AI-based quantitative breast density assessment using transmission ultrasound

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Disclosures

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Purpose

Growing body of evidence indicates that breast density is one of the most important independent risk factors of breast cancer.

Currently, mammography is the only FDA-cleared means to evaluate breast density in a general screening population.

We present 3D transmission ultrasound as a method to visualize and differentiate fibroglandular tissue within the breast and use a fully automated segmentation method machine learning-based method to quantitatively assess the breast density.
QT Scanner – transmission and reflection ultrasound
QT speed of sound and reflection images
3D image volume of speed of sound and reflection
Transmission & Reflection: normal breast anatomy
Tissue segmentation algorithm

- Segment breast from surrounding water using attenuation images
- Determine ‘border’ pixels based on proximity
- Segmentation of high-speed breast tissue from the total breast volume
- Calculate breast density

- Fuzzy clustering into two categories
- Membership map generation
- Thresholding
Testing on tissue phantoms

Density based on theoretical volume = 7.1%

Density based on QBD = 7.6%
Testing on clinical images

- Application of algorithm on 100 unilateral breast scans
- Mammography performed within 90 days of transmission imaging
- Both QBD and VolparaDensity™ (v3.1) scores were available.
- Correlation quantified using Spearman coefficient
Segmentation of fibroglandular tissue

QBD = 10.9%

QBD = 29.5%

QBD = 62.4%

Wiskin et al., Medical Physics, 2019, in press
Correlation of QBD with VolparaDensity

- Spearman $r = 0.94$ (95% CI: 0.91-0.96); $p<0.0001$

- Deming linear regression shows a relationship of $\text{VolparaDensity} = 0.53(\text{QBD}) - 0.87$
QBD relationship with VolparaDensity similar to MRI

Ref: Wang et al., PLoS One, 8(12), 2013
Validation of segmentation algorithm using large format histology

TU fibro glandular volume = 45.1 %

H&E fibro glandular volume = 42.3 %
Validation of segmentation algorithm using UV microscopy

QT speed of sound image – QBD= 34.7%

MUSE image – equivalent breast density = 37.9%
Precision of QBD measurement

- Scanned a single breast/patient ten times
- Calculated QBD for individual scans
- Mean QBD value = 9.4 %; Standard deviation = 0.2 %
Volumetric rendering of segmented breast tissue
Conclusions

The presented segmentation method can accurately identify the fibroglandular tissue volume within the whole breast.

The results indicate that breast density as assessed by fully automated means using TU can be of significant clinical value and play an important role in breast cancer risk assessment.