Clinical Feasibility of CAIPIRINHA-Dixon-TWIST (CDT)-Volume-Interpolated Breath-Hold Examination (VIBE) for Breast DCE-MRI

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Target Audience

Researchers and clinicians interested in the breast imaging and CDT-VIBE imaging

Purpose

The CAIPIRINHA-Dixon-TWIST (CDT)-Volume-Interpolated-Breath-Hold Examination (VIBE) sequence is a combination of volumetric T1 weighted CAIPRINHA-VIBE imaging, TWIST view sharing and Dixon fat separation. In the current study, high temporal resolution (11.9 seconds) 3D data sets can be generated with high spatial resolution ($1\times1\times1mm^3$) for breast dynamic contrast enhancement (DCE) MRI using CDT-VIBE. However, with such short acquisition time, the main concern is of course whether the CDT-VIBE image is qualified for morphology assessment.

In this study, the image quality and morphology assessment of CDT-VIBE were compared with that of conventional GRE images. The aim was to verify the feasibility of CDT-VIBE as a replacement for regular breast DCE-MRI.

Methods This retrospective study was approved by our institutional review board and all patients gave written consent to the examination. The commercially available CDT-VIBE sequence (temporal resolution, 11.9 seconds; spatial resolution $1\times1\times1mm^3$; flip angle, 9°; CAIPIRINHA 4; A/B, 20%/20%; 40 phases in total) was used in this study to perform DCE-MRI examinations on a 3.0-T magnetic resonance system (Skyra; Siemens) for forty-seven women (median age, 62 years) with suspicious breast lesion. The gadodiamide (Omniscan; GE Healthcare) was injected in the fourth phase with a rate of 3mL/s. A conventional T1 weighted VIBE sequence (spatial resolution, $1.0x1.0x1.2mm^3$; temporal resolution, 68s; GRAPPA 2) was acquired immediately after the dynamic CDT-VIBE sequence. The signal-to-noise ratio (SNR), image quality and morphology characterization of CDT-VIBE images were compared with those of conventional VIBE images. Image quality was scored using a 5-point scale with the highest score indicating the optimal assessment in terms of the following parameters: PAT artifact; edge sharpness; lesion conspicuity, internal structure clarity; and overall image quality. Morphology characteristics were depicted in accordance with ACR BI-RADS lexicon. κ statistics were calculated to assess reader agreement. P value <0.05 was considered statistically significant.

Results There is no significant difference in SNR (P=0.513) between the CDT-VIBE and conventional GRE images. Table 1 summarized the results of image quality comparison. The edge sharpness and lesion conspicuity on the CDT-VIBE images were equivalent to that on conventional GRE images (P=0.090, 0.796). But the PAT artifact on CDT-VIBE images was more apparent (P < 0.001) and CDT-VIBE was weaker in displaying internal structure (p=0.013). Regarding the overall image quality, CDT-VIBE was poorer compared with conventional GRE (p=0.001). However, morphology characterization was not seriously affected by the inferior image quality. As shown in Table 2, the inter-reader agreement in lesion types, shape of mass and distribution modifiers of non-mass-like all reached up to 100%. The lowest agreement proportion of 77% with a medium κ value of 0.645 was seen in the internal enhancement pattern of non-mass-like lesion. Fig. 1 shows the CDT-VIBE and conventional GRE image through the same slice of a rim enhancing lesion.

Table 1: Image Quality Analysis of CDT-VIBE and conventional VIBE

	CDT-VIBE	Conventional VIBE	P value
PAT artifact	3.71±0.461	4.39±0.494	<0.001
edge sharpness	4.02±0.689	4.20±0.459	0.090
lesion conspicuity	4.05±0.545	4.02±0.524	0.796
internal structure clarity	3.93±0.565	4.15±0.478	0.013
overall image quality	4.12±0.557	4.39±0.542	0.001

All values are mean ±standard deviation of the scores
PAT: parallel acquisition technique

Table 2: Agreement in lesion morphology characterization

	Type	Mass			NMLE	
		shape	margin	IE	DM	IEP
Reader 1	100%	96%	93%	100%	100%	85%
Reader 2	100%	93%	89%	93%	100%	77%
Kappa	1.00	1.00	0.943	0.949	1.000	0.645
	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001

NMLE: non-mass-like enhancement, IE: internal enhancement, DM: distribution modifier, IEP: internal enhancement pattern

Discussion and Conclusion The CDT-VIBE sequence showed good edge sharpness and lesion conspicuity which was quite equal to that of conventional VIBE image, but needed some perfection in PAT artifacts and blurry. However, the intra- and inter-radiologist reader agreements in comparisons of all morphologic features between the CDT-VIBE and the conventional GRE images were excellent. We believe that CDT-VIBE can be used in breast DCE-MRI for detecting and depicting lesions because of its high spatial resolution and nearly equal image quality to conventional VIBE image. Therefore, it is clinically feasible to replace standard 60-90 second conventional GRE sequence by CDT-VIBE sequence for quantitative breast DCE-MRI with the acquisition schemes employed in this study.
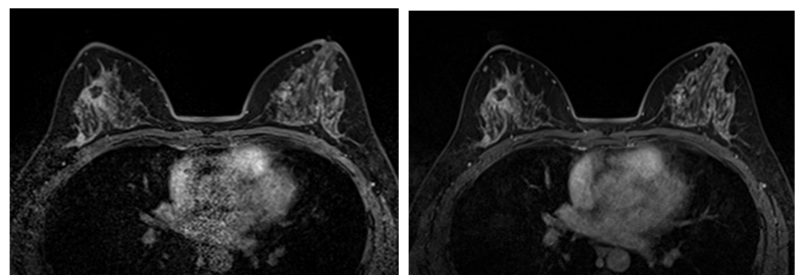

Fig 1. The comparison between the last set of dynamic CDT-VIBE image (left) and conventional GRE image (right). More apparent noise is observed at the center and periphery area of CDT-VIBE image. However, the morphology characteristics displayed on CDT-VIBE image is equivalent to that on conventional GRE image.