

SURGICAL MANAGEMENT OF MEDICATION-RELATED OSTEONECROSIS OF THE JAW (MRONJ)

MANEJO CIRÚRGICO DA OSTEONECROSE DOS MAXILARES ASSOCIADA A MEDICAMENTOS (MRONJ)

TRATAMIENTO QUIRÚRGICO DE LA OSTEONECROSIS MANDIBULAR INDUCIDA POR FÁRMACOS (MRONJ)



<https://doi.org/10.56238/sevened2026.021-002>

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ABSTRACT

Medication-related osteonecrosis of the jaw (MRONJ) is a pathological condition with multifactorial etiology, commonly associated with the use of antiresorptive and antiangiogenic drugs. This study aimed to analyze, through an integrative literature review, the scientific evidence regarding the surgical management of MRONJ, focusing on indications, techniques, and clinical outcomes. The bibliographic search was conducted in scientific databases, including studies published between 2016 and 2025. Clinical studies, systematic reviews, and guidelines addressing surgical treatment were included. The findings demonstrated that surgical management is more effective than conservative approaches, particularly in advanced stages, and is strongly associated with complete removal of necrotic tissue. More extensive surgical techniques showed higher success rates, although the choice of procedure should be individualized. Adjunctive therapies have shown promising results but still lack standardization. Additionally, a shift in clinical guidelines toward early surgical intervention was observed. It is concluded that surgical treatment represents the main therapeutic strategy for MRONJ, and further high-level evidence studies are needed to establish standardized clinical protocols.

Keywords: Osteonecrosis of the Jaw. MRONJ. Surgical Treatment. Oral and Maxillofacial Surgery.

RESUMO

A osteonecrose dos maxilares associada a medicamentos (MRONJ) é uma condição patológica de etiologia multifatorial, frequentemente relacionada ao uso de fármacos antirreabsortivos e antiangiogênicos. O presente estudo teve como objetivo analisar, por meio de uma revisão integrativa da literatura, as evidências científicas acerca do manejo cirúrgico da MRONJ, com ênfase nas indicações, técnicas e resultados clínicos. A busca bibliográfica foi realizada em bases de dados científicas, considerando estudos publicados entre 2016 e 2025. Foram incluídos artigos clínicos, revisões sistemáticas e diretrizes que abordassem o tratamento cirúrgico da doença. Os resultados evidenciaram que a abordagem cirúrgica apresenta maior eficácia quando comparada ao tratamento conservador, especialmente em estágios avançados, estando diretamente associada à remoção completa do tecido necrótico. Técnicas mais extensas demonstraram melhores taxas de sucesso, embora a escolha do procedimento deva ser individualizada. O uso de terapias adjuvantes mostrou-se promissor, porém ainda carece de padronização. Além disso, observou-se uma mudança nas diretrizes clínicas, com maior indicação de intervenções cirúrgicas precoces. Conclui-se que o tratamento cirúrgico representa a principal estratégia terapêutica na MRONJ, sendo necessário o desenvolvimento de estudos com maior nível de evidência para consolidação dos protocolos clínicos.

Palavras-chave: Osteonecrose dos Maxilares. MRONJ. Tratamento Cirúrgico. Cirurgia Bucomaxilofacial.

RESUMEN

La osteonecrosis mandibular asociada a fármacos (ONMF) es una patología de etiología multifactorial, frecuentemente relacionada con el uso de fármacos antirresorptivos y antiangiogénicos. Este estudio tuvo como objetivo analizar, mediante una revisión bibliográfica integradora, la evidencia científica sobre el tratamiento quirúrgico de la ONMF, con énfasis en las indicaciones, las técnicas y los resultados clínicos. La búsqueda bibliográfica se realizó en bases de datos científicas, considerando estudios publicados entre 2016 y 2025. Se incluyeron artículos clínicos, revisiones sistemáticas y guías que abordan el tratamiento quirúrgico de la enfermedad. Los resultados mostraron que el abordaje quirúrgico es más efectivo que el tratamiento conservador, especialmente en estadios avanzados, al estar directamente asociado con la eliminación completa del tejido necrótico.

