

CASE REPORT

Early Diagnosis of Recurrent Optic Neuritis Using Contrast-Enhanced T2 Fluid-attenuated Inversion Recovery Imaging: a Case Report

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Abstract The diagnosis of the recurrent optic neuritis is commonly established clinically, and sometimes it could be challenging because the involved optic nerve does not always show significant enhancement on conventional contrast enhanced-T1 weighted imaging (CE-T1WI). In this paper, we reported a middle-aged female with early diagnosis of recurrent optic neuritis using contrast-enhanced T2 fluid-attenuated inversion recovery imaging (CE-T2FLAIR). The involved optic nerve presented evident enhancement on CE-T2FLAIR and no enhancement on CE-T1WI. This case suggested that the CE-T2FLAIR may be a useful diagnostic tool specifically for the recurrent optic neuritis in clinical practice.

OPTIC neuritis is a common inflammatory disorder of the optic nerve, and MRI is the optimal modality to visualize the optic nerve. Typical MRI findings of optic neuritis were easily recognized in the posterior intraorbital optic nerve (ION),¹ where in more than 90% cases it manifests as swollen, high signal on T2WI, and en-

hancement on contrast-enhanced T1WI (CE-T1WI).^{2,3} For the recurrent optic neuritis, the diagnosis may be challenging. From the clinical viewpoints, the clinical diagnosis of recurrent optic neuritis may be based on the typical clinical characteristics, such as moderate or severe visual loss, accompanied by visual field defects or loss of color vision.⁴ CE-T1WI is regarded as an essential MRI evaluation tool for the imaging diagnosis of recurrent optic neuritis. Conventionally, the enhancement of optic nerve on CE-T1WI suggested the recurrent optic neuritis, and non-enhancement on CE-T1WI indicated the optic neuritis was in silent phase and there was no definite MRI evidence for the recurrence. Although CE-T1WI had shown a good diagnostic validity for the acute optic neuritis, with a high sensitivity of 94%, for recurrence of optic neuritis, the previously

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affected optic nerves usually present no abnormal enhancement.⁵ Based on the mechanism of enhancement on MRI, the non-enhancement on CE-T1WI may indicate no or mild compromised blood-brain barrier, and concentration of MRI contrast agent in interstitial space may be too low to generate contrast enhancement on T1WI.^{6,7}

The contrast-enhanced T2 fluid-attenuated inversion recovery (CE-T2FLAIR) is sensitive to MRI contrast medium. It can detect low concentration of contrast agent in tissue and present enhancement, even there is no enhancement showed up on CE-T1WI.⁸ This MRI technique had been widely used to detect multiple sclerosis lesions,⁹ and small brain metastases.¹⁰ CE-T2FLAIR had also been used to evaluate the diabetic retinopathy.⁸ Therefore, CE-T2FLAIR may provide a new opportunity to clearly depict the involved optic nerve in patients with optic neuritis. In the current case of recurrent optic neuritis, the enhancement of ION was demonstrated on CE-T2FLAIR, while no enhancement on CE-T1WI was shown.

CASE DESCRIPTION

A 36-year-old female suffered from a sudden hypopsia of the right eye without definite incentive 3 days ago. She has history of right optic neuritis which was diagnosed 5 years ago. The patient was clinically suspicious for the right recurrent optic neuritis. Fundus photography examination confirmed that right papilla optica presented pale (**Fig. 1**). Optical coherence tomography (OCT) showed that the thickness of retinal nerve fiber layer (RNFL) in the inferior and temporal quadrant of the right eye decreased compared to that of the left side (**Fig. 2**). The patient was then sub-scribed for an orbital MRI examination.

The MRI examination was performed by a 3.0T MR system with an eight-channel head coil (Magnetom



Figure 1. Fundus photography examination of the right eye of a 36-year-old female. The right papilla optica presented pale on fundus photograph.

skyra, Siemens, Germany), with the patient in supine position. The MR imaging sequences included axial T2 weighted imaging (T2WI), axial T1 weighted imaging (T1WI), and contrast enhanced T1WI (CE-T1WI). The T1WI parameters of plain and contrast enhanced scan were as follows: repetition time (TR) 600 ms, echo time (TE) 9 ms, Flip angle 150°, field of view (FOV) 18 cm×18 cm, matrix 320×320, slice thickness 3 mm, number of averages 2. The parameters of the plain and CE-T2FLAIR were as follow: TR 8500 ms, TE 86 ms, inversion time (TI) 2500 ms, FOV 16 cm×16 cm, matrix 256×256, slice thickness 3 mm, pixel size 0.625×0.625 mm², number of averages 2. The contrast agent (Magnevist, 0.1 mmol/kg, Bayer Healthcare Pharmaceuticals Inc., NJ, USA) was manually injected intravenously. CE-T1WI and CE-T2FLAIR were reperformed 2 minutes sequentially after the administration of contrast agent.

