Assessment of Tissue Ischemia of Nail Fold Precapillary Zones Using a Fluorescence Capillaroscopy

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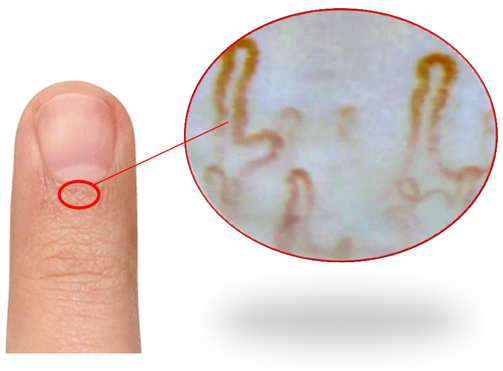
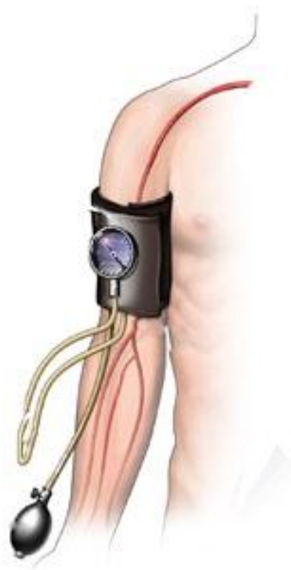
AIM OF THE STUDY

The aim of the study was investigation of respiratory chain parameters by recording NADH fluorescence intensity of nail fold epithelial tissues supplemented by simultaneous tissue reflectance measurements during local tissue ischemia.

MATERIAL AND METHODS

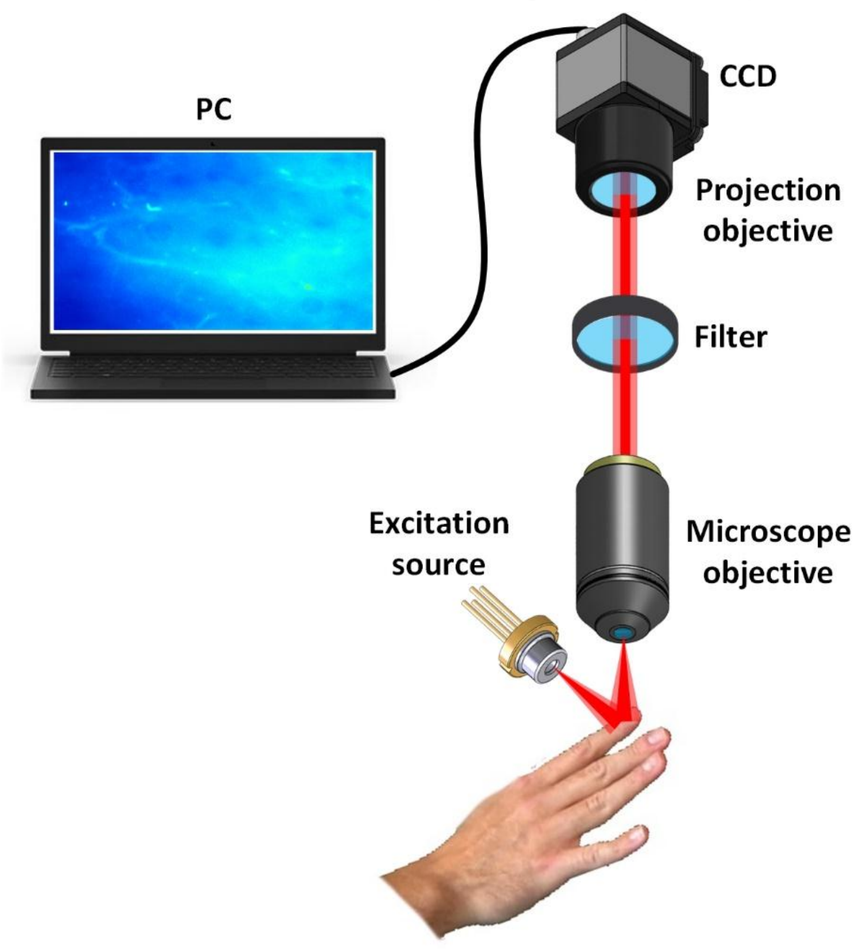


The videocapillaroscopy method relates to digital microscopy technique. It is based on registration and analysis of a video frames series representing capillary blood flow of the nail bed. The method requires significant computational power, but it allows extracting the parameters of capillary blood flow of an individual capillary.



In the protocol of the study, occlusion tests with pressure of 220 mmHg during 1.5 min were conducted. A pair of images (fluorescence and reflectance) were recorded before and at the end of the occlusion test.

