Oral Oncology Reports 10 (2024) 100311

Contents lists available at ScienceDirect

Oral Oncology Reports

journal homepage: www.journals.elsevier.com/oral-oncology-reports

Beyond teeth and gums: Can artificial intelligence predict oral cancer risk and integrated into population-based prevention programs?

ARTICLE INFO

Keywords
Oral cancer
Artificial intelligence
Radiology

Dear Editor,

Oral cancer is the world's sixth most prevalent cancer, with India accounting for over one-third of the total burden [1]. Oral cancer ranks among the top three types of cancer in the country, thus a significant health concern [2]. Despite advancements in oral carcinoma detection and management, the percentage of cases discovered at an initial and localized stage remains low, with a survival rate of under fifty percent [3]. Oral carcinoma is typically linked with traditional signs and symptoms of malignancy, leading to a precise diagnosis. Yet, certain forms of oral cancer, particularly in its initial stages, can be clinically misleading and ignored. A delay in diagnosis is related to a patient delay or professional (clinician) delay. Late detection of diseases and limited access to healthcare services contribute to high mortality rates associated with oral cancer.

Even though a patient's awareness is essential for prompt detection, a clinician's role is crucial. When the tumor is identified and treated promptly, the likelihood of recovery increases dramatically. Oral cancer diagnosis employs traditional clinical techniques such as physical and histological examination, staining, biopsy, spectroscopy, and radiography. Yet, they are affected by subjective interpretation, diagnostic accuracy, low contrast and spatial resolution, speed, availability and accessibility. Prediction analysis suggests that the incidence of oral carcinoma may continue to rise in the coming years. Advances in science and technology have resulted in the discovery of new techniques that outperform traditional approaches.

Strategies

Artificial intelligence uses computer programs or algorithms to make decisions or predictions based on data, often developed by scientists by creating a set of instructions for the computer to follow. Machine learning is an artificial intelligence approach that teaches algorithms to analyze and interpret data, enabling them to identify patterns that are not easily discernible to the human eye or brain. Using artificial neural networks, deep learning, a type of machine learning, can refer to algorithms and classify information in a way the human brain does. As they are exposed to more data, their learning and interpretation abilities improve and can uncover complex patterns surpassing human capabilities. In oral cancer, AI screening tools use advanced algorithms and machine learning techniques to analyze patterns associated with oral lesions, identifying potential signs of oral cancer at an early stage. AI screening tools are trained on many datasets of suspicious, non-suspicious lesions to recognize patterns and features that indicate cancerous growth [4]. Radiographic, pathologic images, gene expression data, spectra data, saliva metabolites, autofluorescence, cytology, CT, and clinicopathologic images are utilized by deep learning to achieve precise diagnosis and prognosis [5,6]. Clinically, these lesions might appear as velvety reddish patches, white plaques, exophytic or verrucous growths, and long-lasting ulcers with elevated margins and swelling. Based on the imaging analysis, AI algorithms can perform risk assessment by providing scores, predicting the risk of developing oral cancer.

CT, MRI, and ultrasonography provide structural details on tumors, whereas positron emission tomography (PET) and single photon emission CT reveal functional and molecular parameters [7]. Furthermore, there is still a need to improve the spatial and contrast resolutions to deliver more precise information [8]. Microscopy-based histopathological analysis is widely accepted as the gold standard for detecting and classifying oral carcinoma. However, this method is slow and prone to errors, which limits its utility in practice. In addition, it may cause subjective interpretation differences and variability in final results. This may alter the therapy process [9].

Fluorescence imaging is a non-invasive, quick, and portable screening method that utilizes monochromatic light to differentiate between healthy tissues and dysplasia. Neural networks identify cancer stages through clinical evaluation, confirm cancer stage and type through radiographic, and estimate prognosis and survival rates after adequate therapy and follow-ups. There are many types of ANN, and multilayer perceptron (MLP) has a higher potential to decide the predictive potential of biomarkers. Grading and detection are carried out using DenseNet121 and the R-Convolutional Neural Network. Optical coherence tomography (OCT) is also employed for AI cancer identification, with diagnostic algorithms able to outperform dentists' interpretation. Convolutional Neural Network (CNN) distinguishes between osseous and soft-tissue features, allowing for precise identification of features in unseen regions [10]. It helps periodontists identify bone loss, assess bone density, and spot affected furcation sites. CNN has demonstrated better diagnostic accuracy than independent professionals.

The primary advantage of AI is that it minimizes the workload of

https://doi.org/10.1016/j.oor.2024.100311
Received 15 March 2024; Accepted 24 March 2024
Available online 4 April 2024

manually visualizing slides. It also helps pathologists make quicker, more accurate diagnoses. Computerized analysis of images of tissue in slides presents details that conventional slide viewing methods might overlook. AI systems provide a consistent performance, analyze large volumes of slides quickly, and efficiently by reducing subjective interpretations, and easily integrate with digital pathology systems.

AI and machine learning algorithms can enhance oncological uses; however, they have constraints such as limited penetration depth, scan area, high-resolution demand, noise, tough picture analysis, and training demands [11]. AI and machine learning can deliver high accuracy for diagnosis, but unless effectively transformed into clinical insights, they can result in inefficient duplication of efforts, and resources. This can result in disproportionate results, such as false positives and negatives for specific demographic groups due to biased or incomplete datasets.

