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Assessing the Reliability of a Dental Diagnostic Software Application in Rendering Diagnosis: A Retrospective Study

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ABSTRACT

Abbreviations: CBCT: Cone-Beam Computed Tomography; IRB: Institutional Review Board; CI: Confidence Intervals; OKCs: Odontogenic Keratocyst

Introduction

Accurate interpretation of radiographic images is fundamental to diagnosing oral pathologies and guiding clinical decisions. Advanced imaging modalities, such as cone-beam computed tomography (CBCT), have significantly enhanced clinicians' ability to visualize dental and maxillofacial structures in 3D, allowing for improved detection of pathologies like cysts, tumors, and bony abnormalities [1]. Despite these advancements, the interpretation of 3D images can be challenging for general dentists, as this skill often falls outside their routine scope of practice [2]. The complexity of CBCT images requires specialized knowledge typically held by oral radiologists or pathologists, contributing to diagnostic uncertainty among general practitioners. Diagnostic software tools have been developed to assist clinicians, primarily focusing on 2D imaging modalities such as panoramic radiographs. ORADIII is one such tool, designed to help general dentists by generating differential diagnoses based on the information from panoramic images [3]. While ORADIII has demonstrated utility in the context of 2D imaging, its effectiveness in interpreting 3D CBCT scans has not been well-studied, leaving a critical gap in the literature. General dentists are increasingly adopting CBCT, yet there is limited support for them in interpreting the complex data these scans provide [4]. Given the growing use of CBCT in dental practices and the need for reliable diagnostic support tools, this retrospective study aims to bridge the gap by evaluating ORADIII's diagnostic performance in interpreting CBCT scans. Specifically, this study com-

pares ORADIII's top differential diagnosis with that of an oral radiologist and the definitive diagnosis confirmed by biopsy. The goal is to assess whether this software, initially developed for 2D images, can accurately function in a 3D context. We hypothesize that ORADIII will correctly match the definitive diagnosis 50-70% of the time, offering valuable insights into its potential role as a diagnostic aid for general dentists using CBCT.

Materials and Methods

This retrospective study analyzed 100 CBCT cases selected from the Oral and Maxillofacial Pathology and Radiology clinical archive at the University of Nebraska Medical Center between 2013 and 2023. Approval for the study was obtained from the Institutional Review Board (IRB) under protocol #0067-23-EX. The study included cases that were presented with radiographically evident bony lesions, such as cysts, tumors, or bony abnormalities. Exclusion criteria comprised patients without bony lesions and those whose scans contained artifacts that could interfere with diagnosis. Biopsy reports were available for 85 cases, providing a definitive diagnosis for comparison. The primary goal was to compare the diagnostic accuracy of ORADIII software with that of an Oral and Maxillofacial Radiologist, using biopsy results as the gold standard. Two primary imaging tools were utilized for the analysis of Cone Beam Computed Tomography (CBCT) scans: In vivo Dental 6 and ORADIII. In vivo Dental 6, developed by Anatomage Inc., is a sophisticated 3D imaging software that allows Oral and Maxillofacial Radiologists to assess various lesion characteristics, including their location, size, internal structure, and the effects on surrounding anatomical structures. In contrast, ORADIII was originally designed for interpreting 2D panoramic radiographs but was repurposed for this study to analyze CBCT data. This software employs a structured approach, requiring users to answer 18 specific questions related to patient demographics (such as sex, race, age, and the presence of pain or paresthesia) as well as detailed lesion features (location, periphery, internal structure, etc.). It generates a list of differential diagnoses.

Cases Evaluations

An oral and maxillofacial radiologist, blinded to the biopsy results, independently evaluated each CBCT scan using true three-dimensional multi-planar imaging and provided a top differential diagnosis based on clinical knowledge and image interpretation. Simultaneously, students independently used the ORADIII software for each case, answering all 18 structured questions and recording the top three differential diagnoses generated by the software. For 85 cases, ORADIII's top diagnosis and the oral radiologist's diagnosis were compared to the definitive biopsy-confirmed diagnosis. A detailed flowchart of the materials and methods is presented in Figure 1.

