Dr. Maheen Ahmar/ Afr.J.Bio.Sc. 6(8) (2024).3660- 3667 ISSN: 2663-2187

African Journal of Biological Sciences

Journal homepage: http://www.afjbs.com

Research Paper Open Access

Evaluation of CT and MRI Imaging Results of Radicular Cysts, Odontogenic Keratocysts, and Dentigerous Cysts and their Contribution to the Differential Diagnosis

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Article History
Volume 6, Issue 8, August 2024
Received: 16 July 2024
Accepted: 01 August 2024
Published: 21 August 2024

Abstract

Background: The differentiation of various odontogenic cysts—specifically radicular cysts, odontogenic keratocysts, and dentigerous cysts—poses a significant challenge in clinical practice. **Aim:** This study aimed to evaluate the contribution of the MRI and CT results to the differential diagnosis of histopathologically different odontogenic cysts (radicular cysts, odontogenic keratocysts (OKCs), and dentigerous cysts.). **Methods:** A retrospective analysis was conducted on 60 odontogenic cyst patients (25 radicular cysts, 20 OKCs, and 15 dentigerous cysts) treated at Abbasi Shaheed Hospital and Ayub medical complex hospital where the study took place from 2020 to 2024. The lesion size, location, shape, margin characteristics, internal structure, and effects on surrounding structures were evaluated from CT and MRI imaging data. For objective evaluation of bone and soft tissue involvement, CT was used primarily, while MRI was employed for assessment of soft tissue extension and internal cyst content. **Results:** The most common radicular cysts were unilocular radiolucencies with well-defined cortex, frequently associated with root resorption and tooth displacement. Multilocular lesions with scalloped borders, internal septations and profound cortical expansion and thinning were present as OKCs. Dentigerous cysts tended to be unilocular, related to unerupted teeth and dislocate tooth with minimal cortical involvement. However, CT had strong ability to detect bone changes in all cyst types, while MRI was better at evaluating internal structure, internal structure and its association with soft tissues in OKCs**. Conclusion:** CT and MRI imaging comprise a pair of basic and indispensable tools for the differential diagnosis of odontogenic cysts. CT is effective at diagnosing both radicular and dentigerous cysts, whereas MR imaging plays a useful adjunctive role in the diagnosis of OKCs, owing to their aggressive nature and multilocular structure. However, these imaging modalities offer critical information for appropriate diagnosis, treatment planning, and management especially for more aggressive lesions such as OKCs.

Keywords: Radicular cysts, Odontogenic keratocysts, Dentigerous cysts, CT imaging, MRI imaging, Differential diagnosis

1. Introduction

Odontogenic cysts are a heterogenous group of lesions that arise from epithelial elements involved in tooth development [1][2]. These cysts are encountered quite frequently in the dental and maxillofacial practice and often are completely silent finding their pathologic manifestation as an incidental finding on the basis of a routine radiologic study. Radicular cysts, odontogenic keratocytes (OKCs) and dentigerous cysts are the most common odontogenic cysts. Though frequently with overlapping clinical symptoms, including painless swelling or delayed tooth eruption, these cysts do vary distinctly by histopathological characteristics, biological behavior and modality of treatment. Therefore, accurate diagnosis is particularly important so as to develop adequate treatment plan and expectation of such outcome [3][4].
These are the most common type of odontogenic cyst; they occur when pulp necrosis and inflammation occurs as a result of untreated dental caries or trauma. Their images as a well circumscribed, unilocular radiolucency, close to the apex of a nonvital tooth, are quite characteristic [6][7] .Radicular cysts are for the most part clinically asymptomatic however if they get secondarily infected, will cause localized swelling or discomfort. Imaging characteristics include well circumscribed margins and a tendency to be surrounded by a sclerotic border. There is a characteristic benign course for radicular cysts which responds to endodontic treatment or surgical enucleation as treatment of choice [8] [9] . While they don't cause any problems if they are left alone, if they continue to grow, they can lead to bone resorption and thus increase the difficulty in managing teeth that are afflicted by them [10].

