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THERAPEUTIC MANAGEMENT OF ODONTOGENIC KERATOCYST: FROM SIMPLE ENUCLEATION TO ADJUVANT TECHNIQUES

MANEJO TERAPÊUTICO DO CERATOCISTO ODONTOGÊNICO: DA ENUCLEAÇÃO SIMPLES ÀS TÉCNICAS ADJUVANTES

MANEJO TERAPÉUTICO DEL QUERATOCISTO ODONTOGÉNICO: DE LA ENUCLEACIÓN SIMPLE A LAS TÉCNICAS ADYUVANTES

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ABSTRACT

Odontogenic Keratocyst (OKC) is a lesion of odontogenic origin recognized for its aggressive biological behavior and high recurrence rate, making its therapeutic management a significant clinical challenge. In this context, several surgical approaches have been proposed over time, ranging from conservative methods such as simple enucleation and marsupialization to more aggressive techniques associated with adjuvant treatments. This study aims to review the therapeutic management of OKC, analyzing the main surgical techniques currently employed and the most effective adjuvant methods in reducing recurrence rates. The literature demonstrates that simple enucleation is associated with higher recurrence rates. On the other hand, the association of enucleation with adjuvant techniques such as peripheral ostectomy, chemical cauterization with Carnoy's solution, and cryotherapy with liquid nitrogen has proven to be more effective in eliminating epithelial remnants and satellite cysts, significantly reducing lesion recurrence and providing better clinical outcomes.

Keywords: Odontogenic Keratocyst. Therapeutic Management. Enucleation. Adjuvant Techniques. Recurrence.

RESUMO

O Ceratocisto Odontogênico (CO) é uma lesão de origem odontogênica reconhecida por seu comportamento biológico agressivo e alta taxa de recidiva, tornando seu manejo terapêutico um desafio clínico relevante. Diante disso, diversas abordagens cirúrgicas têm sido propostas ao longo do tempo, variando desde métodos conservadores, como a enucleação simples e a marsupialização, até técnicas mais agressivas associadas a

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tratamentos adjuvantes. Este estudo tem como objetivo revisar o manejo terapêutico do CO, analisando as principais técnicas cirúrgicas atualmente empregadas e os métodos adjuvantes mais eficazes na redução das taxas de recorrência. A literatura demonstra que a enucleação simples está associada a maiores índices de recidiva. Por outro lado, a associação da enucleação com as técnicas adjuvantes de ostectomia periférica, cauterização química com solução de Carnoy e crioterapia com nitrogênio líquido tem se mostrado mais eficazes na eliminação de remanescentes epiteliais e cistos satélites, reduzindo significativamente a recorrência da lesão e proporcionando melhores resultados clínicos.

Palavras-chave: Ceratocisto Odontogênico. Manejo Terapêutico. Enucleação. Técnicas Adjuvantes. Recidiva.

RESUMEN
El Queratocisto Odontogénico (QO) es una lesión de origen odontogénico reconocida por su comportamiento biológico agresivo y alta tasa de recurrencia, lo que convierte su manejo terapéutico en un desafío clínico relevante. Ante ello, diversas abordajes quirúrgicos han sido propuestos a lo largo del tiempo, variando desde métodos conservadores, como la enucleación simple y la marsupialización, hasta técnicas más agresivas asociadas a tratamientos adyuvantes. Este estudio tiene como objetivo revisar el manejo terapéutico del QO, analizando las principales técnicas quirúrgicas actualmente empleadas y los métodos adyuvantes más eficaces en la reducción de las tasas de recurrencia. La literatura demuestra que la enucleación simple se asocia con mayores índices de recurrencia. Por otro lado, la asociación de la enucleación con técnicas adyuvantes como la ostectomía periférica, la cauterización química con solución de Carnoy y la crioterapia con nitrógeno líquido ha demostrado ser más eficaz en la eliminación de remanentes epiteliales y quistes satélites, reduciendo significativamente la recurrencia de la lesión y proporcionando mejores resultados clínicos.

