ARTIFACT SIMULATING SUBARACHNOID AND INTRAVENTRICULAR HEMORRHAGE ON SINGLE SHOT FAST SPIN ECHO FLAIR IMAGES: A TRAP FOR THE UNWARY

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ABSTRACT
Single-shot-fast-spin-echo fluid attenuated inversion recovery (SS-FSE-FLAIR) images frequently show high signal artifacts in regions not associated with high CSF flow when confused patients are examined. Experiments on volunteers showed that these were due to head motion between the initial inversion pulse and the subsequent 90^0 pulse. Similar patterns were seen in patients. The artifacts represent a trap since single-shot sequences are frequently used in uncooperative patients who are at risk of intracranial hemorrhage and they simulate this condition on otherwise non-artifacted images. They could be controlled by increasing the width of the initial inversion pulse or using a non-selective pulse.

INTRODUCTION
Single shot fast spin echo fluid attenuated inversion recovery (SS-FSE-FLAIR) images are frequently employed to detect disease in the brain and subarachnoid space in confused or uncooperative patients who may move during the examination. In some of these patients high signal areas are seen on good quality images in the subarachnoid space and ventricular system in locations not associated with high CSF flow. These artifacts may simulate hemorrhage or leptomeningeal disease. The purpose of this paper was to determine the cause of these artifacts, describe ways to recognize them, and find methods to reduce or eliminate them.

METHODS
Normal volunteers were studied on six occasions with conventional multislice FSE-FLAIR images and SS-FSE-FLAIR images while at rest and while nodding and rotating their heads at different speeds. In addition, SS-FSE-FLAIR images with different slice widths of the initial inverting pulse and a non-slice selective initial inversion pulse were performed with the subjects moving their heads in the same way. The scans of 30 successive patients with acute neurological syndromes who had been studied with SS-FSE-FLAIR sequences were reviewed for evidence of high signal in the CSF in regions not associated with high CSF flow.

RESULTS
Each of the volunteers showed areas of increased signal in CSF at sites apart from those associated with rapid pulsatile CSF flow on SS-FSE-FLAIR images acquired during head motion. The images were otherwise virtually free of motion artifact. The use of a wider initial inversion pulse slice and a non-slice selected initial inversion pulse reduced the extent of these artifacts. Nineteen of the 30 patients showed areas of high signal in the CSF in regions not associated with highly pulsatile CSF flow. Six of these patients had negative lumbar punctures for blood and xanthochromia, and normal CSF protein levels.

CONCLUSION
High signal artifacts may be seen in CSF as a result of head movement on otherwise artifact free images when imaging uncooperative patients with SS-FSE-FLAIR sequences. These artifacts have a different mechanism and distribution from those caused by CSF pulsation and may simulate subarachnoid and intraventricular hemorrhage. Artifact recognition is aided by signs of patient motion during the examination. The artifacts can be reduced by use of increased slice width and non-slice selective initial inversion pulses.