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Original Article

Magnetic resonance imaging and clinical findings of pseudotumor-type cerebellar infarction

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Abstract: The present study aimed to investigate the value of magnetic resonance imaging (MRI) and clinical features in the diagnosis of pseudotumor-type cerebellar infarction. A total of 18 patients with pseudotumor-type cerebellar infarction were retrospectively analyzed. These patients with cerebellar infarcts presented with non-specific symptoms, including dizziness, nausea, vomiting, unsteady gait, and headache. All patients underwent MRI examination. Fifteen patients received diffusion weighted imaging (DWI) sequence scanning, and 7 patients received contrast mediumen hanced MRI scanning. Infarcts affected one or more of the 3 major cerebellar perfusion territories. Posterior inferior cerebellar artery (PICA) perfusion territory was involved in 12 patients (66.7%). The signal intensities were almost hypointense on T1WI in 16 patients and hyperintense on T2WI in 16 patients. On DWI, the signal intensities of infarcts were almost bright areas on DWI with low signal on apparent diffusion coefficient (ADC) maps due to restricted diffusion (14 cases). On contrasten hanced T1WI, thin line-like enhancement was present in 4 cases. This study demonstrated pseudotumor-type cerebellar infarction usually do not cause diagnostic difficulties due to the characteristic MRI features. Nevertheless, it should be noted that imaging findings may become atypical due to non-specific clinical findings and/or delays on MRI, which may cause misdiagnosis. Thus, MRI should be performed as soon as possible if pseudotumor-type cerebellar infarction is suspected by clinicians.

Keywords: Cerebellum, pseudotumor type, magnetic resonance imaging, clinical

Introduction

Cerebellar infarction represents 3% of all ischemic strokes [1, 2]. Because of nonspecific symptoms [3, 4], an ischemic stroke within the cerebellum presents a clinical diagnostic challenge. Brain CT is the most widely available and commonly used initial radiological technique in the evaluation of patients with suspected stroke [5, 6], but some patients would further examine using MRI to make a definite diagnosis due to insufficient diagnostic sensitivity of brain CT [6, 7]. Because of the difficulty of rapidly diagnosing a cerebellar stroke and then a "missed opportunity" for thrombolysis or early preventative interventions to reduce the risk of recurrent stroke, some cerebellar infarctions progress to a space-occupying cerebellar infarction (also called pseudotumor type), necessitating surgical decompression. In general, large cerebellar infarcts usually do not cause diagnostic difficulties if accompanied by multifocal posterior cerebral artery territory and/or brainstem infarction. However, the diagnosis of a pseudotumor-type cerebellar infarction can be challenging, which maybe misdiagnosed as cerebellar glioma. A delay in diagnosis may be associated with morbidity and mortality [8], but few studies have exclusively clarified the characteristic MRI features of pseudotumor-type cerebellar infarction. Therefore, the present study aimed to document the MRI and clinical features of pseudotumor-type cerebellar infarction by conducting a retrospective MRI and clinical review of 18 patients that received a diagnosis of pseudotumor-type cerebellar infarction.

Materials and methods

The present study retrospectively reviewed the MR images of 18 patients which were finally

Table 1. Baseline characteristics and symptoms of patients with pseudotumor-type cerebellar infarctions

	All Patients (n=18)
Baseline characteristics	
Age-Mean ± SD	61.7± 16.3 years
Sex, n (% male)	15(83.3)
Hypertension, n (%)	12/18 (66.7)
Diabetes, n (%)	5/18 (27.8)
Dyslipidemia, n (%)	4/18 (22.2)
Atrial Fibrillation, n (%)	4/18 (22.2)
Symptoms	
Headache, n (%)	4/18 (22.2)
Nausea, n (%)	8/18 (44.4)
Vomiting, n (%)	7/18 (38.9)
Dizziness, n (%)	11/18 (61.1)
Change in speech, n (%)	4/18 (22.2)
Weakness, n (%)	5/18 (27.7)
Vertigo, n (%)	3/18 (16.7)
Gait disturbance, n (%)	5/18 (27.7)

diagnosed as pseudotumor-type cerebellar infarction, who were treated and histologically diagnosed at The Second Affiliated Hospital of Zhejiang University School of Medicine (Hangzhou, China) between January 2014 and January 2017. Patients with infarcts in other areas, in addition to their cerebellar infarcts, were excluded.