Las técnicas más extensas demostraron mejores tasas de éxito, aunque la elección del procedimiento debe individualizarse. El uso de terapias adyuvantes ha mostrado resultados prometedores, pero aún carece de estandarización. Además, se observó un cambio en las guías clínicas, con una mayor indicación de intervenciones quirúrgicas tempranas. Se concluye que el tratamiento quirúrgico representa la principal estrategia terapéutica en la osteonecrosis maxilar relacionada con medicamentos (MRONJ), y se requieren estudios adicionales con un mayor nivel de evidencia para consolidar los protocolos clínicos.

Palabras clave: Osteonecrosis Maxilar. MRONJ. Tratamiento Quirúrgico. Cirugía Oral y Maxilofacial.

1 INTRODUCTION

Medication-Related Osteonecrosis of the Jaw (MRONJ) is a pathological condition characterized by persistent bone exposure or the presence of fistulas that communicate with the bone in the maxillofacial region, in patients undergoing the use of antiresorptive and/or antiangiogenic drugs, in the absence of a history of local radiotherapy (BEDOGNI et al., 2024; DE CICCIO et al., 2023). Initially described in the early 2000s in association with the use of bisphosphonates, the MRONJ had its etiological spectrum broadened with the introduction of other drugs, such as denosumab and antiangiogenic agents, consolidating itself as a relevant complication in dental and medical clinical practice (ÖZALP et al., 2021; DE CICCIO et al., 2023).

From the pathophysiological point of view, RONJ has a multifactorial etiology, involving the suppression of bone remodeling, the inhibition of osteoclastic activity, the impairment of angiogenesis, and the maintenance of chronic inflammatory processes, often associated with local triggering factors, such as tooth extractions and odontogenic infections (OH; KIM, 2024; DE CICCIO et al., 2023). In addition, systemic factors and local conditions, such as periodontal diseases and poor oral hygiene, contribute significantly to the development and progression of the disease, evidencing the complexity of its pathogenesis (BEDOGNI et al., 2024).

Clinically, ONJM has a wide variability of manifestations, and can progress from asymptomatic stages to advanced stages with severe pain, infection, extensive bone exposure, and significant functional impairment, negatively impacting the quality of life of patients (BEDOGNI et al., 2024; DE CICCIO et al., 2023). The diagnosis is based on the correlation between clinical findings and imaging tests, and computed tomography is essential for the evaluation of the extent of the lesion, staging, and appropriate therapeutic planning (BEDOGNI et al., 2024).

Historically, the management of RONJ has been based on conservative approaches, focusing on symptom control and prevention of disease progression. However, such strategies have demonstrated important limitations, especially in advanced stages, in which the rate of complete resolution is reduced (OH; KIM, 2024). Recent clinical studies and reviews show that surgical treatment, particularly when it involves the complete removal of necrotic bone, has superior healing rates and infection control, making it the most effective approach in these cases (ÖZALP et al., 2021; KOBAYASHI et al., 2022; HSU et al., 2021). This paradigm shift reflects the growing understanding of the limitations of conservative treatment and the need for more resolute interventions.

In this context, there is a contemporary trend towards earlier indication of surgical treatment, often associated with adjuvant therapies, such as the use of platelet concentrates, which contribute to tissue regeneration and improved clinical outcomes (DE CICCIO et al., 2023; ÖZALP et al., 2021). Therefore, the present study aims to analyze, through an integrative literature review, the scientific evidence on the surgical management of osteonecrosis of the jaws associated with medications, emphasizing its indications, techniques, and clinical results.

2 METHODOLOGY

This is a qualitative study, characterized as an integrative review of the literature, whose objective is to gather, critically analyze and synthesize the available scientific evidence on the surgical management of drug-associated osteonecrosis of the jaws (MRONJ). The choice of this methodological design is justified by its ability to integrate results from different types of studies, including clinical research, systematic reviews, meta-analyses and guidelines, enabling a comprehensive and in-depth understanding of the investigated theme.

The bibliographic search was conducted in widely recognized scientific databases, including PubMed/MEDLINE, Scopus, Embase and Web of Science, using controlled descriptors and keywords in English. The search strategy was structured based on the combination of the following terms: ("medication-related osteonecrosis of the jaw" OR "MRONJ") AND ("surgical management" OR "surgery" OR "treatment"), with the use of the Boolean operators AND and OR. The established time frame comprised the period from 2016 to 2025, with the objective of contemplating updated scientific evidence in line with contemporary trends in the management of the disease.