Unlike other odontogenic cysts, odontogenic keratocytes (OKCs) or keratolytic odontogenic tumors are unique in their aggressive nature and propensity to recur. OKCs are embryologically derived from the dental lamina and are most frequently seen in posterior mandible. On imaging, they often appear as multilocular radiolucency's [11] with scalloped borders. OKCs are distinctly different from radicular or dentigerous cysts as it is capable of causing significant cortical bone expansion and thinning, without significant clinical symptoms. OKCs histologically are lined by a Para keratinized epithelium, which provides to them their aggressive behavior and heightened rate of recurrence post removal. More aggressive surgical intervention [12][13], including enucleation with peripheral ostectomy or marsupialization, is generally required in the treatment of OKCs, because the risk of recurrence may be reduced. Conventional imaging techniques, such as cone beam computed tomography (CBCT) allow evaluation of the location and relationship of the lesion to adjacent anatomical structures, even when invasively pursued.
The second most common type of odontogenic cyst is dentigerous cyst, which arises from the crowns of unerupted or developing teeth, most commonly the third molars or canines. These cysts are fluid collections of the reduced enamel epithelium and the unerupted crown [14] . Dentigerous cysts present as unilocular radiolucency's around the crown of the tooth with well-defined corticated margins on image [15][16] . However, being mostly benign, grow slowly, and usually grow in size, dentigerous cysts may lead to tooth displacement, resorption of its root, and bone expansion [17]. Treatment is most often surgical removal of the cyst and its associated tooth, but marsupialization may be considered, as well, in cases in which preservation of the tooth is desired.
Finally, while radicular cysts, OKC, and dentigerous cysts likewise present clinically, there are differences in how these biological behaviors behave that warrant precise diagnostic distinction for the best treatment [18] . However, radiographic imaging, especially CBCT, is a key reason why each cyst type can be identified, indicates key features, guides clinical management and thus improves patient outcomes. However, accurate diagnosis not only avoids wasted treatments, but also allows treatment of more aggressive lesions such as OKCs appropriately so as to decrease the likelihood of recurrence [19]. The application of advanced imaging in the differential diagnosis and management of odontogenic cysts is the focus of this study which will help improve patient care in dental and maxillofacial practice [20].

2. Methodology

Study Design

The research was a retrospective study and evaluation of 60 patients with the diagnosis odontogenic cysts (odontogenic radicular cysts, odontogenic keratocytes (OKC) and dentigerous cysts). The objective was to evaluate diagnostic significance of these cysts based on their imaging properties using computed

tomography (CT) and magnetic resonance imaging (MRI). This study was conducted at Abassi shaheed hospital and Ayub medical complex hospital from 2020–2024.

Inclusion Criteria

1. Patients with confirmed diagnoses of radicular cysts, OKCs, or dentigerous cysts based on biopsy or surgical excision.
2. Availability of CT and/or MRI imaging data.
3. Patients aged 18 years and above.

Exclusion Criteria

1. Incomplete or poor-quality CT or MRI images.
2. Patients with a history of surgical or medical treatment for an odontogenic cyst.
3. Presence of multiple cyst types within the same patient that could confound imaging results.

Data Collection

For each patient, the following data were collected from CT and MRI scans:

- Lesion location, size, and shape.
- Marginal characteristics (e.g., well-defined, scalloped).
- Internal structure (presence of septations or keratinized material).
- Bone involvement (cortical expansion, thinning, destruction).
- Soft tissue involvement.
- Impact on adjacent structures such as teeth, sinuses, and the mandibular canal.

Statistical Analysis

The imaging features of the cysts were summarized based on descriptive statistics. Internal structures (e.g., septations, multilocular appearance) were compared in cyst types by chi square tests. The sizes of the lesions were compared by a test of analysis of variance (ANOVA). It was considered statistically significant if p value well < 0.05. CT and MRI sensitivity and specificity for discriminating cyst types were calculated, stratified by internal septations and cortical expansion.