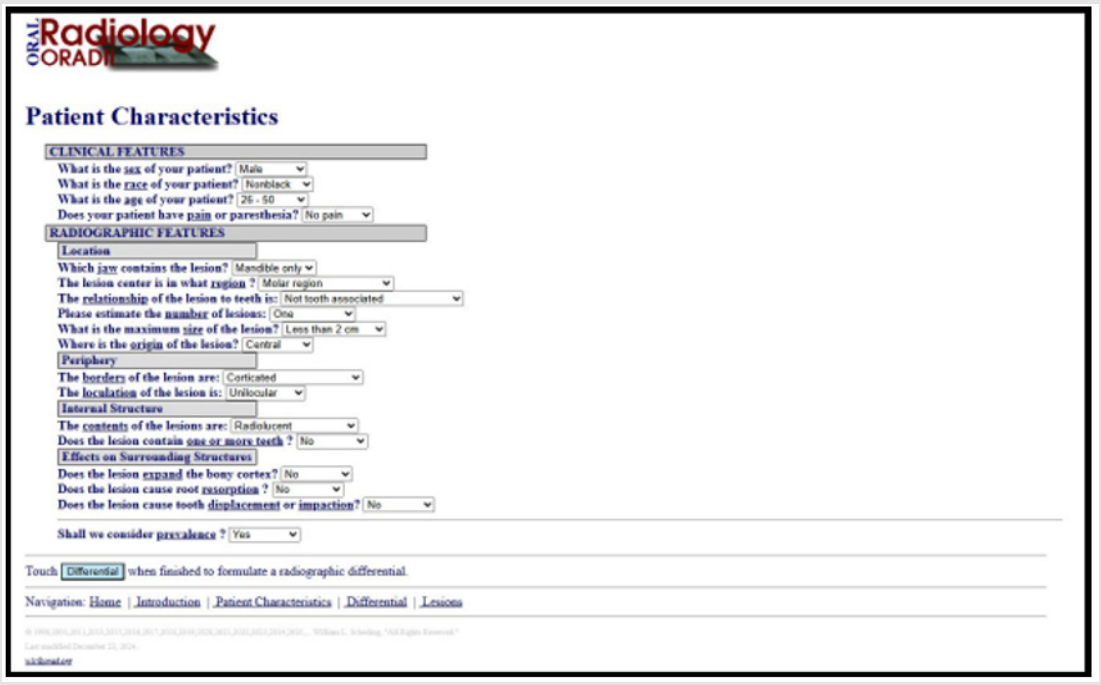

Figure 1: ORADIII app was employed to generate differential diagnoses.

Statistical Analysis

The primary focus of this analysis was to compare the diagnostic accuracy of ORADIII and the oral radiologist, measured as the percentage of cases in which the top differential diagnosis matched the definitive biopsy-confirmed diagnosis. To evaluate diagnostic performance, sensitivity and specificity were calculated. Sensitivity represented the ability of each method to correctly identify true positives (accurate lesion diagnosis), while specificity measured the ability to exclude incorrect diagnoses (true negatives) correctly. McNemar's test was used to compare the accuracy of ORADIII and the oral radiologist across 85 biopsy-confirmed cases. It generated a p-value to assess whether a statistically significant difference existed between the two diagnostic methods. For the 15 cases without biopsy confirmation, Cohen's Kappa (κ) statistic was employed to quantify the level of agreement between ORADIII and the radiologist, with κ values ranging from 0 to 1, representing agreement levels from poor to almost perfect. Additionally, the Chi-square (χ^2) test was applied to examine whether there was a significant difference in the frequency of correct diagnoses between ORADIII and the radiologist. To assess the reliability of the results, 95% confidence intervals (CI) were calculated for accuracy, sensitivity, and specificity, providing a measure of statistical precision.

Results

Out of 85 CBCT scans interpreted, they were biopsy-confirmed, enabling a direct comparison between the diagnostic accuracy of ORADIII and the radiologist. Figure 2 presents the top three differential diagnoses produced by ORADIII, alongside their accuracy rates for the biopsy-confirmed diagnoses. Table 1 and Figure 3 show the percentage agreement between ORADIII's top diagnosis and the definitive diagnosis, with 95% confidence intervals. The radiologist demonstrated a significantly higher level of agreement with the definitive diagnosis than ORADIII. The confidence intervals for ORADIII, in both comparisons (vs. the radiologist vs. the definitive diagnosis), were wider and skewed toward lower values, reflecting greater variability in the system's diagnostic performance. In contrast, the radiologist achieved a more consistent and reliable agreement, as demonstrated by a narrower confidence interval and higher accuracy score. The Chi-Square Test was performed on these observed frequencies, yielding a significant result (x 2=34.27, $p < 0.05$), indicating a substantial difference between the diagnostic accuracy of ORADIII and the definitive diagnosis. The findings from the Chi-Square test suggest that ORADIII's overall diagnostic accuracy is significantly lower than that of the radiologist, particularly in cases where the radiologist correctly identified the diagnosis while ORADIII did not. This discrepancy highlights the need for improvements in ORADIII's algorithm to reduce the occurrence of both false positives and false negatives.

