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Contrast-enhanced T2-FLAIR MR imaging in patients with uveitis

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Abstract To report MRI findings which reflect a pathological inflammatory condition of the uveal tract. This study includes single-center retrospective case series of five patients with clinical diagnosis of uveitis. There were 1 male (20 %) and 4 female patients (80 %). The average age was 29.6 years (range 25–38 years). Patients and 50 age-range-matched control subjects were scanned using a 1.5 T scanner. Ten additional control subjects scanned at 3 T were evaluated to have reference images at that high field. All patients ($n = 5$, 100 %) presented uveal tract enhancement on post-contrast T2-FLAIR fat-suppressed images and only 2 (40 %) had enhancement on T1-weighted images. The enhancement was anterior in 2 (40 %), pan-uveal in 2 (40 %), and posterior in 1 patient (20 %). Two patients (40 %) had unilateral increased vitreous signal on T2-FLAIR. One patient (20 %) had bilateral retrobulbar fat enhancement in both post-contrast T2-FLAIR and T1-weighted images. Post-contrast T2-FLAIR images can reveal abnormal enhancement of the uveal tract and retrobulbar fat as well as increased vitreous signal in patients with uveitis. In our small series, the sensitivity of post-contrast T2-FLAIR was higher than the conventional post-contrast T1-weighted images. Nonetheless, when bilateral uveal tract enhancement is present, there should be discretion before calling uveitis because the finding has been reported in different eye conditions as well as in a small percentage of healthy subjects at 1.5 T. In addition, it should be noted that post-contrast T2-FLAIR enhancement of the uveal tract is a normal finding at 3 T imaging.

Keywords Uveitis · FLAIR · MRI · Gadolinium

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Introduction

The uvea or uveal tract is the middle vascular layer of the eye. From anterior to posterior, the uveal tract is constituted by iris, ciliary body, and choroid. Uveitis comprises a very diverse group of entities in which inflammation of the uvea and retina may lead to

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significant visual loss [1]. Anatomic classification of uveitis can be divided into anterior, intermediate, posterior, or panuveitis according to the main site of inflammation of the uveal tract [3]. The diagnostic approach is based on the history, physical examination, and paraclinical tests. Usually, neuroimaging is requested to rule out uveitis-associated neurological disease; however, its role to establish the primary diagnosis is not well known and reports about the imaging appearance of uveitis are scarce. Our goal is to report MRI findings which can reflect a pathological inflammatory condition of the uveal tract.

Materials and methods

Study design and patients

Institutional review board approval (considering the ethical aspects of the study and adhering to the guidelines of the Helsinki Declaration) and informed written consent were obtained for this single-center retrospective case series. Between September 2013 and August 2014, a total of five patients with clinical diagnosis of uveitis were included in this study (Table 1). Exclusion factors included magnetic susceptibility artifacts affecting the orbits and medical history of eye surgery, glaucoma, or diabetes. There were 1 male (20 %) and 4 female patients (80 %). The average age was 29.6 years (range 25–38 years).

1.5 T MR imaging

Patients and 50 age-range-matched control subjects were scanned using a 1.5 T scanner (Essenza, Siemens, Erlangen, Germany; or Gyroscan Intera, Philips Medical Systems, Best, the Netherlands). Standard MRI sequences including axial and coronal T1- and T2-weighted fat suppression techniques as well as DWI were performed. Post-contrast (Gadolinium-DTPA) T1-weighted and axial fat-suppressed T2-FLAIR images were acquired in both patients and control individuals. T2-FLAIR uveal tract enhancement was considered as positive when signal was higher than extraocular muscles and about the same of ethmoid mucosa or cavernous sinus.

3 T MR imaging

Ten control healthy subjects were scanned at 3 T (Skyra, Siemens, Erlangen, Germany) to have reference images at that high field. No uveitis patients were scanned at 3 T.

