

Correlation between Collagen Entropy within Aorta and Aortic Dissection with polarized Synchrotron-FTIR Microspectroscopy

I-Chun Yeh (葉宜君)¹, An -Chi H (許恩齊)², Pei-Yu Huang (黃佩瑜)³,
Chi-Nan Tseng (曾棋南)^{4*}, Yao-Chang Lee (李耀昌)^{3,5*}

¹Department of Physics, National Kaohsiung Normal University, Kaohsiung 82444, Taiwan

²Department of Biomedical Engineering & Environmental Sciences, National Tsing Hua University, Hsinchu 70013, Taiwan

³Life science National Synchrotron Radiation Research Center, Hsinchu 30076, Taiwan

⁴Department of Cardiac Surgery, Chang Gung Memorial Hospital, Taoyuan 33305, Taiwan

⁵Department of Optics and Photonics, National Central University, Chung-Li 32001, Taiwan

ycllee@nsrrc.org.tw

Abstract

Aortic dissection has been a complex and high mortality rate disease, strongly associated with hypertension, aorta inflammation, apoptosis and fibrosis. Collagen order-disorder distribution (collagen entropy) within inflammatory aorta tissue was proposed to be the major factor to induce aortic dissection. Herein ultrahigh lateral-resolved synchrotron-based polarized-FTIR Microspectroscopy (SR-pFTIR) was employed to study the collagen entropy within aorta tissue section based on the characteristic absorption of amide III band of collagen in the spectral range of 1340-1240 cm^{-1} . Spontaneously hypertensive rats (SHR) and Wistar Kyoto (WKY) rats for 6, 18, 34, 42 and 50-week-old were studied for investigating the development of collagen entropy within the inflammatory aorta tissue examined by histopathological inspection. SR-pFTIR Microspectroscopy utilized s-polarized infrared radiation to investigate the order distribution of collagen within aorta tissue longitudinal section. The SR-pFTIR spectral result of aorta tissue section of SHR group showed a significant increasing absorbance of amide III band of collagen homogeneously distributed within aorta tissue section as the time progressing of hypertension. The SR-pFTIR spectral line map of collagen within aorta tissue section elucidated that seriously fibrosis occurred locally within aorta tissue of SHR group but none for the sample in WKY rats. Based on these findings we suggested that the collagen entropy would be increased in the locally inflammatory tissue of aorta. Therefore, we proposed that the collagen entropy induced by hypertension could be of importance in leading to aortic dissection, demonstrating a strong correlation with fibrosis and inflammatory level.

Keywords – Collagen, Aortic Dissection, FTIR, Synchrotron radiation, Hypertension.