Detection of breast micro-calcifications with MRI at 3T:

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Background

Micro-calcifications (< 1 mm) are a fundamental marker of breast cancer by x-ray mammography, especially for the early diagnosis of ductal carcinoma in situ (DCIS). Micro-calcifications may be the only sign of malignancy in up to 72% of clinically occult DCIS (1, 2). However with MRI, micro-calcifications are rarely detected using standard pulse sequences due to insensitivity to calcification. The purpose of this study was to optimize MRI approaches for detecting micro-calcifications in the breast in comparison to mammography and conventional MRI.

Methods and Results

Twenty ex vivo breast tissue specimens were evaluated with digital mammography to identify micro-calcifications. Eleven clusters of micro-calcifications were identified in 7 out of the 20 specimens, for which high resolution MRI and micro-CT (spatial resolution 100 μ) were performed. Two MRI pulse sequence strategies were compared: a) 3D SPGRE ultra-short TE (UTE) sequence with a radial reconstruction, and b) susceptibility weighted imaging (SWI). Since mammograms are 2D projection images, it was necessary to perform micro CT on the specimens in order to confirm the 3D position of micro-calcifications in relationship to MRI. Calcifications detected on micro CT from seven human breast specimens were co-localized with the MRI scans and calcium conspicuity was noted. Using a 3.0 Tesla system (Achieva, Philips, Best, NL), ultra-short TE images were acquired using a radial projection 3D SPGRE sequence with TR/TE/FA of 11ms/0.15ms/15° with bandwidth of 527 Hz/pixel with 400 μ isotropic acquisition resolution and 0.2 μ isotropic reconstructed resolution. SWI images were acquired with using an SPGRE acquisition with TR/TE/FA of 65ms/16ms/20°, 202 Hz/pix bandwidth and Cartesian reconstruction with similar resolution. Signal intensities were inverted to show low proton density or susceptibility changes as high intensity. Comparing ultra-short TE to SWI, signal to noise was increased by 16.4% (7.8 versus 6.7, respectively) in a comparable 15 minute imaging period. The SWI phase maps had significant chemical shift artifacts at fat water interfaces that masked the micro-calcifications, significantly reducing the confidence of finding macro- as well as micro-calcifications.

	Ultra-short Echo Time	Susceptibility weighted imaging
Number of micro-calcifications clusters visualized	11/11 (100%)	9/11 (82%)
Visibility	Visible	Visible
Micro-calcifications appearance	Spatial details are well recognized	Blooming artifact with no spatial details recognizable
Background	Fairly homogenous	Chemical shift (dark bands) artifacts mask micro-calcifications detection

Discussion

Micro-calcifications by mammography are a hallmark of breast malignancy but are currently poorly localized by MRI, causing difficulty for MRI workup of small lesions otherwise detected on a mammogram. We achieved high spatial resolution and good visualization of micro-calcifications using a proton density weighted ultra-short TE MRI sequence with radial reconstruction. Ultra-short TE MRI has potential for detection of mammographically visualized micro-calcifications.

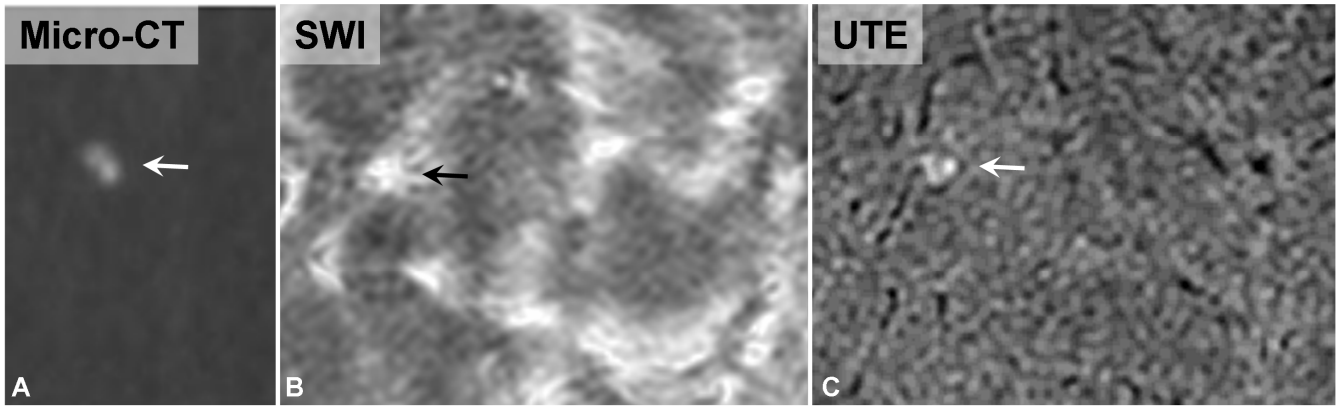

Figure 1. Detection of breast micro-calcifications with MRI. A) Micro-CT image (100μ resolution) of human breast tissue showing < 1 mm micro-calcifications (arrow). B) SWI with inverted video display showing micro-calcification (arrow), but extensive heterogeneity of the background tissue with similar high signal intensity features is present. C) UTE MRI (11ms/0.15ms/15°) with inverted video display shows the spatial details of the micro-calcification (arrow) with a more homogenous, low signal intensity background.

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