MRI was performed using a 1.5T Siemens Sonata MRI scanner. All 18 patients underwent conventional MR sequences axial T1-weighted imaging (T1WI) with the following scan parameters [repetition time/echo time (TR/TE), 1450/11 msec; slice thickness, 6.0 mm; field of view, 230 mm; matrix scan, 256×256]; axial T2-weighted imaging (T2WI) with the following scan parameters (TR/TE, 3700/93 msec; slice thickness, 6.0 mm; field of view, 230 mm; matrix scan, 320×320); and T2WI-Fluid Attenuated Inversion Recovery (T2WI-FLAIR) with the following scan parameters (TR/TE, 7800/104 msec; slice thickness, 6.0 mm; field of view, 230 mm; matrix scan, 256×256). A total of 63 patients underwent the axial Diffusion Weighted Imaging (DWI) sequence with the following scan parameters (TR/TE, 3100/84 msec; slice thickness, 6.0 mm; field of view, 230 mm; matrix scan, 128×128). Axial contrast-enhanced T1WI was repeated after intravenous administration of 0.1 mmol/kg of gadolinium contrast with gadopentetate dimeglumine in 7 patients.

Diagnostic criteria of pseudotumor-type (space-occupying) cerebellar infarction: the large infarction of the cerebellum was accompanied by one of the following conditions: (1) fourth ventricle shift; (2) obstructive hydrocephalus; (3) basal cistern inclined or deformed; or (4) progressive enlargement of the lateral ventricle upon follow-up examination. Patients with infarcts in other areas, in addition to their cerebellar infarcts, were excluded.

Results

A total of 18 individuals with pseudotumor-type cerebellar infarctions were identified. The group included 15 males (83.3%) and 3 females (16.7%) with a mean age of 61.7 years (± 16.3years) and a range between 25 and 91 years. These patients with cerebellar infarcts presented with non-specific symptoms, including dizziness, nausea, vomiting, unsteady gait, and headache. Detailed demographic information and symptoms were summarized in **Table 1**. The duration of symptoms prior to diagnosis was with a range from 4 hours to 15 days. Of 18 cases, 1 patient died due to complication, 3 patients received surgery due to the preoperative misdiagnosis as cerebellar glioma, and the other 14 patients got better after being treated conservatively.

All 18 patients with pseudotumor-type cerebellar infarction were examined using MRI with 15 patients receiving diffusion weighted imaging (DWI) sequence scanning, and 7 patients receiving contrast mediumen hanced MRI scanning. Infarcts affected one or more of the 3 major cerebellar perfusion territories, including posterior inferior cerebellar artery (PICA, 7 cases), anterior inferior cerebellar artery (AICA, 1 case), superior cerebellar artery (SCA, 5 cases), PICA+AICA (2 cases), PICA+ SCA (1 case) and PICA+AICA+SCA (2 cases). PICA perfusion territory was involved in 12 patients (66.7%). Infarcts affected the left cerebellum (8 cases), right cerebellum (8 cases), and bilateral cerebellum (2 cases). On the T1 weighted image (WI), the signal intensities were almost hypointense in 16 patients (**Figures 1A** and **2A**) and were heterogeneously mixed with hypointense and hyperintense (**Figure 3A**) in 2 patients. On the T2WI, the signal intensities were hyperin-