The inclusion criteria included original scientific articles, systematic reviews, meta-analyses, and clinical guidelines that directly addressed the surgical management of RONJ in humans, available in full and published in English. Duplicate studies, experimental research in animal models, isolated case reports, conference abstracts, letters to the editor, and publications that did not adhere to the proposed objective were excluded. The definition of these criteria sought to ensure the selection of evidence with greater scientific relevance and clinical applicability.

The study selection process was carried out sequentially and carefully. Initially, the screening was carried out by reading the titles and abstracts, in order to identify potentially relevant publications. Subsequently, the selected studies were submitted to full reading, including those that fully met the previously established criteria. At the end of the process, 16

studies considered pertinent to the theme were included, which make up the corpus of this integrative review, covering different methodological designs and levels of scientific evidence.

Data analysis was conducted using a descriptive and interpretative approach, with organization of findings into previously defined thematic categories, including pathophysiology of ONJM, diagnostic criteria, indications for surgical treatment, surgical techniques, adjuvant therapies, and clinical outcomes. This systematization allowed the comparison between different therapeutic approaches, as well as the identification of patterns, convergences, and gaps in the literature, contributing to a consistent critical analysis guided by the available evidence.

3 RESULTS AND DISCUSSION

3.1 SURGICAL MANAGEMENT OF MRONJ

The studies included in this review consistently demonstrate that surgical management of drug-associated osteonecrosis of the jaws (RONJM) is more effective when compared to conservative approaches, especially in advanced stages of the disease. Evidence from clinical studies and systematic reviews indicates resolution rates greater than 80% after surgical intervention, particularly when there is complete removal of necrotic tissue, in contrast to conservative treatment, which is predominantly limited to symptomatic control and has a low rate of definitive resolution (KOBAYASHI et al., 2022; HSU et al., 2021; OH; KIM, 2024).

Despite this consensus, it is important to highlight that most of the available evidence derives from retrospective studies and case series, which imposes relevant methodological limitations, such as the absence of randomization and heterogeneity of therapeutic protocols. Still, the consistency of findings across different studies reinforces the superiority of surgical treatment over conservative approaches, especially in more extensive lesions (NISI et al., 2020; OKUYAMA et al., 2020).

Historically, the management of RONJ has been guided by conservative strategies, motivated by the fear of worsening bone necrosis after surgical interventions. However, the evolution of scientific knowledge has shown that such approaches have significant limitations, particularly in moderate and advanced stages, in which disease progression is frequent. This scenario led to the reformulation of clinical guidelines, which began to recognize the benefits of early surgical intervention as a more effective strategy (DE CICCIO et al., 2023; BEDOGNI et al., 2024).

Additionally, studies that address more severe cases of RONJ show that the absence of surgical intervention can favor the progression of the disease to adjacent structures,

including severe complications, such as skull base involvement and systemic infections, reinforcing the importance of a more active approach to the management of the condition (YOSHIZAWA et al., 2019; YAMAGATA et al., 2016). Thus, the current trend points to a paradigm shift, in which surgical treatment is no longer a late option and starts to occupy a central role in the therapy of MRONJ.

3.2 SURGICAL TECHNIQUES EMPLOYED

The surgical techniques used in the management of RONJ vary according to the extent of the lesion and the stage of the disease, and are generally classified into conservative and radical approaches. Among the procedures most described in the literature, sequestrectomy, curettage, and bone resection stand out, with or without safety margins. Evidence indicates that more extensive approaches, which include complete removal of necrotic bone to reach viable tissue, are associated with better clinical outcomes when compared to more conservative techniques (OKUYAMA et al., 2020; NISI et al., 2020).

The achievement of viable and bleeding bone margins is considered one of the main determinants of therapeutic success, since the permanence of necrotic tissue is directly related to disease recurrence (SHIN; KIM, 2018). In this sense, resection with safety margins has been progressively adopted as the preferred strategy in more advanced cases, despite its greater surgical impact.

