International Journal of Research in Health and Allied Sciences

Journal home page:www.ijrhas.com

Official Publication of "Society for Scientific Research and Studies"

[Regd.]ISSN:2455-7803

Original Research

Role of artificial intelligence in early detection of oral cancer

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ABSTRACT:
The early diagnosis of cancer can facilitate subsequent clinical patient management. Artificial intelligence (AI) has been found to be promising for improving the diagnostic process. This review article highlighted the role of Artificial intelligence in Early Detection of Oral Cancer.
Keywords: Artificial intelligence, Oral Cancer,oral submucous fibrosis

Received Date: 28 December, 2024 Acceptance Date: 26 January, 2025

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This article may be cited as: Sharma M, Jayaram R, Bharti S, Pillai SS, Kathuria B, Mohapatra S. Role of artificial intelligence in early detection of oral cancer. Int J Res Health Allied Sci 2025; 11(1):59-62.

INTRODUCTION

Oral cancer is marked by one of the lowest cancer survival rates globally, a situation that remains unchanged despite recent therapeutic advancements. In 2020, the incidence of newly diagnosed cases of lip and oral cancer was 377,713. A significant number of oral and oropharyngeal cancer cases are identified only when the disease has progressed to an advanced stage, leading to unnecessary morbidity and mortality. In this context, the crucial aspect is to identify the lesions at the earliest possible moment, while they are still in their initial stage, so that the prospects for effective treatment can be enhanced. Cancers that are diagnosed at a later stage or are less accessible correlate with reduced survival rates, more complications related to treatment, and higher medical expenses.[1]

OPMDs are defined as "any oral mucosal abnormality that is associated with a statistically increased risk of developing oral cancer." OPMD encompasses the following pathologies: oral leukoplakia, proliferative verrucous leukoplakia, erythroplakia, oral submucous fibrosis, oral lichen planus, actinic keratosis, palatal lesions in reverse smokers, oral lupus erythematosus, dyskeratosis congenital, epidermolysis bullosa, oral lichenoid lesion, and oral chronic graft vs. host disease.

Recognizing lesions with the potential for malignant transformation is crucial. In this context, visual examination of the oral cavity is broadly acknowledged as a practical, secure, and accurate method for identifying such lesions to help diminish oral cancer mortality. Currently, the diagnosis relies on a thorough clinical examination—the latter being part of any routine medical consultation, providing high discriminating capacity and requiring little time to complete in the clinic. Recent studies have assessed the effectiveness of using autofluorescence in population screening interventions, recommending it as a supplement to standard oral examinations for evaluating oral potentially malignant disorders (OPMDs). However, oral biopsy is still considered the definitive diagnostic method in all instances.[2]

The late diagnosis of oral cancer results from a complex interplay of various interconnected factors. In this regard, various writers have identified four issues that need to be addressed with corrective measures: (a) delayed identification of the symptoms;

(b) limited understanding of oral cancer; (c) postponements in pursuing medical treatment; and (d) targeting interventions at specific groups facing risk.[3]

Unprecedented changes are occurring in the healthcare sector due to recent technological advancements. Due to the heightened engagement with new information and communication technologies, the advent of digital medicine is anticipated to change the practices of healthcare professionals. With the advent of artificial intelligence (AI), we will possess tools that enable us to analyze and interpret vast amounts of data within seconds, assisting us in making decisions. Digital technology innovations provide obvious advantages for healthcare workers, healthcare systems, and patients. Artificial intelligence is starting to significantly affect diagnostic accuracy in certain medical domains, and it has the potential to greatly assist in all facets of the oncological workflow—from screening to patient treatment.[4]

Artificial intelligence can be described as the capability of software to replicate human cognitive abilities. Machine learning (ML), a subset of AI, focuses on using algorithms to address various issues such as data classification or regression. It is gaining traction among researchers aiming to convert extensive datasets into knowledge that could aid in clinical decision-making. In ML, algorithms can operate without any prior explicit programming.[5]

Machine learning can be categorized based on the type of learning into the following groups: **Supervised learning:** in this case, the training process relies on labeled data and a known external standard referred to as the "ground truth".