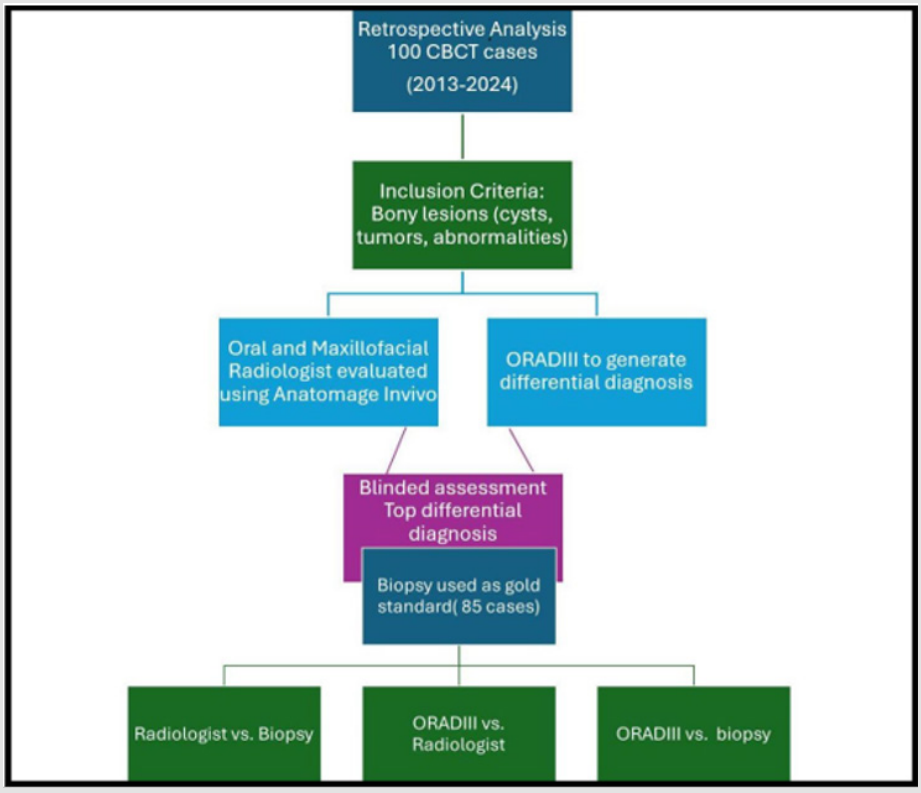

Figure 2: Flowchart of the materials and methods.

