Initial results of the Application of a Modified TWIST Sequence with Flexible View Sharing in Breast DCE-MRI

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Target Audience Radiologists, MRI physicists and scientists.

Purpose The combination of Time-resolved angiography With Stochastic Trajectories (TWIST) acceleration and Dixon fat suppression has been shown to produce superior DCE-MRI results[1-2]. An improved TWIST-Dixon technique with flexible view sharing and flexible echo times (TWIST-Dix-Flex) was developed. With this technique the initial contrast uptake phase can be accessed with high temporal resolution image, which has been found to be helpful [3-4]; while morphologic assessment can also be performed with the high spatial resolution images acquired at the peak enhancement and afterwards. We have applied the improved TWIST-Dix-Flex technique to breast DCE-MRI of a small group of clinical patients with encouraging results.

Methods In TWIST-Dix-Flex, *k*-space sampling at each time point can be prescribed individually as 'Full': ($AB_1 \ldots B_n$); 'Partial': (AB_i); or 'Center-only': (A), where A is the central k-space region and B_i is a portion of the peripheral k-space region. Missing data was shared from the nearest available measurements with backward sharing preferred. Fig. 1 shows the timeline of the acquisition. The non-product dual-echo Dixon with flexible echo times was realized with bipolar gradient readout[2]. With the approval of institutional review board, five patients (ages 35-62) scheduled for clinical MRI exam were recruited for the evaluation of the non-product TWIST-Dix-Flex with informed consent obtained. Images were acquired on a 1.5 T scanner (MAGNETOM Aera, Siemens Healthcare, Erlangen, Germany) using an eight-channel breast coil (Hologic, Bedford, USA). TWIST-Dix-Flex acquisition includes one pre-contrast 'Full', six 'Center-only' during the 60 seconds initial contrast uptake, and three additional measurements (two 'Partial' and one 'Full') afterwards. A single dose of contrast agent (0.1 mmol/kg, ProHance) was infused at 2 mL/s and flushed with 20 mL saline after the pre-contrast measurement. Immediately after TWIST-Dixon-Flex, one additional image set was acquired with standard Volume Interpolated Breath-hold Examination (VIBE) with SPectrally selective Adiabatic Inversion Recovery (SPAIR) for comparison. FOV was 326 – 380 mm; matrix size was 448 x 358. The slice thickness was 1.5 mm and number of slices was 128. TR/TE1/TE2 was 6.6/2.23/4.02 ms for TWIST-Dixon-Flex and 4.13/1.5 ms for VIBE-SPAIR. The central k-space was 8% and peripheral k-space sampling density (b) was 50% for TWIST-Dix-Flex. The TWIST-Dix-Flex images at peak enhancement and the VIBE-SPAIR images were scored by two breast imaging radiologists on a scale of 1 – 5 for Perceived SNR (P.SNR), Visualization of Anatomy, Fat Suppression Quality, Artifacts, and Overall Image Quality (IQ).

Results Among the subjects, one had DCIS, two had invasive ductal carcinoma, and two had no detectable lesion. Table 1 summarizes the image quality scores. These results are further demonstrated in Fig. 2 with direct comparison of TWIST-Dix-Flex and VIBE-SPAIR images from the same slice in one of the subjects. Based on a paired T-test, TWIST-Dix-Flex images have significantly higher scores than VIBE-SPAIR on all criteria. With higher SNR, better visualization of anatomy, superior fat suppression and less artifact, the images produced by the TWIST-Dix-Flex technique have higher overall image quality than those produced with the VIBE-SPAIR technique. Fig. 3 shows the MIPs of initial time points in one of the subjects, demonstrating the capability of measuring the initial uptake slope in the tumor. The enhancing tumor became visible starting from the 5th measurement.

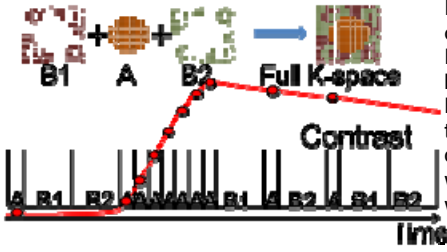

Fig.1 Timing of TWIST-Dix-Flex in breast DCE-MRI relative to the contrast wash-in and wash-out.

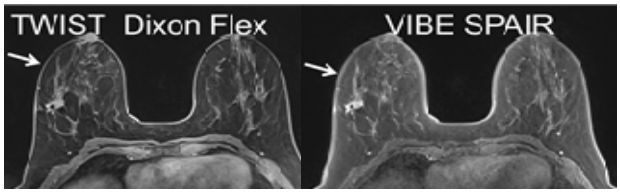

Fig. 2 TWIST-Dixon-Flex vs. VIBE SPAIR. Note the reduced ringing in TWIST-Dixon-Flex

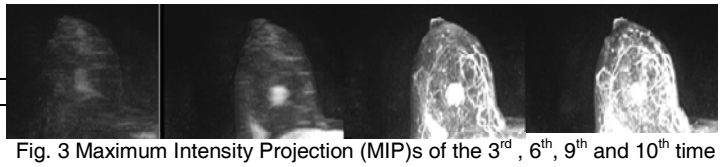

Fig. 3 Maximum Intensity Projection (MIP)s of the 3rd , 6th, 9th and 10th time points demonstrate the early enhancement of a tumor

Table 1. Statistical Analysis of the Imaging Quality Scores

	P. SNR	Anatomy	FS Quality	Artifact	Overall IQ
TWIST-Dix-Flex*	4.9±0.32	4.9±0.32	4.7±0.48	4.3±0.67	4.7±0.48
VIBE-SPAIR*	3.2±0.79	3.1±0.57	3.1±0.57	3.0±0.67	3.0±0.67
P value	0.00015**	<0.0001**	0.00010**	0.0019**	0.00015**

* Mean Score ± Standard Deviation

** TWIST-Dixon-Flex scores significantly higher than VIBE-SPAIR

Discussion The TWIST-Dix-Flex technique produces high spatial resolution images at the peak enhancement and later time points with superior image quality to the conventional VIBE-SPAIR technique. This is consistent with a previous study [1]. At the same time, TWIST-Dix-Flex also provides highly temporally resolved measurements during the period of contrast wash-in to evaluate the early arterial phase of contrast enhancement. Based on initial experience, TWIST-Dix-Flex offers a solution to overcome the compromise between spatial and temporal resolution in breast DCE-MRI. Future study will include more clinical cases and different types of lesions so that the correlation between the early enhancement characteristics and the lesion type can be investigated, and image quality can be assessed in more detail.

References

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