This biofilm impedes the penetration of antibiotics, contributing to the chronicity of the infection (Barker *et al*., 2017) [5].

In addition to S. aureus, other microorganisms commonly associated with osteomyelitis include coagulase-negative staphylococci, Cutibacterium acnes, and Gram-negative bacilli, particularly in infections associated with orthopedic implants and peri-prosthetic infections (Sheehy *et al*., 2010). In these cases, the removal of the infected implant may be necessary to eradicate the infection, as the presence of inert material favors the formation of bacterial biofilm (Street *et al*., 2017).

Often, osteomyelitis is not monomicrobial but polymicrobial, involving a combination of aerobic and anaerobic bacteria. Pathogens such as Clostridium spp. and Nocardia spp. are frequently isolated in infections secondary to open fractures, while Pseudomonas aeruginosa is associated with chronic infected ulcers, particularly in diabetic and immunocompromised patients (Libraty; Patkar; Torres, 2012) [24]. Patients with osteogenesis imperfecta have an increased risk of developing osteomyelitis and septic arthritis, which can further worsen the prognosis and complicate the therapeutic approach (Bobak *et al*., 2024).

The rising prevalence of multi-resistant microorganisms is one of the main challenges in treating osteomyelitis. Prolonged and inappropriate use of antibiotics has contributed to the selection of resistant strains, making infection eradication increasingly complex (Sendi *et al*., 2014). Therefore, antibiotic treatment should be guided by microbiological sensitivity testing, ensuring a personalized and effective approach (Sheehy *et al*., 2010).

Optimization of microbiological diagnosis is crucial to direct appropriate antibiotic therapy. Advanced techniques such as PCR (Polymerase Chain Reaction) and genetic sequencing have shown greater sensitivity in detecting pathogens, allowing for faster and more accurate diagnosis (Street *et al*., 2017). Moreover, the use of sonication of infected orthopedic devices has been widely adopted to increase the recovery rate of pathogenic microorganisms in implant-associated infections (Sheehy *et al*., 2010).

Tissue sample collection must be rigorously performed to minimize contamination and maximize diagnostic accuracy. The ideal method involves obtaining multiple samples from different regions of the lesion and suspending the use of systemic antibiotics at least 48 hours before collection, whenever possible (Sheehy *et al*., 2010). Additionally, the identification of biofilms in clinical samples has proven to be an important marker for predicting therapeutic failure and the need for aggressive surgical approaches (Barker *et al*., 2017) [5].

The choice of the ideal antimicrobial depends on multiple factors, including the susceptibility of the identified pathogen, the presence of biofilm, the pharmacokinetics and pharmacodynamics of the antibiotic, and the drug's ability to penetrate the infected bone (Ziran; Rao; Hall, 2003). The most used antibiotics include beta-lactams, glycopeptides (such as vancomycin), and quinolones, with the choice of specific regimen being individualized (Ferguson; Diefenbeck; Mcnally, 2017) [13].

The use of local antibiotics has become a valuable strategy in the management of osteomyelitis. Controlled-release devices, such as polymethylmethacrylate (PMMA) beads impregnated with antibiotics and ceramic biocomposites, have been used to deliver high concentrations of antimicrobials directly at the infection site, reducing adverse systemic effects (Ferguson *et al*., 2017) [13]. Recent studies show that this approach can significantly increase the infection eradication rate when combined with appropriate surgical debridement (Mcnally; Nagarajah, 2010) [27].

Prolonged administration of systemic antibiotics is necessary in most cases, typically for a minimum of 6 weeks, and may extend for several months depending on the clinical response and severity of the infection (Bode *et al*., 2010) [7]. Regular laboratory monitoring, including serum antibiotic levels and inflammatory markers such as CRP (C-Reactive Protein) and ESR (Erythrocyte Sedimentation Rate), should be performed to evaluate the efficacy of the treatment and identify potential complications (Olesen *et al*., 2015).

Treatment failure in osteomyelitis can result in infection progression, leading to irreversible sequelae, including osteonecrosis, bone deformities, and in extreme cases, amputation of the affected limb (Barshes *et al*., 2016) [6]. Therefore, a multidisciplinary approach, involving orthopedists, plastic surgeons, infectious disease specialists, and microbiologists, is essential to ensure effective treatment and prevent recurrences (Mcnally; Nagarajah, 2010) [27].

