Department of Biomedical Engineering
UNIVERSITY OF WISCONSIN–MADISON

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Biomechanics of the Optic Nerve Head and Applications to Glaucoma

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The optic nerve head is a small region in the posterior eyewall, where the axons of the retinal ganglion cells gather to exit the eye and form the optic nerve. The lamina cribrosa is a connective tissue structure in the optic nerve head composed of a stack of perforated plates that resemble a collagen beam network structure when viewed *en face*. The collagen beams support resident astrocytes and axons of the retinal ganglion cells as they exit the eye. Variations in the mechanical properties of the lamina cribrosa may contribute to the susceptibility and progression of glaucoma. Mouse models of glaucoma have been used to study the biomechanical effects of glaucomatous axon damage. The mouse optic nerve head does not have a connective tissue lamina cribrosa. It contains instead a network of astrocytes with long processes organized into structures that are evocative of the collagen beam structure of the human lamina cribrosa. In this presentation, I will describe our efforts to understand the structure-properties relationship of the optic nerve head tissues of human and mouse eyes. We developed ex-vivo inflation tests with optical imaging and 3D digital image correlation (3D-DIC) to measure the mechanical behavior of the lamina cribrosa and astrocytic lamina under physiological conditions. We also developed methods to quantitatively characterize the beam/pore network microstructure of the lamina cribrosa and astrocytic lamina. This has led to a greater understanding of how the lamina structures remodel with glaucoma.

ABOUT the SPEAKER

Thao (Vicky) Nguyen received her S.B. from MIT in 1998 and her MS and PhD from Stanford in 2004, all in mechanical engineering. She was a research scientist at Sandia National Laboratories in Livermore from 2004–2007 before joining the Mechanical Engineering Department at Johns Hopkins University, where she is currently a Professor and Marlin U. Zimmerman Faculty Scholar in the Department of Mechanical Engineering with secondary appointments in Materials Science and Ophthalmology. Dr. Nguyen's research encompasses the biomechanics of soft tissues and the mechanics of active polymers and biomaterials. Dr. Nguyen has received the 2008 Presidential Early Career Award for Scientists and Engineers (PECASE) and the NNSA Office of Defense Programs Early Career Scientists and Engineer Awards for her work on modeling the thermomechanical behavior of shape memory polymers. She received the 2013 NSF CAREER award for studying the micromechanisms of growth and remodeling of collagenous tissues. She was also awarded the inaugural Eshelby Mechanics Award for Young Faculty for the creative development and applications of mechanics, the ASME Sia Nemat-Nasser Early Career Award for research excellence in mechanics and materials in 2013, and the T.J.R. Hughes Young Investigator Award from the Applied Mechanics Division in 2015. She was elected Fellow of ASME in 2022 and AIMBE in 2023. She currently serves as an Associate Editor for the Journal of Biomechanical Engineering. She was an Associate Editor for the Journal of Biomechanical Engineering from 2014-2020, President of the Society of Engineering Science in 2020, and is currently Editor-in-Chief of the Journal of Biomechanics.

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1003 Engineering Centers (Tong Auditorium)