Optical Biopsy of Cutaneous Tumours

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Introduction

Light-induced autofluorescence spectroscopy (LIAFS) is a very attractive tool for early diagnosis of cancer due to its high sensitivity, easy-to-use methodology for measurements, lack of need for contrast agents' application on the tissue under investigation, possibilities for real time measurements and noninvasive tumor detection[1,2)]. It allows differentiation on the base of differences in biochemical content and metabolic state of the pathology. However, when the lesion is highly pigmented the obtained fluorescence signal is too weak to be used for diagnostics[3)]. Diffuse reflectance spectroscopy is applied for the melanin-pigmented cutaneous pathologies, including malignant melanoma, as well combination of two spectral techniques allow increasing of the diagnostic accuracy in general for all pathologies investigated.

Problems for development of universal optical biopsy system for skin cancer detection are related to the great variety of benign and malignant forms of skin pathologies, for example basal cell carcinoma (BCC) lesions have more than 15 sub-types, squamous cell carcinoma (SCC) lesions, have about 10 subtypes, and all of them have variety of benign and dysplastic forms, as well as they are different, including by their fluorescence and reflectance properties, on different stages of lesion growth. Malignant melanoma could be easily misdiagnosed as pigmented BCC, or dysplastic nevi[4)]. Our investigation is a part of a clinical trial for introduction of optical biopsy spectral diagnostic system for skin cancer detection. We apply autofluorescence and diffuse reflectance spectroscopy to several different classes of malignant non-melanoma cutaneous lesions.

Skin optical biopsy diagnostic clinical trial is currently under implementation and with broadening of the database with fluorescence and reflectance spectra of major skin benign and malignant pathologies we expect to receive objective tool for detection and evaluation of skin lesion type, which could become a basis for reliable system for skin cancer detection. Here, we will present our observations on most typical cutaneous tumours autofluorescence and reflectance properties. The origins of diagnostically significant spectral peculiarities are evaluated and possible differentiation features useful for skin cancer detection and evaluation of their stage and sub-type will be discussed.

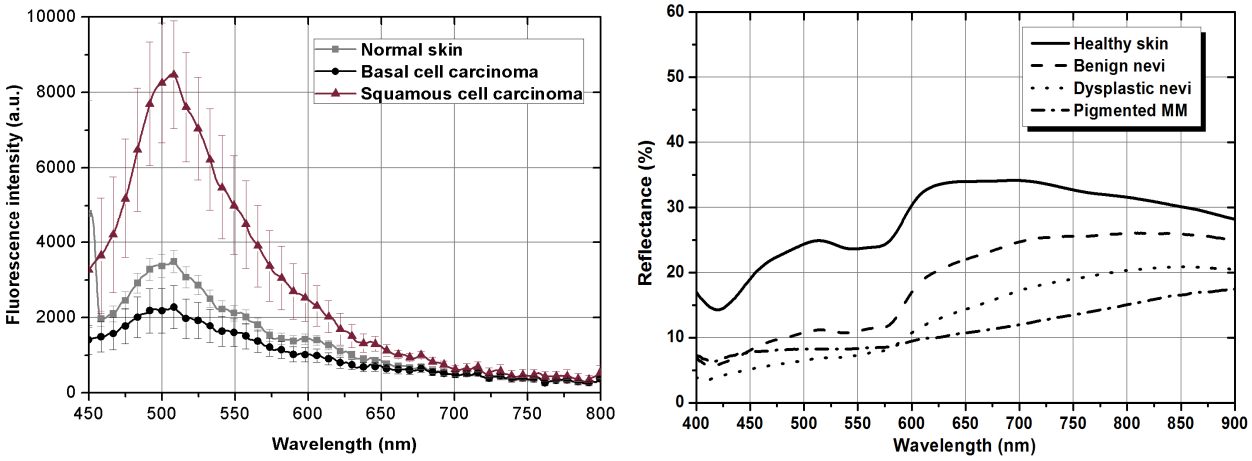
Materials and Methods

Autofluorescence and reflectance spectroscopy combined in common system for optical biopsy is applied to several different classes of malignant cutaneous lesions. Initially, they were classified visually and dermatoscopically using ABCD criteria by experienced dermatologist (E.P. and/or P.T.). Second step was detection of lesion' and surrounding normal skin autofluorescence using different excitation wavelengths, namely 365, 385, and 405 nm. Reflectance spectroscopy is applied in broad spectral region – from 400 to 900 nm. In the end for every lesion histological examination is used as a "gold standard" for all our investigations.

The spectra and dermatoscopic evaluations were obtained from more than 350 patients up to now. Spectral properties of variety of benign cutaneous lesions are also evaluated for development of more precise discrimination algorithms for diagnosis of cancer lesions. Spectra from normal skin are used for comparison and evaluation of alterations occurred in lesions investigated.

Results and Discussion

Every autofluorescence spectrum detected *in vivo* is a superposition of fluorescence spectra of endogenous chromophores existing in the tissue under investigation distorted by re-absorption of tissue pigments, mainly blood and melanin. In the case of BCC lesions, the fluorescence intensity is lower than from normal skin, which could be used as diagnostic indicator; moreover SCC autofluorescence signal usually is higher than from the surrounding skin, or other benign lesions, which allow improving specificity of the spectral diagnostic method, see Fig.1(a).



(a) (b)

Fig. 1. (a) Autofluorescence spectra of normal skin, basal cell and squamous cell carcinoma, using excitation at 365 nm; (b) Diffuse reflectance spectra of normal skin, benign and dysplastic nevi, and pigmented melanoma.

Spectra from melanin-pigmented lesions - benign, dysplastic nevi and malignant melanoma revealed very low fluorescence intensities without significant spectral shape changes, as long as the reflectance spectra detected from this class of lesions present significant changes not only in the intensity level, but in the spectral shape. Thus, the reflectance spectra are more informative for discrimination between dysplastic and malignant forms of melanin-pigmented lesions, see fig.1b.

All clinical applications of optical biopsy *in vivo* are based on extracting information on the optical absorption, fluorescence and scattering properties of tissues by noninvasive measurement of the fluorescence diffusely-reflected light. These properties are related to the function or structure of the tissue. The fluorescence and reflectance spectroscopy of the human skin, combined as optical biopsy method, are very prominent for early diagnosis and differentiation of cutaneous diseases and give wide range of possibilities related to real-time determination of existing pathological conditions.

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