

ARF-OCE FOR MAPPING MECHANICAL PROPERTIES OF OCULAR AND VASCULAR TISSUES

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Elastography is an imaging modality for clinical diagnosis based on the tissue stiffness. Benefiting from the high resolution, three-dimensional, and noninvasive nature of optical coherence tomography (OCT), optical coherence elastography (OCE) has the ability to determine elastic properties with a resolution of $\sim 10 \mu\text{m}$ in 3D. Typical OCE imaging includes excitation for inducing mechanical vibrations, measurement of the sample response using OCT, and estimation of elastic parameters. Acoustic radiation force (ARF) generated by an ultrasonic transducer can noninvasively excite internal tissues without contact; thus, ARF-OCE is suitable for measuring the mechanical properties in deeper tissues. For assessment of the elastic properties of tissues using ARF-OCE, the shear wave velocity, resonant frequency, and vibrational displacement can be measured. Shear wave velocity measurements can be conveniently used for quantitative calculation of the elastic modulus.¹⁻³ The resonant frequency of a tissue has a squared relationship with the Young's modulus, and thus can quantify the elasticity.⁴ Vibrational displacement can be compared directly when the same pressure is applied to different samples.⁵

Several diseases are accompanied by and result in the changes in composition and local geometry of tissues. Keratoconus, which causes vision distortions and blurriness, will change the geometry of the cornea. The development of presbyopia is generally caused by the loss of elasticity in the lens. The composition and biomechanical properties of vessels will usually be altered when atherosclerosis occurs. The ARF-OCE technology provides a new opportunity for the early diagnosis of ocular and vascular diseases. Based on the shear wave measurements, our system can be used to quantify the elastic modulus of the cornea and the crystalline lens. By comparing the vibrational displacement, we have detected the differences between normal and cross-linked cornea.⁶ Recently we developed a miniature probe for mapping the mechanical properties of vascular lesions using ARF-OCE. It has the ability to detect the a vulnerable plaque due to its higher stiffness.⁷ Because of the noninvasive nature, ARF-OCE has the potential to perform *in vivo* imaging of deep tissues for the early diagnosis of ocular and vascular diseases.

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