Unsupervised learning: the algorithm examines data without labels in order to discover hidden structures. In this case, the algorithm aims to identify patterns in the data for learning purposes, as the system does not have prior labeled data or expected outcomes.

Reinforcement learning: here, the software actions are positively and/or negatively reinforced within a dynamic environment.[6]

A recent tendency has been the growing use of radiomics—a computational tool of help in establishing the diagnosis, and which fundamentally involves imaging data conversion to detect differential features not apparent to the human eye. Such new imaging characteristics may be of diagnostic, prognostic, and therapeutic usefulness.[7]

In the field of medicine, supervised learning is the most commonly utilized type of ML. Typically, unsupervised learning necessitates a substantial dataset, and the outcomes can be intricate to comprehend. In the health sciences, implementing reinforcement learning is challenging due to its reliance on a trial-and-error process. currently, it is primarily utilized in robotics, telecommunications, and game theory.[8] In recent years, advancements in technology have facilitated the digitalization of patient data through electronic case histories and image files, particularly in Radiology and Pathology. This has contributed to the growing utilization of ML.

Deep learning (DL) is the latest development in ML and is better characterized as a subfield of ML. It operates in a more complex manner, and it can provide decision-making capabilities and handle extremely large data sets.[9]

Neural networks (NNs) are a set of ML algorithms that have garnered particular interest in recent literature. These intricate models consist of interconnected nodes (referred to as neurons) and represent deep networks with multiple layers. Utilizing NNs of this architecture is often referred to as deep learning. This technology offers a high-level abstraction of input data and demonstrates excellent performance across various tasks, including image analysis and personalized drug design.

AI has led to significant advances and developments in oncology. Different narrative reviews have been published in relation to their usefulness for facilitating the early diagnosis of OPMD and oral cancer, and for the support they provide for the same purpose, as well as radiological, endoscopic, spectrometric or histological images.[10]

AI in oral cancer screening and detection

According to recent systematic reviews, Asia exhibited the highest incidence of lip and OC worldwide. Consequently, most of the studies concentrated on this area. Different imaging methods employing AI have been utilized for OC screening and detection. Clinical photographs were employed in multiple studies to show that suspected OSCC lesions could be automatically and easily differentiated through the use of algorithms. Al-Rawi et al.[11] examined the application of AI in OC diagnosis across 17 studies. It was reported that ML was utilized in six studies, while deep learning was employed in the others. They determined that deep learning was more accurate than supervised ML for the early diagnosis of OC.

A scoping review underscored the impact that inconsistencies in photographic images might exert on the identification process of OC or OPMDs. Warin et al.[12] carried out research aimed at creating an automated system for classifying and detecting OC in screenings. Comprising 350 images of OSCCs and another 350 of normal oral mucosa, this study included a total of 700 clinical oral photographs. The classification model used was DenseNet121, while the detection model utilized faster R-CNN. The research found that the DenseNet121 and faster R-CNN algorithm could be used to detect and classify cancerous lesions.

Optical coherence tomography (OCT) has been employed in several studies for AI-based diagnosis. Research has shown that incorporating a diagnostic algorithm into an OCT system could alleviate the need for users to be trained in interpreting OCT images. A low-cost OCT prototype was utilized to create and assess an automated diagnostic algorithm associated with an image-processing application and user interface. According to Ilhan et al[13]., the automated cancer screening platform achieved 87% sensitivity and 83% specificity in distinguishing between healthy and dysplastic/malignant tissues.In a similar vein, Ramezani et al.[14] noted that AI algorithms produced favorable results when interpreting OCT images of normal oral mucosa as well as precancerous and cancerous lesions. To interpret automated OC screening by OCT, AI algorithms need to progress further; thus, it is necessary to have a continuous data feed that serves as ground information.