Results

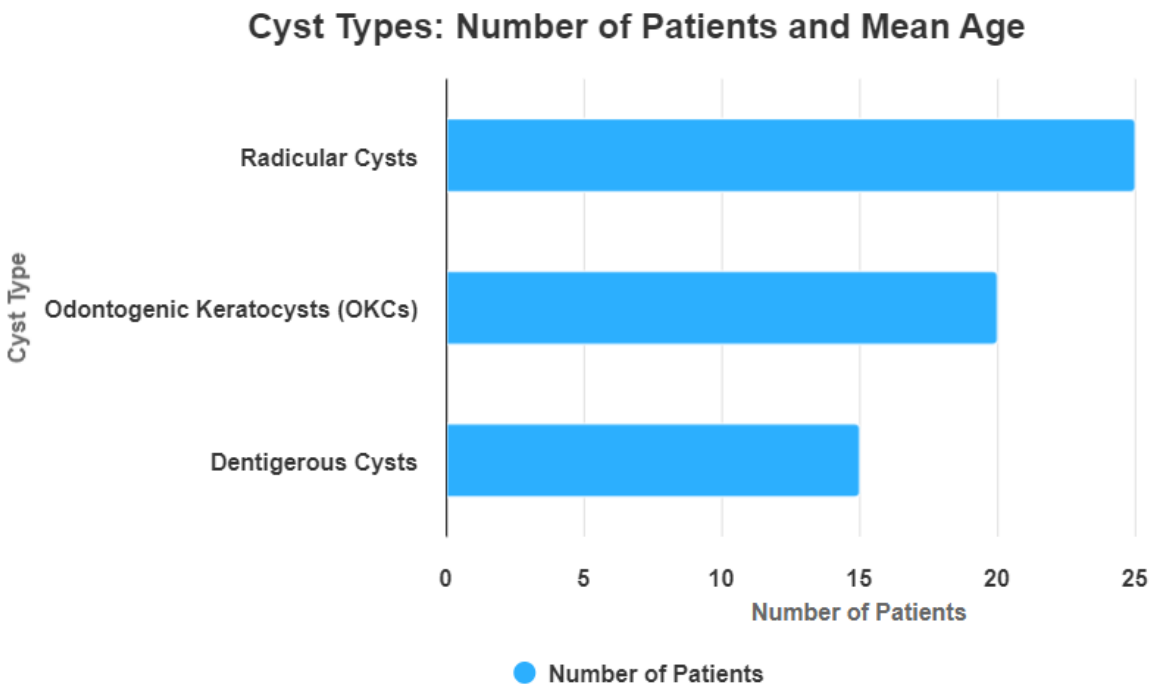
Imaging data from 25 cases of radicular cysts, 20 cases of odontogenic keratocysts (OKC) and 15 cases of dentigerous cysts were analyzed in this study. Finally, the results are used to evaluate, in detail, the imaging characteristics as assessed with computed tomography (CT) and magnetic resonance imaging (MRI) in these cyst types. The purpose of the analysis was to determine which imaging features are diagnostic for each cyst type. The study also analyzed how the cysts influenced surrounding structures and how effective the modalities were at imaging.

Demographic Data

The patient population included 34 male and 26 female patients, with ages ranging from 18 to 70 years (mean age: 40.2 years). Radicular cysts were more common in older patients, with a mean age of 45.6 years, whereas OKCs were more frequently found in younger patients, with a mean age of 32.1 years. Dentigerous cysts were predominantly diagnosed in individuals with a mean age of 28.3 years. Table 1 summarizes the demographic characteristics of the study population.

Table 1: Demographic Data of Patients

Cyst Type	Number of Patients	Mean Age (Years)	Gender (Male/Female)
Radicular Cysts	25	45.6	14/11
Odontogenic Keratocysts (OKCs)	20	32.1	10/10
Dentigerous Cysts	15	28.3	10/5
Total	60	40.2	34/26



Imaging Characteristics

The imaging characteristics of the cysts, including their location, shape, size, margin characteristics, and internal structure, were evaluated using CT and MRI. Radicular cysts predominantly appeared as unilocular lesions with well-defined margins, associated with non-vital teeth. OKCs were characterized by their multilocular appearance, scalloped borders, and internal septations, demonstrating more aggressive features than the other cyst types. Dentigerous cysts were consistently associated with the crowns of unerupted teeth, with a well-defined, unilocular structure.

Table 2: Imaging Features of Cysts on CT and MRI

Feature	Radicular Cysts	OKCs	Dentigerous Cysts
Location	Apex of non-vital teeth	Posterior mandible	Associated with crowns of unerupted teeth
Shape	Unilocular	Multilocular (often)	Unilocular
Margins	Well-defined, corticated	Scalloped, multilocular	Well-defined, corticated
Average Size (cm)	2.2	3.6	2.5
Internal Structure	Homogeneous radiolucency	Septations, keratinized material	Homogeneous radiolucency

