Clinical Evaluation of TWIST DIXON Sequence with Flexible View Sharing for Breast DCE MRI: Can Initial Uptake Phase Provide Accurate Diagnosis

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Target Audience Radiologists, MRI physicists and scientists.

Introduction The initial enhancement slope, detected by ultrafast dynamic breast MRI, has been shown to allow detection and classification of breast tumors with high accuracy[1-2]. Collecting only the initial enhancement phase could lead to shorter exam times. TWIST-Dixon with a more flexible view sharing strategy (TWIST-Dix-Flex)[3] was applied in breast DCE-MRI to detect the rapid enhancement during the initial uptake phase, while keeping the high spatial resolution at the peak contrast. The purpose of this study was to evaluate the potential of the detected maximum slope (MS) of the enhancement for diagnosis breast cancer.

Methods With the approval of institutional review board, 16 subjects (ages 33-68, average 51.8) were recruited for the clinical trial of breast MRI exams using the non-product TWIST-Dix-Flex with Informed consent. Breast MRI exams were performed on a 1.5 T clinical MRI scanner (Aera, Siemens Healthcare, Erlangen, Germany) with an 8-ch Sentinelle breast coil (Hologic, Bedford, MA). As shown in Fig. 1, DCE-MRI of 10 measurements with variable temporal resolution were acquired with TWIST-Dix-Flex sequence (1 pre-contrast with full k-space, 6 during the initial contrast uptake (first 60 seconds after infusion) with center k-space only, then 2 partial k-space which took around 60 seconds each, and 1 full k-space acquisition afterwards which took around 90 seconds). A single dose of contrast agent (0.1 mmol/kg, ProHance) was infused at 2 mL/s and flushed with 20 mL saline. 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. The central k-space fraction (A) was 8% and peripheral k-space sampling density (B) was 50%. The pre-contrast and last three post-contrast image sets, together with a T2 weighted image set and other information such as medical history, were used for conventional clinical reading and BIRADS scoring using DynaCAD,(Invivo, Gainesville, FL). Clinical readings were used as a reference and a BIRADS of 4-6 were considered as 'positive'. Two radiologists independently read the first 8 measurements by evaluating the morphological characteristics and MS, using a prototype TWIST Breast Viewer (Siemens Healthcare, Erlangen, Germany). In suspicious cases MS was measured both at a voxel and in a small ROI inside the most suspicious area, with the guidance of the maximum slope map generated by the software. The maximum slope was compared with the clinical readings using logistic regression and ROC analysis.

Results Fig. 2 shows the subtracted MIPs of the enhancement (post-contrast minus pre-contrast), the targeted image slice and the maximum slope map in one of the subjects, as well as the enhancement curve at the targeted voxel. The MIPs of the early phases showed a low resolution enhancement map as the peripheral k-space was from the pre-contrast dataset. However, the enhancement of the tumor was still obvious (arrow in 2b). For later phases the MIPs showed more details in the morphological analysis (2c-d). In image slice (2e), where the maximum slope map showed the largest area of high initial uptake slope (2f), the targeted pixel (ROI as well) was selected, and the curve was shown in 2g. MS of the suspicious voxel and ROI, were both found to be highly correlated with the clinical readings (positive/negative, $p<0.0001$) as summarized in Table 1.

Discussion Our results showed the potential of TWIST-Dix-Flex in detecting MS during the initial contrast uptake, which in turn closely matched the clinical readings. A high AUC (>0.97) indicates that a shorter breast MRI, which takes about two minutes (60 seconds of rapid image acquisition plus one high spatial resolution image set) may provide almost the same information as the conventional breast MRI exams. One limitation of this study is the lack of a gold standard for the validation of both clinical and initial phase reading. Another limitation is the small sample size. Future study should include further optimizing the temporal/spatial resolution selection, adding a comparison between histologic reading to the statistics analysis, and collecting more subjects.

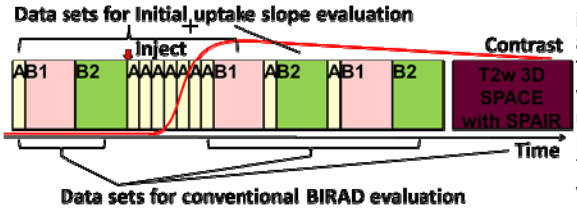

Fig. 1. Timeline of imaging protocol. 1st, 8th, 9th, 10th images from TWIST series and T2 weighted image were used for clinical readings; while the first 7 TWIST image sets were used for initial uptake evaluation.

Table 1 Sensitivity, Specificity and AUC for MS vs. clinical readings.

	Voxel	ROI
P value	<.0001	<.0001
R^2	0.558	0.563
AUC	0.977	0.971
Sensitivity	87.5%	87.5%
Specificity	100%	93.8%
Threshold	7.0	5.7

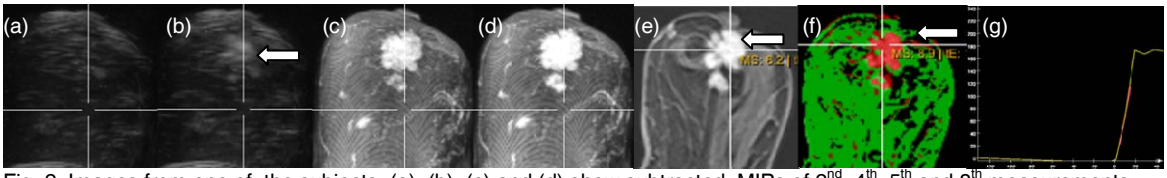

Fig. 2. Images from one of the subjects. (a), (b), (c) and (d) show subtracted MIPs of 2nd, 4th, 5th and 8th measurements (that is the 1st, 3rd, 4th measurements after infusion of contrast, and the first partial measurement after the initial uptake phase); (e) is the image slice in which the voxel was selected (arrow), (f) the maximum slope map overlay of the image in (e), and (f) The enhancement curve at the selected voxel, red line indicate the maximum slope.

References

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