

Treatment of vital teeth involved in the extension of inflammatory radicular cysts: a systematic review

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ABSTRACT

An inflammatory radicular cyst (IRC) is an odontogenic cyst associated to a non-vital tooth, which may affect sound teeth. There is lack of consensus on whether to perform endodontic treatment on teeth involved in the extension of the lesion prior to surgical treatment. **Aim:** To identify and quantify the therapies most often used on teeth with positive response to pulp tests that are involved in the extension of an IRC, and analyze the criteria upon which different authors based their decisions. Identify and evaluate the reliability of the dental pulp tests used for evaluation and deciding on treatment. **Materials and Method:** A review was performed of articles indexed in four databases from 2011 to 2023. The review included studies describing diagnosis and treatment of teeth involved in the extension of an inflammatory cyst. **Results:** Fifteen articles were included in the review: nine case reports, five literature reviews and one comment to the editor. The case reports address 10 cystic lesions, directly associated with a total 21 sound teeth. Three of them report loss of tooth sensitivity, three report preemptive endodontic treatment of teeth with preserved sensitivity, two report recovery of previously lost sensitivity, and one reports preservation of sensitivity after surgical treatment. One of the literature reviews addresses the issue of treating teeth adjacent to a cystic lesion, while the other four, and the comment to the editor, discuss the methods for detecting sensitivity and vitality. **Conclusion:** Clinical studies with long-term follow-up are needed in order to reach a consensus regarding treatment. Better understanding of pulp status is essential in order to select the treatment best suited to each clinical case.

Keywords: radicular cysts - periapical cysts - vitality test - dental pulp test.

Tratamiento de piezas dentarias vitales involucradas en la extensión de quistes radiculares inflamatorios. Revisión sistemática

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RESUMEN

El quiste radicular inflamatorio (QRI) es un quiste odontogénico asociado a una pieza dentaria no vital, que pueden comprometer dientes sanos. Existe una falta de consenso en si se debe o no realizar el tratamiento endodóntico de las piezas dentarias involucradas en la extensión de la lesión, previo al tratamiento quirúrgico. **Objetivo:** Identificar y cuantificar cuáles fueron las conductas terapéuticas más utilizadas en las piezas dentarias con respuesta pulpar positiva involucrada en la extensión de un QRI, y analizar el criterio utilizado por los diferentes autores para la toma de decisión. Identificar y evaluar el grado de confiabilidad de los métodos de respuesta pulpar utilizados para la evaluación y toma de decisión del tratamiento. **Materiales y Método:** Se realizó una revisión de los artículos indizados en cuatro bases de datos entre los años 2011 y 2023. Se incluyeron estudios que describieran el diagnóstico y tratamiento de las piezas dentarias comprometidas en la extensión de un quiste inflamatorio radicular. **Resultados:** Se incluyeron 15 artículos en la revisión. En los 9 reportes de casos incluidos, se reportan 10 lesiones quísticas, las cuales tenían una relación directa con un total de 21 dientes sanos. En 3 de los 9 reportes de caso se detecta pérdida de sensibilidad de los dientes, mientras que otros 3 reportes realizan tratamiento endodóntico de dientes con sensibilidad conservada como maniobra preventiva. Otros 2 reportes plantean la recuperación de la sensibilidad que originalmente se encontraba perdida y el caso restante, deja constancia de la conservación de la sensibilidad de las piezas posterior al tratamiento quirúrgico. Se encontraron en esta búsqueda 5 revisiones bibliográficas. Solo una de ellas plantea el tema del tratamiento de los dientes adyacentes a una lesión quística mientras que los otros 4 y el comentario al editor discuten los métodos de sensibilidad y vitalidad. **Conclusión:** Es necesario el desarrollo de estudios clínicos con seguimiento a largo plazo para lograr un consenso con respecto al tratamiento. Una mejor comprensión del estado pulpar es fundamental para poder optar por el tratamiento que mejor se adapte a cada caso clínico.