In this study, the area of the proximal nail fold of the middle finger was illuminated by LED light source with a 365 nm central wavelength (power ~2 mW) and a broadband halogen source HL-2000 (Ocean Optics, USA, 360-1000 nm, ~7 mW). A high-aperture microscope objective with a numerical aperture of 0.12 and a projection long-focus objective were used to form the scaled-up image on a monochrome CCD sensor. Filtering of fluorescent images was carried out by using bandpass optical filters.



Reflectance images were calculated as follows below:

$$I_d(\lambda) = \frac{I_t(\lambda) - I_b(\lambda)}{I_{PTFE}(\lambda) - I_b(\lambda)}$$

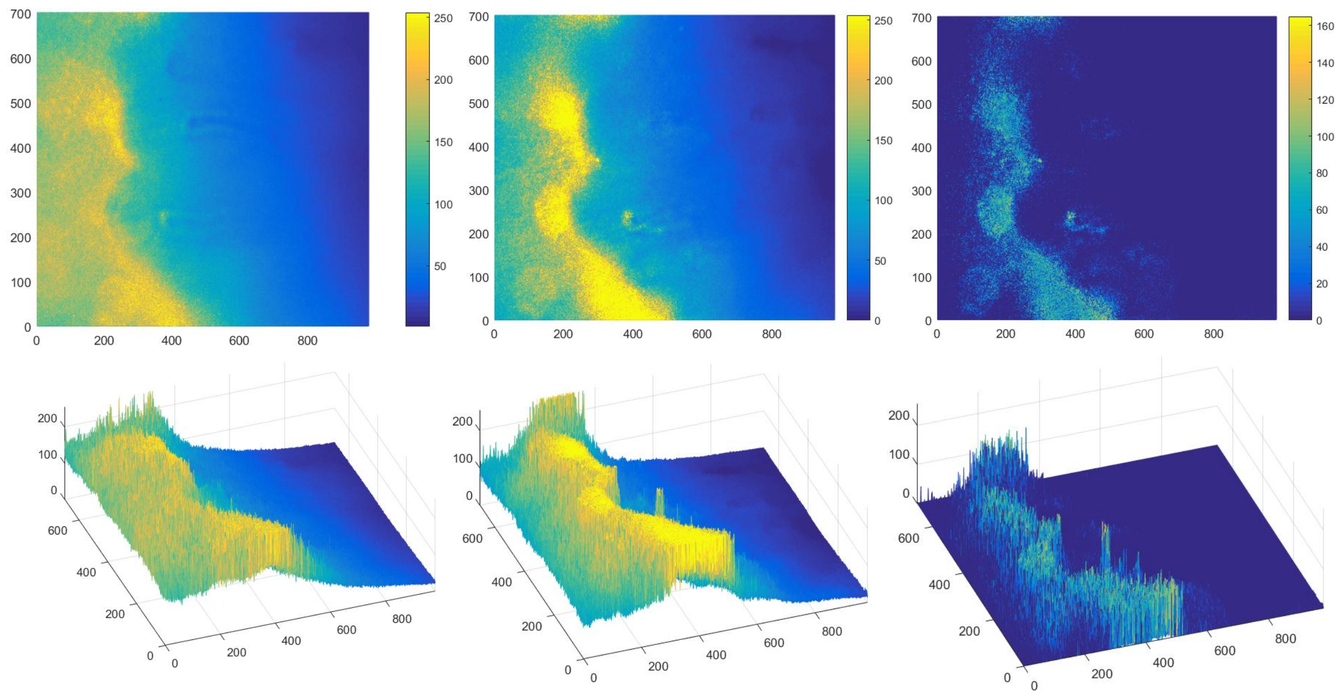
where $I_t(\lambda)$ – the measured reflectance image of biological tissue; $I_{PTFE}(\lambda)$ – the measured reflectance image of the etalon optical diffuser (PTFE); $I_b(\lambda)$ – the background image obtained without any illumination.

Fluorescence images of precapillary zones were normalised to the image of the diffuse reflection

$$F_n(\lambda) = \frac{F(\lambda)}{I_d(\lambda)}$$

EXPERIMENTAL RESULTS AND DISCUSSION

It can be seen that by the end of the occlusion test, the fluorescence intensity significantly increases. The effect is especially bright in the precapillary zones, which may indicate a significant accumulation of NADH due to tissue hypoxia. Thus, the proposed approach can be used to study the dynamics of changes and NADH in vivo and in situ. In vivo registration of NADH fluorescence as a noninvasive marker for the detection of cell death is promising for the development of highly efficient ways to detect and treat cancer.



before occlusion test **end** of occlusion test **difference**

CONCLUSIONS

Results demonstrate the ability of spectroscopic techniques to provide useful information for disease classification in a noninvasive manner. Specifically, fluorescence changes of NADH will provide details about tissue biochemistry. The conducted study can be of particular interest in the research area of cell metabolism as well as find applications in clinical practice.

ACKNOWLEDGMENTS

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