Results

1.5 T MRI findings in uveitis patients

All patients ($n = 5$, 100 %) presented uveal tract enhancement on post-contrast T2-FLAIR fat-suppressed images and only 2 (40 %) had enhancement on T1-weighted images. The enhancement was anterior in 2 (40 %), pan-uveal in 2 (40 %), and posterior in 1 patient (20 %). Two patients (40 %) had unilateral increased vitreous signal on T2-FLAIR. One patient (20 %) had bilateral retrobulbar fat enhancement in both post-contrast T2-FLAIR and T1-weighted images.

There was no fluid in subretinal or subchoroidal spaces. There was no restricted diffusion affecting the globes. There were no signs of optic neuritis or atrophy. There were no demyelinating white matter lesions. No brain abnormalities suggesting infection, granulomatous conditions, vascular, or neurodegenerative disease were found.

Uveal tract enhancement in healthy subjects

Of the 50 control subjects imaged at 1.5 T, 6 % showed bilateral uveal tract enhancement ($n = 3$) on post-contrast T2-FLAIR images. Of the ten healthy subjects evaluated at 3 T imaging, the majority ($n = 9$, 90 %) presented bilateral uveal tract enhancement on post-contrast T2-FLAIR images.

Ophthalmologic findings in uveitis patients

All patients had an active uveal clinical inflammation at the time of the MRI with the presence of anterior chamber cells, vitreous haze cells, or retinal vascular sheathing. Three patients (60 %) had bilateral ocular involvement, and only 2 (40 %) had an identifiable cause of uveitis (EALES disease and Vogt–Koyanagi–Harada in case 1 and 3, respectively). The other three patients were diagnosed as idiopathic uveitis after

Table 1 Patient's list

Patient number	Sex/age	Diagnosis, classification, and laterality	Post-contrast T2-FLAIR findings	Post-contrast T1-weighted findings	Ophthalmologic findings
1	F/31	Intermediate idiopathic chronic uveitis. Right eye	Pan-uveal tract enhancement of the right eye	Negative	VA: 20/30. Anterior chamber cells: 0.5+ and flare: 2+. Vitreous opacity 1+ , dense inferior snowballs in vitreous cavity.
2	M/38	EALES disease, Retinal vasculitis and intermediate uveitis. Bilateral	Posterior uveal tract enhancement of the right eye	Negative	VA OD: 20/25 OS: 20/20. Anterior vitreous cells 2+ in right eye. Extensive peripheral venular sheathing with spot hemorrhages in right eye, and discrete venular sheathing in temporal inferior quadrant in left eye.
3	F/26	Vogt Koyanagi Harada disease. Bilateral	Bilateral pan-uveal tract and retrobulbar fat enhancement. Right vitreous increased signal	Bilateral entire uveal tract and retrobulbar fat enhancement	VA OD: 20/30 OS: 20/25. Both eyes: anterior chamber cells 0.5+ and flare 1+. No vitreous haze. Optic disc edema and inferior serous retinal detachment with macular involvement.
4	F/28	Anterior idiopathic chronic uveitis. Bilateral	Bilateral iris enhancement	Bilateral iris enhancement	VA OD: 20/25 OS: 20/25. Both eyes: Anterior chamber cells 2+, flare 2+.
5	F/25	Anterior idiopathic chronic uveitis. Left eye	Anterior uveal tract enhancement and vitreous increased signal of the left eye	Negative	VA OS 20/60. Anterior chamber cells 0.5+ and flare 3+. Dense subcapsular cataract. No vitreous or retinal abnormalities

excluding autoimmune or infectious diseases. Classification of the uveitis according to the anatomic affection was as follows: two patients with anterior uveitis (40 %), 1 patient with intermediate uveitis (20 %), 1 patient with panuveitis (20 %), and 1 patient with intermediate uveitis and retinal vasculitis (20 %). At the time of the MRI, the visual acuity (VA) was better than 20/40 in all patients except in case 5 (20/60) who had a uveitic cataract. None of the patients had ocular surgeries or intraocular medications at the time of the exam.

Discussion

Uveitis can be the result of multiple diseases in which the final pathway is intraocular inflammation. By anatomic location, uveitis is divided into anterior (iritis or iridocyclitis), intermediate (affecting vitreous and peripheral retina), posterior (chorioretinitis), and panuveitis [2, 3].