However, the choice of surgical technique is still the subject of debate in the literature, especially in relation to the ideal extent of resection. While some studies advocate for more aggressive approaches aimed at maximizing the cure rate, others point to the need to preserve anatomical structures and function, particularly in patients with significant comorbidities or systemic impairment (BEDOGNI et al., 2024). This divergence reflects the lack of standardization in surgical protocols and the heterogeneity of the available studies.

In addition, it should be considered that much of the evidence on surgical techniques derives from retrospective studies and case series, which limits the generalization of results and makes it difficult to directly compare different approaches. The variability in the criteria for surgical indication, extent of resection, and use of associated therapies contributes to the lack of consensus in the literature (HSU et al., 2021).

Thus, the choice of surgical approach should be individualized, taking into account factors such as the extent of the lesion, the stage of the MRONJ, the patient's systemic conditions, and the surgeon's experience. The current trend points to a more problem-solving approach, based on the complete removal of necrotic tissue, associated with functional

preservation whenever possible, seeking to balance therapeutic efficacy and surgical morbidity.

3.3 PROGNOSIS AND ASSOCIATED FACTORS

The prognosis of drug-associated osteonecrosis of the jaws (MRONJ) is directly related to the adequacy of the therapeutic approach adopted, being strongly influenced by the extent of the lesion and the complete removal of necrotic tissue. Clinical studies have shown that the persistence of devitalized bone after surgical treatment is associated with higher rates of treatment failure and recurrence, highlighting the importance of a problem-solving surgical approach (OKUYAMA et al., 2020; SHIN; KIM, 2018).

Several studies report success rates of over 80% after surgical intervention, particularly when performed under appropriate planning and execution conditions (KOBAYASHI et al., 2022; HSU et al., 2021). However, these results should be interpreted with caution, since most of the available evidence derives from retrospective studies, with heterogeneity of diagnostic criteria, staging, and therapeutic protocols, which limits comparability between studies and may overestimate positive outcomes.

In addition to the factors related to the surgical technique, the patient's systemic conditions play a relevant role in the prognosis of ONJM. Factors such as chronic inflammation, systemic comorbidities, and compromised immune status have been associated with worse clinical outcomes, which can interfere with healing and favor disease progression (SHIN; KIM, 2018). These aspects reinforce the need for a comprehensive and individualized clinical evaluation in therapeutic planning.

Another relevant point concerns the stage of the disease at the time of diagnosis. Evidence suggests that interventions performed at earlier stages have better results when compared to those performed in advanced stages, in which there is greater bone impairment and risk of complications (DE CICCIO et al., 2023; BEDOGNI et al., 2024). However, this relationship is still influenced by the variability of the staging criteria adopted in the different studies.

Additionally, more severe cases of RONJM, when not adequately treated, can progress to significant complications, including spread of infection and involvement of adjacent structures, which negatively impacts prognosis and may increase patient morbidity (YOSHIZAWA et al., 2019; YAMAGATA et al., 2016). Thus, the prognosis of RONJ does not depend exclusively on surgical intervention, but results from the interaction between local, systemic, and therapeutic factors, requiring a multidimensional and individualized approach.

3.4 MAXILLARY MRONJ AND ASSOCIATED COMPLICATIONS

The occurrence of RONJ in the maxilla presents relevant clinical particularities when compared to the mandible, especially due to its close anatomical relationship with the maxillary sinus, which favors the occurrence of infectious complications, such as maxillary sinusitis. Clinical studies show that the extension of bone necrosis into the maxillary sinus can result in persistent sinusitis, making it difficult to manage the disease and negatively impacting the prognosis (PARK et al., 2020; OTSURU et al., 2022).

In this context, combined therapeutic approaches have been proposed as a strategy to optimize clinical outcomes. The association between oral and maxillofacial surgery to remove necrotic tissue and endoscopic procedures of the paranasal sinuses has shown greater efficacy in resolving infectious conditions, when compared to the isolated approach (PARK et al., 2020). This strategy allows not only the treatment of osteonecrosis, but also the adequate management of associated sinus complications, reducing the persistence of infection.

However, the literature still has limitations regarding the standardization of these combined approaches, since most of the available studies consist of retrospective analyses and case series, with small samples and heterogeneity in the protocols adopted (OTSURO et al., 2022). This limitation makes it difficult to generalize the results and reinforces the need for prospective studies that more robustly evaluate the efficacy of these interventions.

