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Elastography: principles and applications for characterization of tissue mechanical properties

Speaker:
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Abstract:
Elastography is a general name for a group of diagnostic methods capable of remote evaluation of tissue mechanical properties. Biochemical, molecular, cellular, and functional (i.e., microscopic) changes in biological tissues leading to pathologies often result in mac-roscopic changes in tissue properties, such as tissue elasticity. Areas of applications of elasticity imaging in medical diagnostics and treatment monitoring are steadily expanding. Elastography has shown great promise for many biomedical applications including the diagnosis of breast and prostate cancer, heart diseases, and atherosclerotic plaques, as well as the estimation of muscle condition, the staging of deep vein thrombosis etc. The biomechanical characteristics of ocular tissues have a profound influence on the health, structural integrity, and normal function of the eye. Such conditions as presbyopia, corneal ectasia and keratoconus correlate with stiffness of the tissue. We have developed noninvasive approaches to measure elastic properties of the ocular tissues using acoustic radiation force and air puff stimulation. The displacements in tissue are measured using high frequency ultrasound and optical coherence tomography, and mechanical properties are evaluated based on developed mathematical model of the dynamic deformation of the viscoelastic incompressible medium. This approach has been successfully tested in ex-vivo and animal studies to monitor the changes in mechanical properties during corneal cross-linking treatment and aging. We demonstrated the capability to measure spatial variations in mechanical properties for both normal and treated corneas, young and mature crystalline lenses and vitreous humors.