The diagnostic approach is based on the history, physical examination, and paraclinical tests. Uveitis etiology is diverse including infection, immune-mediated, or related to systemic diseases. Neuroimaging can be helpful to rule out neurological disease which has been reported in approximately 8 % of the patients in a tertiary care uveitis clinic [4]. For example, MRI can help to diagnose uveitis-associated conditions like multiple sclerosis, primary central nervous system lymphoma, sarcoidosis, and neuroinfection. However, in our series, there were no concomitant brain abnormalities suggesting uveitis association with neurological disease.

There is scarce literature evidence about MRI findings in patients with uveitis or the utility of contrast-enhanced FLAIR in the study of orbital pathology. A study on healthy subjects showed delayed 3D FLAIR contrast enhancement in the anterior segment 4 h after contrast medium administration, suggesting a possible utility in the diagnosis of eye diseases [5]. Mathews et al. found that ocular enhancement was not observed on T1-weighted post-gadolinium sequences, but was shown on contrast-enhanced FLAIR imaging in conditions such as diabetic retinopathy, glaucoma, and after ocular

surgery [6]. In our series at 1.5 T imaging, we found a greater sensitivity (S) on gadolinium-enhanced fat-suppressed T2-FLAIR (S, 100 %) compared with post-contrast T1-weighted (S, 40 %) images to demonstrate uveitis findings (uveal tract and retrobulbar fat enhancement or increased vitreous signal; Figs. 1, 2). Differential diagnosis should include optic neuritis, papilledema, endophthalmitis, melanoma, choroid angioma, hemorrhage in vitreous chamber, and the presence of fluid collections in subhyaloid or subretinal spaces.

In addition, we found an 80 % of concordance between the main site of the uveal tract inflammation and localization of MRI enhancement. Only in case 1, where the patient had an intermediate uveitis, a pan-uveal tract enhancement was seen, with no possible subclinical inflammation detection of the remained uveal tract tissue as an explanation of these phenomena. Another interesting finding is the increased vitreous signal in cases 3 and 5 could be explained by the breakdown of the blood retinal barrier seen in patients with Vogt–Koyanagi–Harada disease (case 3) and in anterior uveitis with severe flare of 3+ in case 5.

