Clinical Value of Fluid-Attenuated Inversion Recovery (FLAIR) at 7.0 Tesla MRI: A Comparison with 1.5 Tesla FLAIR Imaging in Patients with Cerebrovascular Disease

Anja G van der Kolk[1], J Martijn Nobel[2], Jaco JM Zwanenburg[1], Fredy Visser[1], Peter R Luijten[1], and Jeroen Hendrikse[1]

[1]Department of Radiology, University Medical Center Utrecht, Utrecht, Netherlands, [2]University Utrecht, Utrecht, Netherlands

Introduction

One of the most important sequences in diagnostic standard brain MRI protocols is the Fluid-Attenuated Inversion Recovery (FLAIR)-sequence, due to its high lesion conspicuousness. Although already standard on lower-field MR platforms, its application at ultrahigh-field MRI at 7.0 Tesla (7T) has only recently been accomplished[1]. 7T FLAIR-imaging yields a higher signal-to-noise ratio (SNR), enabling a higher spatial resolution and, theoretically, increased lesion conspicuousness[2]. However, these advantages have not been studied in patients with cerebral pathology, currently limiting application of 7T FLAIR in clinical practice. To assess the clinical value of 7T FLAIR imaging, we compared this sequence with clinically obtained lower-field standard FLAIR imaging at 1.5 Tesla, in a patient population with varying supratentorial cerebrovascular diseases.

Methods

This study was approved by the institutional review board of our institution. All subjects gave written informed consent. Ten patients with varying supratentorially located cerebrovascular disease were scanned with a clinical protocol, which varied per patient, but always included FLAIR imaging, on a standard 1.5T MR imaging system. Ultrahigh-field imaging was performed on a 7.0 Tesla whole body system (Philips Healthcare, Cleveland, OH, USA) with a 16-channel (6 patients) or a 32-channel (4 patients) receive coil and volume transmit/receive coil for transmission (Nova Medical, Wilmington, MA, USA). Scan parameters were as described in reference 1; briefly, the following parameters were used: FOV 250x250x190mm, acquired resolution 1.0x1.0x1.1mm (4 patients) or 0.8x0.8x0.8mm (6 patients), TSE factor = 128, TR/TE 8000/294ms, scan duration approx. 8 minutes. TI was slightly optimized for CSF suppression during patient recruitment, resulting in a TI varying from 2324ms to 2250ms. Both 7T and clinical 1.5T scans were assessed individually on an offline workstation by two observers, who had knowledge of the clinical background, for closest resemblance to clinical practice. Scans were assessed for tissue contrast, image quality, artifacts, and distinguishing clinical pathology and white matter lesions (WML). In case of differences in assessment between 1.5T and 7T, both scans were compared again and differing results noted.

Table Results of FLAIR assessment in each scored category (mean (range))

Assessment category*	1.5T	7T
Contrast grey-white matter	3.8 (2-5)	4.2 (2-5)
Contrast parenchyma-CSF	4.9 (4-5)	3.8 (2-5)
Image quality	4.0 (3-5)	4.0 (2-5)
Artifacts	4.0 (3-5)	4.3 (2-5)
Distinguishing pathology	2.3 (2-3)	3.0 (-)
Distinguishing WML	2.4 (2-3)	2.9 (2-3)

* Contrasts and image quality were scored on a 5-point scale, where 1=nondiagnostic, 2=questionable, 3=adequate, 4=more than adequate and 5=excellent. Artifacts were scored according to their extent (1=nondiagnostic, 2=interfering with interpretation, 3=moderate, 4=minimal, 5=absent). For distinguishing pathology, a 4-point scale was used (0=not visible, 1=scarcely visible, questionable for diagnosis, 2=visible, adequate for diagnosis and 3=excellent depiction and full confidence level).[3]

Conclusion

This preliminary study in clinical patients with supratentorial cerebrovascular disease shows that 7T FLAIR MRI has a diagnostic quality which is at least comparable with that of clinical 1.5T FLAIR imaging. Further studies regarding the diagnostic usability for other (infratentorially located) brain pathology, like tumors, need to be performed before 7T FLAIR can be implemented in clinical practice in the same way as current 1.5T FLAIR imaging.

Acknowledgements

References

[1]Visser F, et al. Magn Reson Med 2010;64(1):194-202.
[2]Zwanenburg JJM, et al. Eur Radiol 2010;20(4):915-922.
[3]Willinek WA, et al. Radiology 2003;229(3):913-920.

Results

Imaging on both MR platforms was tolerated by all patients. Table 1 shows the assessment results. When assessing image contrast, distinction between white and grey matter was more pronounced on the 7T FLAIR images, while contrast between brain parenchyma and CSF was generally worse on 7T images (7 patients). This was due to inhomogeneous transmit fields and receive sensitivity, which also caused artifacts above the nasal cavities, and in the temporal lobes and cerebellum. Quality was equal in 6 patients; in 2 patients the 1.5T images had superior quality (score of 3 resp. 4), and in 2 patients the 7T image quality was superior (score of 4 resp. 5). 7T FLAIR imaging was better in distinguishing pathology and white matter lesions than 1.5T, although both sequences were at least adequate for diagnosis.
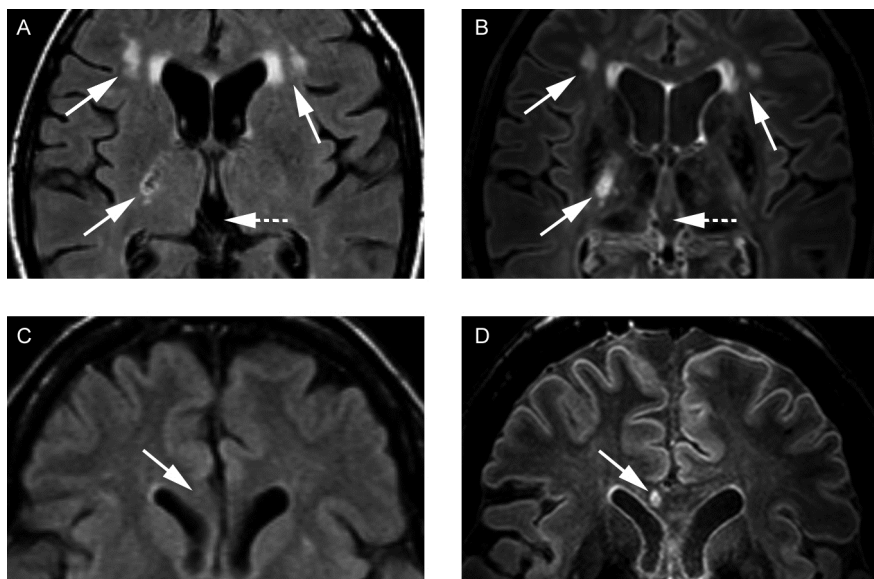
Figure 1.5T (A, C) and 7T (B, D) FLAIR images of two patients with cerebrovascular disease. A-B, 55-year-old woman with recurrent transient ischemic attacks (TIAs) of the left hemisphere, differential diagnosis of vasculitis. Hyperintense periventricular white matter lesions are seen (arrows); on the 7T image, central CSF suppression was worse than at 1.5T (dashed arrow) due to field inhomogeneities. C-D, 39-year-old woman with Susac's syndrome and several hyperintense white matter lesions on MRI. The 7T image shows a hyperintense lesion in the corpus callosum, which was not found on FLAIR-imaging at 1.5T (arrow).