

Dixon FLAIR Outperforms Fat-Suppressed FLAIR Image Quality in Brain MRI

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Introduction

Fluid attenuated inversion recovery (FLAIR) is an essential sequence in brain MRI. By suppressing cerebrospinal fluid (CSF) and free water signals, FLAIR improves the contrast between lesions and brain parenchyma, thereby increasing the detection rate of pathologies adjacent to CSF spaces, such as cerebral infarction, abscess, inflammatory demyelinating diseases, and tumors [1–6]. Therefore, FLAIR has become a routine sequence in clinical neuroimaging.

However, conventional FLAIR without fat suppression suffers from high fat signal and chemical shift artifacts, which may reduce gray white matter contrast and mask lesions involving the skull or intracranial structures. Frequency selective fat suppressed FLAIR (FS FLAIR) has been widely adopted to overcome these limitations. Unfortunately, FS FLAIR is highly sensitive to B0 and B1 inhomogeneities, which are exacerbated by tissue susceptibility differences, geometric distortion, and the presence of metal dental implants. As a result, FS FLAIR often fails to provide uniform fat suppression, leading to degraded image quality, signal distortion, and reduced diagnostic confidence — particularly in patients with fixed metal dentures or high-field and ultra-high-field magnetic resonance equipment [7–9].

To address these problems, we integrated the Dixon technique with FLAIR (Dixon FLAIR).¹ The Dixon method exploits the chemical shift difference between water and fat, using dual echo acquisition and advanced reconstruction algorithms [10]. It is inherently less sensitive to B0/B1 inhomogeneities and local susceptibility variations, offering robust and uniform fat suppression even in challenging anatomical regions with the same scanning duration. This article presents three cases that demonstrate the differences in fat-suppression quality between FS-FLAIR and Dixon-FLAIR in brain MRI, and the impact of those differences on lesion visualization.

Methods and materials

In all three cases, imaging was performed using a 3T MRI scanner (MAGNETOM Skyra, Siemens Healthineers, Erlangen, Germany) that was equipped with a 20-channel head-neck coil and operating on the syngo MR VE11C software platform. Both the FS FLAIR and Dixon FLAIR¹ sequences were acquired with identical parameters, except for the fat-suppression method and bandwidth. The detailed imaging parameters are shown in Table 1.

	Dixon-FLAIR ¹	FS-FLAIR
TR/TE (ms)	9000/95	9000/95
T1 (ms)	2500	2500
Flip angle	150°	150°
FOV (mm ²)	230 × 212	230 × 212
Matrix	304 × 228	304 × 228
Slice thickness/gap (mm)	5/1.5	5/1.5
Number of slices	20	20
Average	1	1
Bandwidth (Hz/pixel)	783	238
Acceleration factor	2	2
Turbo factor	19	19
Fat suppression	Dixon (dual echo)	Fat Sat.
Acquisition time	2 min, 6 s	2 min, 6 s

Table 1: Imaging parameters for the Dixon-FLAIR¹ and FS-FLAIR sequences

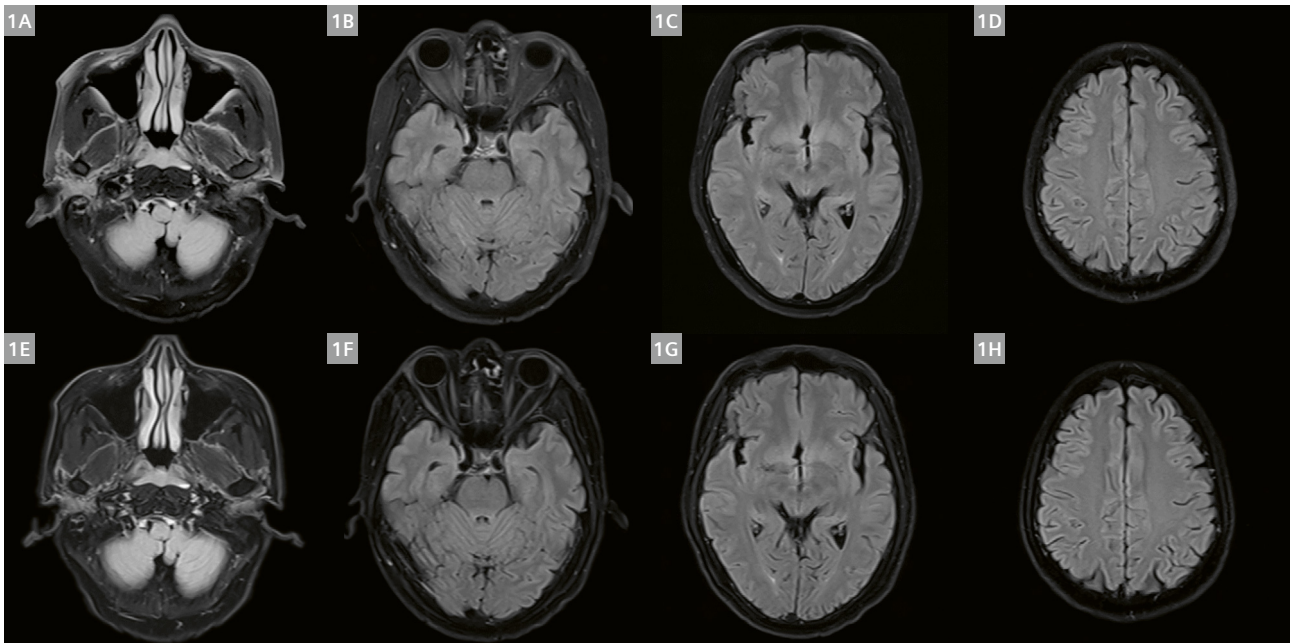
¹ Work in progress. The application is currently under development and is not for sale in the U.S. and in other countries. Its future availability cannot be ensured.

