T2-WEIGHTED LIVER MRI AT 3T USING A BLADE TECHNIQUE: COMPARISON WITH A STANDARD RECTILINEAR T2-WEIGHTED SEQUENCE FOR IMAGE QUALITY AND LESION DETECTION

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Introduction: The quality of T2-weighted images (T2WI) of the liver in the clinical setting is often degraded by ghosting artifact from various sources of motion. This artifact can obscure the margins of the liver, intra-hepatic vessels, and focal liver lesions, lowering diagnostic utility. One study has noted that such motion within the liver is more severe at 3T compared with at 1.5T [1]. Furthermore, it is not uncommon for B_1-inhomogeneity artifact at 3T to lead to prominent areas of signal void over the left lobe. As a result of these artifacts, T2WI of the liver at 3T using conventional sequences is of variable image quality. With the BLADE technique, k-space data is acquired as a series of short overlapping echo trains (blades), each comprising the lowest phase-encoding steps; these acquisitions rotate around the center of k-space in a periodic fashion, yielding central k-space data that is shared by all blades and that may be used to correct for in-plane translation and rotation. Several studies have demonstrated improved image quality for T2WI of the liver using BLADE compared with a conventional rectilinear technique, with one study showing improved accuracy for focal lesion detection [2,3,4]. However, these studies were all performed at 1.5T. Therefore, the purpose of this study was to compare T2WI of the liver at 3T using BLADE and standard rectilinear k-space schemes in terms of image quality and focal lesion detection.

Methods: 28 consecutive patients (23M, 5F; 54+-4y) underwent liver MRI at 3T that included fat-suppressed 2D T2W TSE sequences using a rectilinear k-space trajectory [TR/TE 4000/104, FA 150, slice thickness (ST) 4 mm, FOV 281 x 375 mm, matrix 168 x 320, GRAPPA 2, 2 16s breath-hold (BH) concatenations] and using a BLADE technique [TR/TE 2710/112, FA 150, ST 4 mm, FOV 450 x 450 mm, matrix 256 x 256, GRAPPA 2, 6 "blades" of echo-train length 27, 75% BLADE coverage, 4 19s BH concatenations]. Two readers in consensus rated each sequence for a number of subjective measures of image quality (see Table 1) on 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 (22 verified lesions total). The two observers also placed ROI's to determine the relative contrast between the liver and each of the gallbladder, spleen, and verified lesions as $[(SI_{liver}–SI_{other})/(S_{liver}+SI_{other})]$. 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	**Standard**	**BLADE**	**P**
In-plane respiratory motion	3.46	3.93	**0.0195**
Through-place respiratory motion	3.68	3.79	0.6836
Other ghosting artifacts	2.54	3.93	**0.0195**
Sharpness of liver edge	3.25	3.89	**<0.0001**
Sharpness of vessels	3.00	3.86	**<0.0001**
Flow signal suppression	2.68	3.82	**<0.0001**
B_1-inhomogeneity	3.50	3.82	0.0571
Overall image quality	2.57	3.89	**<0.0001**
Liver-gallbladder contrast	0.75	0.80	**0.0037**
Liver-spleen contrast	0.51	0.62	**<0.0001**
Liver-lesion contrast	0.61	0.70	**0.0054**
Sensitivity	68,2%	72.7%	1.0
PPV	53.6%	84.2%	**0.0123**

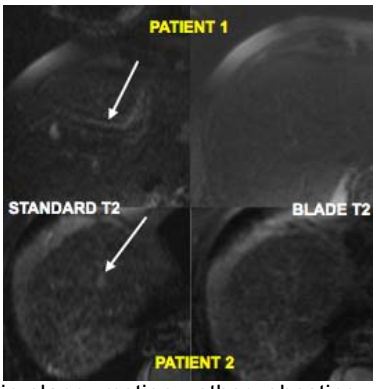

Fig 1: *Patient 1:* Standard T2WI shows ghosting artifacts (arrow) not present with BLADE T2WI. *Patient 2:* Artifact on standard T2WI resulted in a false-positive lesion (arrow), not present on BLADE T2WI.

Results: BLADE received significantly better scores for in-plane motion, other ghosting artifact, liver edge sharpness, vessel sharpness, flow suppression, and overall image quality (p-values ranging from <0.0001 to 0.0195). Of note, BLADE received a mean score of nearly 4 (maximal possible score) for in-plane respiratory motion and other ghosting artifacts. Differences did not quite reach significance for B_1-inhomogeneity artifact (p=0.0571) and were not significant for through-plane motion (p=0.6836). ROI analysis demonstrated significantly improved contrast between the liver and each of the gallbladder, spleen, and focal lesions with BLADE (p-values ranging from <0.0001 to 0.0054). BLADE demonstrated a significant improvement in specificity for focal lesion detection (p=0.0123) but no difference in sensitivity (p=1.0).

Conclusions: In our study, the use of BLADE for T2WI of the liver at 3T resulted in a near-complete elimination of ghosting artifact due to in-plane respiratory motion or other causes, contributing to a substantial improvement in sharpness of the liver edge and intra-hepatic vessels as well as overall image quality. While BLADE uses reference data from a central portion of k-space covered by all blades to correct for in-plane rotation and translation, this scheme is unable to eliminate through-plane motion, as supported by our data. BLADE also showed improved flow suppression within intra-hepatic vessels, an effect noted in a prior study of BLADE-T2 of the kidneys at 3T [5]. Although there was no difference in sensitivity for lesion detection between the sequences, there was a significant improvement in specificity for lesion detection with BLADE. The improved specificity with BLADE was largely attributable to cases in which ghosting or flow artifact simulated a T2-bright lesion on standard T2WI. In summary, our results indicate that use of a BLADE technique for T2WI of the liver at 3T leads to a significant improvement in artifacts, image quality, and specificity for liver lesion detection.

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[3] Hirokawa Y, et al. Radiology 2009;251:388-397. [4] Nanko S, et al. JMRI 2009;30:321-326. [5] Michaely H, et al. JMRI 2008;27:148-153.