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Comparison of diagnostic accuracy of ORAD an artificial intelligence powered software and maxillofacial radiologist in the diagnosis of benign lesions of the jaw – a cross-sectional study.

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ABSTRACT
Background: Artificial Intelligence (AI) is used in many fields and in future. Its application will be tremendously increased in the field of medicine and dentistry. The software ORAD which is one of the form of AI tool concludes radiographic diagnosis on the basis of data provided to it. This study will determine whether radiographic diagnosis can simply be concluded through a mathematical equation or it also require experience, understanding and comprehension of available data.
Aim: The purpose of this study was to compare the diagnostic accuracy of the Oral Radiographic Differential Diagnosis (ORAD) digital software and maxillofacial radiologists in the identification of benign lesions of the jaw.
Setting and design: In the Department of Oral Medicine and Radiology OPGs that revealed benign jaw lesions with a histological diagnosis were chosen for the analysis
Methods and Materials: A total of 38 panoramic radiographs with benign intra-bony diseases were included in the study. The particular information required by the ORAD algorithm was provided to the software and the ORAD diagnosis was noted. A specialist maxillofacial radiologist also evaluated these lesions to give the diagnosis. Both these diagnoses were compared with histopathological diagnosis.
Statistical analysis: z-test was used for comparison of accuracy of diagnosis.
Results: It was discovered that the ORAD program had a lower diagnostic accuracy (50.0%) than maxillofacial radiologists (68.4%) however this difference was not significant statistically (p=0.103)
Conclusion: Diagnostic accuracy of oral radiographic differential diagnosis (ORAD) digital software and maxillofacial radiologist in the diagnosis of benign lesions of jaws was similar. ORAD is useful in the differential diagnosis of intra-bony lesions.
Keywords: artificial intelligence, diagnosis, diagnostic accuracy, orad, panoramic radiography

I. INTRODUCTION

The diagnosis serves as one of the important tool for treatment selection. A general dentist's daily responsibility is to diagnose patients by combining clinical findings with radiographic observation.[1] The advancement of science has greatly benefited from radiographic examinations since it has made anatomical structures visible that were before impossible to consistently observe. Therefore, the historical development of radiology has made possible a significant technological advancement, making support equipment for diagnostic instruments crucial to case resolution, illness information, and therapy application.[2]Many scholars are actively interested in artificial

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intelligence, which has been actively implemented in a wide range of industries recently. This trend is also present in dentistry, with the field of oral and maxillofacial (OMF) radiography showing great promise in the use of artificial intelligence.[3]

Computer programs known as clinical decision support systems (CDSSs) are made to give medical practitioners specialized assistance when making clinical decisions about the prevention, diagnosis, or treatment of specific diseases.[4] For more than 20 years, dental researchers have been developing CDSSs utilizing diverse knowledge representation methods and applying them to a range of fields.[5]

ORAD, or oral radiographic differential diagnosis, is a pathology-related CDSS that was first developed by S.C. White in 1989. It is a computer software designed to assess the clinical and radiographic characteristics of patients who have intra-bony lesions in order to help identify those patients.[6] Oral and maxillofacial radiology has conducted research on the use of artificial intelligence (AI) for the diagnosis of a variety of conditions.[7] Advances in AI and radiology have brought more emphasis to the function of the radiologist as a diagnostician, which basically consists of two processes: radiographic assessment and interpretation.[8]

Reducing uncertainty about the presence or absence of a disease is the goal of the process known as diagnostic accuracy. Tests can be applied in several contexts. Diagnostic imaging procedures typically require an observer to interpret the image; this observer becomes a part of the diagnostic system and increases the accuracy of the system.[1] The existence of a reliable gold or reference standard diagnosis is a requirement for evaluating a test's accuracy. Selecting the right gold standard requires a through and thoughtful strategy and should be based on a different methodology than the test under evaluation. For this reason, it is preferable to assess a test, say, using imaging technology by contrasting it with a gold standard test that does not include imaging, such histology or biopsy.