On the axial T2WI, the right ION presented slightly swollen (diameter 3.8 mm) compared with the left ION (diameter 2.0 mm), and there was no evident abnormal signal observed. Post-contrast enhanced T1WI showed no abnormal enhancement of the right ION.

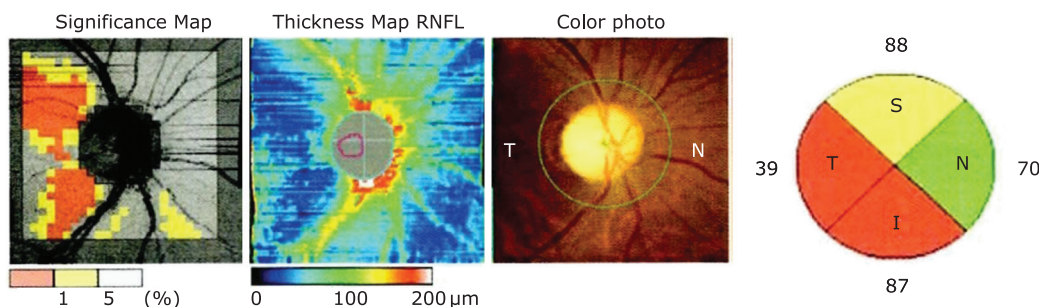


Figure 2. Optical coherence tomography (OCT) of the right eye. The thickness of periopic disc nerve fibers layer in the inferior and temporal quadrant decreased. T:temporal quadrant; N:nasal quadrant; S:superior quadrant; I:inferior quadrant.

The plain T2FLAIR demonstrated slight higher signal of the right ION compared with cerebral white matter. On the CE-T2FLAIR, the posterior two third of right ION presented significant contrast enhancement, while the left ION showed no enhancement (**Fig. 3**).

After admission, the patient received corticosteroid impulse therapy (methylprednisolone, 0.5 g/day, 3 days), followed by an oral adapter (starting dose 1 mg/kg/day), neurotrophic therapy (mouse nerve growth factor, 0.00003 g/day, 8 days), and microcirculation improving therapy by using extract of Ginkgo Biloba Leaves Injection (0.0875 g/day, 7 days). The visual acuity of the right eye improved from 0.12 on admission to 0.2 (tested by the standard table of vision logarithms at 5 m) when discharged.

DISCUSSION

In this case, the right ION did not presented enhancement on CE-T1WI, which suggested the right ION was not in active phase of optical neuritis according to the conventional understanding about typical MRI findings in the recurrent optic neuritis. The non-enhancement on CE-T1WI indicated that the blood-optic nerve barrier (BONB) was not destructed and had no MRI contrast leaking into the extracellular space according

to the conventional contrast enhancement theory.⁸

CE-T2FLAIR sequence did provide an opportunity to decode these complicated conditions. T2FLAIR sequence belongs to the inversion recovery (IR) pulse sequences, which has heavy T2WI effect associated with the long repetition time (TR), long echo time (TE), and a mild T1WI effect related with the long inversion time (TI).⁸ CE-T2FLAIR is sensitive to low concentration of contrast agent in tissue, and could present a contrast enhancement even when there is a negative enhancement on CE-T1WI. As described above, the right ION did present enhancement on CE-T2FLAIR without enhancement on CE-T1WI in this case, which indicated that the inflammation of the right ION was in active phase of optical neuritis. Moreover, the enhancement on CE-T2FLAIR also indicated the destructed BONB and the leakage of contrast agent into the extravascular extracellular space of the ION. Therefore, the quantitative dynamic contrast enhanced imaging¹¹ will be helpful to throw a light on the underlying neuromechanism.