Palabras clave: Queratocisto Odontogénico. Manejo Terapéutico. Enucleación. Técnicas Adyuvantes. Recurrencia.

1 INTRODUCTION

Odontogenic Keratocyst (OC) represents a unique pathological entity within oral and maxillofacial surgery and traumatology, distinguished by its aggressive biological behavior and expressive recurrence rate (Ravi et al., 2022). Initially identified by Philipsen in 1956, CO has been reclassified over the decades by the World Health Organization (WHO) due to its controversial nature, which oscillates between a developmental lesion and a benign odontogenic tumor (Reddy et al., 2023; Petchiammal et al., 2025). Clinically, the lesion often manifests in the posterior region of the mandible and maxilla, in the canine region (Rathi et al., 2023). It has the ability to invade adjacent structures, such as the maxillary sinus and orbital floor (Reddy et al., 2023). Histologically, it originates in the dental lamina, and consists of a cystic cavity covered by parakeratinized squamous epithelium, with a thickness of approximately five to ten cell layers, and the basal layer is formed by columnar cuboid cells arranged in a palisade, with vertically oriented nuclei (Reddy et al., 2023).

The complexity of CO lies in its ability to silently grow intraosseously, often being detected only in routine radiographic examinations or after reaching proportions that cause cortical expansion and facial asymmetry (Rathi et al., 2023). Historically, the therapeutic approach has been a point of intense debate in the scientific literature. While simple enucleation is associated with lower morbidity rates, techniques incorporating chemical or mechanical adjuncts aim to reduce the potential for recurrence derived from epithelial remains and satellite cysts (Petchiammal et al., 2025; Ruslin et al., 2022). This study aims to review the main therapeutic modalities for the management of OC, discussing from conservative techniques to the use of cauterizing solutions and peripheral ostectomy.

2 METHODOLOGY

The present study is a narrative literature review, elaborated with the aim of synthesizing and critically analyzing recent scientific evidence concerning the therapeutic management of odontogenic keratocyst. The data search was conducted in the PubMed indexed database, using the descriptors "Odontogenic keratocyst", "Treatment" and "Diagnosis", duly integrated by means of the Boolean operators AND and OR, in strict compliance with the MeSH terminology. The time frame comprised articles published in the last five years, available in full text and written in Portuguese or English, which

addressed in a substantive way the diagnosis and surgical interventions of the proposed theme. Productions that did not have a direct correlation with keratocyst treatment techniques, duplicate publications, reviews of low methodological rigor, and non-indexed gray literature were excluded from the analysis. The selection of studies was carried out sequentially, starting with the screening of titles and abstracts, followed by immersion in the full texts to validate academic relevance. The collected data were organized and discussed in a descriptive manner.

3 RESULTS AND DISCUSSION

The literature shows that accurate diagnosis is the fundamental pillar for the successful management of odontogenic keratocyst. This need results from the fact that keratocyst can grow silently, reaching large areas before manifesting apparent clinical signs. Despite being classified as a benign lesion, keratocyst presents biologically aggressive behavior and a high recurrence rate, which justifies the need for more careful therapeutic planning. (CAIO URIEL). In addition, an accurate and early diagnosis reduces surgical morbidity, preserves adjacent anatomical structures, and reduces the need for radical interventions, leading to a better aesthetic and functional outcome (Valdivia et al, 2022; Ravi et al, 2022; Petchiammal et al., 2025).

The aggressive biological behavior of odontogenic keratocyst (OC) is due to its high epithelial proliferative activity and the frequent presence of satellite microcysts in adjacent bone tissue, which are usually imperceptible during surgery. Studies have shown that the persistence of epithelial remains, even after surgical removal, is associated with increased expression of antiapoptotic markers and high activity of proliferative markers, favoring cell survival and the potential for continuous growth of the lesion (Valdavia et al., 2022; Petchiammal et al., 2025).