Early identification of acute osteomyelitis is crucial to avoid severe complications. A systematic approach, including laboratory tests, advanced imaging, and early therapeutic intervention, significantly improves clinical outcomes (Aiken *et al*., 2024). Advances in molecular diagnostic techniques and the introduction of new local therapies represent significant progress in managing this complex infection, contributing to better clinical and functional outcomes (Ferguson; Diefenbeck; Mcnally, 2017) [13].

4. Principles of Surgical Treatment of Osteomyelitis

Osteomyelitis poses a significant therapeutic challenge due to its pathogenic complexity and the need for specialized multidisciplinary approaches. Clinical and surgical management should be coordinated by a team comprised of orthopedists specialized in bone infections, infectious disease specialists, and, when necessary, plastic surgeons for soft tissue reconstruction. Radiologists play an essential role in interpreting imaging studies, assisting in proper surgical planning.

In specific cases, vascular surgeons, physical therapists, and psychologists may be included in the treatment, providing a comprehensive and integrated approach to patient care (Aiken *et al*., 2024). Plain radiography remains one of the most commonly used initial exams for detecting bone changes suggestive of osteomyelitis. However, magnetic resonance imaging is crucial for assessing the extent of bone and adjacent soft tissue involvement, providing detailed information for surgical strategy (Foti *et al*., 2023) [14]. In cases of diagnostic uncertainty, exams such as dual-energy computed tomography and bone scintigraphy can complement the evaluation (Street *et al*., 2017).

Most patients with chronic osteomyelitis present comorbidities that directly impact their healing capacity and the efficacy of antibiotic therapy. Thus, optimizing the clinical state is essential before surgical procedures. These patients often exhibit chronic inflammation and a catabolic state, frequently accompanied by malnutrition. Nutritional support is indispensable to promote proper tissue repair and reduce postoperative complications (Bode *et al*., 2010) [7].

The choice of anesthesia technique directly impacts postoperative recovery. Regional anesthesia, such as epidural blockade, has been widely used to minimize physiological stress on the patient and improve postoperative pain control (Kettner *et al*., 2011) [20]. Moreover, adequate pain management reduces the need for opioids, favoring early mobilization and preventing complications associated with prolonged immobility (Aiken *et al*., 2024).

Surgical intervention in osteomyelitis must follow fundamental principles to ensure the eradication of the infection and promote functional reconstruction of the affected limb. The primary objectives of surgery include the removal of bacterial biofilm and necrotic tissues, as the biofilm protects microorganisms against the host's immune response and the action of antibiotics, making its complete resection essential (Barker *et al*., 2017) [5]. Furthermore, accurate microbiological sampling is crucial, as the collection of representative tissue samples for culture and sensitivity testing guides targeted antibiotic therapy (Sheehy *et al*., 2010).

Managing dead space is another essential consideration, as the presence of post-resection bone cavities favors infection persistence and must be addressed (Ferguson *et al*., 2017) [13]. Bone stabilization is indispensable to reduce complications related to poor consolidation and secondary osteopenia (Caterson *et al*., 2015) [9]. Soft tissue coverage also plays a key role in improving healing and preventing recurrent infections (Luo *et al*., 2024) [25].

Complete removal of necrotic tissue is the most important step in the surgical treatment of osteomyelitis, covering all compromised areas, including adjacent tissues, to avoid the persistence of infectious niches (Sendi *et al*., 2014). Bone stabilization contributes to restoring the biomechanics of the limb and avoiding secondary complications, such as joint contractures and muscle injuries (Ziran *et al*., 2003).

Filling the dead space is a fundamental measure to prevent fluid accumulation and new infectious foci. For this purpose, synthetic bone grafts impregnated with antibiotics, such as bone cement with gentamicin or vancomycin, can be used, providing high local concentrations of the drug, favoring infection eradication (Ferguson; Diefenbeck; McNally, 2017) [13]. Osteomyelitis can cause extensive fibrosis of the soft tissues and osteocutaneous fistulas, complicating primary wound closure.

Reconstruction may be performed using muscular or musculocutaneous flaps, which offer advantages such as increased local vascularization and enhanced healing. Microsurgical transfer of composite flaps is an alternative for large bone and soft tissue defects (Olesen *et al*., 2015).

Coverage with vascularized flaps improves tissue regeneration, reduces the risk of infection, and forms a protective barrier against nosocomial organisms. Additionally, muscular flaps promote greater blood perfusion in the affected area, enhancing the penetration of systemic antibiotics and the recruitment of immune cells (Aiken *et al*., 2024). Surgical treatment of osteomyelitis requires a structured approach based on evidence, integrating microbiological diagnosis, aggressive tissue resection, and functional reconstruction.

