Case Report

Journal of Emergency Medicine Case Reports

Pseudosubarachnoid Hemorrhage on MRI: A Potential Pitfall

Ozan Karatag[1], Ali Kilinc[1], Bilge Gultac[1], Ibrahim Oztoprak[1]
[1]Department of Radiology, Canakkale Onsekiz Mart University, School of Medicine Canakkale, Turkey

Abstract

Fluid attenuated inversion recovery (FLAIR) is one of the most effective magnetic resonance imaging (MRI) sequences in the diagnosis of subarachnoid hemorrhage (SAH). However, sometimes false positive or false negative results can occur. One of the reasons that can lead to erroneous interpretation is artifacts. Especially when metallic artifact occurs, hyperintensity may be observed in the subarachnoid space, similar to SAH. Although FLAIR hyperintensities in the sulci can be detected in many serious diseases, they are not always pathological. Artifact related hyperintensities, especially in cases with severe headache, may be mistakenly evaluated as SAH by a clinician or radiologist who is not well-experienced in MRI. However, it is extremely important to recognise these artifact related hyperintensities, to make a correct diagnosis and to prevent unnecessary interventions. In order to achieve this, the evaluation of all radiological images, especially SWI and GRE, is critical. Both radiologists and clinicians evaluating neuroradiological examinations should be knowledgeable about this subject and show maximum attention.

In this report, we present the radiological images of 4 cases of pseudosubarachnoid hemorrhage, one of which was caused by conductive EEG gel and the other three due to braces artifacts, who were admitted to the hospital with headache.

Keywords: Magnetic resonance imaging, subarachnoid hemorrhage, subarachnoid space, cerebrospinal fluid, artifacts.

Introduction

Today, fluid attenuated inversion recovery (FLAIR) sequence has become an indispensable part of routine cranial magnetic resonance imaging (MRI) examination[1-3]. In this sequence, while the cerebrospinal fluid (CSF) signal is suppressed with the inversion recovery pulse, heavy T2 images are obtained by applying a long echo time[1-4]. Compared to other conventional sequences, the FLAIR technique is superior in detecting lesions in the subarachnoid space and brain parenchyma, especially near the brain-CSF interface[1].

CSF relaxation time changes when there is pathology in the subarachnoid space. Therefore, in FLAIR sequence, complete suppression of CSF with inversion recovery pulse is interrupted and hyperintensity occurs in the subarachnoid space. Commonly encountered conditions that cause hyperintensity in the CSF/subarachnoid space in FLAIR sequence are subarachnoid hemorrhage (SAH), meningitis, leptomeningeal metastasis, stroke, and status epilepticus.1-4 Also, it has been reported that CSF/subarachnoid space hyperintensity may be present in FLAIR images in cases where propofol, supplemental oxygen, or previous iodine/gadolinium-containing contrast material was applied[2,3,5]. Similar hyperintensities can be observed due to head movements, vascular and CSF pulsation, and metallic body-induced artifacts[1].

In this case series, we aimed to present the radiological findings of 4 artifact-induced subarachnoid hyperintensity cases resembling SAH on FLAIR images, and to discuss the pathologies that may cause similar appearance in the light of literature data.

Case Reports

Case 1

A 13-year-old female with a diagnosis of cerebral palsy and refractory epilepsy was admitted to the pediatric neurology department with a generalized tonic-clonic seizure characterized by locking in the jaw and deviation in the eyes, which had occurred every hour for the past 3 days. In her clinical examination, motor and mental retardation and

Corresponding Author: Ozan Karatag **e-mail:** okaratag17@gmail.com
Received: 10.08.2022 • **Revision:** 22.11.2022 • **Accepted:** 24.11.2022
DOI: 10.33706/jemcr.1160208

Cite this article as: Karatag O, Kilinc A, Gultac B, Oztoprak I. Pseudosubarachnoid hemorrhage on mri: a potential pitfall. Journal of Emergency Medicine Case Reports. 2022;13(4): 132-136