Palabras clave: quistes radiculares - quistes periapicales - vitalidad pulpar - test pulpar.

INTRODUCTION

An inflammatory radicular cyst (IRC) is an inflammatory odontogenic cyst associated to a non-vital tooth. It is the most frequent type of cyst in the jawbone, accounting for 55% of odontogenic cysts¹⁻⁴. Its etiology is necrosis of the pulp tissue that reaches periapical tissues and, via different proinflammatory chemical mediators, stimulates the epithelial rests of Malassez, which give rise to the formation of the cyst membrane. IRCs are slow-growing^{2,5} but may compromise sound teeth if they attain considerable size^{2-4, 6-8}.

There is lack of consensus regarding whether to perform endodontic treatment on adjacent teeth before surgical treatment of an IRC. Some authors consider preemptive endodontic treatment of all teeth involved in the lesion to be “good practice”, based on the risk of causing pulp necrosis in originally vital teeth by damaging the neurovascular bundle during enucleation of the cystic membrane⁹⁻¹¹. Even though the risk is not high, when it does occur, it causes immediate aesthetic damage that requires endodontic treatment and internal whitening. Other authors, in contrast, propose watchful waiting and postponing endodontic treatment, or deciding to perform endodontic treatment according to the degree to which the apices are involved in the lesion, which is very difficult to determine objectively¹²⁻¹⁴. Determining the pulp status of teeth adjacent to an IRC *a priori* is also a controversial issue because there is no consensus on the efficacy of the methods used to evaluate the pulp response to stimuli. In recent years, pulse oximetry using devices adapted to tooth anatomy, and Doppler ultrasound to study blood flow have been considered the most efficient. However, for the time being, these methods are not standardized and are therefore “operator dependent” and difficult to replicate¹⁵⁻¹⁶.

Due to the lack of consensus found in the literature, the aims of this study were:

- a) To identify and quantify the most frequently used therapies for teeth with positive response to pulp tests that are involved in the extension of an IRC, and to analyze the criteria upon which different authors based their decisions;
- b) To identify and evaluate the reliability of the pulp response tests used for evaluation and deciding on treatment of teeth involved in the IRC extension.

MATERIALS AND METHOD

An exhaustive review was conducted of articles indexed in Pubmed, Medline, Embase and Scielo databases from 2011 to 2023, utilizing the followings MeSH terms, synonyms and free terms: “radicular cysts”, “periapical cysts”, “pulp vitality”, “pulp test”. Boolean operators (OR and AND) were used for combination of terms. The search key is described in Fig. 1.

Fig. 1: Search strategy for Pubmed, Medline, Embase and Scielo databases

Term= (Cyst) AND Term= (radicular OR periapical).
Term= (Dental pulp Test OR Dental pulp vitality test OR Dental pulp sensitivity test)

The PICO criteria – Population, Intervention, Comparison and Outcome – were used to prepare a structured summary and evaluate the methodological characteristics of each selected article. The criteria were defined in detail as follows: Population: teeth with positive response to pulp test and involved in the extension of an IRC; Intervention: pulp response assessment methods, cold test, electric test, flowmetry, etc.; Comparison: different methods for evaluating pulp response, and Outcome: the outcome of the hypothesis, reported reliability of pulp testing methods, and what decision was made for treatment of the teeth involved in the IRC extension).

Clinical studies, meta-analyses, systematic reviews, control cases, cohort studies, observational and analytical studies describing diagnosis and treatment of teeth involved in the expansion of an inflammatory radicular cyst were included. No randomized control study on the subject was found. Any articles referring to dental trauma history, studies in pediatric patients or patients with temporary dentition, experimental studies and articles without at least the abstract in English were excluded.

RESULTS

The search identified 3420 articles, of which 3346 were excluded because their titles and abstracts revealed that they did not address the treatment of teeth adjacent to an IRC and/or the method used for diagnosing pulp status. The full texts of the 74 remaining articles were analyzed. Of these, 45 were discarded because they did not provide data that would enable evaluation of the procedures. Of the 29 remaining articles, 14 presented one of the

exclusion criteria mentioned above. Thus, only 15 articles were included in the final analysis. Fig. 2 shows the article selection process. Selected articles are listed in Table 1.

