PhD Thesis title: 'Measurement of kidney viscoelasticity with Shearwave Dispersion Ultrasound Vibrometry'

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ABSTRACT: Kidney mechanical properties such as elasticity are linked to kidney pathology state. Several groups have proposed shear wave propagation speed to quantify tissue mechanical properties. It is well known that biological tissues are viscoelastic materials; therefore velocity dispersion resulting from material viscoelasticity is expected. Shearwave Dispersion Ultrasound Vibrometry (SDUV) is a method that quantifies tissue viscoelasticity by measuring dispersion of shear wave propagation speed. However, there is not a gold standard method for validation. On the other hand, a concern with kidney elasticity imaging is the variability of kidney material properties associated with hemodynamic variables such as renal blood flow (RBF) regardless of kidney pathology. In this thesis the focus is centered in three areas: validate Shearwave dispersion ultrasound vibrometry (SDUV) with a gold standard method, study the feasibility of SDUV to estimate kidney mechanical properties *in vitro,* study the feasibility of SDUV to estimate kidney mechanical properties *in vivo* and use SDUV to study kidney mechanical properties during acute gradual decrease of renal blood flow. In this thesis, an independent validation method of elastic modulus estimation by SDUV in gelatin phantoms is presented as well as a method that has the potential to fully quantify viscoelastic parameters in a model independent manner by acoustic radiation force creep and shear wave dispersion ultrasound vibrometry. Moreover, feasibility of SDUV for *in vitro* measurements of viscoelasticity in healthy swine kidney as well as *in vivo* measurements of viscoelasticity in healthy swine kidney during acute changes is renal blood flow. Shearwave dispersion ultrasound vibrometry provides a fast, low cost noninvasive tool to measure not only tissue elasticity but tissue viscosity and has the potential to monitor progression of disease with less risk, potential sampling error and cost inherent to biopsies.

References to author publications that relate specifically to the dissertation:

C. Amador, M. W. Urban, S. Chen, Q. Chen, K. An, and J. F. Greenleaf, "Shear Elastic Modulus Estimation From Indentation and SDUV on Gelatin Phantoms," Biomedical Engineering, IEEE Transactions on, vol. 58, pp. 1706-1714, 2011.

C. Amador, M. W. Urban, S. Chen, and J. F. Greenleaf, "Shearwave Dispersion Ultrasound Vibrometry (SDUV) on swine kidney," IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control, Dec, 2011.

C. Amador, M. W. Urban, S. Chen, and J. F. Greenleaf, “Loss tangent and complex modulus estimated by acoustic radiation force creep and shear wave dispersion”, Phys Med Biol. Mar 2012.