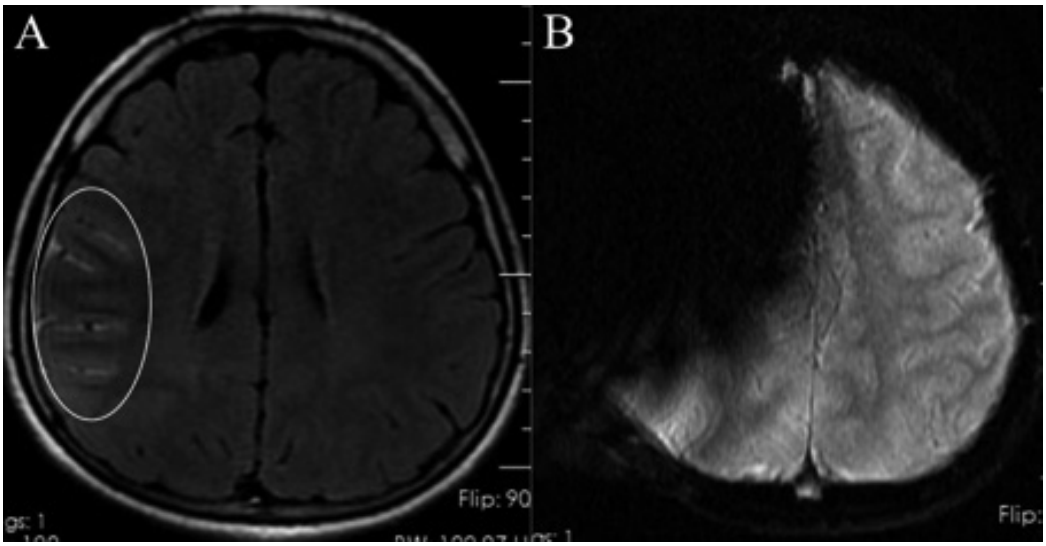

Figure 1. Pseudo-SAH appearance secondary to conductive EEG gel. A, On MRI, FLAIR image shows sulcal hyperintensities in the right frontoparietal region (ellipse). B, Extensive magnetic susceptibility artifact is present in the right frontal region on SWI images.

hypotonia in the lower extremities were detected. She was referred to the radiology department for cranial computed tomography (CT) and MRI examination. CT examination was within normal limits. On MRI, sulcal FLAIR hyperintensities in the right cerebral hemisphere, and extensive susceptibility artifacts in the right frontal area on susceptibility weighted imaging (SWI) were observed (Figure 1). When the patient was retrospectively analyzed in detail, it was learned that an electroencephalography (EEG) was performed before the MRI scan. Sulcal hyperintensities in FLAIR and large susceptibility artifact in SWI were thought to be related to the electrolyte content in the conductive EEG gel.

Case 2

A 15-year-old female was admitted to the pediatric neurology outpatient clinic with headache in the bilateral orbita and frontal region. The patient's physical examination findings were normal. On MRI, FLAIR images revealed hyperintensities in the frontal horns of the lateral ventricle, suprasellar and prepontine cisterns, and frontal sulci on both sides. Signal loss due to susceptibility artifact covering most of the anterior half of the cranium was also observed in SWI images. When the national medical archive information of the case was searched, it was seen that the cranial CT images obtained a few days ago in another center with the same complaints were normal (Figure 2). Sulcal hyperintensities observed in FLAIR images were interpreted as braces-related artifact.

Case 3

A 15-year-old female applied to the pediatric neurology outpatient clinic with occasional numbness in the tongue. The patient's physical examination findings were normal. On MRI, FLAIR hyperintensities were observed in the bilateral frontal sulci and pontocerebellar cisterns. In this case, it was considered that the appearance was related to the braces, due to the artifact extending from the maxillofacial area to the anterior cranium and the intense susceptibility artifact on SWI images (Figure 3).

