UNIVERSITY of HOUSTON | ENGINEERING
Department of Biomedical Engineering

Ph.D. Dissertation Defense

Tissue Engineered Heart Pump Development and Assessment

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Abstract: Development of a natural alternative to cardiac assist devices (CADs) will pave the way to a heart failure therapy which overcomes the disadvantages of current mechanical devices. Through implementation of the three principles of tissue engineering, cell sourcing, material scaffolding, and bioreactors, development of a tissue engineered heart pump (TEHP) can be a viable biological CAD option. An experimental model of a TEHP was first fabricated by wrapping artificial heart muscle (AHM), composed of rat neonatal cardiac cells on the surface of a fibrin gel, around an acellular goat carotid artery and a chitosan hollow cylinder scaffold in various configurations. Histological assessments revealed the presence of cardiac cell layer cohesion and adhesion, as well as retention of cardiac myocyte phenotype. Biopotential measurements revealed the presence of ~2.5 Hz rhythmic propagation of action potential throughout the TEHP. A more clinically applicable TEHP was then fabricated by use of human adipose derived mesenchymal cells (hADMCs), which have been programmed towards a cardiac lineage, in conjunction with a chitosan scaffold imbued with purified porcine extracellular matrix proteins. The second generation TEHP was lined with human endothelial cells and conditioned with pulsatile flow and electrical stimulus. As a result, hADMCs were further matured along their cardiac potential and the TEHPs they embodied formed the foundation for biological CADs.