Various studies evaluated tissue sections of head and neck cancers from sites including the tongue, floor of the mouth, gingivae, alveolar ridge, mandible, soft palate, supraglottis, nose, maxillary sinus, parotid gland, and thyroid. Recent systematic reviews emphasized the role of ML techniques as a diagnostic tool for histology images in recognizing OSCC and several OPMDs.

According to García-Pola et al.[15], several studies have utilized exfoliative, liquid, scraped, and brush biopsies for cytological diagnosis. Mahmood et al. assessed studies employing different ML methods to identify specific histological features and to compare changes in spatial architectural patterns for the statistical differentiation of benign and malignant lesions. They mentioned that the limited evidence contained in unicentric small datasets could result in a high risk of bias. They thus recommended that future studies involving large samples and multiple centers would provide the best support for medical practice.

AI in oral cancer prediction

In recent years, much research has been done in the field of OC and AI.Several studies reported that developing AI models could successfully predict the occurrence and recurrence of OC. AI has been used in cancer prognosis to predict lymph node metastasis and assess the risk of cancer. As mentioned previously, the prediction of the malignant transformation of OPMDs is crucial in the prevention/early diagnosis of OSCC.[16,17]

Time-to-event learning models were successfully employed by Adeoye et al.[18] to evaluate the risks of malignancy in oral leukoplakia and oral lichenoid lesions among 1098 subjects. 24 cancer biomarkers are generated directly by tumor cells or by non-tumor cells that are affected by tumor tissue. The detection of biomarkers aids in comprehending both cancer pathogenesis and prognosis. Due to the limited use of cancer biomarkers in clinics, AI's capacity for analyzing vast amounts of data could assist in their accurate detection.

Lymph node metastasis, the most prevalent pathway for cancer spread, results in a grim prognosis. Research conducted by Bur et al.[19] provided an accurate prediction of pathological lymph node metastasis in patients suffering from OSCC. According to Sun et al.[20], the most commonly employed imaging technique for assessing cervical lymph nodes was contrast-enhanced CT (CECT). They also pointed out that the prediction result was very precise in terms of extranodal extension. Multiple investigations were carried out to determine the proteins and peptides that predict lymph node metastasis.

AI in oral cancer management

AI has been applied to address issues in planning head and neck cancer treatment, including automated treatment planning, providing clinical decision support, calculating doses for intensity-modulated radiotherapy (IMRT), assessing treatment outcomes, and performing auto-segmentation for cancer patients. Alabi et al.[21] carried out a systematic review and noted that deep learning techniques aided clinicians in making informed decisions, choosing treatment options, and enhancing OSCC management. The choice of treatment and prognosis for OC are influenced by early detection and cervical lymph node metastasis, making AI systems potentially helpful for clinicians in managing OC.

Implications for future research

Research in the area of AI and OC can assist in addressing current limitations. Radiomics, a developing area of study, utilizes radiographic images along with data characterization algorithms. Radiomics has facilitated the extraction of features like intensity, shape, and surface texture from CT and MRI images of malignancy that may be overlooked by the human eye. Radiomics may serve as a useful resource for oncologists assessing tumor metastatic potential, oncogene expression, and treatment response.

CONCLUSION

In recent years, the application of AI in disease diagnosis and prognosis has developed. Prior research has demonstrated that ML yields precise outcomes for OC detection. It aids clinicians in their diagnostic processes and reduces unintentional mistakes. prior research utilizing deep learning (neural networks) demonstrated higher accuracy in the early detection of OC compared to ML. AI offers the chance to create new methods that incorporate traditional approaches to enhance the precision of OC and OPMD detection, as well as to forecast the progression of precancerous and cancerous lesions based on retrospective data. Future studies may explore the development of data fusion algorithms that integrate multiple modalities—clinical, radiological, histological, and molecular assessments—to aid in the early diagnosis and outcome prediction of the disease.

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