Results

Case 1: A 43-year-old healthy female volunteer

A comparison of the default FS-FLAIR sequence (1A–1D) with Dixon-FLAIR (1E–1H) revealed the following:

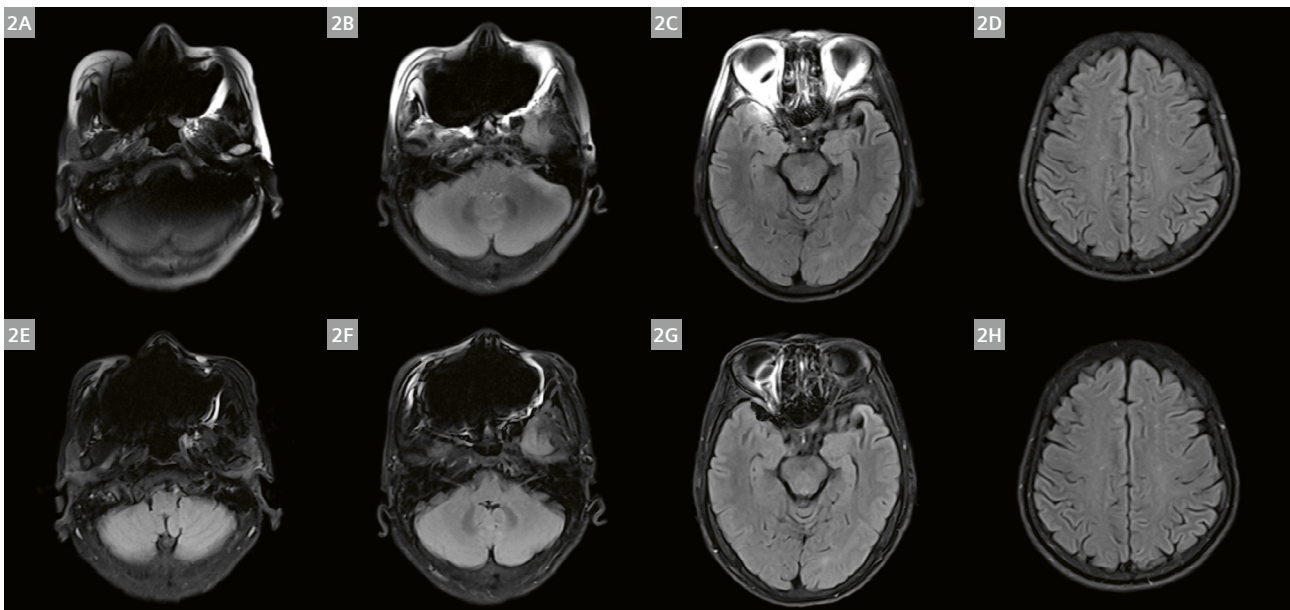
1. Dixon-FLAIR images show superior fat suppression and image quality over FS-FLAIR.
2. The apparent signal-to-noise ratio of the two sequences is almost the same.



