Clinical Evaluation of Breast DCE MRI with TWIST DIXON Sequence

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Introduction Breast MRI has been increasingly used in screening women at high breast cancer risk, in evaluating the extent and stage of disease as well as the response to therapy [1]. A critical component of breast MRI exam is Dynamic Contrast Enhanced (DCE) acquisition which provides both morphological and functional (i.e. perfusion) information for detecting and differentiating benign and malignant breast lesion [2-3]. In breast DEC-MRI, high temporal and spatial resolution are both desirable and such conflicting requirements need to be carefully balanced. In addition, accurate fat suppression (FS) is helpful to prevent the signal from adipose tissue in the breast from masking certain contrast-enhanced lesions. To meet such challenges, a novel pulse sequence was developed which combines k-space sharing strategy used in Time-resolved angiography With Stochastic Trajectories (TWIST) [4] with fat and water separation by dual-echo Dixon (TWIST-Dixon). In this study, we compared the image quality of TWIST Dixon sequence with a conventional method of Volume Interpolated Breath-hold Examination (VIBE) with SPectrally selective Adiabatic Inversion Recovery (SPAIR) for fat suppression in a group of clinical patients.

Methods With institutional review board approval, 18 patients scheduled for breast MRI exam were recruited. After written informed consent was obtained from each subject, imaging was performed on a clinical 3T scanner (TIM Verio, Siemens, Germany) using either an 8-channel coil (Hologic, Toronto, Canada) or a 7-channel coil (Invivo, Gainesville, FL), with the subject in head-first prone position. The breast DCE MRI includes 6 sets of TWIST Dixon images (1 pre- and 5 post- contrast) was acquired and followed immediately with 1 set of VIBE with SPAIR fat suppression images. A single dose of contrast agent (ProHance, Bracco DiagnosticsInc, Princeton, NJ) was injected after the acquisition of the first set of TWIST Dixon images and flushed with 20 ml of saline. In TWIST Dixon, the central 33% of k-space data was acquired for each time point while 50% of the peripheral k-space data was shared from the acquisition of previous time point [5]. To achieve the same spatial resolution, both TWIST Dixon and VIBE with FS have the identical matrix size = 448x358, FOV = 300 – 360mm; slice thickness = 1.0-1.1mm and number of slices = 112-134; For TWIST Dixon, receiver BW = 744 Hz/pix; TE1/TE2=2.45ms/3.675ms, minimum TR =5.6 ms were used and the temporal resolution is 63-73 sec. For VIBE with FS, receiver BW = 744 Hz/pix; TE=1.4-1.5ms, minimum TR of 3.8 ms were used and the acquisition time is 71-84 sec. Automatic shim was applied prior to the acquisition of dynamic series and no adjustment was made between TWIST Dixon and VIBE SPAIR.

The last set of TWIST Dixon images and the following VIBE SPAIR images were reviewed and scored independently by three radiologists. For each image set, 7 image quality criteria: Perceived SNR (P.SNR), Visualization of Anatomy, Fat Suppression (FS) Accuracy, FS Uniformity, Ghosting, Edge enhancing Artifact and Overall Image Quality (IQ), were scored for breast and axillary regions respectively on a scale of 1-5 with 1=poor, 2=below average, 3=average, 4=above average and 5 = excellent. To test for any difference in image quality, random-effects ANOVA was performed (JMP 9.0.0, SAS, NC) with the sequence and region as fixed effects and the readers and cases as random effects. The model was full factorial in fixed effects but main effects only for random effects. Post-hoc tests were performed with Tukey's HSD to correct for multiple comparisons.

Results Figure 1 shows a typical image acquired with TWIST Dixon and the corresponding VIBE SPAIR from the same location in one of the subjects. SPAIR image has more edge enhancement artifact (arrow) and less uniform fat suppression. Table 1 summarizes the image quality scores and the statistical analysis. Statistically, TWIST Dixon has significantly higher scores in almost all criteria than VIBE with FS except for ghosting where the differences were not significant.

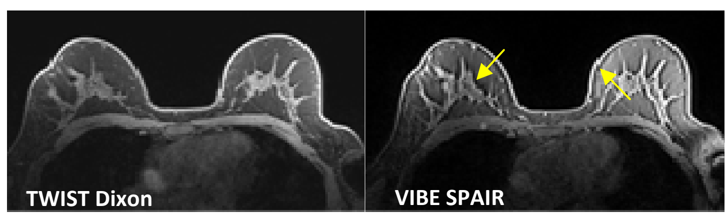

Figure 1 TWIST Dixon and VIBE-SPAIR images from one of the subjects. Edge artifacts are marked by arrows

Table 1. Statistical Analysis of the Imaging quality scores

	P. SNR	Visualization	FS Accuracy	FS Uniformity	Ghosting	Edge Artifact	Overall IQ
TWIST Dixon*	3.68±0.85	3.68±0.84	4.06±0.73	4.29±0.67	3.79±0.92	4.69±0.55	3.83±0.74
VIBE SPAIR*	3.30±0.64	3.42±0.61	3.39±0.67	2.97±0.82	3.67±0.93	3.05±0.70	3.24±0.61
Sequence p-val	<.0001**	.0036**	<.0001**	<.0001**	0.212	<.0001**	<.0001**

* Mean Score ± Standard Deviation

** TWIST Dixon scores significantly higher than VIBE with SPAIR fat suppression

Discussion Our study shows that TWIST Dixon technique provides higher perceived SNR, more accurate fat suppression and overall better image quality for breast DCE-MRI than the conventional technique. These results are consistent with a previous quantitative phantom study. In that study we found that TWIST Dixon images had a higher relative SNR efficiency (3.2-18.9) than VIBE-SPAIR images, (2.8-16.8), as well as a higher fat suppression accuracy and uniformity, 0.66±0.03 for TWIST Dixon compared with 0.56±0.23 for VIBE-SPAIR(reference value is 0.70, by spectroscopy). The impact on diagnosis sensitivity and specificity of breast lesions from the improved image quality of TWIST Dixon also need to be evaluated.

References 1.Li, S.P., et al., Radiology, 2011. **260**(1): p. 68-78. 2.Schnall, M.D., et al., Radiology, 2006. **238**(1): p. 42-53. 3. Kuhl, C., Radiology, 2007. **244**(2): p. 356-78. 4.Lim, R.P., et al., AJNR Am J Neuroradiol, 2008. **29**(10): p. 1847-54. 5.Song, T., et al., Magn Reson Med, 2009. **61**(5): p. 1242-8.