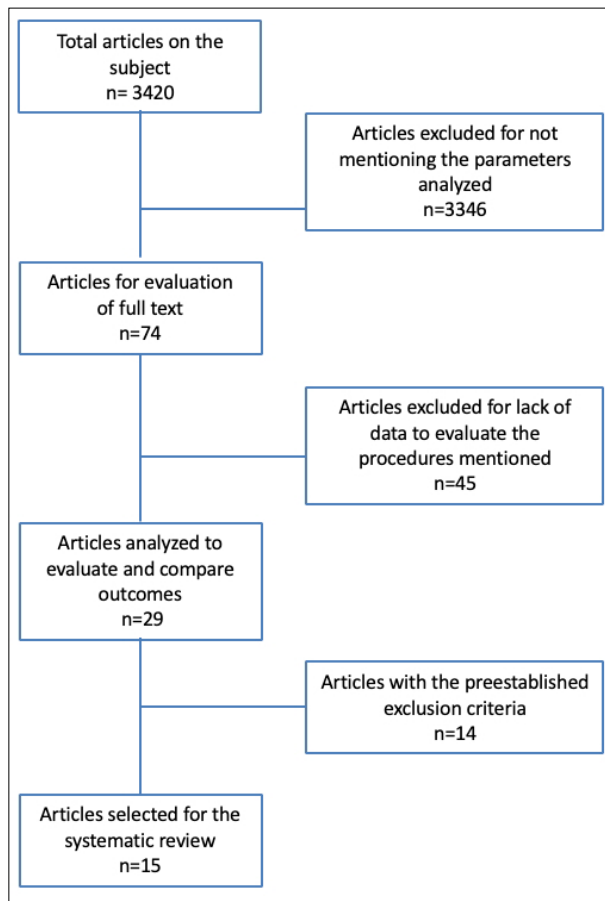


Fig. 2: Flowchart showing article selection process

The articles selected for review consisted of nine case reports, five literature reviews and one comment to the editor.

Altogether, the nine case reports discuss ten cystic lesions that were directly associated with a total of 21 clinically sound teeth (one to three teeth per case, except for one clinical case¹⁰ involving seven teeth). Pulp status in adjacent teeth was evaluated using cold and electric pulp sensitivity tests in seven of the case reports^{10-12,14,17-19}. Another case²⁰ reports an unspecified sensitivity test followed by a cavity test, while the remaining one⁹ reports using the two temperature tests (cold and hot) and an unspecified vitality test. Only two of the case reports^{10,20} evaluated the cystic lesion

by tomographic images, while the rest used periapical or panoramic radiographs. Lesion enucleation is reported in six, but was not the first treatment choice in another two. Regarding treatment of choice and pulp status monitoring, three of the nine cases report loss of sensitivity in teeth that originally had a positive response to the tests used¹⁷⁻¹⁹. Another three⁹⁻¹¹ report endodontic treatment of the teeth with preserved sensitivity to prevent loss of vitality that was believed would occur during cyst enucleation. Two cases report recovery of the originally lost sensitivity^{12,20}, and the remaining case reports conservation of tooth sensitivity following surgical treatment of the lesion¹⁴.

Only one of the five literature reviews¹³ addresses the subject of treating teeth adjacent to a cystic lesion, highlighting teeth related to odontogenic keratocysts rather than to inflammatory radicular cysts. It notes the lack of established criteria for the therapeutic approach and the clinical importance of preserving teeth with vital pulp, considering that despite the efficacy of the root canal treatment on mature teeth, it is important to consider long-term complications ranging from loss of tooth defensive capacity to potential tooth fracture and extraction. The other four literature reviews^{15,21-23} and the comment to the editor¹⁶ discuss methods for testing sensitivity and vitality. Patro et al.²¹ considers pulse oximetry to be the most precise method, while Alghaithy et al.²³ concludes that laser doppler flowmetry is closest to the gold standard. Mainkar et al.¹⁵ claims that laser doppler flowmetry and pulse oximetry are the most precise diagnostic methods and do not differ significantly. Balevi¹⁶ states that the cold test is the simplest and most precise pulp sensitivity test available. Donnenmeyer et al.²² concludes that the effectiveness of pulp tests cannot be determined due to lack of scientific evidence.

