Comparison of SNR and contrast in FLAIR at 3T and 7T

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Purpose:

To compare the SNR and contrast of the multislice FLAIR sequence at high field (3T) and ultra-high field (7T). Due to the prolonged T_1 relaxation times of gray- and white matter, with relatively constant T_1 of CSF [1], the contrast in FLAIR may be less at ultra-high field, as T_1 contrast counter-acts the T_2 contrast.

Methods:

The parameters of the FLAIR sequence are largely determined by the requirement to null CSF, and the limitations imposed by the SAR constraints. A straightforward comparison of the FLAIR sequences on different field strengths was performed by slightly adjusting the inversion delay (TI) to null CSF on all scanners, and by reducing the number of slices at the 7T scanner to stay within the SAR limits. Common scan parameters were: FOV 230 x 183 mm in transverse orientation, acquired resolution 0.65 x 0.88 mm, slice thickness 4 mm, turbo spin-echo factor = 26, refocusing flipangle 120°. Field dependent parameters were (3T / 7T): TI 2900/3100 ms, TR 14,000/22,227 ms, TE 125/80 ms (compensating the shorter T_2 values at 7T), echo spacing 9.3/6.0 ms, and readout bandwidth 221/331 Hz/pixel.
Five volunteers (24 ± 4 y) were scanned on 3.0T and 7.0T scanners (Philips), with an 8 channel receive head coil and body transmit coil at 3T (max. B_1 13.5 μT), and a 16 channel receive coil with volume T/R coil for transmission (max. B_1 20 μT) at 7T (Nova Medical). Each scan was repeated with the same receiver gain, but without active RF and gradients to sample a noise image for signal-to-noise ratio (SNR) determination. After reconstruction, regions of interest (ROIs) were defined as illustrated in Figure 1. The standard deviation of the same ROI in the noise image was used as noise metric for the SNR calculation. Relative contrast between GM and WM was defined as $(SNR_{GM}-SNR_{WM})/((SNR_{GM} + SNR_{WM})/2)$.

Results and Discussion:

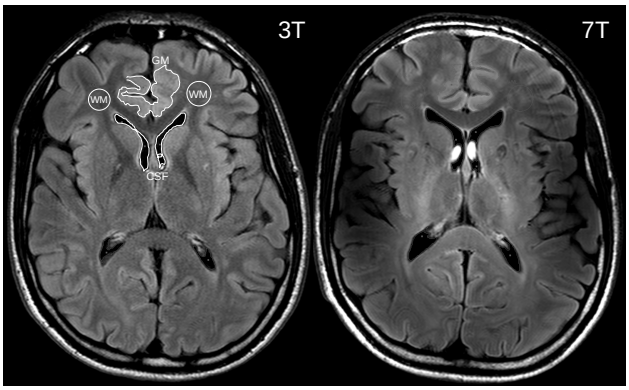

Figure 1. *3T and 7T FLAIR images with the location of the ROIs indicated for white matter (WM), gray matter (GM) and CSF.*

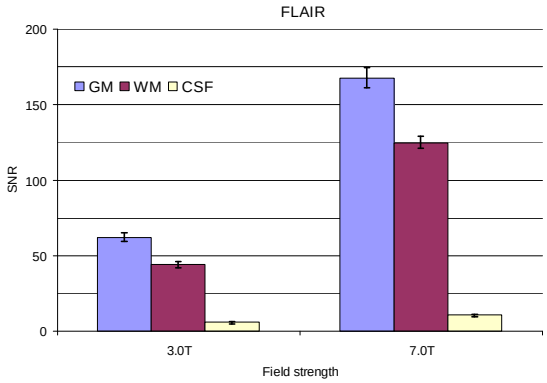

Figure 2. *Mean SNR values and standard deviation for gray matter, white matter and CSF at 3T and 7T.*

Figure 1 shows representative FLAIR images of the same subject for 3T and 7T, respectively. The overall image quality of the 7T FLAIR images was good, despite the well known intensity variation caused by B_1 inhomogeneity. The SNR values at 7T (mean ± SD: GM 168 ± 15, WM 125 ± 11, CSF 10 ± 3) were slightly more than proportionally larger than the SNR values at 3T (GM 62 ± 7, WM 44 ± 4, CSF 5.6 ± 0.9), see Figure 2. The relative contrast at 7T (0.29 ± 0.05) was slightly less than that at 3T (0.34 ± 0.09), but this difference was not significant ($P = 0.12$, $n = 5$).

Conclusion:

The SNR of gray- and white matter increases approximately linearly between 3T and 7T, while the relative contrast is not significantly different. However, the number of volunteers is limited, and this study should be extended to more subjects.

References: *1. Rooney WD, et al, Magn Reson.Med. 57(2): 308-318, 2007.*