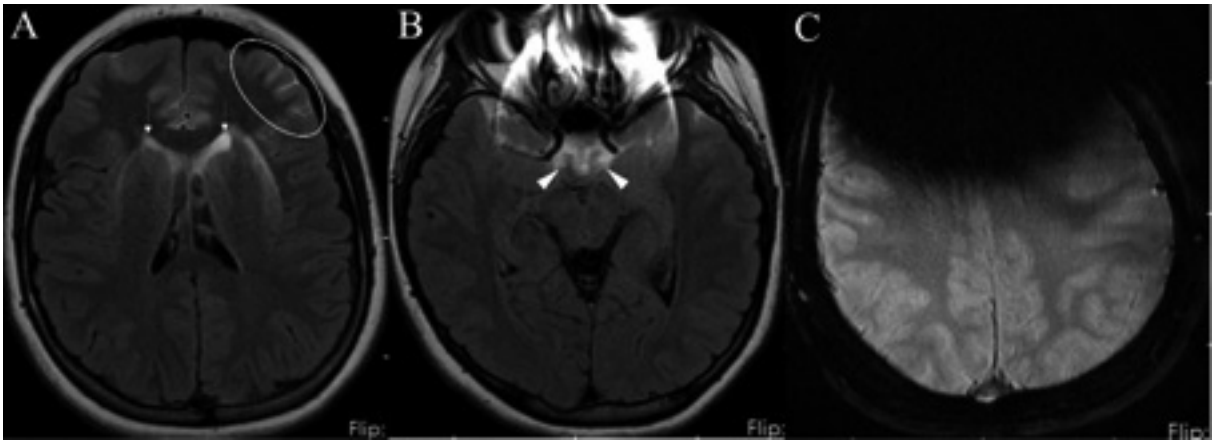

Figure 2. Pseudo-SAH appearance due to braces. A, FLAIR hyperintensities are visible in the left frontal sulci (ellipse) and bilateral lateral ventricular frontal horns (arrows). B, FLAIR hyperintensity at the suprasellar cistern (arrow heads). C, Anterior cranial wide magnetic susceptibility artifact is present on SWI image.

DOI: 10.33706/jemcr.1160208
Journal of Emergency Medicine Case Reports. 2022;13(4): 132-136

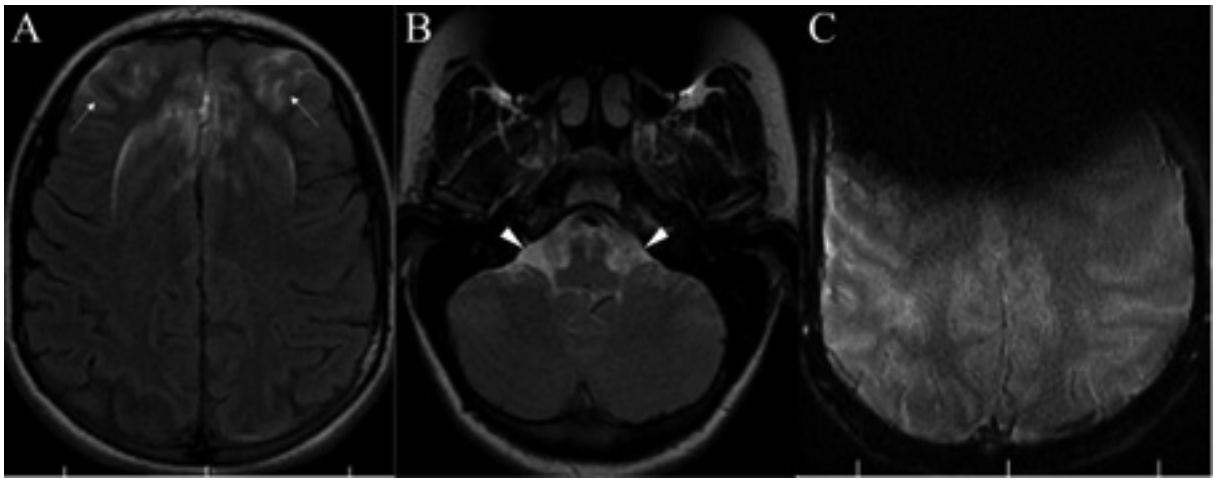

Figure 3. Pseudo-SAH appearance due to braces. A and B, Bifrontal sulcal (arrows) and pontocerebellar cistern (arrow heads) hyperintensities on FLAIR images. C, There is anterior cranial wide magnetic susceptibility artifact on SWI image.

Case 4

An 18-year-old male was admitted to the neurology outpatient clinic due to headache. The patient's physical examination was normal. Kranial MRI examination revealed sulcal hyperintensities that were more prominent in the bilateral frontobasal regions in FLAIR images, while intense susceptibility artifact was present in SWI images (Figure 4). This appearance was also considered to occur due to braces artifact.

Discussion

It has been reported by many researchers that FLAIR imaging is highly sensitive, but not specific, in the detection of many pathologies, especially involving the subarachnoid space[3]. Although in the past years it was accepted that the radiological diagnosis of SAH was easier with CT than with MRI, today FLAIR sequence is known as one of the most sensitive imaging methods for SAH[4]. In SAH, because blood and CSF are mixed, and the oxygen level in CSF is high, the hemoglobin concentration in the hemorrhagic content progresses more slowly. Moreover, SAH is usually of arterial origin; thus hemoglobin is primarily present as oxygenated hemoglobin. In acute SAH, hyperintensity is observed in the subarachnoid space on FLAIR images due to the higher protein content of the bloody CSF. The diagnosis of subacute and chronic SAH is also easier with FLAIR than with CT and other conventional MRI sequences. In addition, this sequence is particularly useful in the diagnosis of SAH in the posterior fossa, which is difficult to evaluate on CT due to beam-hardening artifact[1,4,6].

