Fast FLAIR Imaging of the Normal Brain: Comparison of 3.0T Vs 1.5T

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Introduction

Fluid-attenuated inversion recovery (FLAIR) is a very useful sequence for brain imaging because of its demonstrated sensitive to white matter disease. Normal MR findings with FLAIR imaging using 1.0 T and 1.5 T MR scanners have been reported. [1,2] At 1.0 T and 1.5 T, one interesting MR finding in the normal brain is high signal intensity of the corticospinal tract, especially the centrum semiovale (CS). In recent years, 3.0 T MR scanners have been used for neurological imaging. In our four years of clinical experience, we have found that there are several differences in the MR findings in normal brain when using FLAIR at 3.0 T compared to 1.5 T. Theses observations suggest differences in the signal intensities of the CS, pulvinar thalami (PT), and normal iron-containing structures (ICS) [such as globus pallidus (GP), dentate nucleus of cerebellum (DN), red nucleus (RN), pars reticulata of substantia nigra (SN), and putamen (P)]. Our objective was to evaluate these differences in FLAIR imaging between 3.0 T and 1.5 T in normal human brains.

Materials and Methods

Eleven normal adults (six men, five women) between the ages of 26 and 71 years (mean 55 years) underwent fast FLAIR imaging at 1.5 T and 3.0 T on equivalent scanner platforms (Signa; General Electric Medical Systems, Waukesha, WI). The maximum period between each pair of studies was one hour. Our fast FLAIR imaging protocol covered the whole brain with TI = 2250 ms, TR = 11002 ms, effective TE = 135 ms, 19-axial sections, echo train length = 16, 512 × 192 acquisition matrix, 23 cm field-of-view, and an acquisition time of 6 min 36 s. Two neuroradiologists qualitatively assessed signal intensities of the CS, PT and ICS on 3.0 T fast FLAIR images and compared these with values obtained at 1.5 T. First, we evaluated whether the different signal intensities of CS, PT and ICS were visible on the 3.0 T and 1.5 T images. For structures visible at both field strengths, the following evaluation criteria were then used: (1) In CS – we assessed whether the signal intensity of CS was higher relative to the subcortical white matter signal intensity; and (2) in the PT and ICS – we assessed whether the signal intensities in these structures were lower than signal intensity of surrounding structures. In the cases who had (1) and (2) criteria at both scanners, the following conspicuity grading system was used: +1 = 3.0 T images had greater conspicuity than 1.5 T images; 0 = 3.0 T and 1.5 T conspicuity was equivalent; and –1 = 1.5 T images had greater conspicuity than 3.0 T images. Consensus scores were reported.

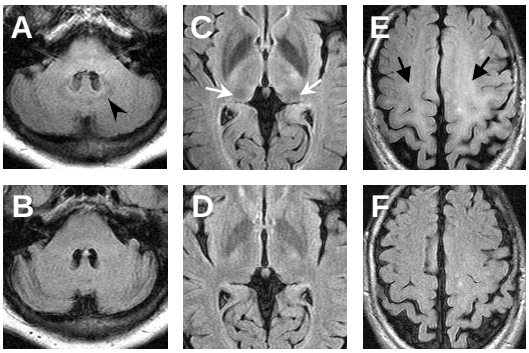

Figure 1: Fast FLAIR images at 3.0 T (A, C, E) show hypointensities in the dentate nucleus of cerebellum (A, arrowhead) and pulvinar thalami (C, white arrows) and hyperintensities at the both centrum semiovale (E, black arrows). These findings are absent on the corresponding 1.5 T images (B, D, F).

Results

The Table summarizes the study findings. In all instances the effect (signal hyperintensity in CS or hypointensity in PT and ICS) indicated improved conspicuity at 3 T. In some structures, only a fraction was visible on the 1.5 T images (CS, DN and P – 91% visible at 1.5 T, PT – 36% at 1.5 T). Fig 1 presents an example where the DN was not visualized at 1.5 T. In all cases, 3.0 T fast FLAIR images had increased conspicuity of hyper- and hypo-intense anatomic structures (Fig 2).

Discussion

In normal subjects at 1.5 T, fast FLAIR images show bilaterally the high signal intensities that are due to unmyelinated fibers in the posterior CS; although these features are often faint and ill defined. [2] At 3.0 T, fast FLAIR imaging increases the conspicuity of the CS. In some patients, this normal MR finding at 3.0 T could be misinterpreted as white matter disease. The cause of this signal change has not yet been determined. Also at 3.0 T, magnetic susceptibility is increased compare to 1.5 T. This phenomenon decreases signal intensity in ICS and improves conspicuity at higher field strengths. To our knowledge, this is the first report of low signal intensities in the PT. The differences between signal intensity in PT and other thalamic structures are likely due to differences in myelination or iron concentration.

References

[1] Hajnal JV, *et al*. *J Comput Assist Tomogr* 1992; 16: 506-513.

[2] Gawne-Cain ML, *et al*. *Neuroradiology* 1997; 39: 324-349.

Table 1: Summary of results across eleven patients by structure visibility and conspicuity at 1.5 T and 3.0 T

Visibility		Grade	Anatomic Structures						
1.5 T	3.0 T		CS	PT	DN	RN	SN	GP	P
Yes	Yes								
		+1	10	4	10	11	11	11	10
		0							
		-1							
No	Yes		1	7	1				1
Yes	No								
No	No								
Total			11	11	11	11	11	11	11

** Where a structure was visible at both field strengths the grade system (see text) records whether conspicuity was greater at 1.5 T (-1) or 3.0 T (+1) or equivalent (0).*

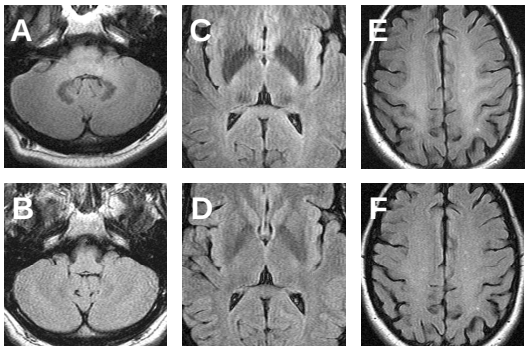

Figure 2: Fast FLAIR images at 3.0 T (A, C, E) show increased conspicuity of low signal intensities at dentate nucleus of cerebellum (A) and pulvinar thalami (B), and high conspicuity of high signal intensities at both centrum semiovales (E), compared with 1.5 T (B, D, F).