In addition, the approach to JRONJ in the maxilla often requires multidisciplinary action, involving oral and maxillofacial surgeons and otorhinolaryngologists, especially in cases with maxillary sinus involvement. This integration between specialties is essential for the appropriate management of complications and for obtaining better clinical outcomes.

Thus, although the association between maxillary RONJ and sinusitis represents an additional therapeutic challenge, current evidence suggests that integrated and more aggressive approaches can contribute significantly to the resolution of the disease. However, the absence of standardized protocols and the methodological limitations of the available studies indicate the need for greater scientific production in this area, with a view to consolidating better established guidelines for the management of these complications.

3.5 ADJUNCTIVE THERAPIES IN SURGICAL TREATMENT

The use of adjuvant therapies in the treatment of JRONJ has been widely investigated with the aim of enhancing the results obtained with surgical intervention, especially with regard to tissue healing and the reduction of postoperative complications. Among these approaches, the use of autologous platelet concentrates, such as platelet- and leukocytes-

rich fibrin (L-PRF), stands out, which has shown positive effects on bone regeneration and modulation of the local inflammatory response (ÖZALP et al., 2021; RICOTTA et al., 2021).

The available studies suggest that the application of L-PRF in surgical sites promotes gradual release of growth factors, contributing to angiogenesis and acceleration of the tissue repair process. However, despite the promising results, the evidence is still limited by small sample sizes and the absence of randomized controlled trials, which makes it difficult to standardize this approach and compare between different protocols (ÖZALP et al., 2021).

In addition to platelet concentrates, other adjuvant therapies, such as photobiomodulation (low-level laser), have been explored in an attempt to improve clinical outcomes. Although some studies point to benefits related to pain reduction and healing stimulation, there is still no consensus in the literature regarding its efficacy and clinical indication, due to the heterogeneity of the parameters used and the low methodological quality of the available studies (OH; KIM, 2024).

Additionally, the use of biomaterials and topical agents has been investigated as an alternative to optimize bone regeneration and reduce the risk of infection. However, as observed with other adjuvant therapies, the absence of standardized protocols and the scarcity of high-level studies limit their routine incorporation into clinical practice.

Thus, although adjuvant therapies represent a promising strategy in the management of RONJM, their use should be considered complementary to surgical treatment, not a substitute. Current evidence suggests that the best clinical outcomes are obtained when these approaches are coupled with complete removal of necrotic tissue, reinforcing the central role of surgery in treating the disease. Still, there is a need for prospective and controlled studies that allow the establishment of more consistent protocols based on robust evidence.

3.6 GUIDELINES AND CURRENT TRENDS IN THE MANAGEMENT OF MRONJ

Current clinical guidelines for the management of drug-associated osteonecrosis of the jaws (MRONJ) reflect a significant shift in the therapeutic paradigm observed in recent decades. Initially, the recommendations prioritized conservative approaches, focusing on symptom control and preventing disease progression. However, with the accumulation of scientific evidence, especially from clinical studies and systematic reviews, the superiority of surgical treatment in various clinical scenarios has come to be recognized (DE CICCIO et al., 2023; BEDOGNI et al., 2024).

The update of the guidelines of the American Association of Oral and Maxillofacial Surgeons (AAOMS), as well as European societies, evidences this transition, by

incorporating the indication of early surgical intervention as a valid therapeutic strategy, especially in cases with greater extent of bone necrosis. This change is directly related to the more favorable outcomes observed in patients undergoing complete necrotic tissue removal, compared to those treated exclusively by conservative methods (D.E. CICCIO et al., 2023).

However, despite this advance, there are still divergences between different international guidelines, particularly with regard to the ideal timing of surgical intervention and the extent of the procedure. While some recommendations suggest a more aggressive and earlier approach, others still indicate caution, especially in patients at high systemic risk, reflecting the absence of absolute consensus in the literature (BEDOGNI et al., 2024).