The combination of strategies such as local antibiotic therapy and adequate skin coverage has proven effective in eradicating the infection and preventing relapses (McNally; Nagarajah, 2010) [27]. Recent advances, such as the use of antibiotic-impregnated biocomposites and microsurgical reconstruction techniques, have revolutionized the management of chronic osteomyelitis, allowed better limb preservation and optimized functional recovery (Ferguson *et al*., 2017 [13]; Bobak *et al*., 2024).

5. Single-Stage Versus Multiple Approaches

At the Hospital de Base of the Federal District, the surgical approach to osteomyelitis follows protocols based on scientific evidence, prioritizing bone excision and soft tissue reconstruction in a single surgical stage whenever possible. Recent studies demonstrate that early coverage is directly associated with lower infection rates and reduced hospitalization time, favoring patient recovery and minimizing postoperative complications (Aiken *et al*., 2024; Ferguson *et al*., 2017 [13]).

Conversely, delayed reconstruction is associated with a significant increase in bacterial colonization at the surgical site, promoting biofilm formation and consequently increasing the risk of osteomyelitis recurrence. Additionally, evidence suggests that delays in reconstruction correlate with increased bacterial resistance to antibiotic therapy, making treatment more prolonged and challenging (Barker *et al*., 2017 [5]; Sheehy *et al*., 2010).

The decision between single-stage and multiple approaches depends on several factors, including the extent of the infection, the presence of comorbidities, and the patient's hemodynamic stability. In cases where bone infection is extensive or the viability of soft tissues is compromised, multiple surgical stages may be necessary to ensure complete eradication of the infection before definitive reconstruction (McNally; Nagarajah, 2010) [27].

Where a single-stage approach is feasible, the technique involves aggressive resection of necrotic tissue, followed by bone reconstruction and soft tissue coverage in the same intervention. This strategy has been widely adopted due to its effectiveness in reducing reinfection and improving clinical outcomes (Ferguson *et al*., 2017; Ferguson; Diefenbeck; McNally, 2017) [13].

In contrast, the approach involving multiple surgical stages includes performing serial debridements to control the infection, often combined with negative pressure therapy (NPT) to optimize wound preparation. NPT allows efficient drainage of exudate and promotes granulation tissue formation, being a widely used adjunctive resource in clinical practice (Olesen *et al*., 2015; Sendi *et al*., 2014).

However, recent studies indicate that prolonged use of negative pressure therapy can result in increased bacterial colonization by skin microorganisms, which can adhere to internal bone fixation material, complicating complete eradication of the infection (Bode *et al*., 2010; Luo *et al*., 2024) [7, 25]. Thus, while NPT is a valuable tool, its use should be carefully indicated and monitored.

Another factor to consider when choosing between single and multiple surgical stages is the financial and logistical impact. Treatment performed in multiple stages generally implies longer hospital stays, increased hospital costs, and higher morbidity associated with multiple anesthetic and surgical procedures (Bobak *et al*., 2024; Caterson *et al*., 2015 [9]).

Moreover, the need for multiple interventions can compromise the patient's quality of life, prolonging the rehabilitation period and increasing the risks of secondary complications, such as muscular atrophy and joint mobility restriction (Ziran *et al*., 2003; Street *et al*., 2017).

Managing osteomyelitis requires meticulous surgical planning and a multidisciplinary approach, involving orthopedists, infectious disease specialists, plastic surgeons, and physical therapists. The integration among these specialties is crucial to ensure that the choice between a single stage or multiple approaches is made based on the best prognosis for the patient (Aiken *et al*., 2024).

In cases of single-time reconstruction, the use of antibiotic-impregnated biocomposites has proven to be an effective strategy for filling bone defects and preventing the formation of dead spaces, significantly reducing the risk of infection persistence (Foti *et al*., 2023; Ferguson *et al*., 2017) [14, 13]. On the other hand, when opting for a multiple-stage approach, the use of antibiotic-impregnated spacers can be an alternative to ensure local release of antimicrobial agents and improve infection control before definitive reconstruction (McNally; Nagarajah, 2010) [27].

Studies indicate that the choice between one or multiple stages should consider not only the eradication of the infection but also the preservation of the function of the affected limb. Patients undergoing late bone reconstructions have higher rates of complications, including graft integration failures and the need for additional procedures to correct residual deformities (Ferguson *et al*., 2017; Luo *et al*., 2024) [13, 25].

