**PhD Thesis title: 'A NONINVASIVE METHOD FOR QUANTIFYING VISCOELASTICITY OF THE LEFT-VENTRICULAR MYOCARDIUM USING LAMB WAVE DISPERSION ULTRASOUND VIBROMETRY'**

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**ABSTRACT:** Diastolic dysfunction is the inability of the left ventricle to supply sufficient stroke volumes into the system circulation under normal conditions and is accompanied with stiffening of the left-ventricular myocardium. A clinical tool capable of quantifying mechanical properties of the myocardium would aid in assessment of diastolic function.

Changes in tissue stiffness due to pathophysiological changes have been known for centuries. In recent decades, several imaging techniques have been developed to quantify mechanical properties of the myocardium. These techniques often use a mechanical vibrator or focused ultrasound radiation force to excite mechanical waves in the myocardium, and ultrasound or magnetic resonance imaging modalities to track the myocardial deformation and relate it to the mechanical properties of the tissue.

This thesis presents Lamb wave Dispersion Ultrasound Vibrometry, or LDUV, a novel ultrasound technique for quantifying viscoelasticity of the myocardium using ultrasound radiation force to excite cylindrical Lamb waves in the myocardium, and a pulse echo transducer to track and measure the wave velocity. Change in the Lamb wave velocity as a function of excitation frequency (dispersion) is used to estimate elasticity and viscosity of the myocardium. A mechanical model of anti-symmetric Lamb wave dispersion in a viscoelastic plate surrounded by a blood-mimicking fluid is derived and validated.

The LDUV method has been used to measure elasticity and viscosity of a beating heart through a heart cycle. *In vivo* open- and closed-chest studies in porcine left-ventricular myocardium show that both elasticity and viscosity increase from diastole to systole.

**References to author publications that relate specifically to the dissertation:**

I. Z. Nenadic, M. W. Urban, S. A. Mitchell, and J. F. Greenleaf, "Lamb wave dispersion ultrasound vibrometry (LDUV) method for quantifying mechanical properties of viscoelastic solids," *Phys Med Biol,* vol. 56, pp. 2245-64, Apr 7 2011.