Abstract ID: 15262 Title: Simulation and tissue-mimicking phantom validation of shear strain imaging for mass differentiation

Purpose:Axial and full-shear strain imaging have been utilized to differentiate between benign breast masses that are loosely bound, from malignant masses that are firmly bound to the background normal tissue. We examine contributions of different mass properties such as modulus contrast, mass shape, and asymmetric location within the background tissue to the shear strain features.

Methods:Both numerical and experimental tissue-mimicking phantoms were utilized to evaluate the feasibility of axial and full-shear strain imaging. Finite element analysis models a circular and elliptical inclusion in the center of a uniform background. Friction coefficient values at the inclusion/background interface is varied to simulate different bonding conditions. Experimental phantoms with ellipsoidal masses (both firmly and loosely attached) oriented at 00, 300, 600 and 900 and embedded into a uniformly elastic background are utilized to corroborate the numerical simulations. Shear strain images are estimated from the gradient of the local displacement vectors. Axial and full-shear strain areas are normalized to the mass dimensions, applied deformation and strain contrast to quantify the shear strain features.

Results:The normalized axial-shear strain area (NASSA) and full-shear strain area (NFSSA) features are both significantly larger for firmly bound masses when compared to loosely bound masses for both spherical and ellipsoidal shaped masses. Differentiation between loosely and firmly bound masses is improved for masses with larger modulus contrasts. Larger applied deformations may result in slippage of loosely bound masses. For asymmetric masses the best differentiation is obtained at orientations of 00 and 900 with respect to the direction of the applied deformation.

Conclusions:Our numerical and phantom results demonstrate the feasibility of utilizing NASSA and NFSSA features to classify a mass as benign or malignant based on their bonding to the background tissue. This feature can be utilized in conjunction with stiffness contrast and size-ratio features currently utilized in axial-strain elastography.

Funding Support, Disclosures, and Conflict of Interest:

This work is supported by Komen Foundation Grant BCTR0601153 and NIH Grants R01CA112192-S103, 5R21CA140939-02 and 5R21EB010098-02.