ABCDE: Assessing Blood vessels for Cardiovascular Disorders through the Eye

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Assessment of properties and integrity of blood vessel wall tissue can play a crucial role in the early diagnosis of cardiovascular disorders, which can significantly increase the risk of heart, brain, kidney, arteries and liver failure [1]. We used polarisation sensitive optical coherence tomography (PS-OCT) to assess the blood vessel wall integrity, *in-vivo*, and non-invasively through optical imaging of the eye. Since the blood vessel walls consist of organized fibrous connective tissue, they have intrinsic polarisation dependant optical properties such as birefringence. As the microvasculature disorders can disrupt the organization of the fibrous tissue, hence altering the birefringence, assessment of micro-structural loss with PS-OCT offers an opportunity to diagnose cardiovascular diseases in very early stages [2]. In the current study, we used PS-OCT to image the blood vessel walls near the optic nerve head of a healthy subject and compared them to the images taken from a subject with hypertension. A custom designed PS-OCT system with a beam diameter of 2.4 mm at 840 ± 50 nm was used to image the retina over an area of 4.5 mm by 4.5 mm. The axial and lateral resolutions of the captured images were approximately 6 μm and 12.9 μm, respectively. After analysing the acquired images, thickness of the retinal blood vessel wall and its retardation values (as a measure of the integrity of the organized connective tissue) were determined. Results showed that the birefringence of the blood vessel wall of the hypertensive subject was significantly lower than that of the normotensive (without hypertension) subject, while the vessel wall was thicker. Table 1 summarizes the data from the PS-OCT images. Our ABCDE approach can be a promising tool for the early diagnosis of hypertension and associated cardiovascular diseases with a low-cost non-invasive method.

Table 1: Comparing the averaged blood vessel wall properties of two subjects

	\<Thickness\> (μm)	\<Birefringence\> (-)
Normotensive subject	14 ± 1	6.89×10^{-4}
Hypertensive subject	28 ± 2	4.20×10^{-4}

References:
[1]. Wentzel, A., et al, 2020. Heart rate variability, the dynamic nature of the retinal microvasculature and cardiac stress: providing insight into the brain–retina–heart link: the SABPA study. Eye, 34(5), pp.835-846.
[2]. Afsharan, H., et al, 2021. Polarization properties of retinal blood vessel walls measured with polarization sensitive optical coherence tomography. Biomedical Optics Express, 12(7), pp.4340-4362.