Artificial Intelligence in Precancerous Lesion Detection

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ABSTRACT
Oral cancer is one of the most dangerous and alarming diseases for human. The diagnosis of oral cancer are still inadequate, with half of patients getting their diagnosis at advanced scenario due of inadequate screening and poor staff follow-up, resulting in increased morbidity and mortality. The emergence of AI has the ability to improve diagnostic procedures and assist the field of oncology by analysing large datasets from various parameters. This study aimed to evaluate the effectiveness of CNN in classifying and detecting oral diseases that can be caused by oral imaging and concluded that AI can achieve this by simplifying details, utilizing automation and quantification. It aids in examining tissues, teaching diagnosis, and treatment
Keywords: Oral cancer, Imaging modalities, Deep convolutional network.

INTRODUCTION

According to the current scenario, oral cancer is becoming as prevalent as any other health issue in modern civilization. In terms of prevalence, it ranks as the 18th most common cancer in today's world, having claimed over 170,000 lives in 2022. Oral squamous cell carcinoma (OSCC) constitutes about 90% of all oral cancers, particularly prevalent in Southeast Asia. Each new case of OSCC can be considered a precursor to potentially malignant disorders (OPMDs) of the oral cavity, such as erythroplakia, leukoplakia, erythro-leukoplakia, and oral lichen planus.

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Since these lesions often appear asymptomatic and harmless, early detection is challenging and can lead to delayed diagnosis. Moreover, many countries still lag behind in terms of their laboratory facilities and costly procedures due to economic, social, and logistical challenges. AI represents one of the most promising technologies in this context, encompassing a wide range of methodologies that enable machines or computer programs to perform tasks that typically require human intelligence

AI IN ORAL CANCER PREDICTION

Nowadays, numerous studies have been conducted in the fields of oral cancer (OC) and artificial intelligence (AI). Several studies have demonstrated that the development of cognitive structures can inhibit the onset and recurrence of OC. As mentioned previously, the poor prognosis of potentially malignant disorders (OPMDs) is significant for the prevention of oral squamous cell carcinoma (OSCC).

Cancer biomarkers, which are produced directly by tumour cells or non-cancerous cells affected by cancer cells, play a crucial role in understanding disease and cancer. Biomarker testing can aid in this understanding. Since the clinical use of cancer cells is limited, the ability of AI to analyse large datasets will assist in the search for accurate biomarkers. AI is designed to develop predictive models, identify biomarkers related to cervical cancer and human papillomavirus (HPV), and detect transcriptomic markers and metabolites. Therefore, the integration of the best clinical pathology and omics data using artificial intelligence methods can enhance treatment outcomes. AI enables automatic learning without human intervention. This model predicts future events based on current observations. It can process and integrate processes at different levels and provide results to guide clinical decisions. Micro-morphological features can be combined with geographic information, risk factors, differential signals, and risk models. An in-depth study by Kim et al. has been used to predict survival in OC patients and has been shown to be highly predictive. They concluded that predictive modelling based on artificial intelligence can yield favourable outcomes. This is supported by a review by Khanagar et al., who reported positive results from previous studies using AI to predict OC.

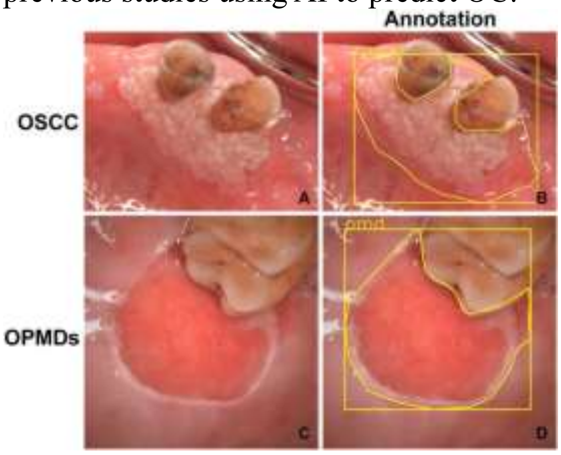

Fig 1. (A) OSCC image; (B) OSCC image annotation; (C) OPMDs image; (D) OPMDs image annotation.

Image Classification

Image classification involves computer based algorithms that categorize images into different groups. DenseNet-169, DenseNet-101, SqueezeNet and ResNet Swin S are utilized to generate different types of image classification for "OSCC" and "OPMD" without mouth images.

TYPE OF IMAGING MODALITY/INPUT DATA USED

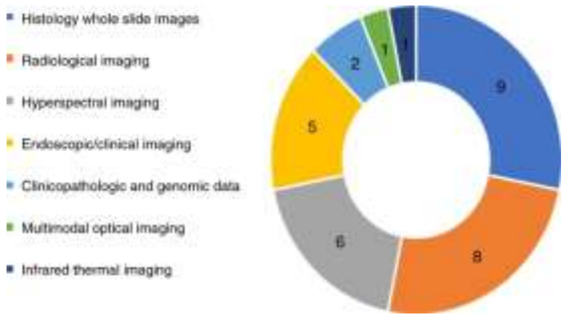

Fig2. Different imaging modalities

In CNN, all layers are directly connected to each other. DenseNet uses compression models that are redundant, easy to train, and parameter-efficient. Residual Network (ResNet) based on the design used by representing the layer as a learning residual function using the input layer. This residual learning method can achieve more accurate classification by increasing the depth. SqueezeNet was proposed by Landola et al. utilizing model compression technology based on a small CNN architecture. It compresses the model to less than 0.5 MB by reducing the number of parameters and making the budget less accurate.

