Ultrasound Tomography for Breast Cancer Screening

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Abstract
Both mammography and standard ultrasound (US) rely upon subjective criteria within the breast imaging reporting and data system (BI-RADS) to provide more uniform interpretation outcomes, as well as differentiation and risk stratification of associated abnormalities. In addition, the technical performance and professional interpretation of both tests suffer from machine and operator dependence. Breast MR has become the new gold standard for screening of high-risk women but has cost and access limitations in extending screening to the entire population. We have been developing a new technique for breast imaging that is based on ultrasound tomography which quantifies tissue characteristics while also producing 3-D images of breast anatomy. Results are presented from clinical studies that utilize this method.

Informed consent was obtained from all patients, prospectively recruited in an IRB-approved protocol following HIPAA guidelines. Coronal images were produced by tomographic algorithms for reflection, sound speed and attenuation. All images were reviewed by a board-certified radiologist who has more than 20 years of experience in breast imaging and US-technology development. In the first phase of the study, UST images were compared to multi-modal imaging to determine the appearance of lesions and breast parenchyma. In the second phase of the study, correlative comparisons with MR breast imaging were used to establish basic operational capabilities of the UST system including the identification and characterization of parenchymal patterns, determination of the spatial resolution of UST and an estimate the breast volume that can imaged with UST. The third phase of the study focused on lesion characterization. Region of interest (ROI) analysis was performed on all identified lesions using all three UST image types. Combinations of the ROI generated values were used to characterize all masses in the study.

Our study demonstrated a high degree of correlation of breast tissue structures relative to fat subtracted contrast enhanced MRI and the ability to scan ~90% of the volume of the breast at a resolution of 0.7mm in the coronal plane. With a scan duration of ~ 1-3 minutes, no significant motion artifacts were observed. Initial clinical results suggest an ability to characterize lesions using margin boundary scores in combination with sound speed and attenuation parameters.