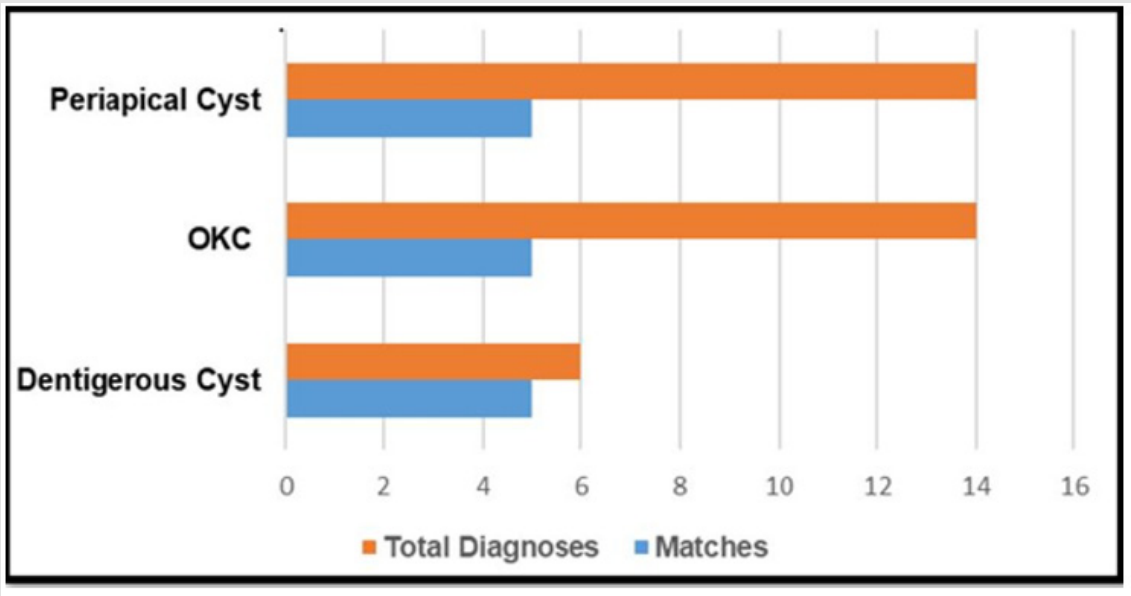

Figure 3: Graphical representation of the top three differential diagnoses was provided from ORADIII with their respective accuracy. Orange bar (Total diagnoses), Blue bar (correct matches).

Table 1: Comparing ORADIII software, the radiologist, and the definitive diagnosis.

	Matches	Total Diagnoses	Accuracy	95% C.I
ORADIII vs. Radiologist	21	85	0.214	(0.133,.0295)
ORADIII vs. Definitive Diagnosis	18	85	0.212	(0.125, 0.299).
Radiologist vs. Definitive Diagnosis	58	85	0.694	(0.596, 0.792).

Discussion

This study aimed to assess the efficacy of ORADIII in diagnosing hard-tissue lesions using CBCT scans compared to an oral radiologist's assessments. Our findings indicated that while ORADIII provided some accurate differential diagnoses, the oral radiologist demonstrated superior accuracy in aligning with definitive biopsy results. The results indicated that ORADIII's top differential diagnoses included periapical cysts, odontogenic Keratocyst (OKCs), and dentigerous cysts. Specifically, it correctly diagnosed dentigerous cysts in five out of six instances, suggesting that the software may be particularly effective in identifying this specific lesion. These findings are consistent with previous studies that highlight the potential utility of diagnostic software in assisting clinicians with complex cases, particularly in the context of odontogenic lesions [5-7]. However, the overall accuracy of ORADIII was found to be only 21% when compared to the oral radiologist and the definitive diagnosis, which is significantly lower than our hypothesis that ORADIII would correctly diagnose 50-70% of cases. This discrepancy raises important considerations regarding the software's reliability and highlights the necessity for clinicians to utilize their clinical judgment in conjunction with technological tools [8]. The oral radiologist achieved an accuracy of 68.23 % in matching the definitive diagnosis, significantly outperforming ORADIII. This finding reinforces the crucial role of clinical expertise in radiographic interpretation. Previous studies have highlighted that the nuanced understanding of an experienced clinician allows for better differentiation between similar pathologies, which automated systems may struggle to discern [9,10]. While ORADIII serves as a valuable adjunct, it should not replace the critical analysis provided by trained professionals.

Limitations of the Study

Several limitations were noted that could have affected the study's outcomes. Notably, only 85 of the 100 cases had biopsy reports available, limiting our ability to draw comprehensive conclusions across all cases. Previous research emphasizes the importance of having definitive diagnostic tools, such as biopsy results, to enhance the accuracy of radiographic interpretations [11]. Additionally, the lack of complete clinical reports, including essential patient characteristics such as race and the presence of pain or paresthesia, may have influenced ORADIII's diagnostic capabilities. These clinical features are critical for appropriate lesion evaluation, as they can provide context and improve diagnostic accuracy [12,13].

Future Implications and Recommendations

Given the promising results for specific lesions, ORADIII could be integrated as a supplemental tool for general dentists, especially in complex cases where rapid decision-making is essential [14]. However, its use must be accompanied by thorough clinical evaluations and the application of additional diagnostic modalities, such as biopsy and histopathological examinations, for confirmation of lesions [7,15]. Future research should focus on improving the software's algorithms by integrating additional clinical data, enhancing its diagnostic accuracy, and validating its effectiveness across larger, more diverse populations [16,17]. The incorporation of machine learning techniques could also be explored to further refine the diagnostic process and improve outcomes [18].

While ORADIII demonstrates potential as an adjunct tool for general dentists in diagnosing jaw lesions, it should not be relied upon as a standalone solution. The study underscores the importance of clinical expertise in achieving accurate diagnoses. It highlights the need for further research to enhance ORADIII's algorithms by incorporating additional clinical data and exploring machine-learning techniques for improved diagnostic accuracy. This study reinforces the complementary roles of technology and clinical judgment in the field of dentistry.

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None.

Conflict of Interest

The authors affirm that there are no conflicts of interest pertaining to the research, ensuring transparency, and maintaining the integrity of the study.

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