Artificial intelligence in population-based screening can facilitate better access to diagnostics and support clinical decision-making based on clinically relevant data. However, the implementation and operation can pose significant challenges. High-quality datasets and well-trained machine-learning models are necessary to build a sustainable strategy. Obtaining data from high-income countries may not be applicable elsewhere, which might lead to algorithmic bias. Ethical considerations are another important consideration in addressing transparency, accountability, permission, and privacy concerns.

To assess these challenges, it is necessary to collect data from the target population for training and to assess the model's performance. Developing shared data repositories is a crucial strategy to facilitate the external assessment of researchers and the improvement of models. To prevent the adverse effects, healthcare facilities, research organizations, policy and regulatory bodies must be integrated with electronic health records to enable standardization, monitor issues, train, pay, and improve over time. Telehealth platforms can adopt AI screening tools, allowing people in rural and underserved areas to benefit from early detection of oral cancer. AI screening tools can be integrated with community organizations, targeted outreach programs, and high-risk populations to access services remotely by eliminating geographical barriers.

As we navigate the complexities of integrating AI, it is essential to remain meticulous in addressing the challenges and maximizing the opportunities for early detection of oral cancer. By doing so, we can harness the power of artificial intelligence into healthcare and improve public health outcomes for the last mile.

Ethical approval and consent to participate

Not applicable.

Source of funding

None.

CRediT authorship contribution statement

Elakeya Udhaya Subramaniyan: Conceptualization, Writing – original draft, Writing – review & editing. **Snehasish Tripathy:** Conceptualization, Writing – original draft. **Gaurav Lakhchora:** Writing – original draft.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

None.

References

[1] Borse V, Konwar AN, Buragohain P. Oral cancer diagnosis and perspectives in India. Sensors International, vol. 1; 2020, 100046. https://doi.org/10.1016/j.sintl.2020.100046.

[2] Coelho KR. Challenges of the oral cancer burden in India. Journal of Cancer Epidemiology 2012;2012:1–17. https://doi.org/10.1155/2012/701932.

[3] Thavarool SB, Muttath G, Nayanar SK, Duraisamy K, Bhat P, Shringarpure K, Nayak P, Tripathy JP, Alfonso T, Philip S, Satheesan B. Improved survival among oral cancer patients: findings from a retrospective study at a tertiary care cancer centre in rural Kerala, India. World J Surg Oncol 2019;17(1). https://doi.org/10.1186/s12957-018-1550-z.

[4] Hegde S, Ajila V, Zhu W, Zeng C. Artificial intelligence in early diagnosis and prevention of oral cancer. Asia-Pacific Journal of Oncology Nursing 2022;9(12): 100133. https://doi.org/10.1016/j.apjon.2022.100133.

[5] Alabi RO, Bello IO, Youssef O, Elmusrati M, Mäkitie A. Utilizing deep machine learning for Prognostication of oral squamous cell carcinoma—a systematic review. Frontiers in Oral Health 2021;2. https://doi.org/10.3389/froh.2021.686863.

[6] Das N, Hussain E, Mahanta LB. Automated classification of cells into multiple classes in epithelial tissue of oral squamous cell carcinoma using transfer learning and convolutional neural network. Neural Network 2020;128:47–60. https://doi.org/10.1016/j.neunet.2020.05.003.

[7] Derlin T, Grünwald V, Steinbach J, Wester H, Roß TL. Molecular imaging in oncology using positron emission tomography. Deutsches Arzteblatt International 2018. https://doi.org/10.3238/arztebl.2018.0175.

[8] Czernin J, Allen-Auerbach M, Schelbert HR. Improvements in cancer staging with PET/CT: literature-based evidence as of September 2006. J Nucl Med 2007;48(1 suppl):78S–88S.

[9] Kong J, Sertel O, Shimada H, Boyer KL, Saltz J, Gürcan MN. Computer-aided evaluation of neuroblastoma on whole-slide histology images: classifying grade of neuroblastic differentiation. Pattern Recogn 2009;42(6):1080–92. https://doi.org/10.1016/j.patcog.2008.10.035.

[10] Kale I, Mhapuskar A, Jhawar M, Hiremutt DP. Artificial intelligence in oral medicine and oral radiology. SRM Journal of Research in Dental Sciences 2023;14(4): 199. https://doi.org/10.4103/srmjrds.srmjrds_106_23.

[11] Ramezani K, Tofangchiha M. Oral cancer screening by artificial intelligence-oriented interpretation of optical coherence tomography images. Radiology Research and Practice 2022;2022:1–10. https://doi.org/10.1155/2022/1614838.

Elakeya Udhaya Subramaniyan
Intelehealth, Mumbai, 400607, India

Snehasish Tripathy*
Department of Dental Research Cell, Dr. D. Y. Patil Dental College and Hospital, Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune, 411018, India

Gaurav Lakhchora
School of Pharmacy, Graphic Era Hill University, Bell Road, Clement Town, Dehradun, 248002, India

* Corresponding author. Department of Dental Research Cell, Dr. D. Y. Patil Dental College and Hospital, Dr. D. Y. Patil Vidyapeeth, Pimpri, Pune, 411018, India.
E-mail address: snehasish.tripathy12@gmail.com (S. Tripathy).