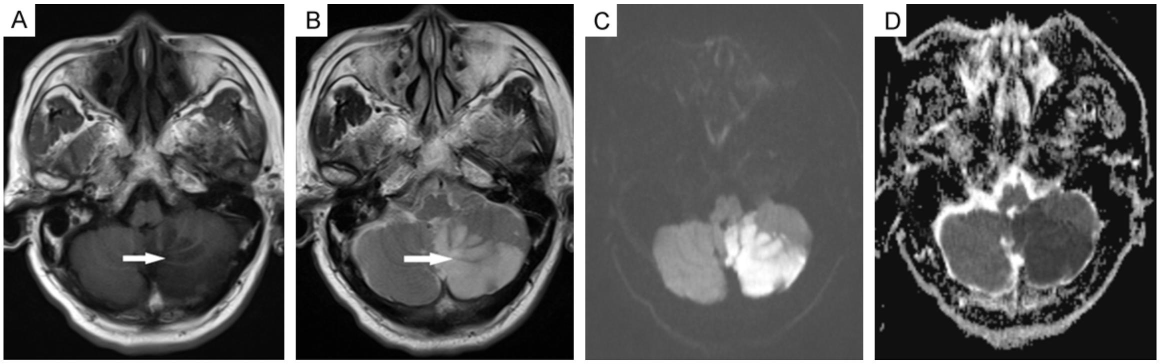

Figure 1. Male, 65 years old, pseudotumor-type cerebellar infarction in PICA perfusion territory. (A) On T1WI, the signal intensities were almost hypointense. (B) On T2WI, the signal intensities were hyperintense.Cerebellar sulcus was observed on both T1WI and T2WI (arrows). On the DWI, the signal intensities of infarcts were almost bright areas on DWI (C) with low signal on ADC maps (D).

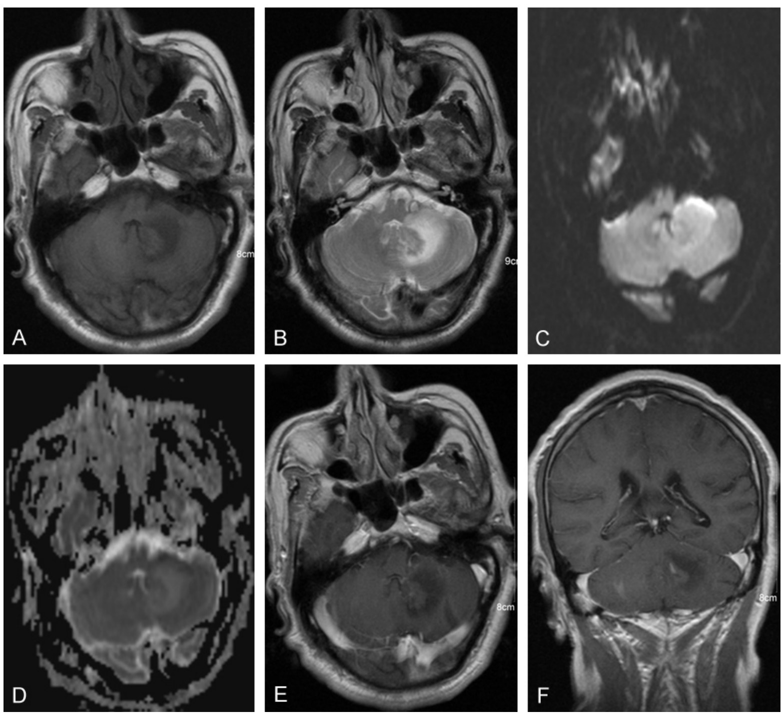

Figure 2. Male, 64 years old, pseudotumor-type cerebellar infarction in SCA perfusion territory. (A) On T1WI, the signal intensities were almost hypointense. (B) On T2WI, the signal intensities were hyperintense. On DWI, the signal intensities of infarcts were slightly high signal on DWI (C) with high signal on ADC maps (D). (E, F) On contrasten hanced T1WI, slight nodule-like enhancement was present.

tense in 16 patients (**Figures 1B** and **2B**), and heterogeneously mixed with hyperintense and hypointense (**Figure 3B**) in 2 patients due to hemorrhagic transformation after infarction. On both T1WI and T2WI, cerebellar sulcus were observed in 13 cases (**Figure 1A** and **1B**). On the DWI, the signal intensities of infarcts were almost bright areas on DWI (**Figure 1C**) with low signal on apparent diffusion coefficient (ADC) maps (**Figure 1D**) due to restricted diffusion in 14 cases. There was a slightly high signal on DWI (**Figure 2C**) with high signal on ADC maps in 1 case (**Figure 2D**). On contrasten hanced T1WI, thin line-like enhancement presented in 4 cases (**Figure 3C** and **3D**); heterogeneously marked mass-like enhancement presented in 2 cases (**Figure 4A** and **4B**); slight nodule-like enhancement presented in 1 case (**Figure 2E** and **2F**).

