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Differential Pathlength Spectroscopy for diagnosis of head and neck cancer

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The development of optical techniques for non-invasive diagnosis of cancer is an ongoing challenge to biomedical optics. For oral cancer biopsy has a low specificity because of a thick keratin layer that often covers potential malignancies. We investigated the possibility to distinguishing potentially malignant visible lesions from benign ones to reduce the number of unnecessary biopsies.

Major challenge here is to measure through the thick keratin layer that often covers the biologically active layers. Differential Pathlength Spectroscopy is a fibre optic measurement technique that samples tissue in a predetermined sampling volume. We constructed a probe for sampling up to 1mm deep into the tissue. By analysing the white light spectrum with a mathematical model developed earlier we could determine scattering parameters, blood volume, micro vascular saturation and the average blood vessel diameter in the sample volume just below the probe.

A total of 110 measurements were performed in 21 patients on 75 suspicious lesions that were biopsied after measurement and 35 clinically normal locations that were not biopsied. Lesions were classified as normal, hyperplasia, inflammation, dysplasia or cancer. With this data we built a logistic regression model that predicts the need for a biopsy (if classification equals dysplasia or cancer) on the basis of the spectra. The model was trained and evaluated using the leave-one-out-approach. The results showed a very good combination of relative sensitivity and specificity with an area under the curve of 0.943. When removing the obvious lesions from the dataset (i.e. the unbiopsied normals and half the samples classified as cancer that were clinically unmistakable, the area under the ROC curve even improved to 0.951. In practice this comes down to reducing the number of biopsies to 50% without reducing the overall sensitivity of the diagnostic procedure, or reducing the number of biopsies by 90% at a loss of 5% relative sensitivity.

We believe Differential Pathlength Spectroscopy is a very promising technique that may help to reduce the costs of healthcare without compromising the quality.

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