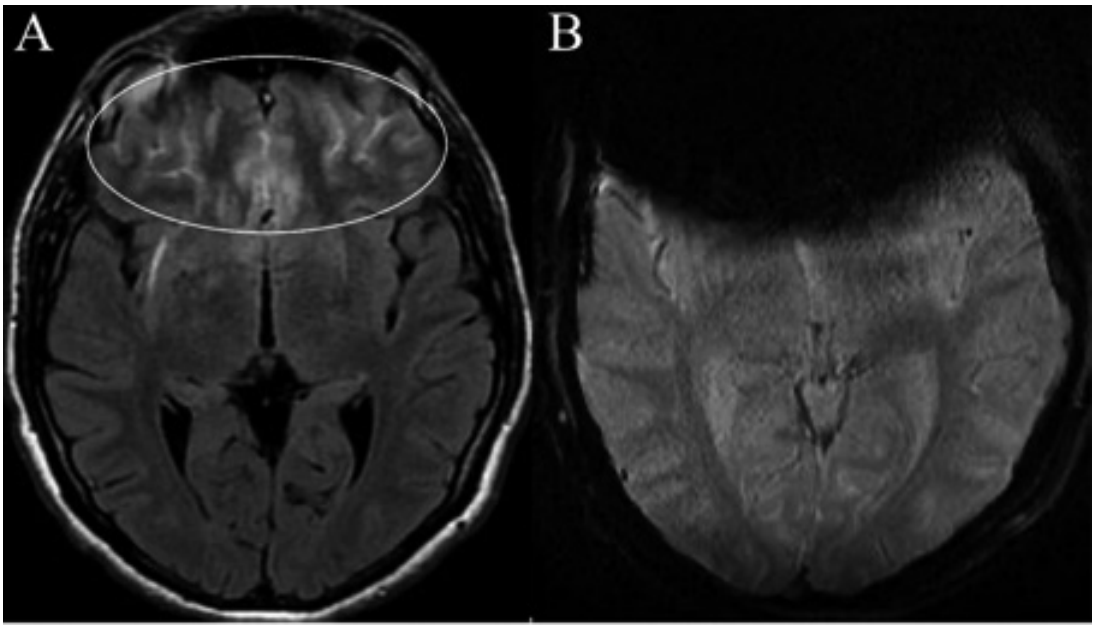

Figure 4. Pseudo-SAH appearance due to braces. A, In FLAIR image, hyperintensities in the bifrontal sulci (ellipse) are seen. B, There is anterior cranial wide magnetic susceptibility artifact in SWI images.

Non-traumatic SAH due to rupture of saccular aneurysm is usually observed at the level of the basal cisternae. In addition, one of the rare causes of SAH close to this region is perimesencephalic hemorrhage. On the other hand, spontaneous cortical SAH, which is mostly observed at the level of convexity, may occur due to vascular and non-vascular causes. These include dural and cortical cerebral vein thrombosis, vascular malformations, reversible cerebral vasoconstriction syndrome, vasculitides, Moyamoya disease, severe atherosclerotic carotid disease, amyloid angiopathy as vascular causes, and cerebral neoplasia and abscess as non-vascular causes. The clinical manifestations of cortical SAH differ from the classic thunderclap headache described in aneurysmal SAH. In these patients, findings such as migraine with aura and epileptic seizures may be observed, in addition to focal deficits that may suggest transient ischemic attack (TIA)[7]. In our cases, similar to the cortical SAH findings mentioned in the literature, sulcal hyperintensities compatible with pseudosubarachnoid hemorrhage were present, and headache in two of the cases, seizure in one and TIA-like clinical findings in one were consistent with the literature data.

Apart from SAH, many other pathological conditions such as meningitis, leptomeningeal metastasis, dural venous thrombosis, stroke, status epilepticus may similarly cause hyperintensity in the subarachnoid space[3,4,6,7]. While the increase in protein and cellularity in the CSF content is responsible for this hyperintensity in meningitis and leptomeningeal metastases, vascular slow flow, congestion, occlusion and thromboembolism are responsible in acute stroke and venous thrombosis[1].

In addition, it has been reported that hyperintensity may occur in the subarachnoid space in patients receiving supplemental oxygen during MRI, intravenous anesthetic agent such as propofol, and previously administered intravenous contrast material containing iodine or Gadolinium[3,4,7].