In addition, the critical analysis of the guidelines reveals that many of the recommendations are based on low- to moderate-level evidence, predominantly derived from observational studies, which limits the robustness of the conclusions and reinforces the need for controlled clinical trials. This limitation highlights one of the main challenges in the management of RONJM, which is the scarcity of high-quality evidence capable of definitively guiding clinical practice.

In this context, there is a contemporary trend towards individualization of treatment, in which the therapeutic choice is based not only on the stage of the disease, but also on the patient's systemic conditions, the extent of the lesion, and the professional's experience. This personalized approach seeks to balance treatment efficacy with minimizing surgical morbidity, reflecting a more patient-centered clinical practice.

Thus, current guidelines point to a more dynamic and evidence-based approach, in which surgical treatment plays a central role in the management of RONJM. However, the heterogeneity of the available studies and the lack of standardization reinforce the need for greater scientific production, especially prospective and randomized studies, which allow the consolidation of more consistent and widely accepted therapeutic protocols.

4 CONCLUSION

It is concluded that the surgical management of osteonecrosis of the jaws associated with drugs is the most effective therapeutic approach, especially in advanced stages of the disease, with higher resolution rates when compared to conservative treatment. The complete removal of necrotic tissue is a determining factor for clinical success, and can be enhanced by the use of adjuvant therapies. In addition, there is a current trend towards early indication of surgical intervention, although there are still gaps in the literature regarding the standardization of protocols, reinforcing the need for studies with a higher level of evidence.

REFERENCES

- Bedogni, A., et al. (2024). Italian position paper (SIPMO/SICMF) on medication-related osteonecrosis of the jaw (MRONJ). *Journal of Bone Oncology*.
- De Cicco, D., et al. (2023). Medication-related osteonecrosis of the jaws: A comparison of SICMF–SIPMO and AAOMS guidelines. *Diagnostics*, 13(13), 2137.
- Hsu, K. J., et al. (2021). Investigation of the effectiveness of surgical treatment on medication-related osteonecrosis of the jaw: A systematic review. *Journal of Clinical Medicine*.
- Kobayashi, E., et al. (2022). Prognosis of medication-related osteonecrosis of the jaw with surgical treatment. *Journal of Oral and Maxillofacial Surgery*.
- Nisi, M., et al. (2020). Surgical management of medication-related osteonecrosis of the jaw related to dental implants. *Clinical Oral Implants Research*.
- Okuyama, K., et al. (2020). Surgical strategy for medication-related osteonecrosis of the jaw in the maxilla. *Journal of Oral and Maxillofacial Surgery*.
- Otsuru, M., et al. (2022). Retrospective analysis of treatment outcomes of maxillary sinusitis associated with medication-related osteonecrosis of the jaw. *Journal of Oral and Maxillofacial Surgery*.
- Park, J., et al. (2020). Medication-related osteonecrosis of the maxilla: Surgical management combined with endoscopic sinus surgery. *Journal of Craniofacial Surgery*.
- Ricotta, F., et al. (2021). The use of platelet-rich plasma in the management of medication-related osteonecrosis of the jaw. *Minerva Stomatologica*.
- Shin, W., & Kim, C. H. (2018). Prognostic factors for outcome of surgical treatment in medication-related osteonecrosis of the jaw. *Journal of Cranio-Maxillofacial Surgery*.
- Özalp, Ö., et al. (2021). Promising results of surgical management of advanced medication-related osteonecrosis of the jaw with L-PRF application. *Journal of Stomatology, Oral and Maxillofacial Surgery*.
- Oh, S., & Kim, Y. (2024). Medication-related osteonecrosis of the jaw: A rapid review of treatment strategies. *Journal of Oral Medicine*.
- Kim, J., et al. (2025). Medication-related osteonecrosis of the jaw: An evidence-based position statement. *Journal of Bone Metabolism*.
- Yoshizawa, Y., et al. (2019). Advanced medication-related osteonecrosis of the jaw with cranial base involvement: Report of cases. *Journal of Oral and Maxillofacial Surgery*.
- Yamagata, K., et al. (2016). Brain abscess caused by medication-related osteonecrosis of the jaw: Case report. *Journal of Oral and Maxillofacial Surgery*.
- Altay, M., et al. (2018). Medication-related osteonecrosis of the jaw: An institutional experience. *Journal of Oral and Maxillofacial Surgery*.