According to the characteristics of high sensitivity of T2FLAIR to the low concentration of MRI contrast agent, CE-T2FLAIR had been used in the diagnoses and therapeutic evaluation of multiple sclerosis,^{9,12,13} meningeal disorders,¹⁴⁻¹⁸ small brain metastases,^{10,19,20} pituitary microadenoma,²¹ idiopathic sudden sensorineural hearing

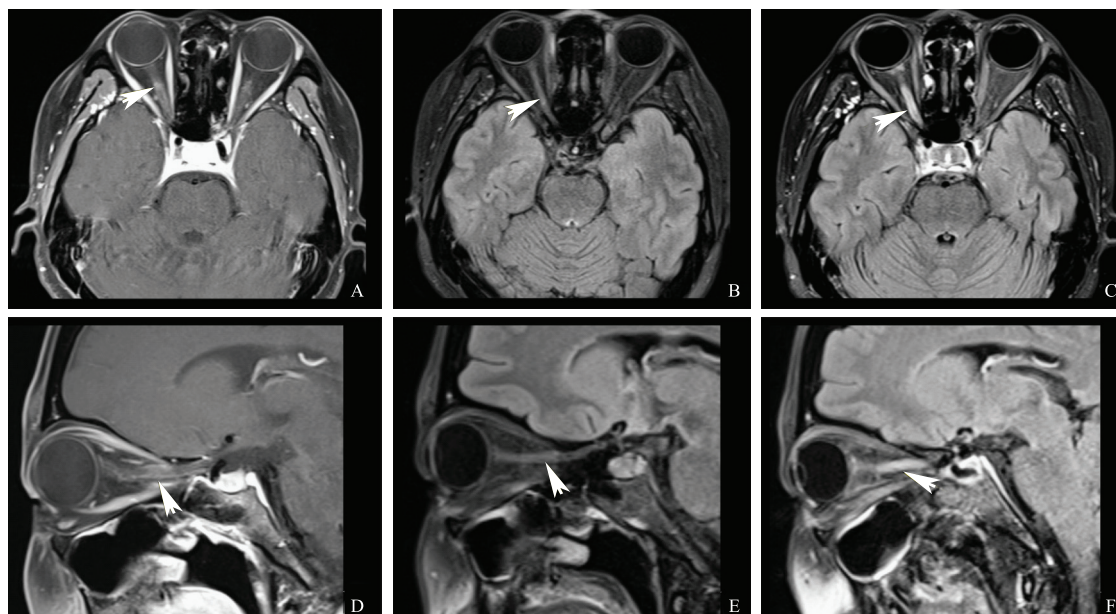


Figure 3. MR imaging findings in a 36-year-old woman with recurrent optic neuritis in the right intraorbital optic nerve (ION). A and D, axial and sagittal post-contrast T1WI; B and E, axial and sagittal pre-contrast T2FLAIR; C and F, axial and sagittal post-contrast T2FLAIR. The right ION presented no enhancement on CE-T1WI (A and D, arrowheads), slightly hyperintensity on pre-contrast T2FLAIR (B and E, arrowheads) images compared with the cerebral white matter, and significant enhancement on post-contrast T2FLAIR (C and F, arrowheads) images.

loss,²²⁻²⁸ inflammatory disorder of cranial nerve,^{8,29} uveitis³⁰ and cerebellar hemangioblastoma.³¹ For these disorders, CE-T2FLAIR not only help in early diagnosis of the disease, but also better delineation of the lesions, which may bring about prompt treatment and better prognosis.

Although the previous study had reported that CE-T2FLAIR could increase the sensitivity, specificity and accuracy of acute optic neuritis,³² the recurrent optic neuritis has not been evaluated by the CE-T2FLAIR by far. In this case, we successfully utilized the CE-T2FLAIR sequence to diagnose recurrent optic neuritis, and thus provided direct imaging evidence for the clinical diagnosis in this patient. Once the diagnosis of recurrent optic neuritis has been established, the glucocorticoid pulse therapy can be performed timely, and to save the visual acuity of the patient can be possible.

The current case study suggested a potential utility of CE-T2FLAIR in diagnosis of recurrent optic neuritis. The benefit of CE-T2FLAIR lies in the following aspects: 1. it can detect the lesion in early stage, especially for inflammatory diseases; 2. as a conventional MRI sequence which can be performed at any MRI scanner, it has a good feasibility in the clinical practice; 3. it could provide direct imaging evidence for the recurrence of optic neuritis. Further investigations using quantitative dynamic contrast enhancement are needed to explore the neuromechanism of enhancement on CE-T2FLAIR. Additionally, the relationship between CE-T2FLAIR findings and visual impairment should be studied in the future for the outcome prediction of recurrent optic neuritis.

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