Another crucial aspect of managing osteomyelitis is the optimization of perioperative antibiotic therapy. The selection of the antimicrobial regimen should be based on microbiological identification and the sensitivity profile of the involved bacteria, avoiding the indiscriminate use of broad-spectrum antibiotics (Sheehy *et al*., 2010; Ferguson *et al*., 2017 [13]).

Individualization of treatment is essential to achieve better clinical outcomes, minimizing the impact of infection on the patient's quality of life. The combination of aggressive resection, appropriate antibiotic therapy, and early reconstruction represents the ideal strategy to reduce recurrence rates of osteomyelitis and improve functional outcomes (Aiken *et al*., 2024). Thus, at the Hospital de Base of the Federal District, the decision on the most appropriate approach for each case of osteomyelitis is made based on updated protocols and robust scientific evidence, ensuring efficient and safe treatment for patients affected by this complex condition.

6. Choice of Flap

Soft tissue reconstruction in osteomyelitis is a significant challenge, especially in cases involving the tibia, where the availability of viable local tissues is limited. This limitation is more pronounced in the middle and lower thirds of the tibia, areas where vascularization is often compromised due to the scarcity of well-perfused adjacent tissues. The complexity of surgical management requires an individualized approach to ensure the viability of the flap and adequate coverage of the bone defect.

Studies show that pedicled flaps in lower limbs are associated with high complication rates, including partial or total necrosis, especially in patients with systemic comorbidities. Among the most significant risk factors for flap failure are diabetes mellitus, chronic venous insufficiency, peripheral arterial disease, and smoking (Barker *et al*., 2017; Ferguson *et al*., 2017) [5, 13].

Diabetes mellitus, for example, contributes to microvascular dysfunction and reduced tissue perfusion, compromising healing capacity and increasing the risk of recurrent infection. Chronic venous insufficiency also plays a crucial role, as venous stasis can lead to persistent edema, tissue hypoxia, and delayed wound repair (Aiken *et al*., 2024).

Moreover, peripheral arterial disease directly affects the viability of flaps, hindering adequate graft nutrition and predisposing to necrosis. Smokers have an even higher risk of flap integration failure due to the deleterious effects of tobacco on microcirculation, resulting in vasoconstriction and tissue hypoxemia (Sheehy *et al*., 2010).

Given the high failure rate associated with pedicled flaps, many surgical teams have opted for microsurgical techniques, such as free micro vascularized flaps, for covering defects in lower limbs. These flaps have better success rates due to direct revascularization, allowing greater blood supply and better integration of the graft to the recipient bed (McNally; Nagarajah, 2010) [27].

Among the most used options for tibia reconstruction are the free latissimus dorsi muscle flap and the anterolateral thigh flap. The latissimus dorsi muscle flap is widely used due to its reliability, extensive reach, and versatility, providing good coverage of large bone defects. The anterolateral thigh flap, on the other hand, offers the advantage of being a fascio cutaneous flap, which facilitates adaptation to the leg contour and minimizes donor site morbidity (Olesen *et al*., 2015).

The decision between pedicled and microsurgical flap should consider not only the clinical conditions of the patient but also the extent of the bone defect and the vascular conditions of the recipient area. For patients with poor vascular status or contraindications to microsurgical procedures, alternative techniques such as dermo epidermal grafts or negative pressure therapy combined with local flaps may be explored (Foti *et al*., 2023; Ferguson *et al*., 2017) [14, 13].

Another crucial aspect of planning reconstruction is the prevention of complications, such as wound dehiscence, secondary infection, and flap loss. The use of targeted antibiotic therapy, based on the microbiological culture of the surgical site, is essential to prevent bacterial colonization and optimize the integration of the graft into the underlying tissue (Sendi *et al*., 2014).

Moreover, rigorous postoperative monitoring, including assessment of tissue perfusion and early interventions in cases of vascular distress of the flap, can significantly improve the functional and aesthetic outcomes of the reconstruction (Luo *et al*., 2024) [25].

In cases where there is severe vascular impairment of the limb or recurrent infection, amputation may be considered as a therapeutic alternative to improve the patient's quality of life. However, this decision should be made based on well-established criteria and after multidisciplinary discussion, ensuring that all limb salvage options have been exhausted (Ferguson; Diefenbeck; McNally, 2017) [13].

