Multimodal imaging of Optical Biomarkers for Label-free Oral Cancer Diagnosis

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Abstract

Oral cancer is one of the ten most common malignancies worldwide, associated with high recurrence and poor survival rate. The current approaches to screening and identification of oral neoplasia relies on subjective interpretations, resulting in low sensitivity and specificity. Definitive cancer diagnosis helps to improve patient survival by reducing the need for multiple biopsies, thereby alleviating patient trauma and minimising the diagnostic lead times. This mandates specific and sensitive detection and discrimination of both benign and malignant lesions aiding provision of optimal prognosis.

The aim of this study was to develop a multimodal optical diagnostic tool, combining Raman spectroscopy, wide-field fluorescence (WF) imaging, second-harmonic generation (SHG) imaging, two-photon fluorescence intensity (2PF) and life-time imaging (FLIM) for label-free tissue characterisation. The proposed system quantitatively performs objective classification of normal, benign and cancerous lesions without selective sampling the areas to be imaged, yielding improved sensitivity and specificity compared to current techniques.

The pre-processed Raman, WF, 2PF, SHG and FLIM images were co-registered and background segmented. An in-house statistical method was used to perform binary and multiclass classification of the normal, benign and malignant tissue types. The neoplastic and non-neoplastic tissues were discriminated with 100% sensitivity and 100% specificity. In multiclass classification, the benign was detected with 100% sensitivity and 95.2% specificity and the malignant was classified with 100% sensitivity and 71.4% specificity.

In summary, an optical diagnostic model for unbiased classification of normal, benign and malignant lesions was developed. This multi-modal imaging approach showed the potential to serve as a reliable screening tool for pathologists to objectively identify the diseased cases.

Summary

A key advance in the field of optical cancer diagnosis is illustrated, allowing patient prognosis to be performed objectively without pre-selecting the tissue area for data acquisition. The quantitative multimodal optical imaging model presented shows the potential to provide the different probabilities of the tissue belonging to a particular class. The proposed model would potentially become a pre-screening tool for the pathologists. As this method is independent of knowledge, even less experienced personnel at the point of care could screen the tissue sections, avoiding subjective interpretation and human errors.