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ROLE OF ARTIFICIAL INTELLIGENCE IN DIAGNOSIS OF ORAL CANCER :NARRATIVE REVIEW.

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Abstract

Artificial intelligence has been evolving since the last decade in the field of dentistry. The incidence and prevalence of oral potentially malignant disorders and oral cancer seems to be increasing and it requires early management. There are numerous diagnostic aids that helps in the diagnosis of oral malignancy ranging from basic chairside investigations to light-based detection systems, which has good sensitivity and specificity.Also,timely application of Diagnostic aids increases the survival rate. AI is perceived to be an excellent adjunct for dentists. AI can be user-friendly, transparent, reproducible, and unbiased. The present review outlines the progress and potential applications of AI as a diagnostic aid in the detection of oral potentially malignant disorders and Oral cancer.

keywords: Artificial intelligence, Oral potentially malignant disorders, oral cancer, Diagnostic aids

INTRODUCTION:

Digital technology has its own place towards the revolution of dentistry. With Increasing prevalence and alarming mortality rate of oral cancer at a rate of 12% worldwide annually, early screening is essential for better prognosis and improved Quality of life.

According to GLOBOCAN, the incidence rate in male was found to be 13.9 (per 100,000 persons/year)and 4.3 (per 100,000 persons/year) among females, thus oral cancer remain to be the sixth most common type of cancer. Also, the incidence of oral tongue cancer in India is three-fold higher compared to the U.S.The Indian Council of Medical Research (ICMR) and National Centre for Disease Informatics & Research (NCDIR), estimate that there would be 12% increase in cancer cases from 13.9 lakhs in 2020 to 15.7 lakhs by 2025. [(1)]

Early detection is mandatory to prevent minimize the potential complications, the progression of the disease and to enhance the life expectancy of the patients. Various screening modalities ranging from basic chairside investigations to advanced diagnostic techniques aids in the early detection of oral cancer. Artificial intelligence has been an integrated part of our life as Siri,Alexa, google assistant etc.AI has fastened and replaced human needs in all aspects with greater access and accuracy.

The term “Artificial intelligence” was coined by mathematician, John McCarthy in 1955. It is termed as the ability of the machine to imitate the human mind and behaviour towards problem-solving.Artificial intelligence in medicine is categorized in two forms:1. virtual part which includes the Neural network and 2. Physical part includes the robots.[(2)]

Artificial Intelligence achieves diagnosis by augmenting physician capability with patient’s medical records and radiological images, which is found to have greater accuracy,minimal error.[(3)]

Diagnostic aids are commonly used for the detection of premalignant lesions includes vital Stainings,autofluorescence and chemiluminescence. There is minimal usage of these diagnostic aids because of the

lack of their efficacy. Late detection of oral cancer reinforces higher-end diagnostics such as lab-on-chip, microfluidics, nano-diagnostics, liquid biopsy, which are highly technically sensitive and requires trained personnel.[4] Yet Biopsy and histopathological examination remains to be the gold standard.AI has been the new frontier with its widespread application in dentistry and eloping in oral lesions.

Oral cancer screening camps should be enhanced with diagnostic aids so that early detection could be possible without specialists. AI paves the way for a non-invasive, and easy-to-use diagnostic tool that can support and improvise the screening process. According to ADA, "Identifying white and red spots that show dysplasia and removing before it transforms into cancer has proved to be one among the efficacious methods in reducing the incidence and mortality of cancer".[5]

This review emphasizes the role of artificial intelligence in the diagnosis of oral cancer and its potential to serve as an adjuvant to the existing diagnostic aids.

ARTIFICIAL INTELLIGENCE:

Artificial intelligence is termed as the ability of machines that exhibit their own intelligence, so that they can solve their problems.

Machine learning is part of AI, which learns from the data ,converts into algorithms and predicts outcomes without human input.Machine learning is not meant to replace human physicians, but rather assists or augments the medical care.ML has improved the outcome of cancer prediction by 15-20%

Neural networks are a set of algorithms that compute signals via artificial neurons i.e.,it functions like the human brain.

Deep learning is a component of machine learning that utilizes the network with different computational layers in a deep neural network to analyze the input data. It automatically identifies patterns to improve feature detection.For example, The number of radiology scans is continuously increasing while the radiologists are not. AI assistance in this area can reduce the time frame from exam to results due to faster readings as well as 24/7 working capability.[6]

Studies show that these AI-powered automated systems performed extremely well in various scenarios. Shortliffe et al.,reported that dentists are relying upon computer applications to urge insights for clinical diagnosis.AI serves the process of diagnosis to be more accurate and efficient.[7]

SCREENING AND DIAGNOSTIC AIDS :

The screening for oral cancer starts with the visual examination(could also be done by self) to palpation (by professionals) and the diagnostic tools/aids which helps in alarming the patient towards detection and probability of cure. High risk group such as smokers,pan chewers,alcoholics and person with deleterious habits should be advised for annual examination for any suspicious asymptomatic lesions. Public awareness campaigns regarding the warning signs of oral cancer, OPMDs ,adverse hazards of tobacco and alcohol should be enhanced.[8]

Though Biopsy is the gold standard diagnostic modality ,its invasiveness restricts patients from undergoing it.

With the aim of improvising early detection,newer techniques are being developed to complement clinical examination and to facilitate early diagnosis.Advancements in the field of oral cancer research have led to the evolution of diagnostic tools at both the clinical and molecular level .

