Differentiation between periapical cysts and granulomas using computed tomography scans: A literature review

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ABSTRACT

Periapical lesions are formed in response to an inflammatory process involving the periodontal region of necrotic teeth. Thus, endodontic treatment is often related to treatment of these lesions which may manifest as cysts or periapical granulomas. Nevertheless, many questions about the differential diagnosis of these lesions remain. Histopathological evaluation of a sample subjected to biopsy remains as the gold standard of determining the type of periapical lesion. In order not only to provide the least invasive endodontic treatment possible, but also with the aim of optimizing it, a nonsurgical method capable of differentiating periapical cysts and granulomas should be identified. Cone-beam computed tomography (CBCT) has been used with a view to seeking a new diagnostic method. However, despite the fact that this method is able to identify periapical lesions, its real potential to provide a distinction between cysts and granulomas remains unclear. Thus, the main objective of this literature review is to provide a comprehensive overview on the potential of CBCT to differentiate periapical cysts and granulomas. It was concluded that there is a real need for more research on alternative and non-invasive methods of performing a differential diagnosis that differentiates cysts and granulomas. However, based on studies conducted to date, computed tomography might be considered an important and possibly the most appropriate tool used for differential diagnosis of periapical lesions.

Keywords: Cysts. Granuloma. Cone-beam computed tomography.

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Introduction

Clinical and radiological methods are used to identify the existence of a periapical lesion. The presence of discomfort or swelling can lead to diagnosis of periapical lesion under confirmation by periapical radiography or by a more precise method, such as cone-bean computed tomography (CBCT).

Researchers have sought a non-invasive alternative method to reach differential diagnosis of periapical lesions, namely: periapical radiograph,[1] imaging examination with water-soluble contrast media,[2] Papanicolaou smears,[3] albumin tests[4] and ultrasound.[5] However, none of them have proved effective. Other studies have recently presented imaging technologies, such as multi-slice computed tomography (MSCT)[6] and CBCT.[7,8]

Computed tomography (CT) scan is widely known for being capable of identifying a periapical lesion; however, its real potential to provide a distinction between cysts and granulomas remains unclear. Thus, histopathological evaluation of a sample subjected to biopsy remains as the gold standard of determining the type of periapical lesion.

In order not only to provide the least invasive endodontic treatment possible, but also with the aim of optimizing it, a nonsurgical method capable of differentiating periapical cysts and granulomas should be identified.

In this context, CBCT has proved its importance to endodontic pre and post-operative management, including: diagnosis of endodontic and non-endodontic pathologies; assessment of root canal morphology; evaluation of root and alveolar fracture; analysis of external/internal root resorption and invasive cervical resorption; and in pre-surgical planning of apical surgery.[9] Furthermore, studies have been conducted to prove its ability to differentiate periapical cysts and granulomas.

The importance of determining an alternative method to reach differential diagnosis of periapical lesions is based on potential benefits provided to treatment of these kind of lesions. A non-surgical diagnostic method would yield quicker results prior to treatment itself, thereby allowing endodontists to come up with a more precise treatment plan conducted within a single intervention, the least invasive and most effective as possible.

Furthermore, this diagnostic method precedes any intervention and, for this reason, would prevent the patient from being subjected to unnecessary procedures as well as from suffering stress during treatment. Despite the common sense view that both pathologies are treated by the same approach, the scientific community partially disagrees about the potential of endodontic treatment to heal an periapical cyst, particularly in cases of large cysts.[10-11] Either way, previous diagnosis is certainly important to both cases.

Cases in which the clinician believes that an endodontic intervention can heal a cyst require that he be aware of the lesion. As a result, he will be able to adopt an appropriate approach to access the lesion by means of root canal instrumentation, thereby providing an appropriate environment that allows the immune system to promote repair of periapical tissues.[12,15] On the other hand, cases in which the endodontist does not believe that endodontic treatment is able to heal a periapical cyst still require previous differential diagnosis in order to avoid ineffective endodontic treatment.

Previous non-surgical diagnosis also benefits immunosuppressed patients and individuals who have the potential to develop osteonecrosis. Once endodontists are capable of performing early differential diagnosis, they are able to develop treatment planning with absolute precision, which is indispensable for safety of any clinical procedure performed in high-risk patients.

In view of the aforementioned facts, the main objective of this literature review is to provide a comprehensive overview on the potential of CBCT to differentiate periapical cysts and granulomas.

Literature review

Granuloma *versus* Cysts

Periapical lesions are formed in response to an inflammatory process involving the periapex around the root of necrotic teeth.[16,18] Periapical granuloma is an example of periapical lesions and consists of chronic inflammatory infiltrate associated with repair elements. Inflammatory cells comprise 50% of this type of lesion which is presented as a well-defined radiolucent image associated with the root apex with loss of integrity of the lamina dura.[19]

Histologically, these lesions present as granulomatous tissue predominantly infiltrated by lymphocytes, plasma cells and macrophages, with or without epithelial remnants.[20]

When stimulated, epithelial rests of Malassez proliferate and form a cystic cavity which grows due to accumulation of fluid.[21] This group of lesions are known as periapical cysts characterized by a capsule of fibrous connective tissue covered by epithelium with the lumen containing liquid and cell debris. Radiographically, periapical cysts are radiolucent, with round or oval areas associated with the periapical region of the tooth circumscribed by osteogenesis represented by a radiopaque sclerotic continuous and very clear line.[22] The epithelial lining of the cyst consists of stratified squamous non-keratinized cells of variable thickness. Cystic liquid is essentially formed by water, desquamated epithelial cells, leukocytes and cholesterol.[23]

Although differentiation has been strictly based on histopathological analysis, there has been an effort to set radiological methods of reaching differential diagnosis. With a view to identifying the cause of periapical lesions, tomographic imaging exams were assessed in a variety of ways.