Discussion

Cerebellar infarcts typically present with non-specific symptoms such as dizziness, nausea, vomiting, unsteady gait, and headache [9]. These may mimic benign conditions such as viral gastroenteritis or labyrinthitis. The first case reports involving patients with space-occupying cerebellar infarcts date back to the end of the 19th century [10]. The exact number of patients who develop space-occupying edema after cerebellar infarction is not known. A previous study demonstrated that 50% of patients who developed radiographic evidence

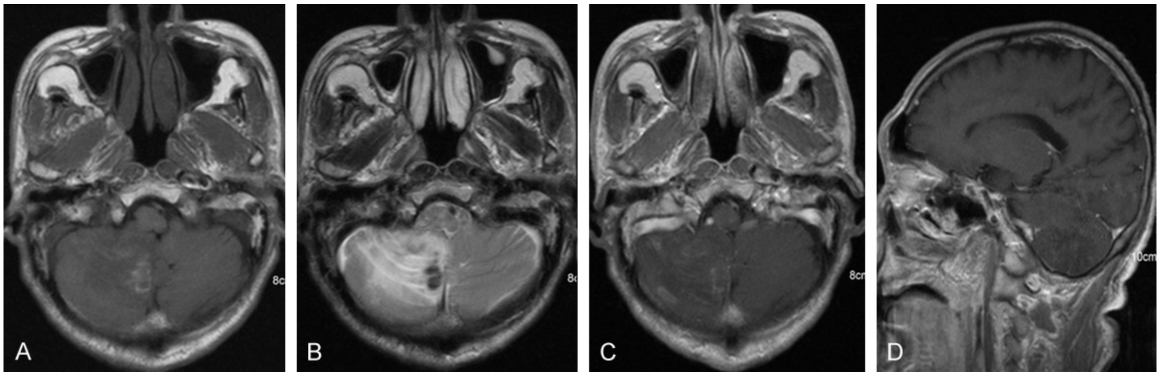

Figure 3. Male, 76 years old, pseudotumor-type cerebellar infarction in PICA perfusion territory. A. On T1WI, were heterogeneously mixed with hypointense and hyperintense. B. On T2WI, the signal intensities were heterogeneously mixed with hyperintense and hypointense. C, D. On contrasten hanced T1WI, thin line-like enhancement was present.

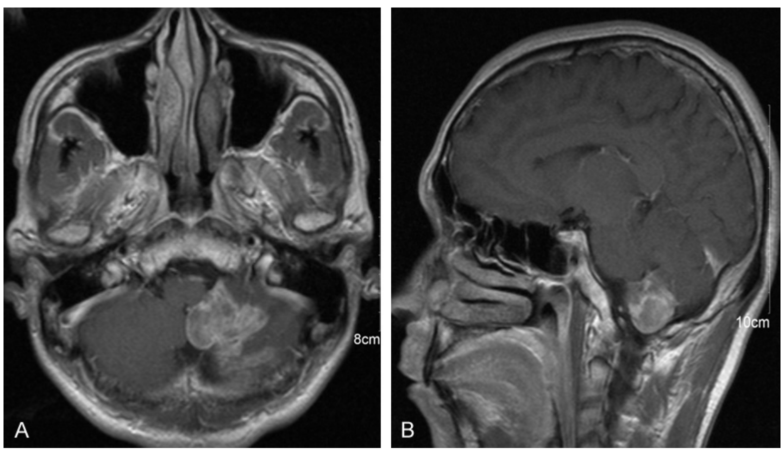

Figure 4. Male, 42 years old, pseudotumor-type cerebellar infarction in PICA perfusion territory. A, B. On contrasten hanced T1WI, heterogeneously marked mass-like enhancement was present.

of mass effect showed subsequent clinical deterioration [11]. The diagnosis of cerebellar infarctions can be challenging, as the commonly associated clinical signs and symptoms and the unfound reliance on a negative CT scan [12] may not necessarily alert a physician to a stroke. Large cerebellar infarctions prone to space-occupying edema formation (pseudotumor-type cerebellar infarction) are often not recognized until complications due to mass effect become evident with clinical deterioration. The most feared complications in the posterior fossa are brainstem compression and occlusive hydrocephalus. Thus, proper understanding of the presentation of pseudotumor type of cerebellar infarctions on MRI is an important issue.

