USE OF A TWO-POINT DIXON VIBE SEQUENCE FOR POST-CONTRAST LIVER MRI: COMPARISON WITH STANDARD CHEMICALLY-SELECTIVE FAT-SUPPRESSED VIBE FOR IMAGE QUALITY AND LESION DETECTION

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Introduction: Dynamic gadolinium-enhanced T1-weighted images are a critical component of clinical liver MRI examinations for focal lesion detection and characterization. This is typically performed as a 3D acquisition using chemically-selective fat-saturation, as demonstrated by the volumetric interpolated breath-hold examination (VIBE) sequence. A limitation of this approach is that chemically selective fat saturation is prone to suboptimal fat suppression in regions of magnetic field inhomogeneity. While multi-echo Dixon techniques offer a more robust method of achieving fat suppression in the presence of field inhomogeneity, these sequences generally take longer because of the need to obtain multiple echoes. More recently, the feasibility of imaging the upper abdomen using a multi-echo Dixon technique within a single breath-hold has benn demonstrated [1,2]. In this study, we compare image quality and lesion detection in post-contrast liver MRI between a standard VIBE sequence that uses chemically-selective fat-saturation (FS-VIBE) and a recently introduced VIBE sequence that achieves fat-suppression via a two-point Dixon algorithm with incorporation of a phase unwrapping step to correct for field inhomogeneity (Dixon-VIBE).

Methods: 30 consecutive patients (22M, 8F; 53+-10y) undergoing liver MRI at 1.5 T comprised the study sample. Routine dynamic post-gadolinium images were obtained using FS-VIBE [TR 3.79, TE 1.36, FA 12, partition thickness 2 mm, FOV 350 x 284, matrix 256 x 127, iPAT 2, acquisition time (TA) 13s]. Immediately following the final FS-VIBE sequence (an equilibrium-phase image obtained 3 minutes after injection), a single Dixon-VIBE acquisition (TR 7.48, TE_1 2.38, TE_2 4.76, FA 10, partition thickness 2 mm, FOV 380 x 285, matrix 256 x 125, iPAT 2, TA 17s) was obtained. The equilibrium-phase FS-VIBE and Dixon-VIBE sequences were reviewed in consensus by two radiologists during separate sessions for a number of subjective measures of image quality (see Table 1) using a 1-4 scale (4=highest quality). In addition, the two readers identified all focal liver lesions for each sequence. Following the initial interpretation sessions, the two readers again reviewed the cases in conjunction with other sequences, all previous and follow-up imaging, clinical history, and any surgical or pathologic data, to establish a reference standard for the presence of lesions (55 verified lesions total). The two observers also placed ROI's to determine the relative contrast between the liver and fat and between the liver and verified lesions as $[(SI_{liver}–SI_{fat/lesion})/(S_{liver}+SI_{fat/lesion})]$. The subjective image quality scores and relative contrast ratios were compared using an exact paired-sample Wilcoxon test. Binary logistic regression for correlated data was used to compare the sensitivity and PPV of the sequences for focal lesions.

Table 1

Measure	FS-VIBE	Dixon-VIBE	P
Homogeneity of fat suppression	2.80	4.00	**<0.0001**
Strength of fat suppression	2.87	3.97	**<0.0001**
Vessel sharpness	3.17	3.67	**0.0029**
Motion artifact	3.67	3.53	0.3877
Overall image quality	3.00	3.47	**<0.0001**
Liver-fat contrast	0.35	0.76	**<0.0001**
Liver-lesion contrast	0.29	0.26	0.2312
Sensitivity	85.5%	80.0%	0.448
PPV	94.0%	97.8%	0.347

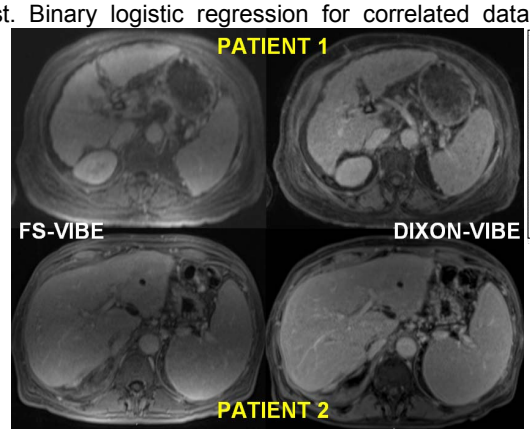

Fig 1: Dixon-VIBE shows more homogeneous and complete fat suppression than FS-VIBE. Small cyst in the left lobe in Patient 2 is well seen in both images.

Results: Dixon-VIBE received significantly better scores for homogeneity of fat suppression ($p<0.0001$), strength of fat suppression ($p<0.0001$), relative liver-fat contrast ($p<0.0001$), vessel sharpness ($p=0.0029$), and overall image quality ($p<0.0001$). Of note, 30/30 cases and 29/30 cases received a maximal score of 4 for homogeneity of fat suppression and strength of fat suppression respectively with Dixon-VIBE. Motion artifact was not significantly different between sequences ($p=0.3877$). There were no significant differences between FS-VIBE and Dixon-VIBE for sensitivity or PPV for focal liver lesion detection ($p=0.448$ and 0.347 respectively).

Conclusions: In our study, Dixon-VIBE successfully achieved improved fat suppression compared with FS-VIBE, with nearly perfect scores received for homogeneity and strength of fat suppression. Dixon-VIBE also received better scores for sharpness of intra-hepatic vessels, overall image quality, and relative liver-fat contrast. Although Dixon-VIBE required a slightly longer acquisition time to obtain two echoes, there was no significant difference between the sequences for motion artifact. Despite the improved image quality of Dixon-VIBE, the sensitivity and PPV for lesion detection in these 30 patients was not significantly different from FS-VIBE. Complete swapping of water and fat signal with Dixon-VIBE in two patients was immediately apparent, and the reconstructed images labeled as "fat-only" images were reviewed as the "water-only" images in these cases, mitigating the clinical impact of this artifact. While other techniques such as IDEAL and VARPRO may provide even more robust fat-water separation [3,4], these require at least three echoes and therefore may lengthen acquisition time even further. Future studies may explore the impact upon focal lesion detection of a Dixon-VIBE sequence that achieves a higher temporal resolution to match that of the standard FS-VIBE, either by decreased spatial resolution or by continued technical optimization of Dixon-VIBE, for instance via the use of echo sharing or keyhole techniques.

References: [1] Ma J, et al. MRM 2004;52:415-9. [2] Ma J, et al. JMRI 2006;23:36-41.
[3] Reeder SB, et al. MRM 2004;51:35-45. [4] Hernando D, et al. MRM 2008;59:571-80.