Abstract ID: 17303 Title: Quantitative Elasticity Imaging with Acoustic Radiation Force Induced Shear WavesPurpose: Shear waves can be generated in soft tissues using impulsive acoustic radiation force (ARFI), and the resulting shear wave speeds (SWS) can be related to the shear moduli (G) by SWS = sqrt(G/rho). Time-of-flight (TOF) algorithms can be used to track shear wave positions through time to estimate SWS. The spatial resolution of these methods is inherently limited by the size of the regression kernel, and, improved spatial resolution comes at the cost of increased variance in the SWS estimate. Here existing methods are reviewed, and a novel SWS reconstruction method that employs a spatial homogeneity constraint (SHC method) to obtain improved spatial resolution in ARFI-based SWS images is presented.
Methods: The SHC SWS reconstruction method performs an iterative maximum a posteriori estimation that weights each TOF SWS estimate in the image based upon its similarity to surrounding pixels. Next, ARFI images of relative tissue stiffness are used to identify homogeneous regions for which TOF based SWS estimates are expected to be accurate and precise in matched datasets. These regions are then used to derive a nonlinear mapping between the quantitative SWS estimates, and the the higher spatial resolution ARFI image. Both FEM simulations and experiments were performed to compare the SHC and TOF methods.
Results: The spatial resolution of SWS estimates was directly related to the reconstruction kernel size in TOF methods, and the precision increased with increasing kernel size. The spatial resolution of the combined SHC images was comparable to that in the ARFI images, and was significantly better than that in the TOF SWS images.
Conclusions: ARF-induced TOF based SWS estimation methods provide quantitative stiffness information with spatial resolution that is dictated by the ARF shear wavelength, and the reconstruction kernel size. Improved accuracy and precision is obtained with larger reconstruction kernels in homogeneous media. The SHC reconstruction method provides improved contrast over qualitative ARFI images, and improved spatial resolution over TOF based quantitative SWS images.

Learning objectives:

1) Define acoustic radiation force phenomenon
2) Describe its use for elasticity imaging
3) Explain tissue response
4) Describe wave arrival time and shear wave speed estimation methods
5) Provide examples of clinical use