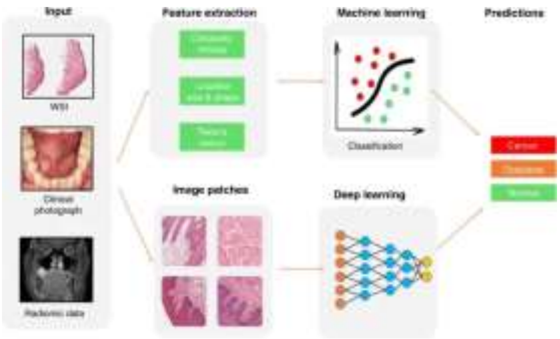

Fig 3. For outcome features form the selected dataset are extracted and pooled through CNN

Image Classification Results

For image classification results GRAD CAM, area under the curve and F1 scoring systems are used

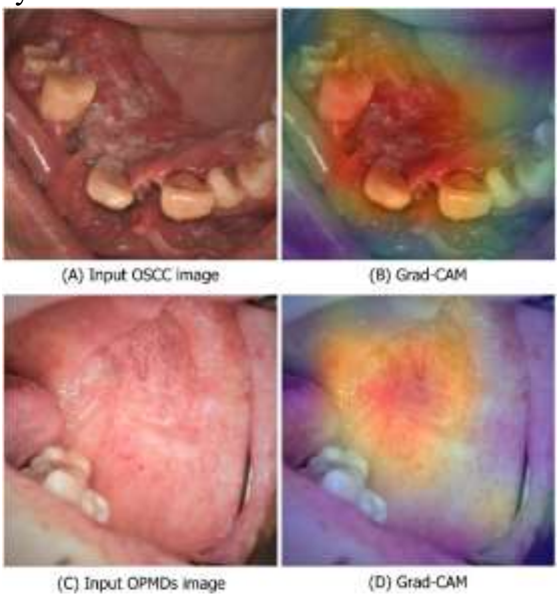

Fig 4. Grad-CAM demonstration of the DenseNet-169.
(A) OSCC lesion; (B) classification of dataset and labelling of lesion and determining the location (C) OPMDs lesion (D) classification of dataset and labelling of lesion and determining the location of OPMDs

Object Detection

After discovery of the lesion the object detection protocol is undertaken consideration. Faster R- CNN, YOLOv5, RetinaNet and CenterNet2 were used in this study.

Object Detection Results

The trained dataset is pooled through the object detection systems and the results are classified under the object detection results

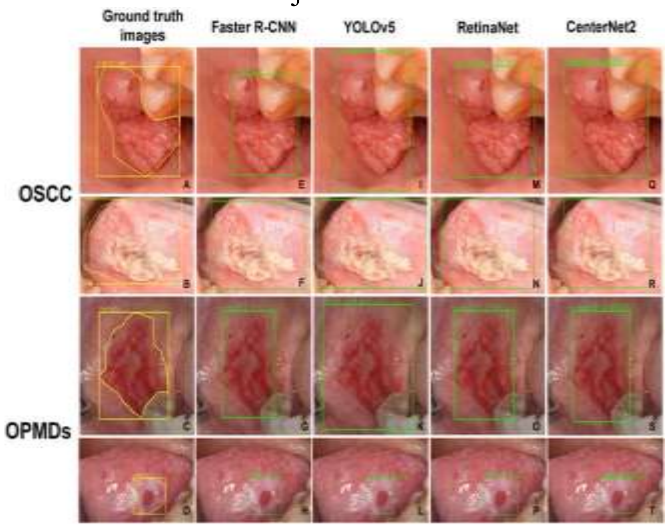

Fig5. Box based on surgeons' annotations of the imaging of OSCC (location: retromolar trigone and lateral tongue); Box based on surgeons' annotations of OPMDs (location: retromolar trigone and lateral tongue); CNN detected positive outcomes; YOLOv5 detected positive outcome; Retina Net detected positive outcomes; CenterNet2 detected positive outcomes.

APPLICATIONS & ADVANTAGES OF AI

- Ability to analyse large data sets
- Detection and classification of cancer cells
- Image interpretation based on oral mucosa/pre-cancerous image/cancerous lesions
- Easy to use in multi-centre studies
- Artificial intelligence provides automatic learning without human intervention, without the need for instructions or commands.
- Works and connects differences at different levels and delivers results
- Ability to continue learning with more information

- Artificial intelligence systems help doctors deliver the best results with minimal diagnosis errors.
- Ability to combine clinical data, geographic data, event risk, clinical features, imaging and omics data to improve risk assessment
- Identifying lymph node involvement, predicting OPMD malignancy, and biomarkers for metastasis.
- Supporting treatment professionals in treatment planning.

DISCUSSION

This article provides an in-depth look at recent applications of artificial intelligence in the field of image analysis for evaluating precancerous lesions. It presents a variety of imaging techniques commonly used over the last decade to provide input for algorithm training. Many studies demonstrate that Convolutional Neural Networks (CNNs) can achieve high levels of accuracy and precision surpassing statistical methods and human decision-making capabilities regarding the data.

The emergence of various optimal solutions (e.g., multimodal optical, microendoscopic, hyperspectral, and infrared thermal imaging) has been accompanied by low-cost and non-invasive imaging. This extraction presents unprecedented opportunities.

CONCLUSION

CNN-based diagnostic models were compared to experts in differentiating between OSCC and OPMD based on imaging. It is worth noting that DenseNet and ResNet outperform experts in classification accuracy. This suggests that these models could serve as innovative diagnostic tools from a professional standpoint

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