High Resolution Bilateral Dynamic Contrast Enhancement Breast Imaging

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Introduction Dynamic contrast enhanced (DCE) imaging [1] requires fat suppression and fast scan time for first-pass bolus tracking. These problems have been previously addressed by using stack-of-spiral acquisitions with spectral-spatial excitations [2]. However, bilateral breast exams have been difficult with such an approach due to large and differing amounts of off-resonance in the two breasts. To solve this problem, we use dual-band spectral-spatial RF pulses to excite two slabs simultaneously with independently controlled shims and center frequency [3, 4]. Here, we present patient study results demonstrating the capability of such bilateral pulses incorporated into variable-density stack-of-spirals trajectories [5] for pharmacokinetic analysis.

Theory Bilateral exams with single-band spectral-spatial RF pulses are difficult, mainly because of the failure in fat suppression caused by large off-resonance fields created across two breasts. By using dual-band pulses, separate center frequency and linear shims can be applied to each breast during RF excitation [3, 4]. This enables robust fat suppression for both breasts with optimal center frequency and shim values corresponding to the values that would be used for two separate single breast exams.

With a bilateral excitation, a larger volume needs to be acquired to cover both breasts. To incorporate large volume coverage with high temporal resolution, variable-density stack-of-spirals trajectories were used [5].

Methods The experiments were conducted on a GE 1.5 T EXCITE whole-body scanner with a maximum gradient amplitude of 40 mT/m and maximum slew rate of 150 mT/m/ms. A 4-channel breast coil was used.

Dual-band spectral-spatial RF pulses (excitation profile shown in Fig. 1a) [4] were incorporated into a variable-density stack-of-spirals trajectory [5] with 20 x 20 x 30 cm^3 FOV and 1.5 x 1.5 x 5 mm^3 resolution, 8 spiral-interleaves and 60 stack locations. With a 25 ms T_R, temporal resolution of 12 sec was achieved for the volume coverage of both breasts.

A patient with biopsy proven cancer in the right breast was scanned. The contrast (Magnevist) injection occurred after 4 frames of volume acquisition. A total of 20 temporal frames were acquired over 4 min.

For this exam, a 50 Hz of center frequency shift was corrected for using the dual-band RF pulse during acquisition, and used to individually demodulate the data for each breast during reconstruction.

Results Robust fat suppression is observed in both breasts while obtaining relatively high resolution (Fig 1b, c). For the right breast, where the tumor was observed, contrast enhancement curves were plotted for three different regions (Fig. 2). The red and blue curves show contrast dynamics within the tumor and the green curve shows the contrast in normal breast tissue.

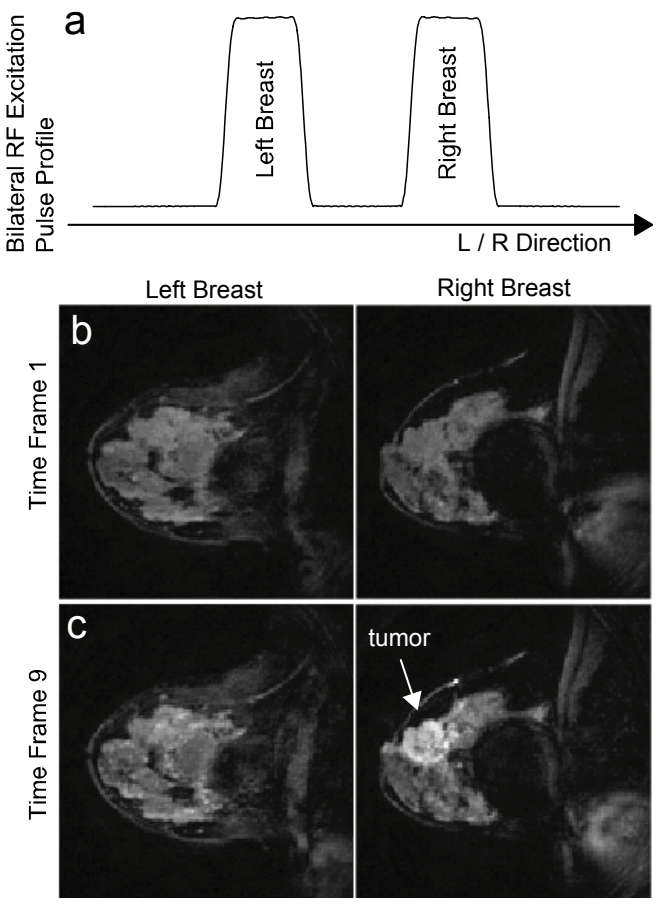

Figure 2 (a) Dual-band spectral-spatial RF pulse profile. Images (b) before contrast (0 sec) and (c) after contrast (96 sec)

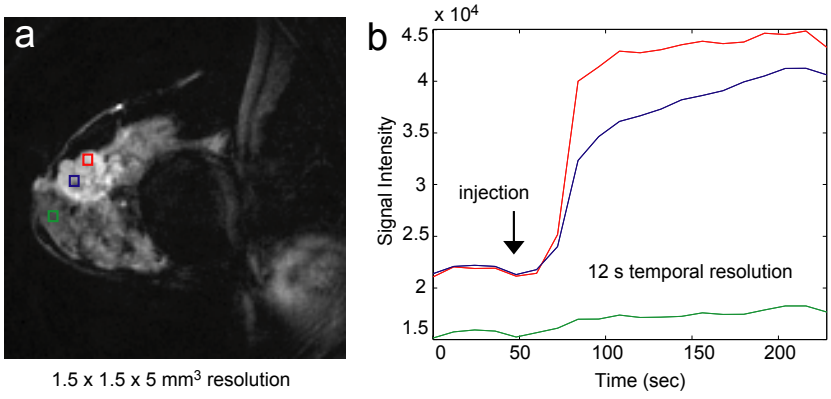

Figure 1 (a) Right Breast. Three boxes indicate ROIs for which the contrast enhancement curves were plotted. (b) Contrast enhancement curves display high (12 sec) temporal resolution.

Discussion Dual-band spectral-spatial RF pulses in combination with 3D variable-density stack-of-spiral trajectories achieve robust fat suppression while obtaining high spatio-temporal resolution which is necessary for bilateral DCE breast exams.

References

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