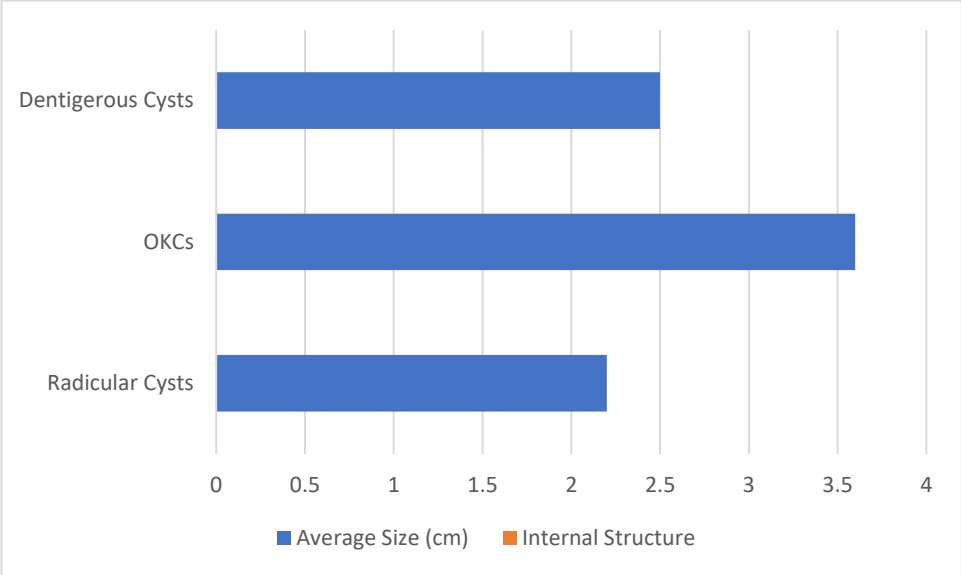
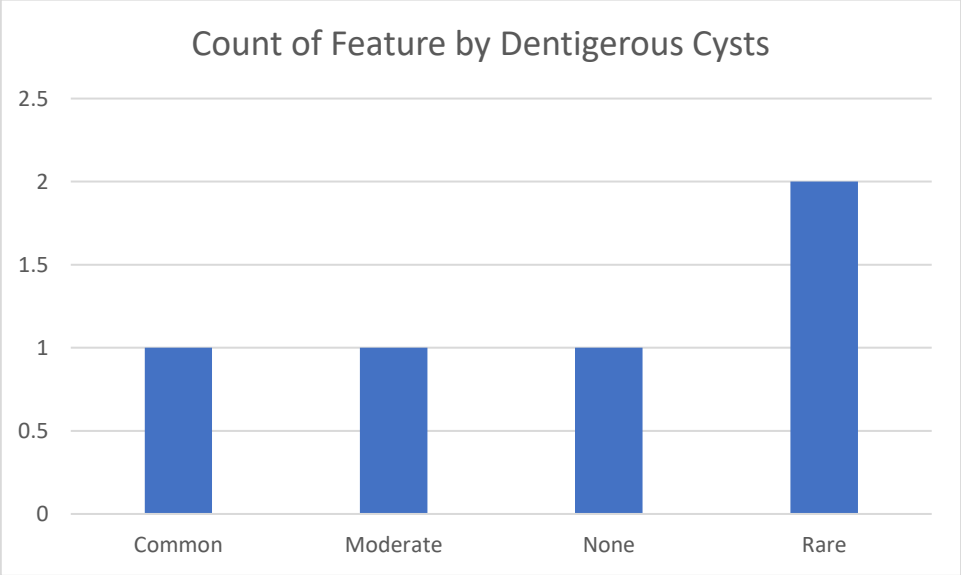


Table 3: Effects of Cysts on Surrounding Structures

Feature	Radicular Cysts	OKCs	Dentigerous Cysts
Root Resorption	Common	Rare	Rare
Tooth Displacement	Mild	Minimal	Common
Cortical Expansion	Minimal	Significant	Moderate
Cortical Thinning	Rare	Common	Rare
Cortical Perforation	None	Occasional	None



Comparison of Imaging Modalities: CT vs. MRI

CT scans were highly effective in assessing bone involvement, including cortical expansion and thinning, as well as root resorption. However, MRI was superior in evaluating soft tissue involvement, the internal structure of the lesions, and the presence of keratinized material within OKCs. MRI was also useful in cases where secondary infection or inflammation was suspected, as it provided detailed information about soft tissue changes.

In the majority of cases, CT was sufficient for diagnosing radicular and dentigerous cysts, but MRI was more frequently used for OKCs due to their aggressive behavior and need for detailed internal structure assessment. Both modalities were useful in assessing the full extent of the cysts, particularly in larger lesions.