Case 2: A 63-year-old male patient with metal dentures

The comparison of the two sequences revealed the following:

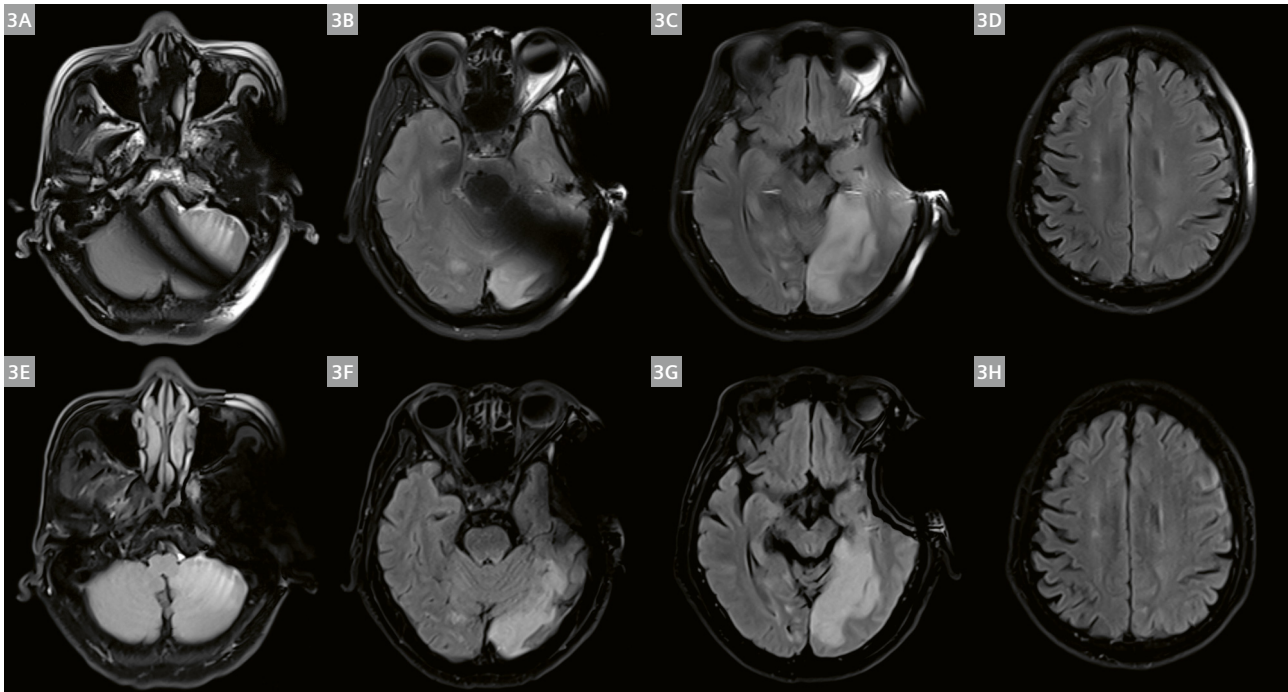
1. Dixon-FLAIR (2E–2H) showed significantly better overall image quality, fat suppression, and signal distortion than the default FS-FLAIR (2A–2D).
2. Free water suppression at the maxillary sinus, orbit, and frontal sinus levels is better in the Dixon-FLAIR sequence, which shows superior gray-matter and white-matter contrast.



Case 3: A 54-year-old male patient with cerebral infarction and metal dentures

When comparing the performance of the two sequences under extreme conditions involving metal dental prostheses and intracranial lesions, the following findings were observed:

1. FS-FLAIR images (3A–3D) show marked metal artifacts, inhomogeneous fat suppression, and incomplete water suppression that obscure lesion visualization.
2. Dixon-FLAIR images (3E–3H) demonstrate substantially reduced metal artifacts and better lesion conspicuity.



Conclusion

In brain MRI, Dixon FLAIR provides significant advantages over conventional FS FLAIR in terms of fat-suppression uniformity, water-suppression quality, and overall image robustness. The following key findings are observed:

1. In routine brain MRI, Dixon FLAIR demonstrates superior fat-suppression uniformity compared to FS FLAIR, particularly in regions with complex anatomy such as the skull base. This enhanced fat suppression improves the contrast between lesions and adjacent bony or intracranial structures, thereby increasing the detection rate of lesions involving the skull and skull base.
2. In patients with metal dental prostheses, Dixon FLAIR not only maintains uniform fat suppression but also achieves more homogeneous water suppression (e.g., in the maxillary sinus, orbit, and frontal sinus regions)
3. Dixon FLAIR is robust against B0/B1 inhomogeneities caused by metal dentures and tissue susceptibility effects — limitations that often compromise FS FLAIR image quality with identical scan timing.

than FS FLAIR. The reduced metal artifacts and improved fluid suppression lead to better lesion conspicuity and higher diagnostic confidence, especially for intracranial pathologies adjacent to air–bone interfaces.

Therefore, Dixon FLAIR is a reliable and preferable alternative to FS FLAIR for fluid attenuated brain imaging, particularly in routine clinical practice and for patients with metal dental restorations in whom uniform fat and water suppression are critical for accurate lesion detection.

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