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Clinical ultrasound breast tomography using Softvue®: a preliminary in vitro and in vivo assessment

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Softvue® (Delphinus Inc.) ultrasound tomography (UST) provides images of sound speed (SS), attenuation coefficient (AC), a combination of SS and AC called stiffness, and relative reflectivity. We have compared volume-averaged SS (VASS) with MRI volume-averaged water versus fat, to quantify breast density (O'Flynn et al., 2017). Here, clinical reproducibility is assessed, stiffness compared with MRI, and VASS compared with mammographic density. Performance is estimated using phantoms.

(2) Material and Methods

Forty three healthy volunteers underwent breast UST and Dixon MRI. Semi-automated breast segmentation was developed for VASS. Left-right breast correlation assessed reproducibility of VASS and SS breast texture. VASS and stiffness were compared with MRI water and (in a subset of 13) mammographic density (Cumulus®). To further assess UST stiffness, images of a commercial elastography phantom (CIRS, model 059) and a custom built gelatine phantom with solid inclusions were compared with shear wave elastograms (SWE) (Aixplorer®, Supersonic Imagine). To assess SS and AC, gelatine and agar phantoms containing ethanol or castor oil inclusions were scanned at various temperatures and the results compared with independent measurements.

(3) Results

Stiffness correlated extremely well with breast composition estimated by MRI, although slightly less well than previously reported VASS with MRI. VASS correlated well with mammographic density, slightly better when the density was estimated with a craniocaudal view than a mediolateral view. Good left-right breast correlation was obtained with VASS and with SS histograms of each breast, as well as with summary first-order texture measures. In phantoms, a UST stiffness halo signature signified the presence of a mass that was stiff on SWE. SS imaging detected inclusions at least as small as 3 mm diameter. The accuracy of SS and AC, and the average inclusion/background contrast, varied with inclusion size.

(4) Discussion and Conclusion

VASS and SS breast texture are reproducible. VASS and stiffness describe breast adipose/parenchymal composition well and hold promise as breast density estimates. Correlation with mammographic density may be influenced by variability in the latter. Mass stiffness in phantoms is displayed differently by UST and SWE, suggesting the need for a clinical comparison. Small inclusions are detectable although SS and AC vary with mass size. Similar testing is required with the latest version of Softvue®

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