Diffusion-weighted Whole Body MR Imaging with Background Body Signal Suppression: A Feasibility Study at 3.0 Tesla

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Introduction

Recently, a new magnetic resonance technique called DWIBS (Diffusion-weighted Whole body Imaging with Background body signal Suppression) has been introduced for 1.5-Tesla-MR-scanners by Takahara et al. [1]. Diffusion-weighted imaging of the whole body is obtained by acquiring multiple thin axial slices with a high number of signal averages (NSA) during free breathing in combination with a special fat suppression technique. Maximum intensity projection (MIP) images with inverted gray scale show PET-like image contrast. The purpose of the present study was to investigate the feasibility of whole body DWI at 3.0 Tesla.

Methods

A diffusion-weighted (DW) single-shot spin-echo (SE) echo-planar imaging sequence (60 transversal slices with 4 mm thickness, FOV = 400 mm × 314 mm, matrix 112 × 86, EPI-factor = 47, half-fourier-factor = 0.6, b = 0 with NSA = 2, b_{max} = 1000 s/mm^2 with NSA = 6 and with motion probing gradients in three orthogonal directions, paralell acceleration (SENSE) factor 2, free breathing) was combined with the following methods of fat suppression: short TI inversion recovery (STIR), spectral attenuated inversion recovery (SPAIR), and spectral pre-saturation by inversion recovery (SPIR). Optimized sequences (Table 1) were implemented on a 3.0-Tesla- and a 1.5-Tesla-system (Philips Medical Systems, gradient systems at 3.0/1.5 T: 80/30 mT/m max. amplitude, 0.16/0.2 ms min. rise time, 200/150 T/m/s max. slew rate, respectively). Two healthy volunteers without a history of disease of the head/neck, chest, and abdominal organs and six patients with enlarged lymph nodes suspicious of malignancy were included in the study. 1) In one healthy volunteer and two patients, the sequences with different fat suppression techniques were acquired at 3.0 Tesla in the head/neck region, chest, and abdomen. Gray scale inverted MIP images were reconstructed and image quality was judged with respect to the degree of fat suppression. 2) In one healthy volunteer and two patients, DW STIR imaging was performed at 3.0 Tesla as well as at 1.5 Tesla for intra-individual comparison of image quality of DWIBS at both field strengths. Lesion-to-surrounding tissue contrast and artifacts were assessed by visual scoring. 3) Feasibility of DWIBS at 3.0 Tesla was evaluated in all six patients. Image quality in terms of fat suppression and degree of artifacts were assessed by visual scoring.

		1.5 T	3.0 T
STIR	TI	180 ms	260 ms
	Acqu. Time	3:38 min	7:11 min
	TR / TE	4961 / 65 ms	9799 / 41 ms
SPAIR	TI	65 ms	75 ms
	Acqu. Time	3:39 min	5:18 min
	TR / TE	4990 / 65 ms	7245 / 41 ms
SPIR	Acqu. Time	3:39 min	5:18 min
	TR / TE	4983 / 65 ms	7247 / 41 ms

Tab. 1: TI and TR values used for the different fat suppression methods and different acquisition times of the sequences at 1.5 and 3.0 Tesla.

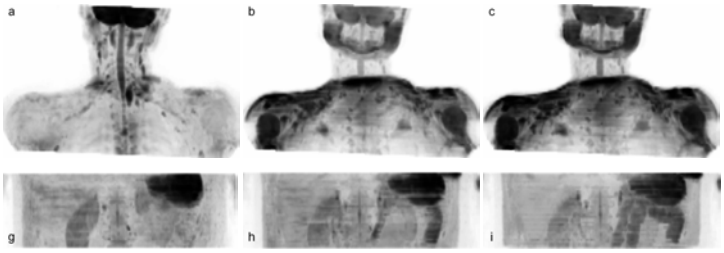

Fig. 1: MIP images of the neck region (a-c) and the abdomen (g-i) acquired with DW sequences using STIR (a, g), SPAIR (b, h), and SPIR (c, i) fat suppression at 3.0 Tesla. On all DWIBS images with STIR fat suppression, body fat is adequately suppressed and central parts of the body are clearly visible. On the DW STIR image (g), but not on the DW SPAIR and SPIR images (h, i), the intestines are suppressed due to their short T1 relaxation times.

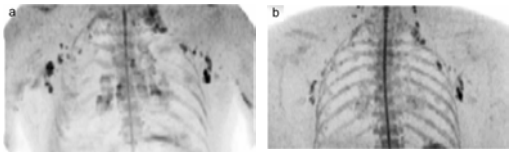

Fig. 2: Coronal MIP images of STIR DWI of a patient with multiple lymph node metastases (a) at 3.0 and (b) at 1.5 Tesla. A better Lesion-to-surrounding tissue (spinal cord, vertebral bodies, ribs) contrast can be noted at 3.0 Tesla (a) as compared with 1.5 Tesla (b).

Results

1) Good fat suppression for all regions, and especially for the head/neck region, was obtained with the DW STIR sequence (Fig. 1). However, using the DW SPAIR or the DW SPIR sequence fat suppression was satisfactory only in the abdomen. 2) In comparison to 1.5 Tesla, DWIBS images at 3.0 Tesla were scored to provide a better lesion-to-surrounding tissue contrast (Fig. 2). However, larger susceptibility-induced image distortions and signal intensity losses especially at air / soft tissue interfaces, stronger blurring artifacts, and more pronounced motion artifacts degraded the image quality at 3.0 Tesla compared with 1.5 Tesla. 3) The feasibility of DWIBS at 3.0 Tesla was shown in six patients.

Conclusion

Diffusion-weighted whole body MR imaging with background body signal suppression (DWIBS) is feasible at 3.0 Tesla with the advantage of better lesion-to-surrounding tissue contrast.

References

[1] Takahara, T., Imai, Y., Yamashita, T., Yasuda, S., Nasu, S., and Van, C. M. *Radiat. Med.* **22:** 275-282; 2004.