Multiscale Engineering of Vocal Fold Biomechanics and Fibrosis

Dr. Amir K. Miri

Professor · New Jersey Institute of Technology (NJIT)

DATE

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TIME

2:00pm – 3:00pm

LOCATION

ME Conference Rm – ST254

ABSTRACT

Vocal fold scarring stiffens the lamina propria and leads to voice loss, and no current treatment restores the tissue's mechanical function. Progress has been slow because in native scar tissue, collagen alignment, crosslinking, and hydration all change at once, making it hard to isolate what drives vibratory impairment. This talk describes a decade-long effort to decouple these factors by first measuring the tissue, then rebuilding it. The measurement work spans scales: full-field strain on excised laryngeal vocal folds by digital image correlation and combined microstructural and mechanical characterization of scarred folds. These define the targets a synthetic surrogate must meet. The reconstruction work has three parts. We built a phonatory platform from a composite of natural hydrogels and synthetic silicone rubber, scaled across three geometries under Reynolds- and Womersley-based dynamic similarity and instrumented for subglottal pressure, acoustics, and high-speed imaging. We engineered hydrogel microtissues from gelatin and hyaluronic acid that encapsulate viable human vocal fold fibroblasts and reproduce healthy and fibrotic states, with TGF-β1 driving α-SMA conversion in three dimensions. By tuning matrix fiber crosslinking to vary fiber architecture at matched bulk stiffness, we showed that architecture alone shifts oscillation onset pressure and frequency. These results may help assess new therapeutic tools for vocal fold fibrosis and related disorders.

SPEAKER BIO

Amir K. Miri is an Associate Professor of Biomedical Engineering (BME) at the New Jersey Institute of Technology and Director of the Advanced Biofabrication Lab. He holds a PhD in Mechanical Engineering from McGill University, where his doctoral work characterized vocal fold tissue mechanics across scales, and completed postdoctoral training in additive biomanufacturing at the MIT–Harvard Division of Health Sciences and Technology. He began his independent career at Rowan University before joining NJIT. His laboratory develops bioprinting and biofabrication platforms — multi-axial extrusion, multi-material digital light processing, volumetric, and handheld systems — and applies them to engineered microtissues for disease modeling in cancer, fibrosis, and voice disorders. NIH and NSF have supported his work as principal investigator, including mimicking stress-mediated invasive solid tumors using bioprinted microtissue and acoustofluidics. He has also led three NSF I-Corps projects, translating a handheld bioprinter for in situ hydrogel deposition, volumetric light-assisted manufacturing of dental implants and scaffolds, and image-processing tools for education. He is currently the BME undergraduate program coordinator, and he teaches Biotransport and BioMEMS Design at NJIT.