Classification of maxillary sinus pathologies in digital diaphanoscopy based on machine learning

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ABSTRACT

The use of the digital diaphanoscopy method, based on the transmission of maxillary sinus tissues by low-intensity radiation, and subsequent registration of diaphanograms, is currently characterized by the absence of classification models to exclude the subjectivity of diagnosis. Thus, the purpose of this study is to use machine learning methods to identify the pathology of the maxillary sinuses by digital diaphanoscopy.

Experimental studies were conducted using the developed digital diaphanoscopy device in conditionally healthy volunteers and patients with confirmed diagnosis. The maxillary sinuses were probed with radiation of 650 nm and 850 nm using an LED applicator and the subsequent registration of diaphanograms was carried out using a CMOS camera (Fig. 1,a-b) [1]. The intensity parameter (*I*) and the asymmetry coefficient (*AC*) were calculated. To calculate the *I*, the average value of the light intensity on the registered diaphanogram was calculated. The calculation *AC* consisted in determination of the face central line (symmetry axis), diaphanograms rotation to ensure vertical position of the central line, and calculating the asymmetry coefficient between the left and right parts of the face.

Analysis of the data obtained by the Mann-Whitney criterion revealed a statistically significant difference ($p < 0.05$) for the calculated quantitative parameters in the studied groups. The application of linear discriminant analysis to construct a classification model is proposed. The best values of sensitivity and specificity (0.88 and 0.98, respectively) and an accuracy value of 0.93 were obtained for the sensing wavelength of 850 nm (Fig. 1,c) [2]. Thus, the proposed approach makes it possible to detect the presence of pathology in the maxillary sinuses with high accuracy, and reduces the probability of a false negative diagnostic result compared to traditional screening diagnosis methods [3,4].

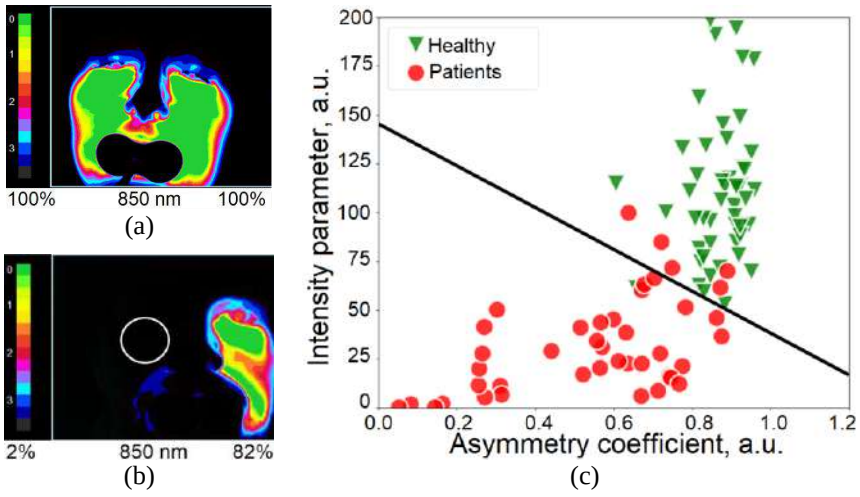

Figure 1: *(a) Typical diaphanoscopy examination results for healthy volunteer, (b) and patient with chronic right-sided maxillary sinusitis (white circle indicates the area of pathology), (c) the scatter plot with applied discriminant line obtained by linear discriminant analysis method.*

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