The list of various diagnostic aids used are summarized down in table 1.[9]

TABLE 1:LIST OF DIAGNSOTIC AID

CHAIR SIDE INVESTIGATIONS (at clinical level)	1.VITAL STAINING (TOLUIDINE BLUE, LUGOL'S IODINE AND OTHERS), 2.ORAL BRUSH BIOPSY, 3.VELSCOPE, 4.AUTOFLUROSCENCE,CHEMILUMINESCENCE AND OTHER LIGHT-BASED SYSTEMS.
DIAGNOSTIC PROCEDURES(BASIC) (at microscopic level)	1.LIQUID-BASED CYTOLOGY 2.HISTOPATHOLOGY 3.ELISA 4.IMMUNOHISTOCHEMISTRY 5.FLOW CYTOMETRY 6.POLYMERASE CHAIN REACTION 7. IN-SITU HYBRIDIZATION AND OTHERS.

ADVANCED DIAGNOSTIC PROCEDURES	1.MICROARRAYS 2.SEQUENCING 3.MICROFLUIDICS (LAB- ON-CHIP,)BASED TECHNIQUES 4.NANO-DIAGNOSTICS, (QUANTUM DOTS,OCT,SERS) 5.LIQUID BIOPSY 6.'OMICS' TECHNOLOGY (GENOMICS,PROTEOMICS,TRANSCRIPTOMICS,METABOLOMICS) 7.SYNTHETIC BIOLOGY (CHIMERIC ANTIGEN RECEPTORS)

ARTIFICIAL INTELLIGENCE IN CANCER:

Although oral cancer is easily identifiable,recognising them at an early stage avoids unnecessary morbidity and mortality.Government aided community intervention programs should be enhanced in rural areas and among people with low Socioeconomic status,as they are unaware about OPMD as they are no thread to the functional ability of the person until it turns into malignancy.Also, their accessibility towards disease management in advanced stages lays a huge burden financially and emotionally.

Elimination of risk factors and early diagnosis of OPMDs remains to be the most effective process to lessen the transformation into Oral cancer.[10] Despite the increasing number of prognostic markers, the overall prognosis of the disease has not changed.[11]

AI could serve as a better diagnostic aid with the potential to improve the screening process as well as early accessibility to oral cancer.With an increased sensitivity rate when compared with other screening methods,AI would enhance and improvise so that its potential application via mobile phones and other devices could reach the nook and corner of the rural population.

The advantages of screening via AI with that of traditional screening methods is the absence of observational fatigue and other minute changes in a single pixel can be detected at an improved and enhanced manner.

Similarly, the deep learning model is capable of stratifying the patients into high-risk patients where they could be assigned to a specific treatment. This could increase the overall survival rate by reducing the possibility of side effects.[12]

With the consideration of AI as the evolving screening procedure,Morikawa et al was the first one to suggest that utility of optical instruments in oral screening finding along that high-quality medical AI could be established as an oral cancer screening system.[13]

In order to overcome the lack of specialists in rural areas,Shamim et al., proposed an automated screening process with deep convolutional neural network (DCNN) models using annotated photographic images of pre-cancers tongue lesions.It was proposed in an attempt to achieve a near-human level towards detection of oral cancer.[14]

Rosma et al suggested that both fuzzy regression and fuzzy neural network models provide improved prediction of oral cancer susceptibility compared with human expert analyses.AI was found to be efficient in categorizing patients with risk factors.[15]

Nanditha et al. used a Deep learning network with 320 oral lesion images to classify lesions as either precancerous or normal lesions.The network used in this study was able to differentiate and acquire better results with sensitivity and specificity rates of 96.2% and 94.23%respectively.[16]

Das et al.,proposed a two-stage approach for OSCC detection using Characterization of constituent layers and keratin pearl using histology images, where 12-layered deep convolution neural network (CNN) are used for segmentation of constituent layers in the first stage and in the second stage the keratin pearls were detected from the segmented keratin layer.This study had an accuracy of 96.88% towards detection of keratin pearls.[17]

ARTIFICIAL INTELLIGENCE IN ORAL POTENTIALLY MALIGNANT DISORDERS:

Oral potentially malignant disorders are defined as a group of oral mucosal lesions with different histological patterns with the potential risk of transforming into cancer due to field cancerization.

Most of the risk factors associated with OSCC contribute for the development of the premalignant lesion.The key factor is to detect at an early stage by improving the awareness,campaigns ,screening and massive education about risk factors at the primary health care sector .[18]

Sunny et al., conducted a cross-sectional comparative study using an Artificial Neural Network (ANN) based risk-stratification model for 82 photographs early detection of oral potentially malignant (OPML)/malignant lesion.They developed a portable, automated tablet-based tele-cytology platform,a novel strategy capable of digitization of cytology slides was evaluated for its efficacy in the detection of OPML/malignant lesions in comparison with conventional cytology and histology. [19]

Jeyaraj et al., used Deep learning CNN algorithm for an automated, computer-aided oral cancer-detecting system for Detection of pre-cancerous as benign and post cancerous as malignant region.[20]

Fahed Jubair et al. developed a lightweight deep convolutional neural network (CNN) with the binary classification of oral lesions into benign and malignant or potentially malignant using standard real-time clinical images.They concluded that Deep CNNs can be an effective method to build low-budget embedded vision devices with limited computation power and memory capacity for the diagnosis of oral cancer.[21]

CONCLUSION :

The foundation stone to diagnose cancer should be the clinical content along with its histopathology. Although artificial intelligence has good sensitivity and specificity rate,it has its own disadvantages.Hence effective application of

diagnostic aids should be carefully weighed and performed significantly which impacts the future strategies towards the detection of lesions.These shreds of evidence indicate that AI has the greater potential to forecast the changes and would serves to be a better diagnostic aid.Further research is required in this field.

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