DISCUSSION

The studies included in this review propose widely differing treatment criteria, clearly reflecting the

Table 1. Articles selected for review

AUTHOR - REFERENCE	YEAR	TITLE	TYPE
Komabayashi et al. ¹⁷	2011	Apical infection spreading to adjacent teeth: a case report	Case Report
Asgary S. et al. ¹⁸	2013	Necrosis of intact premolar caused by an adjacent apical infection: a case report	Case Report
Sood N. et al. ⁹	2015	Treatment of Large Periapical Cyst Like Lesion: A Noninvasive Approach: A Report of Two Cases	Case Report
Martins J. et al. ¹⁰	2015	Cystic Lesion with Origin on a Single Long Time Traumatized lower Incisor.	Case Report
Alghaithy et al. ²³	2016	Pulp sensibility and vitality tests for diagnosing pulpal health in permanent teeth: a critical review	Review
Mainkar et al. ¹⁵	2018	Diagnostic accuracy of 5 dental pulp tests: A systematic review and meta-analysis	Systematic Review and Meta-analysis
Asgary S. et al. ¹⁹	2018	Partial Necrosis Consequence of the Infection Spreading from an Adjacent Apical Periodontitis: A Case Report	Case Report
Ben Balevi ¹⁶	2019	Cold pulp testing is the simplest and most accurate of all dental pulp sensibility tests	Comment to the editor
Yi Zhao et al. ¹³	2019	Controversies Regarding the Management of Teeth Associated with Cystic Lesions of the Jaws	Review
Ricucci D. et al. ¹¹	2020	Atypically grown large periradicular cyst affecting adjacent teeth and leading to confounding diagnosis of non-endodontic pathology	Case Report
Elhakim A. et al. ¹⁴	2021	Preserving the vitality of teeth adjacent to a large radicular cyst in periapical microsurgery: a case report with 4-year follow-up	Case Report
Patro et al. ²¹	2022	Diagnostic Accuracy of Pulp Vitality Tests and Pulp Sensibility Tests for Assessing Pulpal Health in Permanent Teeth: A Systematic Review and Meta-Analysis	Systematic Review and Meta-analysis
Asgary S. et al. ²⁰	2022	Pulp Vitality Preservation of an Involved Tooth in a Large Radicular Cyst: A Case Report with 4-Year Recall	Case Report
Donnermeyer et al. ²²	2022	Effectiveness of diagnosing pulpitis: A systematic review	Systematic Review
Kim et al. ¹²	2023	Recovery of Pulp Sensibility After the Surgical Management of a Large Radicular Cyst: A Case Report with a 4.5-Year Follow-up	Case Report

lack of consensus. Ricucci et al., Martins et al. and Sood et al.⁹⁻¹¹ apply endodontic treatment to all teeth involved in the lesion because they believe that cyst enucleation irreversibly damages the neurovascular bundle of tooth apices, leading to subsequent pulp necrosis. Komabayashi et al.¹⁷ report the enucleation of a 20 x 12 mm cyst after finding that root canal treatments alone did not suffice to achieve regression of the pathology. More moderately, Elhakim et al., Kim et al. and Yi Zhao et al.¹²⁻¹⁴ propose cyst enucleation while preserving the vitality of adjacent teeth whenever possible.

