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Biomedical Engineering
Wallace H. Coulter Foundation
Lecture Series

Wallace H. Coulter Foundation

"Cardiac Bioengineering: 3D Visualization of Myocardial Fiber Disruption and Tissue Engineered Cardiac Patch"

Dr. Jun Liao
Mississippi State University

Friday, February 28th, 2014
LECTURE: 9:00 AM - 10:00 AM

ENGINEERING CENTER
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Abstract:

Each year, approximately one million Americans suffer myocardial infarctions (MIs) with a 10% in-hospital mortality rate. Medical interventions are needed for those patients suffering from MIs. In the development of new treatment approaches, there are needs for 3D visualization of the infarcted tissues and customized cardiac repair strategies. In this presentation, two topics are covered: one is 3D visualization of myocardial fiber disruption after acute MI via diffusion tensor magnetic resonance imaging (DT-MRI), the other is cardiac patch tissue engineering based on porcine acellular myocardial scaffolds. Two days after an induced infarction, pig hearts were explanted and immediately scanned by a 3T MRI scanner with a diffusion tensor imaging protocol. 3D fiber tracks and clustering models were generated from the diffusion-weighted imaging data. We found in the normal explanted hearts the DT-MRI fibers showed a multilayered helical structure, with fiber architecture and fiber density reflecting the integrity of muscle fibers. For the infarcted heart explants, we observed either a lack of fibers or disruption of fibers in the infarcted regions. 3D contours of the disrupted DT-MRI fibers were found to be consistent with the infarcted regions. Identifying infarcted tissues in a 3D manner can help better design tissue-engineered cardiac patch, a new approach for ventricular wall reconstruction. Recently, we have successfully developed an optimal decellularization protocol to generate 3D myocardial scaffolds from porcine myocardium. The acellular myocardial scaffolds preserved the natural extracellular matrix structure, mechanical anisotropy, and vasculature templates, showing good recellularization and differentiation potential of mesenchymal stem cells. A multi-stimulation bioreactor was further built to provide coordinated mechanical and electrical stimulations for facilitating stem cell differentiation and cardiac patch development. It was found that the cardiomyocyte differentiation and tissue remodeling were more effectively and efficiently promoted with the coordinated simulations, evidenced by good cell viability, proliferation, differentiation, and positive tissue remodeling in a short period of time (2 - 4 days).

Biography

Dr. Jun Liao received his doctoral degree in biomedical engineering from the Cleveland Clinic Foundation/Cleveland State University. After his postdoctoral training in the University of Pittsburgh, Dr. Liao joined the Mississippi State University in 2007, focusing his research on tissue biomechanics and tissue engineering. Dr. Liao's interest is to better understand the role of biomechanics in maintaining optimal tissue performance in physiological conditions and the biomechanical abnormality in diseased/ injury conditions. The hope is to apply the gained knowledge to better design medical interventions. Dr. Liao has published 42 peer-reviewed journal articles in tissue biomechanics/tissue engineering; his research has been funded by NIH, AHA, DOE, NASA, and DoD.

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