Artifacts are another important cause of hyperintense CSF in FLAIR images[4]. The displacement of the suppressed CSF due to motion artifacts and metal-induced magnetic susceptibility artifacts may occur[4,5]. While FLAIR hyperintensity due to CSF pulsation is observed mostly at the basal, prepontine and pontocerebellar cisternae levels and in the areas close to the foramen in the ventricles, it is less common in the convexity parts of the cerebral hemispheres where the CSF flow is slow[1]. The reason here is that the pulsatile CSF flow displaces the suppressed CSF protons and causes them to be replaced by unsuppressed protons[5]. Artifacts due to vascular pulsation, on the other hand, appear along the phase coding direction, mostly in the form of ghosting artifacts, having a similar shape, size and location to the vascular structure[1]. Similar artifacts may also be observed due to the patient's head movements.1 As a result of this movement, FLAIR hyperintensity may occur within the subarachnoid space and ventricles when unsuppressed or insufficiently suppressed CSF protons enter the imaging area[5]. Metallic artifact occurs due to insufficient suppression of CSF by inversion pulse due to the inhomogeneous magnetic field caused by the metal in the section[4]. As a result, it leads to a hyperintense appearance in FLAIR in the subarachnoid space[1]. In order to understand whether the sulcal hyperintensities observed in the FLAIR sequence are caused by artifacts, the intense susceptibility artifact in SWI or gradient echo (GRE) sequences that are currently applied in routine cranial MRI practice can be examined. In all of our cases, intense signal loss due to susceptibility artifact was observed in a much larger area than FLAIR sulcal hyperintensities in SWI images.

In conclusion, hyperintensities that can be seen in the subarachnoid space, CSF or sulci on FLAIR images may be an indicator of many serious pathologies, especially SAH. However, similar findings may also occur due to some artifacts. Therefore, both radiologists and clinicians evaluating cranial MRI images should be aware of this aspect. In order to understand whether the hyperintensities of the sulcal/subarachnoid/CSF on FLAIR images in the cranial MRI examinations of the patients who applied to the emergency department or the outpatient clinic with various complaints are due to artifacts, all consecutive sections should be carefully evaluated, and SWI or GRE sequences, if present, should be examined. In this way, the appearance of artifact-induced pseudosubarachnoid hemorrhage is not mistakenly interpreted as pathological, and unnecessary further investigations and interventions are prevented.

Authors' Note : *Ozan Karatag, Ali Kilinc, Bilge Gultac and Ibrahim Oztoprak contributed equally to the manuscript. Written informed consent for patient information and images to be published was provided by the patient. Ozan Karatag, Ali Kilinc, Bilge Gultac and Ibrahim Oztoprak contributed to study concept and design, acquisition of data, data analysis and interpretation, drafting, and revision of manuscript for intellectual content. Ibrahim Oztoprak contributed to revision of manuscript for intellectual content. Study funded by the authors.*

References

1. Stuckey SL, Goh TD, Heffernan T, Rowan D. Hyperintensity in the subarachnoid space on FLAIR MRI. *AJR Am J Roentgenol* 2007;189:913-21.
2. Hacein-Bey L, Mukundan G, Shahi K, Chan H, Tajlil AT. Hyperintense ipsilateral cortical sulci on FLAIR imaging in carotid stenosis: ivy sign equivalent from enlarged leptomeningeal collaterals. *Clin Imaging* 2014;38:314-7.
3. Morris JM, Miller GM. Increased signal in the subarachnoid space on fluid-attenuated inversion recovery imaging associated with the clearance dynamics of gadolinium

DOI: 10.33706/jemcr.1160208
Journal of Emergency Medicine Case Reports. 2022;13(4): 132-136

chelate: a potential diagnostic pitfall. *AJNR Am J Neuroradiol* 2007;28:1964-7.

4. Maeda M, Yagishita A, Yamamoto T, Sakuma H, Takeda K. Abnormal hyperintensity within the subarachnoid space evaluated by fluid-attenuated inversion-recovery MR imaging: a spectrum of central nervous system diseases. *Eur Radiol* 2003;13 Suppl 4:L192-201.

5. Cianfoni A, Martin MG, Du J, Hesselink JR, Imbesi SG, Bradley WG, et al. Artifact simulating subarachnoid and intraventricular hemorrhage on single-shot, fast spin-echo fluid-attenuated inversion recovery images caused by head movement: A trap for the unwary. *AJNR Am J Neuroradiol* 2006;27:843-9.

6. Verma RK, Kottke R, Andereggen L, Weisstanner C, Zubler C, Gralla J, et al. Detecting subarachnoid hemorrhage: comparison of combined FLAIR/SWI versus CT. *Eur J Radiol* 2013;82:1539-45.

7. Cuvinciuc V, Viguier A, Calviere L, Raposo N, Larrue V, Cognard C, et al. Isolated acute nontraumatic cortical subarachnoid hemorrhage. *AJNR Am J Neuroradiol* 2010;31:1355-62.