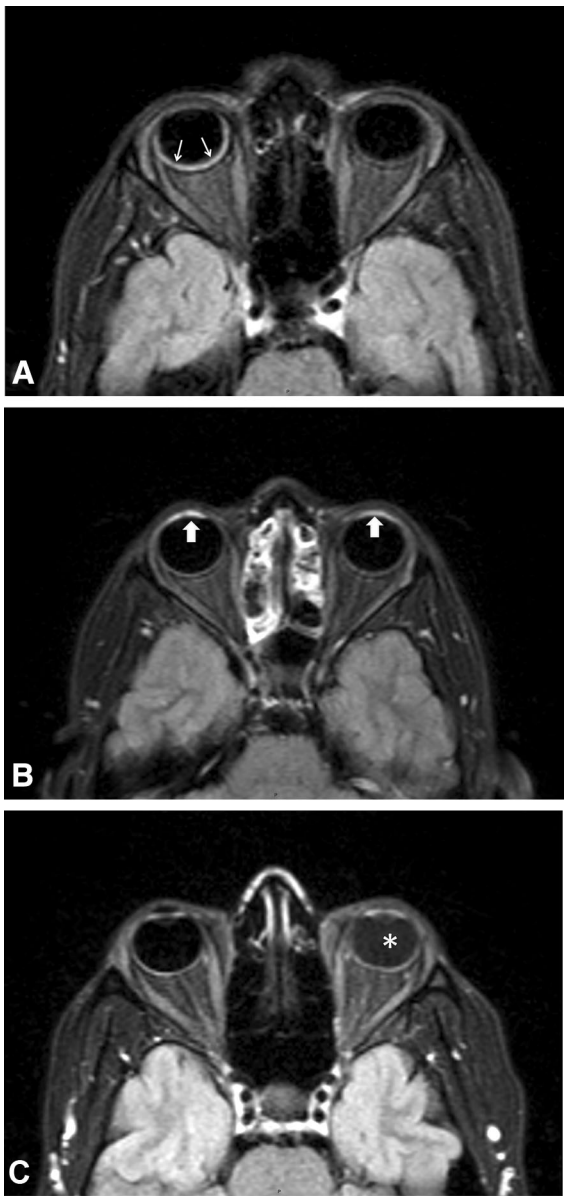

Fig. 1 Post-contrast T2-FLAIR findings in uveitis. **a** Right uveitis in a 31-years-old woman (*thin arrows* show uveal tract enhancement). **b** Bilateral anterior uveitis in a 28-years-old female patient (*thick arrows* show bilateral anterior uveal tract enhancement). **c** Chronic left anterior uveitis in a 25-years-old woman. There is left increased vitreous signal (*asterisk*) and uveal tract enhancement

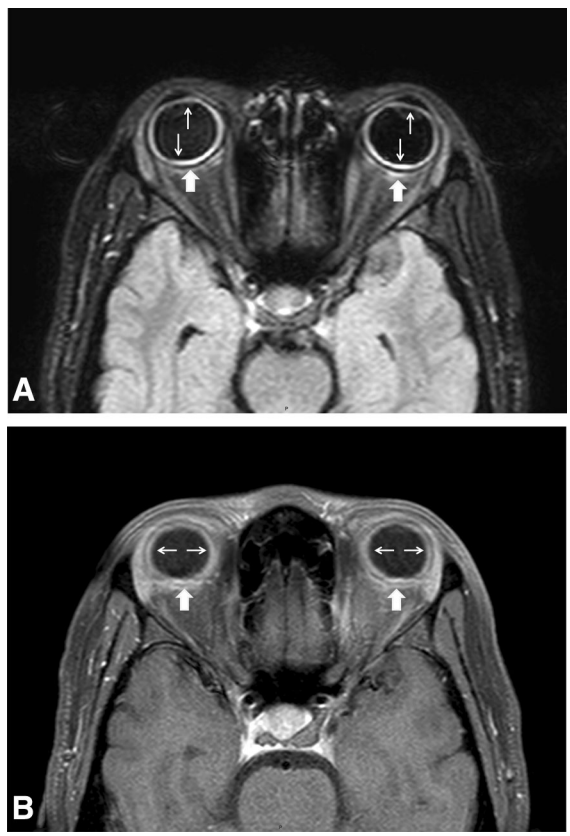

Fig. 2 Bilateral uveitis in a 26-years-old patient with Vogt–Koyanagi–Harada syndrome. Both post-contrast T2-FLAIR (**a**) and T1-FAT SAT (**b**) axial images show uveal tract (*thin arrows*) and retrobulbar fat (*thick arrows*) enhancement

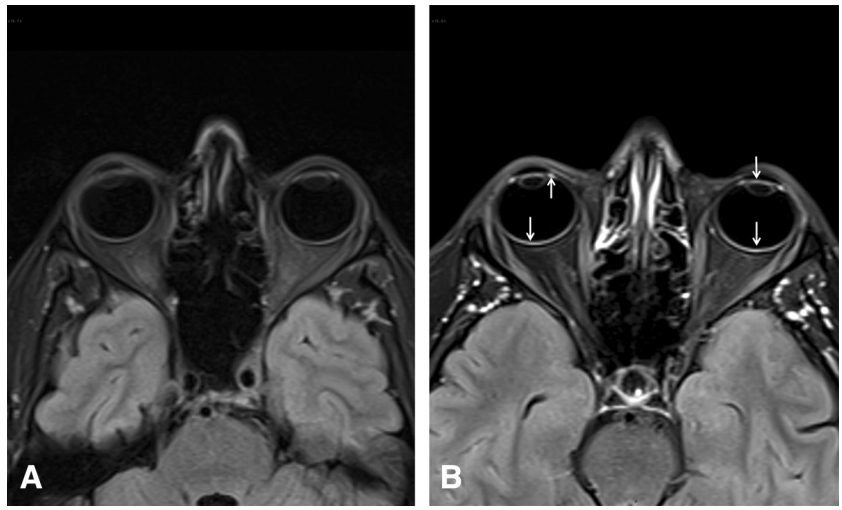

Fig. 3 Axial 3 T nonenhanced (**a**) and contrast-enhanced (**b**) T2-FLAIR images in healthy control subjects. Anterior and posterior uveal tract enhancement (*arrows*) is a normal finding at 3 T imaging