CO can occur at any age, but has a predilection between the second and fourth decades of age, predominant in white men, occurs twice as often in the mandible when compared to the maxilla (Valdivia et al, 2022; Ravi et al, 2022). Differential diagnosis includes periapical cyst, dentigerous cyst, and ameloblastoma (El Gaouzi Rajae et al, 2021). Ameloblastoma should be considered because of the radiographic similarity and bone expansion potential presented by odontogenic keratocyst.

The use of fine-needle aspiration cytology (FNAC) has proven to be a valuable preoperative resource for diagnostic confirmation, allowing the surgeon to plan a more

assertive approach (Petchiammal et al., 2025), which is reflected in diagnostic performance characterized by sensitivity of 77.7% and specificity of 100%, with rare false-positive results (Petchiammal et al., 2025). However, FNAC does not replace definitive histopathological examination, it should be used only as a complementary method since, in lesions with scarce content or associated inflammation, its result is inconclusive.

Histopathologically, the differentiation between the parakeratinized (POC) and orthokeratinized (OOC) variants is crucial, since the parakeratinized form demonstrates a significantly greater local aggressiveness, having greater expression of antiapoptotic markers, such as the Bcl-2 protein and more satellite cysts in the fibrous wall, thus, its behavior is more infiltrative and has a high propensity to recurrence compared to the orthokeratinized variant, which has a more stable epithelial organization, performing fewer mitoses and having less potential for bone invasion, resulting in a better clinical prognosis and lower recurrence rate after conventional surgery (Valdivia et al., 2022; Ravi et al., 2022; Petchiammal et al., 2025).

Epidemiologically, there is a higher prevalence of CO in males, with a peak incidence in the third decade of life (Ravi et al., 2022; Ruslin et al., 2022). Although the mandible is the preferred site, atypical cases in the maxillary sinus pose diagnostic challenges, and may mimic sinusitis or polyps, which reinforces the need for advanced imaging tests, such as computed tomography, to delimit the extent of the pathology (Reddy et al., 2023). In the long term, strict radiographic follow-up is mandatory, since recurrences can occur years after the initial treatment, reinforcing that management does not end with the surgical act (Valdivia et al., 2023; Ruslin et al., 2022).

Regarding therapeutic options, the spectrum ranges from conservative to aggressive interventions and adjuvant techniques.

1) Conservative treatments

- **Simple Enucleation and Marsupialization:** techniques often used for minor lesions or in pediatric populations to preserve noble structures. However, when applied alone to OC, enucleation has the highest rates of therapeutic failure due to the fragility of the cystic capsule and the presence of satellite microcysts (Ruslin et al., 2022; Petchiammal et al., 2025). Marsupialization, in turn, preserves the relevant anatomical structures and favors the development of permanent dental germs, although it is limited by the maintenance of pathological tissue in situ (El Gaouzi Rajae et al., 2021).

According to *Ruslin et al.* The choice of the conservative treatment method can be defined taking into account the size of the lesion, with enucleation for smaller cysts (diameter less than 2.5 cm) and marsupialization for larger cysts (from 2.5 cm in diameter). In addition, marsupialization can be done initially to reduce the proportion of the lesion, which in turn would facilitate total enucleation, reduce the chances of cyst recurrence, reduce the risk of fracture, depending on the extent of the lesion, and could promote a faster recovery, due to the formation of the blood clot in a cavity less extensive than the initial one, especially in younger patients (Ruslin et al., 2022 ; El Gaouzi Rajae et al., 2021).

The choice of methods should also take into account the variations of odontogenic keratocyst, since the aggressive nature of parakeratinized keratocyst requires a less conservative approach and association with more assertive adjuvant treatments compared to treatments performed on orthokeratinized keratocysts, which allow for less invasive methods (Ravi et al., 2022).

