Feasibility of a respiratory-triggered SSEPI diffusion-weighted sequence for liver imaging using navigator echo technique: comparison with breath-hold diffusion-weighted sequence

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Introduction:

Several studies (1-3) showed the utility of diffusion-weighted imaging (DWI) for liver lesion detection and characterization. However, most prior studies have used a breath-hold (BH) SSEPI sequence, which is limited in image quality, spatial resolution, and SNR, especially at high b-values. Our objective was to test a new non breath-hold (NBH) SSEPI DWI sequence combined with a navigator echo technique (2D-PACE: Prospective Acquisition Correction) and to compare it with a BH DWI sequence.

Methods:

We prospectively evaluated 29 patients (14 men, mean age 57.7 y) with chronic liver disease and/or suspected of having focal liver lesions on a 32-channel 1.5T system (Magnetom Avanto, Siemens Medical Solutions). Two DWI sequences (BH and NBH) were obtained in all patients. Sequence parameters were: TR/TE 1x respiratory cycle (NBH)-2300 (BH)/82, 256x256, FOV 350 mm, slice thickness/gap 7/2 mm, 14 slices, 1 (BH)-4 (NBH) averages, b=0, 50, 500 sec/mm^2, parallel imaging (GRAPPA) factor 2 (4). Acquisition times were 21 sec for the BH sequence and at least 120 sec for the NBH. Qualitative evaluation was performed on a 3-point scale (1-3, 3: good to excellent) by 2 observers and included overall image quality, liver edge conspicuity, ghosting and distortion artifacts). Quantitative evaluation included the following:

1. Liver SI normalized by SD on b0 and b500.
2. Lesion to liver contrast ratio (SI lesion – SI liver/ SI liver) on b0 and b50 (because lesions were typically detected at b50).
3. Liver and lesion ADCs.
4. To evaluate the level of noise contamination in liver ADC measurement, the ratio of SD ADC/mean ADC was also measured.

Results:

NBH DWI sequence showed overall better image quality and better normalized liver SI both at b0 and b500 (table). 27 focal liver lesions were detected in 18 patients (17 benign, 8 hepatocellular carcinomas, 2 metastases), with a mean size of 2.7 cm. Lesion to liver contrast ratio was significantly higher with NBH DWI both at b0 and 50. ADCs of liver and focal lesions with both sequences were significantly correlated, but were smaller with the BH sequence, likely related to noise contamination in the measurement, shown as a significantly higher SD ADC/ADC ratio for the BH sequence.

	BH-DWI	NBH-DWI	
Qualitative score (max. 9)	6.77 ± 1.66	8.01 ± 1.08	$p < 0.001$
Normalized liver SI b0	5.35 ± 1.5	7.66 ± 2.3	$p < 0.001$
Normalized liver SI b500	7.12 ± 1.17	10.27 ± 1.89	$p < 0.001$
Lesion to liver contrast ratio b0	1.70 ± 1.50	2.32 ± 2.10	$p < 0.001$
Lesion to liver contrast ratio b50	1.77 ± 1.34	2.89 ± 2.60	$p < 0.001$
SD ADC/mean ADC	0.41 ± 0.17	0.28 ± 0.14	< 0.001
ADC* liver	0.94 ± 0.25	1.03 ± 0.27	r 0.88
ADC* focal lesions	1.74 ± 0.78	1.91 ± 0.74	r 0.98

*ADC: value x10^{-3} mm^2/sec

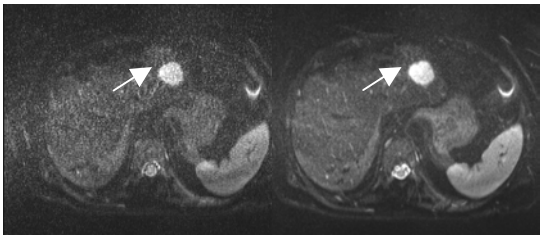

Fig 1 Patient with hemangioma in left lobe of the liver seen with BH (left) and NBH DWI (right) at b0 (arrow). The NBH image show better image quality, and better lesion conspicuity than BH image.

Discussion:

The use of a navigator echo to trigger a SSEPI DWI sequence improves image quality and liver lesion conspicuity. In addition, ADC measurement is more precise using this sequence, because of the improved signal. However, the superior image quality is offset by a longer acquisition time. The role of the PACE-DWI sequence should be further evaluated and compared with T2-weighted sequences for lesion detection and characterization.

References:

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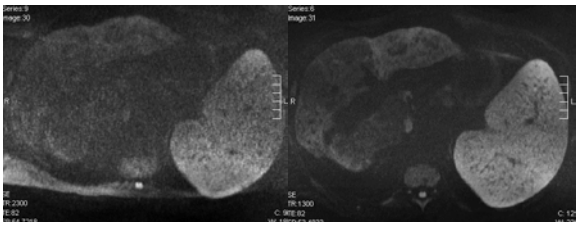

Fig 2: Cirrhotic patient imaged with BH (left) and NBH DWI (right) at b500. Note the superior image quality and higher signal with NBH acquisition. Geographic signal changes in liver parenchyma are better depicted on the NBH image.