Therefore, this study compared the diagnostic accuracy of Oral radiographic differential diagnosis (ORAD) digital software and maxillofacial radiologist in the diagnosis of benign lesions of jaw bones.

Objectives of the study were :-

1. To evaluate the diagnostic accuracy of ORAD in the diagnosis of benign lesion of the jaws with respect to histopathological diagnosis.
2. To evaluate the diagnostic accuracy of maxillofacial radiologist in the diagnosis of benign lesions of jaws with respect to histopathological diagnosis.
3. To compare the diagnostic accuracy of ORAD and a maxillofacial radiologist in the diagnosis of benign lesions of jaws.

II. MATERIAL AND METHODS:-

After receiving approval from the institutional ethical committee, the current cross-sectional investigation was carried out in the Department of Oral Medicine and Radiology. Purposive sampling was used to choose the samples.

Study design

A total of 38 OPGs that revealed benign jaw lesions with a histological diagnosis were chosen from the archives of radiology data base of department of oral medicine & radiology of our dental college and hospital. OPG scans with artifacts, low picture quality, or fragmentary images were not included in the analysis.

ORAD diagnosis

In this present study the ORAD-Oral radiographic differential diagnosis (ORAD III) software was used. The exact data needed for the ORAD algorithm was submitted to ORAD software by an independent participant who was not involved in the radiographic diagnosis. The required patient's information (viz. age, sex, race and pain or paresthesia etc.) was submitted as per the drop down menu boxes. Similarly radiographic features details about the location, periphery, internal structure and effect on surrounding structure of the lesion were submitted to the program. The radiographic diagnosis given by ORAD was recorded.

Radiological diagnosis

The selected OPGs were examined by the specialist maxillofacial radiologist who was not aware about the histopathological diagnosis of the lesion. Depending on the location, content, periphery, margins and effect of lesion on surrounding structure the radiologist concluded the diagnosis.

Comparison with gold standard

The radiographic diagnosis given by maxillofacial radiologist and radiographic diagnosis by ORAD was compared with histopathological diagnosis and accuracy was determined and compared.

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Statistics

Data was collected, tabulated, formulated and was analyzed using SPSS statistical software 17.0 version. z-test was used for comparison of accuracy of diagnosis given by ORAD tool to that of the maxillofacial radiologist in diagnosis of benign lesions of jaws.

III. RESULTS

A total of 38 jaw lesions as depicted in panoramic radiograph were included on the study.

Table no. 1 shows the accuracy of ORAD in the diagnosis of benign lesions of jaw. The accuracy of ORAD was 50% with respect to histopathological diagnosis

Table no. 2 shows the accuracy of maxillofacial radiologist in the diagnosis of benign lesions of jaw. The accuracy of maxillofacial radiologist was 68.4% with respect to histopathological diagnosis.

Table 1: Accuracy of ORAD with respect to histopathologic diagnosis

Accuracy of oral radiographic differential diagnosis (ORAD) digital software	Frequency	Percentage
No	19	50.0%
Yes	19	50.0%
Total	38	100.0%

Table 2: Accuracy of maxillofacial radiologist with respect to histopathologic diagnosis

Accuracy of maxillofacial radiologist	Frequency	Percentage
No	12	31.6%
Yes	26	68.4%
Total	38	100.0%

Groups	N	Accuracy (%)	95% CI	Z value	P value
ORAD digital software	38	50.0	34.1 – 65.9	1.63	0.103; Not significant
Maxillofacial radiologist	38	68.4	53.6 – 83.3		

Table3:Comparison of accuracy of ORAD and maxillofacial radiologist (z test)

z-test was used for comparison of accuracy of diagnosis. It was found that the diagnostic accuracy of oral radiographic differential diagnosis (ORAD) digital software (50.0%) was less as compared to that of maxillofacial radiologist (68.4%) but the difference found in the accuracy was not significant statistically. (p value 0.103). Thus the diagnostic accuracy of oral radiographic differential diagnosis (ORAD) digital software and a maxillofacial radiologist in the diagnosis of benign lesions of jaws was found to be similar.

