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Mechanical Engineering

Mechanical Engineering Seminar Series

October 8th, 2025, 3:00pm

Dean's Conference Room, E203-E

Title: Engineering Living Functional Heart Valve Tissues with Tissue-Mimetic Nanofibrillar Biomaterials and Umbilical Cord Perivascular Cells

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Abstract: Congenital heart disease (CHD) affects ~1% of newborns worldwide. Children born with CHDs often have defective heart valves that require repair or replacement early in the patient's life. For example, in tetralogy of Fallot (≈10% of all CHDs), the pulmonary valve is often repaired in infancy using patches of pericardial tissue or polytetrafluoroethylene, but subsequent complications due to material failure necessitate valve replacement. However, currently available valve replacement devices are incapable of growth, and therefore pediatric patients can face several reoperations throughout their lives. Heart valve tissue engineering (HVTE) holds great promise to address the enormous need for living valve repair materials or replacements with the potential to grow, remodel, and repair throughout a patient's life. Among numerous cell sources for *in vitro* HVTE, umbilical cord perivascular cells (UCPVCs) are particularly attractive because they are autologous, readily available, and have excellent regenerative capacity. Here, we established protocols that enable porcine UCPVCs isolation and expansion to large numbers, and further defined a culture strategy to support production of collagen type I, elastin, and glycosaminoglycans, the primary structural components of heart valve tissues *in vitro*. To translate the extracellular matrix (ECM) producing capacity of UCPVCs to a viable heart valve tissue engineered sheet, we fabricated aligned nanofibrous polycarbonate polyurethane scaffolds with anisotropic biaxial mechanical behavior. We then cultured porcine UCPVCs into both sides of the scaffolds for 21 days and showed that UCPVCs aligned themselves along the fibers of the scaffold, and produced significant amounts of ECM components, in particular aligned mature collagen fibers. To examine the feasibility of this engineered sheet for preclinical testing in a porcine model, engineered patches were implanted into left brachiocephalic vein, right common carotid artery, and pulmonary artery of two piglets. We observed that the engineered tissue was saturable and withstood the blood flow after 6 hours *in vivo*. The proposed engineered tissue sheet has the potential for successful translation towards a functional, multi-layer, anisotropic living pulmonary heart valve replacement with tissue-like microstructure and mechanics, resembling those of native pulmonary heart valves.

Brief Bio: Neda Latifi is currently a Tenure Track Assistant Professor in the Department of Medical Engineering at the University of South Florida. She is the Director of the Translational Tissue Engineering and Biofabrication Laboratory (TTEB Lab). Prior to joining USF, she was an NSERC postdoctoral research fellow in the Department of Mechanical & Industrial Engineering and the Ted Roger Center for Heart Research at the University of Toronto working with Professor Craig Simmons. She holds a B.Sc. with distinction in Mechanical Engineering (2008) and an M.Sc. with distinction in Applied Solid Mechanics (2011) from Isfahan University of Technology as well as a Ph.D. in Tissue Engineering from McGill University (Nov. 2018). Upon graduation, she joined Simmons Laboratory as an FRQNT postdoctoral fellow in October 2018. Her postdoctoral research mainly focused on addressing the current challenges in the development of a functional living engineered heart valve replacement for the stenotic pulmonary valve in pediatric patients with tetralogy of Fallot. She is the recipient of several awards, such as the 2020 Rising Stars in Engineering in Health by Columbia University, NSERC PDF Award, FRQNT PDF Award, Student Scientist Award from TERMIS-Americas 2017 Annual Meeting, and First-place Student Paper Award from ASME 2014 Congress, among others. Her research spans tissue-mimetic biomaterials, cell-biomaterial interactions, autologous mesenchymal stromal cells, tissue culture bioreactors, bio-fabrication techniques, and translational studies. Her ultimate goal is to develop functional engineered load-bearing tissues as personalized, one-time tissue replacements capable of growth and repair in the human body.