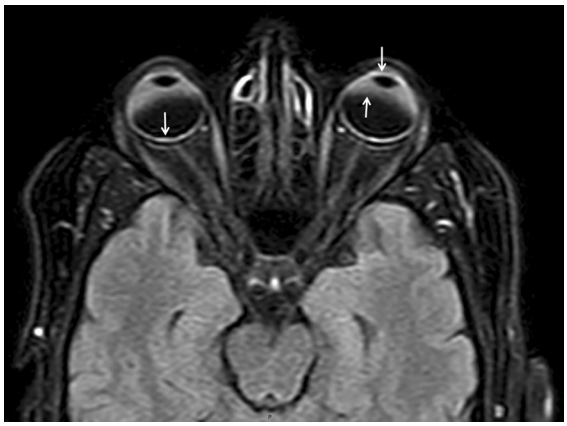

Fig. 4 Axial 1.5 T post-contrast T2-FLAIR image shows bilateral susceptibility artifact (*arrows*) mimicking uveal tract enhancement in a healthy subject

FLAIR imaging is a technique in which water attenuation inversion recovery pulses are applied to improve the detection of intracranial lesions compared to conventional T2-weighted images. The required long inversion recovery time confers a T1 effect; consequently, it has been suggested that gadolinium administration may improve lesion detection in the FLAIR sequence [7–12]. There have been several studies evaluating the utility of contrast-enhanced T2-FLAIR in the diagnosis of intracranial pathology. It has been shown that choroid plexus, pituitary stalk, pineal gland, and venous structures typically enhance this sequence. When evaluating pathologic states, gadolinium-enhanced FLAIR has shown high sensitivity to detect extra-axial lesions especially when leptomeninges and CSF spaces are affected [6–8, 10, 13]. However, there are well-known issues of that sequence including artifacts associated with field inhomogeneities and nonpathologic increased signal related to anesthetics or high-oxygen concentration [14].

Our findings support the use of post-contrast fat-suppressed T2-FLAIR technique for the study of eye disease when conventional sequences show negative findings at 1.5 T. However, it should be noted that we found a small percentage (6 %) of control subjects without known ocular disease which can have ocular enhancement on that sequence at 1.5 T, in agreement with about 3 % described in a previous report [6].

We did not have any uveitis patients imaged at 3 T. Nevertheless, when evaluating 3 T images of healthy subjects, we found post-contrast T2-FLAIR bilateral uveal tract enhancement, which is a normal finding (the finding was present in 90 % of control subjects at 3T; Fig. 3). Therefore, we suggest being careful when uveal tract enhancement is bilateral before calling uveitis. In those cases, field strength should be evaluated, susceptibility artifacts (Fig. 4) must be ruled out, and strong clinical correlation is required.

Conclusion

In summary, 1.5 T post-contrast T2-FLAIR images can reveal abnormal enhancement of the uveal tract

and retrobulbar fat as well as increased vitreous signal in patients with different types of uveitis, showing good concordance with the main site of uveal inflammation. In our small series, the sensitivity of post-contrast T2-FLAIR was higher than conventional post-contrast T1-weighted images. Nonetheless, when bilateral uveal tract enhancement is present, there should be discretion before calling uveitis because this finding has been reported in different eye conditions as well as in a small percentage of healthy subjects at 1.5 T. In addition, it should be noted that post-contrast T2-FLAIR enhancement of the uveal tract is a normal finding at 3 T imaging.

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Compliance with ethical standards

Conflict of interest The authors certify that there is no actual or potential conflict of interest in relation to this article.

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