3.0 T detects more lesions in MS and optic neuritis compared to 1.5 T. A proposal for an MS protocol at 3.0 T.

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Background: In the diagnosis and follow up of multiple sclerosis (MS), consensus exists concerning magnetic resonance imaging (MRI) protocols at 1.5 T or lower field strengths. How to perform MRI in optic neuritis (ON) and MS at 3.0 T is less clear, and it is unknown whether higher field strengths will detect more lesions and lead to the diagnosis of MS more often or at an earlier stage in clinically isolated ON.

Objective: The purpose of this study was to propose an MRI protocol for use at 3.0 T in the diagnosis of MS and to compare the results at 3.0 T with the results obtained at 1.5 T using a standard MRI protocol for imaging of MS. Specifically, we compared the number and volume of enhancing lesions on T_1-weighted images after a double dose of gadolinium (0.2 mmol/kg) and the number and volume of hyperintense lesions on FLAIR (fluid attenuated inversion recovery) images, and, in addition, we investigated whether the higher field strength could have an impact on the diagnosis of patients with ON. As to our knowledge, no studies have proposed a full protocol for MS at 3.0 T including both T_2-weighted and post contrast T_1-weighted images optimized for the higher field strength.

Methods: The study was performed on a Siemens Vision 1.5 T whole-body scanner using a standard head coil and on a Siemens Trio 3.0 T whole-body scanner using an eight channel head coil. 30 patients with ON were scanned at both field strengths. The following sequences and parameters were used (sequences 1, 2 and 3 covered the whole brain with 42 slices of 3 mm):
1) Fast-FLAIR at 3.0 T: TR/TI/TE = 9000/2400/85 ms, flip-angle 150˚, FOV 230 mm, matrix 256 x 256, acquisition time 9 min 2 sec; at 1.5 T: TR/TI/TE = 9000/2500/110 ms, FOV 250 mm, matrix 198 x 256, flip-angle 180˚, acquisition time 12 min 18 sec.
2) T_1-weighted spin echo post gadolinium at 3.0 T: TR/TE = 450/12 ms, flip-angle 90˚, FOV 230 mm, matrix 256 x 256, acquisition time 4 min 25 sec; at 1.5 T: TR/TE = 680/15 ms, flip-angle 90˚, FOV 250 mm, matrix 192 x 256, acquisition time 8 min 48 sec.
3) Proton density and T_2-weighted turbo spin echo (TSE) at 3.0 T: TR/TE = 8820/115/14 ms, FOV 230 mm, matrix 256 x 251, flip-angle 163˚, acquisition time 3 min 7 sec; at 1.5 T: TR/TE = 3200/98/16 ms, FOV 250 mm, matrix 190 x 256, flip-angle 180˚, acquisition time 8 min 22 sec.
In addition, MPRAGE (magnetization prepared rapid acquisition gradient echo) was obtained at 3.0 T with the following parameters: voxel dimension 1x1x1 mm, TR/TE/TI = 1540/3.93/800 ms, FOV 256 mm, matrix 256 x 256, flip-angle 9˚, acquisition time 6 min 36 sec.
Image data were blinded with regard to patient identity and field strength, and the number of lesions was assessed by an experienced observer. Lesion-volumes were measured with a threshold-finding technique using in-house made software: Regions of Interest Program (RIP) programmed in MATLAB (Mathworks, USA).

Results: Relative to scanning at 1.5 T, the 3.0 T scans showed an increase of 22% in enhancing lesion number, a 21% increase in enhancing lesion volume, and an increase of 27% in number of lesions detected on FLAIR images (see fig. 1). The difference in number of lesions detected on FLAIR images was significant testing with Wilcoxons Signed Ranks Sum Test (p=0.002). Comparing post gadolinium T_1-weighted spin echo and MPRAGE at 3.0 T there was a difference of *one* lesion (74 vs. 73 lesions), thus MPRAGE proved to be suitable for detecting enhancing lesions at 3.0 T.

Conclusion: The proposed MRI protocol at 3.0 T showed to be more sensitive than the standard MRI protocol at 1.5 T. The increase in enhancing lesion number on T_1-weighted images and hyperintense lesions on FLAIR images could have an impact on the diagnosis of MS. In our study 18 patients fulfilled the MRI-criteria of MS recommended by the International Panel on the Diagnosis of Multiple Sclerosis[1] at 3.0 T, and 16 patients fulfilled these criteria at 1.5 T.

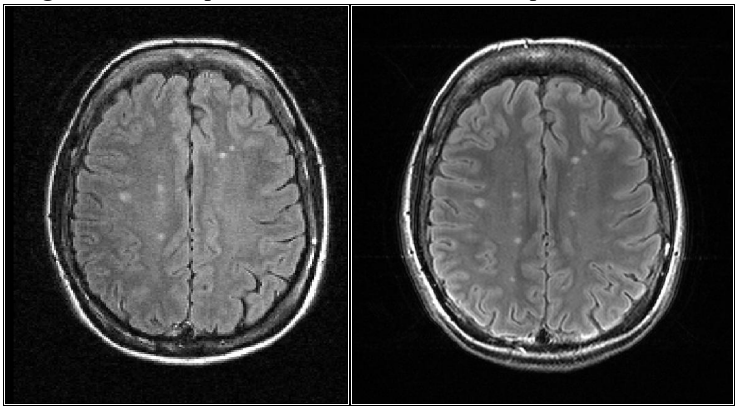

Fig.1. An example of FLAIR images from 1.5 T (left) and 3.0 T

1. McDonald WI, Compston A, Edan G, Goodkin D, Hartung HP, Lublin FD et al. Recommended diagnostic criteria for multiple sclerosis: guidelines from the International Panel on the diagnosis of multiple sclerosis. Ann Neurol 2001; 50(1):121-127.