IV. DISCUSSION

A. F. Simeos et al. (2012) assessed the validity of ORAD in patients with jaw bone

pathologies. Four investigators who were unaware of the histopathology diagnosis of the jaw bone lesions participated in this study. They found out that 67% of the radiographic diagnosis concluded by ORAD does not match with the histopathology diagnosis. Thus they came to the conclusion that while ORAD can be helpful in aiding in the differential diagnosis of jaw pathologies, it should only be used as a supplemental tool in the decision-making process.[5] In the present study half of the radiographic diagnoses (50%) made by ORAD do not match the histopathology diagnosis.

Brooks SL. (2017) in his case series used ORAD III software. The necessary information needed for this software program was provided through the CBCT scans. A total of 5 different bony lesions of jaw were included in the study. The author approved the usefulness of such software. He did, however, stressed the importance of accuracy of the data input. We also agree that the program's accuracy is totally dependent on the correctness of the information presented to it.[10]

Vicari AP et al. (2018) discussed the use of ORAD to aid in the interpretation and determination of diagnoses of pathologies of the jaws in panoramic radiographs. They analyzed the capacity of the tool and professionals to interpret and determine diagnoses of maxillary pathologies in panoramic radiographs. The results showed a sensitivity of 87.5% for the online platform and 93.75% for the specialists, and concluded that the use of the tool as an aid in the diagnosis in cases of certainty of the existence of the pathology.[2] A similar trend was observed in the present study where the diagnostic accuracy of the ORAD was less as compared to the Maxillofacial radiologist. However this difference was not significant statistically.

Despite the advancement of contemporary imaging technologies, radiography continues to be the method of research used to assess diseases. ORAD markets itself as a clinical decision support tool for radiological differential diagnosis in dentistry. It's also critical to remember that ORAD only offers recommendations for differential diagnoses to take into consideration rather than the "best" diagnosis. When it comes to helping clinicians make decisions about diagnosis and treatment for patients, the utilization of digital tools is particularly noteworthy. ORAD should be utilized as a supplement to the decision-making process rather than as a conclusive diagnosis, although being a helpful tool for aiding in differential diagnosis. Professionals still need to have prior experience in the field.

There hasn't been much CDSS system implementation. For a number of reasons, including the absence of formal evaluations of these systems, difficulties creating standard representations, a dearth of research on the decision-making process, and the expense and structured data entry procedure, these systems—including CDSSs—remain challenging. Since many systems have not undergone official evaluation, it's possible that their usefulness for clinical practice has not yet been determined.

The future road for CDSS:-

Numerous obstacles remain to be surmounted. The adoption of evidence-based practice, advancements in the creation of practical programs, the acceptance of standards enabling interoperability, the removal of logistical obstacles to implementation, recognition of the dynamic and complex nature of clinical knowledge, and appropriate program validation are all necessary for the future of CDSS.

Limitations :-

The limitation of the present study was the limited sample size. Also instead of a single maxillofacial radiologist multiple maxillofacial radiologists should have participated in the study.

Future scope

In future a study with large & diverse sample should be done with more advanced program & with multiple maxillofacial radiologists.

V. CONCLUSION: -

According to the study's findings, computerized software for oral radiographic differential diagnosis (ORAD) and maxillofacial radiologist both had comparable diagnostic accuracy when it came to identifying benign lesions of the jaws. Although ORAD shouldn't be utilized as a conclusive diagnosis, it is useful in the differential diagnosis of intrabony lesions.

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Abbreviations:-
ORAD - Oral Radiographic Differential Diagnosis
OMF - oral and maxillofacial
CDSS - clinical decision support systems
AI – Artificial Intelligence
CBCT – Cone Beam Computed Tomography