Information gathered so far suggests that each case should be assessed carefully to avoid overtreatment of teeth involved in the extension of an IRC. The

greatest challenge is determining pulp soundness using tests to measure sensitivity or vitality. The most frequently used sensitivity tests are thermal (cold or heat), and electric testing, all of which measure tooth nerve fiber response to stimuli, but not tooth vitality. The most frequently used vitality tests are laser doppler flowmetry and pulse oximetry, which ascertain whether there is blood flow in the tooth, and are currently considered to be the most sensitive and precise¹⁵. Some authors believe that pulse oximetry is the most exact method²¹, though there is greater agreement that laser doppler flowmetry is closer to the gold standard²³. However, their use is largely limited by the need for customized equipment and standardization, and the expense involved.

Other authors therefore believe that the cold test is simplest and most precise method available for testing sensitivity, and it continues to be the main diagnostic tool for evaluating pulp status¹⁶.

Ideally, cone beam computed tomography should be used^{19, 24, 25} to determine whether an apex is located within a cyst cavity, and if so, its degree of involvement. However, in daily practice, decisions are usually based on panoramic or periapical radiographs, even though they both provide two-dimensional images which may lead to erroneous conclusions, such as an apex being observed as located within a cyst cavity, when a three-dimensional study might show that it is in fact in front of or behind the cavity, separated by sound bone. In these cases, two-dimensionality may lead to unnecessary treatment a tooth.

Another controversy was identified regarding the cause of loss of sensitivity in teeth adjacent to an IRC. Some authors suggest that the increase in hydrostatic pressure within the cyst lesion may interfere with sensory transmission of the dental pulp, producing a transitory absence of sensitivity to stimuli^{7,13,26}. In this case, sound teeth with negative sensory response at the beginning of the treatment might recover sensitivity when pressure is removed from their neurovascular bundles.

Stashenko et al.²⁷ and Komabayashi et al.¹⁷ claim that suprainfection in an IRC may spread to adjacent teeth and cause loss of vitality, which would be irreversible¹⁷⁻¹⁹. Establishing whether loss of pulp response is caused by microbes or by an increase in intra-cyst hydrostatic pressure would require microbiological and histopathological studies that would not be possible to implement in a clinical investigation design.

Reestablishment of the blood flow interrupted by damage to the apical neurovascular bundle may be expected in teeth with incomplete root formation, as occurs after reimplantation or autotransplantation. Existing studies do not suffice to draw conclusions about mature teeth. It has been suggested that some autotransplanted teeth with complete root formation

and not subjected to root canal treatment may have potential for revascularization²⁸. No study was found on revascularization or pulp regeneration following IRC enucleation, but it may be expected that in the near future, knowledge gained regarding treatment of transplanted teeth may be applied to managing teeth adjacent to an IRC. Currently, pulp revascularization treatments in immature permanent teeth with pulp necrosis are considered the first choice. In these cases, it is indicated to clean and disinfect the pulp cavity followed by stimulation of periapical periodontium cells by bleeding into the root canal²⁹, which promotes the entry of proliferative cells that generate new tissue with different characteristics from pulp and dentin. A vascular network already present in the tooth could reconnect to the newly formed vessels in the healing bone cavity. It is not clear what factors contribute to revascularization: whether patient age, apical diameter of the affected tooth, or type of cyst lesion¹³.

It must also be considered whether the degree to which apices are included in the cavity has any influence on loss of tooth vitality. One anatomical study suggested that 98% of the apical ramifications and 93% of lateral canals are located in the last 3 mm of the root¹³. This suggests that vascularization in teeth that are only minimally included in the cyst could be preserved after cyst enucleation by means of irrigation provided by the lateral canals.

CONCLUSION

There is lack of consensus regarding the best way to deal with vital teeth involved in the expansion of an IRC, and on the criteria for decision making.

Widely varying methods have been reported for evaluating pulp status. The use of reliable, replicable methods should be an essential requisite for choosing the treatment best suited to each clinical case.

Clinical studies with long-term follow up are needed in order to reach a consensus on how to deal with vital teeth involved in the extension of an inflammatory radicular cyst.

CONFLICT INTERESTS

The authors declare no potential conflicts of interest regarding the research, authorship, and/or publication of this article.

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