The cerebellum mainly receives arterial blood supply from 3 paired cerebellar arteries, including PICA, AICA, and SCA. Large cerebellar infarcts with obvious space-occupying effects on MRI is called pseudotumor-type cerebellar infarction, which typically affect one or more of the 3 major cerebellar perfusion territories (PICA, AICA, and SCA). PICA is the largest branch of vertebral artery intracranial section and the predilection site of thrombus and embolism. In the present study, PICA perfusion territory was the most common sites of involvement (12 patients, account for 66.7%). Acute cerebellar infarcts are usually readily high signal on DWI with low signal on ADC maps due to restricted diffusion. DWI becomes positive within minutes after the onset of infarction due to cytotoxic oedema [13]. In the following hours, infarcts become hyperintense on FLAIR and T2-weighted images (T2WI). It should be noted that T2WI are preferred as FLAIR images are often false negative in the posterior fossa because of local field heterogeneities [14]. At about 3 days, brain swelling reaches the peak. Then during the following 4-7 days, infarcts considerably diminish in size and diffusion normalizes after around 10 days (1-4 weeks) [13]. In the present study, 14/15 cases were observed with restricted diffusion and these patients were examined by MRI within 10 days after infarct. Nevertheless, the signal intensities were hyperintense in 16/18 patients on T2WI in our series. Thus, it can be concluded that MRI provides the greatest diagnostic yield when performed as soon as possible (certainly within a few days) of symptom onset. On both T1WI and T2WI, cerebellar sulcus within infarcts areas were observed in 13/18 cases. This importantsign may help us to distinguish pseudotumor-type cerebellar infarction from space-occupying cerebellar tumor. Subacute infarcts may become isointense and therefore nearly invisible on different MRI sequences around 10 days, a phenomenon known as "fogging", which corresponds to the occurrence of necrosis, angiogenesis, and microglia/macrophage infiltration [15, 16]. In this stage, infarcts may be best seen as areas of parenchymal contrast enhancement, which appear around 1 week and may be visible up to 8 weeks to 4 months after infarction. Afterwards, both small and large cerebellar infarcts tend to heal with cavitation, leaving a cerebrospinal fluid-filled cavity surrounded by a rim of gliosis [17]. In our group, 3 cases were misdiagnosed as cerebellar glioma (**Figure 2**). MRI examination was performed in these cases at 10 days later after infarct. Therefore, the signal intensities of the infarct with slightly high signal on DWI (**Figure 2C**) with high signal on ADC maps (**Figure 2D**) are due to occurrence of necrosis. In our opinion, the contrast-enhanced nodule (**Figure 2E**) may be formed by microglia/macrophage infiltration, which led us to make a misdiagnosis of cerebellar glioma. Thus, radiologists and clinicians should acknowledge these atypical imaging findings of pseudotumor-type cerebellar infarction due to non-specific clinical findings and/or delays (10 days later after symptoms appear) on MRI to avoid misdiagnosis and give appropriate treatment without delay.

On MRI, pseudotumor-type cerebellar infarction has the characteristic MRI feature of vascular distribution in a typical perfusion territory, which is easily recognized and reflects the name of the cerebellar artery by which it is supplied. PICA perfusion territory is the most common site of involvement. In the acute stage, DWI allows for excellent visualization of acute cerebellar infarcts. Cerebellar sulcus within infarct areas is usually observed, which is an important sign may help us to distinguish pseudotumor-type cerebellar infarction from space-occupying cerebellar tumor. Nevertheless, it should be noted that imaging findings may become atypical due to non-specific clinical findings and/or delays (10 days later after symptoms appear) on MRI, which may cause misdiagnosis. Thus, if pseudotumor-type cerebellar infarction is suspected by clinicians, MRI should be performed promptly.

Disclosure of conflict of interest

None.

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