Increased Cerebrospinal Fluid Signal Intensity on Fluid-Attenuated Inversion Recovery MR Images: Differential Diagnosis

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Purpose
Owing to improved conspicuity of lesions of brain parenchyma and increased detection of lesions within or adjacent to the CSF, the fluid-attenuated inversion recovery (FLAIR) imaging is widely used as a routine part of cerebral MR examinations in most institutions. MR finding of increased CSF signal intensity on FLAIR images indicates failure to suppress the CSF signal, and has been reported extensively in patients with abnormal CSF including those with subarachnoid hemorrhage and increased CSF protein content. However, other etiologies also may cause increased CSF signal intensity on FLAIR images. The purpose of this exhibit is to illustrate disorders and conditions which may show increased CSF signal intensity on FLAIR images and to describe differential features.

Materials & Methods
Illustrative cases showing increased CSF signal intensity on FLAIR images were collected over a 3-year period. The majority of the examinations were carried out with 1.5 T MR unit.

Results
FLAIR images of patients with subarachnoid hemorrhage, infectious meningitis, carcinomatous meningitis, moyamoya disease, and patients under oxygen inhalation showed increased CSF signal intensity. FLAIR images obtained 1 day after the intravenous administration of gadodiamide in patients with chronic renal failure also showed hyperintense CSF. Pulsatile CSF flow-related artifact mimicked the abnormally increased CSF signal intensity as well. In subarachnoid hemorrhage, the corresponding CSF was isodense to hyperdense to brain parenchyma on CT. In infectious and carcinomatous meningitis, the meninges adjacent to the hyperintense CSF showed enhancement on Gd-enhanced T1-weighted images. The meningeal enhancement could be a distinguishing feature from the other etiologies, although infectious meningitis could not be differentiated from carcinomatous meningitis on imaging studies alone. In moyamoya disease, MRA showed stenosis or obstruction of the carotid fork. In the
patients under oxygen inhalation, the CSF signal increase tended to be mild or moderate within the basal cistern. The signal intensity within the cerebral sulci and ventricles also increased in some cases, but the signal increase was less conspicuous within the ventricles. In the patients with chronic renal failure, increased CSF signal intensity was observed throughout the subarachnoid space, and within the ventricles to a lesser extent, which was attributable to Gd excretion into CSF. The distinguishing features were hyperintense aqueous and vitreous humor of the eyes on FLAIR images, and enhancement of these structures as well as choroid plexus and nasal mucosa on T1-weighted images.

**Conclusion**
Caution should be taken in interpreting MR findings of increased CSF signal intensity on FLAIR images. A comprehensive knowledge of the causative disorders and conditions is necessary to avoid diagnostic errors. Knowledge of the distinguishing features also will help to make correct diagnosis.