2) Treatment Adjuvants

- **Peripheral Ostectomy:** consists of the removal of a thin bone layer from the lumen of the cavity after enucleation in order to eliminate residual epithelial nests and the surrounding cells corresponding to the cyst. This mechanical technique is widely recommended to increase the safety of the surgical margin, in association with other adjuvant techniques, such as chemical cauterization - discussed later, ostectomy has a potentiation of the effect, leading some authors to believe that it results in a recurrence rate close to zero (Petchiammal et al., 2025; Valdivia et al, 2022).
- **Chemical Cauterization (Carnoy's Solution or Modified Carnoy):** its method of action is based on the coagulation of proteins located at the margins of the bone after total enucleation of the cyst, in addition, its effects after five minutes in contact with the treated area include chemical cauterization (Valdivia et al, 2022). The application of chemical agents after the removal of the lesion acts on the fixation of possible remaining cell debris. Studies have shown that this multimodal approach — combining enucleation, peripheral ostectomy, and chemical cauterization with modified carnoy solution — is the most effective in drastically reducing recurrence rates, although authors still question its long-term effects (Petchiammal et al., 2025).

- **Cryotherapy:** an alternative for devitalization of cystic remains that use liquid nitrogen, reaching cells beyond the visible margins of the lesion. In addition to preventing recurrences, the use of this substance facilitates the patient's healing, promoting osteogenesis and allowing graft placement. However, the manipulation of the component can bring risks if used by professionals who are not properly trained, due to its imprecision and effects on adjacent structures and tissues. (Valdivia et al, 2022)

3) Aggressive Treatment: It is the partial or total resection of the maxilla or mandible (Valdivia et al, 2022). Used only in cases in which there is extensive structural involvement, it is also an alternative when the histopathological examination confirms a parakeratinized keratocyst, even so, the preference remains for more conservative approaches, aiming at the patient's well-being. (Ravi et al., 2022; Valdivia et al, 2022).

Authors highlight a clinical, laboratory and social investigation to define the best approach for the patient, since multiple factors, such as age, histopathological characteristics of the lesion, comorbidities and resources for full recovery are determinants in the preference for conservative or aggressive treatments, as well as the choice of the adjuvant technique that best suits the patient's reality (Rathi et al., 2023; El Gaouzi Rajae et al., 2021).

The chance of recurrence is decreased when the association of conservative treatment with adjuvant treatment and/or aggressive treatment with adjuvant treatment is performed (Petchiammal et al, 2025).

Recovery is a gradual process that requires the dentist to monitor closely. In cases submitted to marsupialization, healing occurs by reducing intracystic pressure that allows bone neoformation and eruption of the teeth involved, preserving the functionality of the dental arch (El Gaouzi; El Harti, 2021). In more aggressive approaches, recovery may involve edema and localized discomfort, but with a better long-term prognosis, with less possibility of reinterventions. Postoperative follow-up should be long, since most recurrences occur in the first five years after the end of treatment, requiring periodic imaging tests to ensure stability and bone health for the patient (Ruslin et al., 2022).

4 CONCLUSION

Odontogenic keratocyst (OC) is a pathological entity with aggressive biological

behavior and inherent risk of recurrence, which imposes a significant clinical challenge to its therapeutic management. The high recurrence rate is primarily associated with cystic capsule fragility, the presence of satellite microcysts, and, crucially, the identification of the parakeratinized variant (POC), which demonstrates greater infiltrative potential.

In view of this, diagnostic accuracy, combining clinical evaluation, advanced imaging tests, and histopathological confirmation with variant differentiation, is the pillar for treatment success. The therapeutic approach must be individualized, considering the size and location of the lesion, the patient's age, and the histopathological characteristics of the OC.

The literature reviewed reinforces that simple enucleation, when used alone, has higher failure rates. The incorporation of **adjuvant techniques**, such as peripheral ostectomy, chemical cauterization with Carnoy's solution, or cryotherapy with liquid nitrogen, is essential. The multimodal approach — combining enucleation with an adjuvant method — has been shown to be the most effective strategy in eliminating epithelial remnants and satellite cysts, drastically reducing the risk of recurrence.

Finally, rigorous and prolonged radiographic and clinical postoperative follow-up is mandatory, since recurrences may manifest years after the initial treatment. It is concluded that the integrated and multidisciplinary performance between surgeons, pathologists and radiologists is essential to ensure safety, diagnostic accuracy and the best functional and aesthetic prognosis for the patient.

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