The individualization of the surgical approach is essential to optimize outcomes and minimize morbidity associated with the reconstructive procedure. The choice of flap should be based on anatomical, physiological, and microbiological criteria, ensuring that the adopted strategy offers the best conditions for the functional recovery of the affected limb (McNally; Nagarajah, 2010) [27].

The surgical team's experience and the hospital's infrastructure also play a decisive role in choosing the reconstructive technique. Centers with expertise in microsurgery have better success rates with free flaps, reducing the incidence of complications and optimizing patient recovery times (Aiken *et al*., 2024).

At the Hospital de Base of the Federal District, the approach to soft tissue reconstruction in cases of osteomyelitis follows updated protocols based on scientific evidence, prioritizing techniques that ensure the best viability of tissues and minimize complication rates. Continuous monitoring and reevaluation of protocols ensure that patients receive the most advanced and safe treatment.

Thus, the selection of the most appropriate flap should always consider the complexity of the case and the clinical condition of the patient, ensuring effective treatment and reducing the risk of osteomyelitis recurrence. The adoption of modern reconstruction techniques and the use of advanced biomaterials have revolutionized the approach to reconstructive surgery, allowing for better clinical and functional outcomes for patients afflicted by this challenging condition (Bobak *et al*., 2024).

7. Conclusion

The treatment of osteomyelitis is a complex challenge that requires a structured multidisciplinary approach, based on scientific evidence and adapted to the individual needs of each patient. At the Hospital de Base of the Federal District, the therapeutic strategy for osteomyelitis follows updated protocols, prioritizing interventions that promote the eradication of the infection and the functional restoration of the affected limb.

The choice between a single-stage or multiple surgical approaches must consider the severity of the infection, the viability of the soft tissues, and the clinical conditions of the patient. Evidence indicates that early soft tissue coverage significantly reduces infection rates and hospitalization time, while delayed reconstruction is associated with a higher risk of infection recurrence and bacterial biofilm development (Aiken *et al*., 2024; Ferguson *et al*., 2017 [13]).

The use of negative pressure therapy as an adjunct in multi-stage treatment has shown benefits in wound preparation, promoting better vascularization and infection control. However, its prolonged use can lead to colonization by resistant microorganisms, requiring careful monitoring to avoid additional complications (Bode *et al*., 2010; Luo *et al*., 2024) [7, 25].

The surgical approach should follow fundamental principles, including complete removal of necrotic tissue, accurate microbiological sampling, proper management of dead space, bone stabilization, and efficient soft tissue coverage. The use of antibiotic-impregnated biocomposites has proven to be an effective strategy to prevent the persistence of infection, contributing to a better functional prognosis (Ferguson *et al*., 2017; McNally; Nagarajah, 2010) [13, 27].

The choice of flaps for lesion coverage should consider the viability of local tissues, the vascular condition of the recipient area, and the patient's comorbidities. Pedicled flaps have high failure rates in individuals with diabetes, chronic venous insufficiency, and peripheral arterial disease, making free micro vascularized flaps preferable in these cases (Olesen *et al*., 2015; Sheehy *et al*., 2010).

Antibiotic therapy plays a crucial role in eradicating the infection and should be guided by microbiological tests and adjusted according to the clinical response of the patient. The individualization of the antimicrobial regimen is essential to reduce the risk of bacterial resistance and optimize therapeutic outcomes (Sendi *et al*., 2014; Ferguson *et al*., 2017 [13]).

Postoperative rehabilitation should also be integrated into the therapeutic plan, involving physical therapists and occupational therapists to ensure the functional recovery of the patient. Early mobilization and rigorous pain control are determining factors to avoid secondary complications and improve the quality of life of individuals affected by osteomyelitis (Aiken *et al*., 2024).

Advances in surgical techniques, the development of new biomaterials, and the implementation of evidence-based strategies have revolutionized the management of osteomyelitis, allowing for better success rates and reduced associated morbidity. At the Hospital de Base of the Federal District, the multidisciplinary approach and the use of cutting-edge technology have provided increasingly positive outcomes for patients undergoing treatment for this challenging condition.

Given the complexity of osteomyelitis, therapeutic decision-making must be based on a careful evaluation of each case, prioritizing strategies that combine effective infection eradication with the functional preservation of the limb. The individualization of treatment and adherence to evidence-based protocols continue to be fundamental pillars to achieve better clinical results and ensure the recovery of patients affected by this debilitating pathology.

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