

## **B0 maps highly accentuate spiculations at the tumor margin**

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**Introduction:** To increase breast MRI specificity, [1,2] better assessment of lesion morphology is needed. This is especially true for differential diagnosis of fibro-adenomas, which present with DCE curves similar to those of malignant lesions. Furthermore, the smaller the lesion, the more difficult it is to assess its morphology. Yet, it is these small lesions where high specificity is paramount, as a larger proportion of small lesions is diagnosed as benign, than is the case with larger lesions. Using echo-planar spectroscopic imaging (EPSI), we produced high spatial resolution maps of the B0 field. The local B0 changes at magnetic susceptibility interfaces, e.g. at fat-water interfaces or micro-calcification sites. B0 is also shifted in regions with high blood vessel density, hypoxia, or differential accumulation of certain proteins. B0 variations can thus be used to assess lesion morphology, or as markers for malignancy. We report B0 maps that are highly sensitive to fat-water boundaries and that accentuate spiculations at the lesion margin. Thus B0 field mapping can be used as diagnostic imaging that supplements current clinical imaging, especially for morphologic assessment of small lesions with malignant-type DCE uptake curves.

**Methods:** After informed consent, 2 women with invasive mass lesions were imaged on a GE SIGNA scanner with ECHO SPEED PLUS<sup>TM</sup> self-shielded gradients. The standard clinical protocol was used, including a T1-weighted, fat-saturated fast spoiled gradient echo (SPGR) sequence (in-plane resolution 1.5 mm, 4 mm thick slices). Prior to contrast agent (CA) injection, an echo-planar spectroscopic imaging (EPSI) –based sequence [3] was acquired (resolution: 0.65 in-plane, in 3 mm thick slices, 2.6 Hz spectral, for Patient 1; or 0.95 in-plane, in 3 mm thick slices, 5.2 Hz spectral, for Patient 2). Due to non-Cartesian k-space sampling of the EPSI sequence, Nyquist ghosting in the spectral dimension occurs, and can be corrected by applying a constant phase correction to either even or odd echoes in the echo train. The value of the phase correction is proportional to local B0 and is calculated in each voxel separately – hence a high-resolution B0 map is obtained. Large-scale variations of B0 inside the breast, such as those arising from residual gradients, were not corrected for.

**Results:** Figure 1 shows the post-contrast T1-weighted fat-saturated SPGR images (a and d), a square region around the lesion magnified (b and e), and pre-contrast B0 maps (c and f) for two patients (Patient 1, up; and Patient 2, down) with invasive cancer lesions. B0 maps highly accentuate spiculations at the lesion boundaries – they were more prominent and better delineated than those visualized in standard clinical fat-saturated SPGR images. Smaller spiculations, not easily seen on the standard T1-weighted images, can also be seen in B0 map images (arrows).

**Discussion:** B0 field maps of human breast are qualitatively different from clinical fat-saturated images, with contrast that may be more sensitive to morphologic detail at the margins of tumors. As the long echo train sampling of the EPSI sequence increases the signal-to-noise (SNR) dramatically, B0 mapping can be done at spatial resolutions higher than that in current clinical sequences. B0 mapping is sensitive to tissue boundaries, and does not require good T1 or T2/T2\* contrast between water and fat tissue, fat suppression, nor contrast agent injection. It can present a valuable option for patients who can not use MR contrast agents safely. Thus B0 mapping can be included as a diagnostic sequence to be used after a lesion was identified, either before or after contrast agent administration. B0 mapping is a novel approach to imaging lesion morphology, with great potential for improving lesion assessment and thus increasing breast MRI specificity.

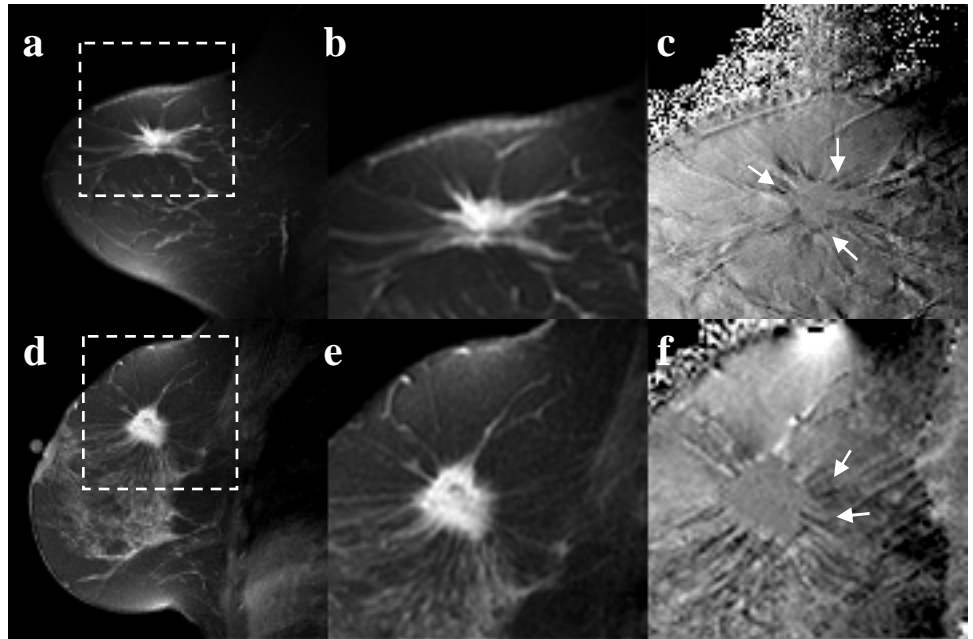


Figure 1: Post-contrast T1-weighted fat-saturated SPGR image of the lesion is shown, for a patient with infiltrating ductal carcinoma (a, Patient 1) and infiltrating ductal carcinoma *in situ* (b, Patient 2). In b) and e), a small region around the lesion (square in a, d) is shown. B0 maps (c and f), are shown in the same region and at the same scale as in b) and e). B0 maps highly accentuate spiculations at lesion boundary, which could facilitate lesion assessment. Some spiculations were only observed in the B0 maps (arrows).

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3. Mansfield, P, *Magn Reson Med*, 1:370-386, 1984.