Ultrafast Isotropic 3D Axial Bilateral Breast Acquisition with Uniform Fat Suppression with Eight Channel Breast Coil

A. Priatna[1], A. T. Vu[1], X. Zhao[1], A. Knowles[1], C. Lehman[2], L. N. Tanenbaum[3]

[1]GE Healthcare Technologies, Waukesha, WI, United States, [2]Seattle Cancer Care Alliance, University of Washington, Seattle, WA, United States, [3]Edison Imaging, Edison, NJ, United States

Introduction:

Axial 3D bilateral breast acquisition with contrast-enhanced MR imaging technique has been used clinically for evaluating breast lesions, which are usually embedded in the fat tissues. Several methods of fat suppression techniques have been used such as using fat saturation pulses, binomial water excitation pulse, or a spectrally selective inversion pulse (1,2). However, applying fat saturation pulses or binomial water excitation in the already long 3D MR acquisition extends the scan time. Using a spectrally selective inversion pulse with centric encoding in 3D imaging sequence helps reducing the scan time, however, this results in a non-homogeneous fat saturation and ringing artifacts. The method proposed here is to provide effectively homogeneous fat suppression that can be acquired for isotropic 3D high resolution dynamic contrast enhanced axial 3D bilateral breast studies using spectrally selective RF pulses, asymmetric k-space acquisition in slice encoding direction, and three-fold ASSET acceleration factor with 8 channel breast coil.

Materials and Method:

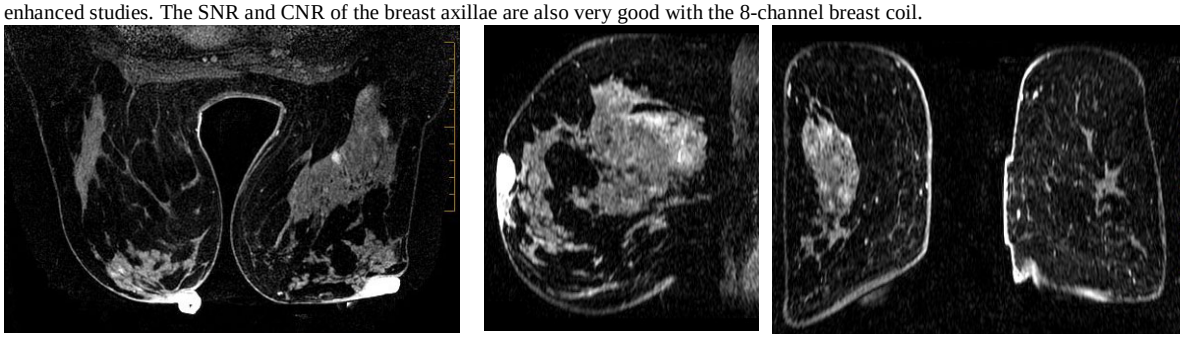
The proposed method is to utilize a fast three-dimensional spoiled gradient echo sequence with asymmetric k-space acquisition in the slice direction, multiple spectrally selective inversion pulse (SPECIAL) to suppress the fat signal, and ASSET parallel imaging with three-fold acceleration factor in view encoding to dramatically reduce the scan time using an eight channel coil. The SPECIAL pulse inverts the fat magnetization only and the fat signal was nulled at the fat inversion time. The SPECIAL inversion pulse was applied for every 12 to 14 slice-encoding steps that were arranged in sequential manner immediately after the asymmetric zero filling in the slice direction (0.74). The flip angle of the SPECIAL inversion pulse was automatically adjusted so that the fat signal was nulled at the center of K-space. ASSET parallel imaging in view direction is used to acquire isotropic axial bilateral breast imaging. The method was implemented on 1.5T GE Twinspeed EXCITE HD MR systems (GE Healthcare Technologies, Waukesha, WI). The following typical imaging parameters were used on 5 volunteers and 5 patients with Zoom (140 mT/m/ms) and Whole (80 mT/m/ms) modes:

Prot	Grad	BW	TE	TR	FA	FOV	Thick	# Slice	Xres	Yres	Asset factor	Other
1	Zoom	62,5KH	2.3ms	4.8ms	10	30cm	2mm	94	370	370	3 fold	Zip2
2	Whole	41.67KH	2.9ms	6ms	10	34cm	1.6mm	114	388	300	3 fold	

A GE eight-channel breast coil (GE Healthcare Technologies, Waukesha, WI) was used. Two small volume shims was used with one volume shim was applied on each breast. An average shimming and center frequency from both of the breasts was used as the shim and center frequency values for the 3D acquisition.

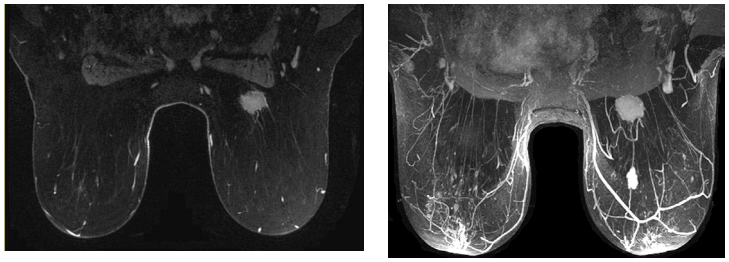
Results:

Fig.1 shows a contrast-enhanced image data set of a patient's breast that shows the feasibility of the technique to uniformly suppress the fat signal on both breasts while maintaining good SNR with isotropic resolution. Total acquisition time = 1 min. Fig.2 shows another clinical cases obtained with this technique. The asymmetric k-space acquisition and the ASSET imaging with three-fold acceleration factor greatly reduced the scan time to obtain high resolution within clinically acceptable time for dynamic contrast enhanced studies. The SNR and CNR of the breast axillae are also very good with the 8-channel breast coil.



(a) (b) (c)

Figure 1. Contrast-enhanced high resolution, isotropic axial 3D bilateral breast acquisition image with uniform fat suppression using the technique proposed here with protocol 1: (a) actual axial image, (b) sagittal reformatted, and (c) coronal reformatted images.



(a) (b)

Figure 2. Another case of contrast-enhanced high resolution axial 3D bilateral breast acquisition with protocol 2 that shows clearly breast lesions: (1) actual axial slice, (b) the maximum intensity projection (MIP) image that shows the vessels and the lesions.

Conclusion:

The proposed method utilizing asymmetric acquisition in the slice direction, multiple SPECIAL pulses and high acceleration factor ASSET parallel imaging with eight channel coil can homogeneously suppress the fat signal applied for high resolution isotropic 3D axial bilateral breast acquisition that is suitable for fast dynamic contrast enhanced studies.

References:

1. Hylton NM, et al. MRI Clin N. Am 1994, 2(4):511-25.
2. Niitsu M, et al. JMRI 2003, 18(3):310-4.