COMPERATIVE ANALYSIS OF RAMAN SPECTRA OF VEIN WALLS APPLIED IN CABG OPERATIONS AND VEIN FROM CHRONIC VENOUS INSUFFICIENCY PATIENS

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In the last decade NIR Raman spectroscopy turned out to be extremely useful in biomaterials studies. When using laser radiation of 1064 nm we avoid fluorescence, the denaturation and dehydration as well as thermal degradation of biomolecules. The vein walls generally consist of structural proteins such as collagen, elastin and smooth muscle cell protein actin. Pathological changes appearing in veins may be related to changes in the structure of molecular group being basic component of proteins. These changes can be studied comparing the Raman spectra of normal veins, veins applied in CABG operations, and veins burdened with chronic insufficiency. The paper reports the preliminary results of the Raman studies of the above mentioned materials.

The FT NIR Raman technique records frequencies associated with various vibrational motions between covalently bonded atoms. Raman peak position, FWHM (full width at half maximum), peak surface area permit to obtain information on vein wall composition. Vein wall samples were taken from patients 50 –60 years old. Veins applied in CABG operations were burdened with no pathological changes, whereas veins taken form chronic venous insufficiency patients were pathologically changed. NIR Raman spectra were measured at room temperature using Bruker IFS66 FRA 106 Raman spectrometer. The samples were excited with a continuous wave diode-pumped YAG:Nd laser operated at A power of ~100 mW. The spectra were taken with 1000 scans and 4 cm^{-1} spectral resolution

The main molecular constituents of the tissue determine the most important features in the Raman spectra of both vein vessel walls applied in CABG and vein vessels from chronic venous insufficiency patients. Therefore, the major bands in recorded spectra are associated with the vibrational modes of collagen and elastin. Found in all spectra, the protein bands were assigned to the amide I at ~1665 cm^{-1}, amide III, at ~1255cm^{-1} and CH_2 stretching symmetric vibrations at 2936 cm^{-1}. Amide I and amide III are sensitive to secondary structure of protein. The intensities of the band at 934 cm^{-1} assigned to the C-C stretch of α-helix in native collagen and the band assigned to the stretch of the pyridine aromatic ring at 1030 cm^{-1} decrease significantly in pathological veins. Amino acids having either saturated or aromatic rings in their side chains – phenylalanine, proline, hydroxyproline – are strong Raman scatterers. It was also found that the band at ~1065cm^{-1}, assigned to fenyloalanine change its intensity to much lower values in pathological veins. The Raman intensity of the band centred at ~870 cm^{-1} decreases in pathological veins as well. The band is assigned to the C-C stretching vibrations of hydroxyproline ring. It may suggest the decrease in the content of characteristic for collagen specific amino acid hydroxyproline. The intensity of the band at ~1332 cm^{-1} assigned to elastin is smoothed and decreased in pathological vein walls.

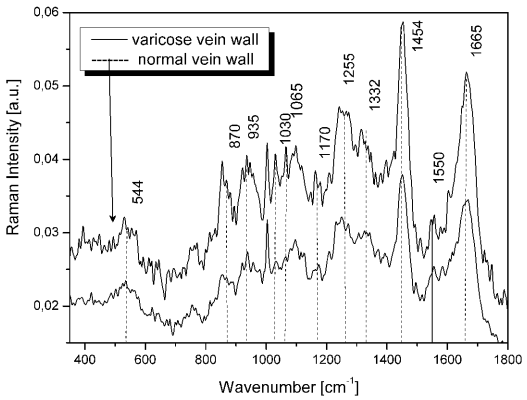

Fig. 1. Raman spectra of normal vein and varicose vein walls