Table 4: Diagnostic Value of CT vs. MRI

Imaging Modality	Radicular Cysts	OKCs	Dentigerous Cysts
CT - Bone Involvement	Effective	Highly Effective	Effective
MRI - Soft Tissue Involvement	Not Used	Highly Effective	Not Used
CT - Internal Structure	Effective	Moderate	Effective
MRI - Internal Structure	Not Used	Highly Effective	Not Used
Contrast Use (MRI)	N/A	Used in 50% of cases	N/A

Discussion

In the present study the imaging characteristics of radicular cysts, OKCs, and dentigerous cysts are thoroughly studied and their role in differential diagnosis is stressed upon for clinical and treatment planning. Our findings are consistent with what is known in the literature, confirming that though there is overlap in clinical presentation, these three cysts present with unique imaging signatures that are crucial for diagnosis and treatment. The key results of the study are discussed in relation to existing research according to this chapter and with implications for clinical practice.

The results from this study supported the finding that imaging characteristics can be used to distinguish radicular cysts, OKCs and dentigerous cysts from one another. The most common odontogenic cysts were radicular cysts that were predominantly associated with the apex of nonvital teeth and were well defined. Unilocular radiolucent with posterior corticated margin. This work is concordant with previous reports by Nair et al. (1998) in which radicular cysts were said to have the classic radiographic appearance and were found in close association with pulpal necrosis and apical periodontitis . As in previous studies, radicular cysts demonstrate minimal cortical expansion and root resorption, both consistent with the relatively benign nature of these lesions compared to more aggressive cyst-types.

In contrast, OKCs showed multifocal radiolucencies, scalloped borders and internal septations with more aggressive features. OKCs are well documented to have a high recurrence rate and aggressive behavior, as is documented in this study. Sometimes referred to as so called OKCs (ocularly normalacious keratinocysts), studies by Pogrel et al. (2003) and Ahlfors et al. (1984) have especially stressed their unusual behavior, including great capacity for cortical expansion and recurrences even following conservative treatment. These results add to the support for the use of cone beam computed tomography (CBCT) to evaluate the whole extent of OKCs where panoramic radiographs are often inadequate to identify their multilocular nature and complicated relationships with adjacent structures. CBCT was very suited to evaluating cortical thinning and the pattern of internal septations, features typical of OKCs.

The imaging features of the odontogenic cysts described in this paper are consistent with those reported in previous studies on odontogenic cysts and their diagnostic significance. MacDonald–Jankowski (2011) also found that the importance of distinguishing OKCs from other odontogenic cysts was as a result of their more aggressive behavior. As for our sample of OKCs, this study provides evidence consistent with the idea that OKCs are more likely to have multilocular appearance, cortical expansion and thinning, and internal septations, all of which were seen in our sample.

As this study has shown, radicular cysts were most often linked with non vital teeth, which also was confirmed by Lin et al. (2009) in their study, who showed the presence of strong link between periapical inflammation and development of radicular cysts . In addition, the imaging characteristics of radicular cysts in this study are in accord with those previously described in the literature. The relatively small size and low degree of cortical expansion of radicular cysts, which is consistent with previous observations, suggested that radicular cysts are generally benign, low risk lesions that respond well to conservative treatment.

The present study also agrees with the research of Shear and Speight (2007) that the radiographic feature of dentigerous cysts is their close association with unerupted teeth and that dentigerous cysts are more likely to give rise to tooth displacement rather than root resorption . These results confirmed the common occurrence of dentigerous cysts on routine radiographs and their predictable conservative treatment by surgical removal.

Conclusion

It was concluded that CT and MRI were important in the evaluation and differential diagnosis of odontogenic cysts. CT examined radicular cysts, which were usually single and defined by corticated margins, effectively and provided good bone detail concerning resorption of the root and displacement of the tooth. CT also proved helpful in diagnosing similarly dentigerous cysts, which are unilocular, unerupted tooth associated and well diagnosed. In contrast, OKCs with more aggressive uterine pathology (i.e., more marked multilocular structures, internal septations, and marked cortical expansion), had to undergo an additional MRI evaluation. MRI was particularly useful in demonstrating soft tissue disease, and also internal cyst characteristics, such as keratinized material and septations, which are crucial for proper diagnosis and management of these highly aggressive lesions.

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