Analysis of radiodensity

Initially, analysis of lesion density by means of CT scans was thought to be an effective method to distinguish cysts from granulomas. As granulomas consist of inflamed granulation tissue surrounded by a fibrous connective tissue wall,[22] they are presented with greater radiodensity than cysts which are cavities surrounded by an epithelial cortex.

According to Trope et al,[24] periapical granulomas differ from periapical cysts due to markedly lower density of the cyst cavity in relation to granulomatous tissue. The authors performed a CT scan on eight selected teeth, including the apical portion of the roots and the periapical lesions. Their results revealed that some periapical lesions had a cloudy-like appearance and were similar in density to other lesions as well as to surrounding soft tissue. Histological tests confirmed that these lesions were granulomas. On the other hand, another sample subjected to CT scans revealed dark areas with density similar to the background. Histological tests confirmed that these lesions were cysts.

Afterward, analysis of density was also used by Simons et al[25] and Aggarwal et al.[6] The first authors highlighted the importance of considering the size of the lesion during CT analysis. They proposed that analysis of the shades of gray allows one to distinguish soft tissue from fluid or empty areas on CBCT. Thus, they suggested that shades of gray negative values indicated cysts, whereas positive values were indicative of granulomatous tissue. They concluded that, in comparison to histopathological analysis, CBCT proves a better, more accurate and faster method for differential diagnosis of solid and fluid-filled lesions.

On the other hand, Aggarwal et al[6] conducted an analysis on the basis of Hounsfield units (measurements ranging from -20 to +20 were classified as cysts; whereas measurements with Hounsfield units > 40 were classified as granulomas), given that multislice computed tomography (MSCT) was used. Ten out of twelve cases were classified as cystic cavities, while only two cases were classified as granulomas. All twelve cases had histopathological findings consistent with the diagnosis obtained by MSCT scans, thereby suggesting analysis of density in CT scans to be highly effective in diagnosing periapical lesions.

Both aforementioned studies carried out numeric, thus, objective evaluations. However, it has been proved by several studies[26-30] that whenever MSCT is used, as in Aggarwal et al's[6] study, analysis of density of an object is uniform throughout the dental arch, no matter the location or CT scanner. In these cases, measurements are expressed in Hounsfield units (HU) which express x-ray attenuation of a voxel relative to attenuation of water. Thus, numerical analysis is relevant and appropriate.

Nevertheless, this evaluation is no longer possible by means of CBCT scans. It has also been proved that in CBCT analysis, the density of an object is not uniform throughout the dental arch and between different scanners. Therefore, due to lack of uniformity, simple comparison of absolute CBCT values measured at different anatomical locations might be misleading.[26]

Simon et al[25] used CBCT scans, but did not correlate density measurements with HUs. The authors assessed individual images, comparing the gray scale on the center of the lesion, the maximum and minimum gray scale values inside de lesion, as well as

buccal and lingual cortical bone readings. They also proposed evaluation of the gray scale on a numerical range (positive numbers indicated hyperdense tissue suggestive of granuloma, whereas positive numbers indicated hyperdense tissue suggestive of cysts). They also proposed an objective analysis that proved effective in their experiment, but risky and questionable in view of the above.

Analysis of criteria and characteristics of image

Two recently published studies[31,32] suggest another approach to distinguish between cysts and granulomas. Both used pre-established criteria and analysis of images by calibrated radiologists whose results were later confirmed by histopathological exam.

Results were contradictory. Rosenberg et al[31] found strong agreement between both pathologists; however, no agreement was found between CBCT scans, thereby suggesting that the technique was incapable of distinguishing granulomas from cysts.

Nevertheless, a few years later, Guo et al[32] also evaluated the reliability and accuracy of using CBCT scans to distinguish periapical cysts from granulomas. Their methodology was similar to the one used by Rosenberg et al;[31] however, unlike previous results, they stated that CBCT scans provided good to excellent accuracy in reaching differential diagnosis of cysts and granulomas.

Although the set of criteria proposed by both studies were similar, Guo et al[31] used a simpler list. Rosenberg et al[31] listed characteristics of five different types of lesions that could be found on CBCT scans (cysts, cyst-like structures, granulomas, granuloma-like structures, among others). Since Guo et al[32] only listed criteria for cyst identification, it is presumed that whatever did not fit cyst criteria was considered as granuloma. Guo et al's[32] study proposed two diagnosis criteria only, whereas Rosenberg et al[31] proposed five diagnosis criteria. Therefore, it is reasonable to suggest that authors proposing fewer variables render evaluation more complex and are more likely to yield correct results.

Both studies used radiologists' interpretation as the key to diagnosis. Nevertheless, subjective analysis is always susceptible to interpretation mistakes, which renders this kind of evaluation extremely dependent on evaluator's skills.

Conclusion

On the basis of this study, it is reasonable to conclude that further research on alternative and non-invasive methods of performing differential diagnosis of cysts and granulomas is necessary.

This type of research benefits immunosuppressed patients with systemic disease and individuals who have the potential to develop osteonecrosis, as it provides them with better prognosis as a result of precise treatment planning made possible by non-surgical diagnosis methods.

Radiological analysis proves to be a good, quick and inexpensive non-surgical diagnosis method. However, as in all imaging exams, it remains more suggestive than absolute. Nevertheless, based on studies conducted to date, computed tomography might be considered an important and possibly the most appropriate tool used for differential diagnosis of periapical lesions.

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