Symmetrical Lesions of the Middle Cerebellar Peduncle: MR Imaging and Differential Diagnosis

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The purpose of this paper is to show several diseases that manifest symmetrical hyperintense lesions on the middle cerebellar peduncles, the largest connecting peduncles between the brainstem and the cerebellum, in conventional magnetic resonance (MR) images. We retrospectively reviewed cranial MR images obtained with 0.3-, 0.5-, 1.0-, and 1.5-Tesla scanners. We found symmetrical middle cerebellar peduncular lesions in patients with Wilson's disease; hepatic encephalopathy; extrapontine myelinolysis; acute disseminated encephalomyelitis; wallerian degeneration of the pontocerebellar tracts after either pontine infarction, pontine hemorrhage, or central pontine myelinolysis; leukodystrophy; olivopontocerebellar atrophy; and toluene abuse. Definitive diagnosis of these diseases can be made relatively easily on the basis of clinical data; however, examination of associated brainstem or supratentorial lesions in MR images is also important.

Keywords: middle cerebellar peduncle, pontocerebellar tract, demyelinating disease, magnetic resonance imaging

Introduction

The middle cerebellar peduncles are the largest connecting peduncles between the brainstem and the cerebellum. The corticopontine tracts synapse with the ipsilateral pontine nuclei. The axons of the pontine nuclei cross the midline of the pons and pass through the contralateral middle cerebellar peduncles to reach the cerebellar cortex. These large tracts of white matter are affected by various demyelinating processes because they comprise predominantly myelinated axons. Okamoto et al. recently reported magnetic resonance (MR) features of diseases involving bilateral middle cerebellar peduncles. They reported symmetrical middle cerebellar peduncular lesions in neurodegenerative diseases and metabolic diseases. We found similar lesions in some other diseases. Our paper displays the conventional MR images of ten patients, each with a different disease, who have a symmetrical lesion bilaterally on the middle cerebellar peduncles.

Wilson's disease (hepatolenticular degeneration)

Basal ganglia, thalami, and dentate nuclei are frequently bilaterally affected in Wilson's disease. In some patients, the middle cerebellar peduncles are also affected bilaterally (Fig. 1). However, the possibility exists that the lesion in our case is degeneration secondary to chronic hepatic failure, as described below.

Hepatic encephalopathy

T1-weighted MR images in patients with a portosystemic shunt, such as those with advanced stage liver cirrhosis, generally show hyperintense lesions in the basal ganglia, midbrain, and pituitary gland due to manganese deposition. In some patients, however, there are hyperintense lesions in the pyramidal tracts and in the middle cerebellar peduncles in T2-weighted MR images (Fig. 2). While the reason for this hyperintensity is unclear, it could be a demyelinating process such as extrapontine myelinolysis (see below). Clinical data suggestive of severe liver dysfunction are important for a definitive diagnosis.

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Extrapontine myelinolysis

Osmotic myelinolysis is one of the severe complications of alcohol abuse, and its mechanism is the too-rapid correction of severe hyponatremia. Central pontine myelinolysis is the most common form of this disease. Extrapontine myelinolysis commonly occurs symmetrically in the thalami and basal ganglia. However, the middle cerebellar peduncles can be affected with or without a pontine lesion. Our patient had both central pontine and bilateral middle cerebellar peduncular lesions (Fig. 3).

Acute disseminated encephalomyelitis (ADEM)

Both ADEM and multiple sclerosis can involve a middle cerebellar peduncle; however, most patients with these demyelinating diseases have unilateral or asymmetrical lesions. We observed only one patient
Fig. 3. Extrapontine myelinolysis in a 50-year-old man with alcoholism.

**a, b:** Axial T2-weighted (a TR/TE, 4000/80) and T1-weighted (b 550/9) images at the level of the lower pons show a definite oval lesion bilaterally in the middle cerebellar peduncles (1.5T scanner). c: An axial T2-weighted image at the level of the upper pons shows a hyperintense lesion in the central basis pontis, indicative of central pontine myelinolysis.

Fig. 4. Acute disseminated encephalomyelitis in a 20-year-old woman.

**a, b:** Axial T2-weighted (a TR/TE, 4000/104) and T1-weighted (b 616/12) images obtained two months after onset show a cavitory oval lesion bilaterally in the middle cerebellar peduncles (1.5T scanner). The pons is also involved.

**c:** An axial T2-weighted image shows multiple small hyperintense lesions in the cerebral white matter, suggestive of demyelinating foci.

with ADEM who had symmetrical bilateral middle cerebellar peduncular lesions (Fig. 4).

**Wallerian degeneration after pontine infarction and hemorrhage**

Approximately one month after a large ventromedial pontine infarction or large basis pontis...
Fig. 5. Wallerian degeneration of the pontocerebellar tract after pontine infarction in a 65-year-old woman

a–c: Axial T₂-weighted (a, b TR/TE, 4000/104) and fluid-attenuated inversion recovery (FLAIR) (c TR/TI/TE, 10002/2200/133) images obtained three months after ictus show a left ventromedial upper pontine infarction and an oval lesion bilaterally in the middle cerebellar peduncles, indicative of wallerian degeneration (1.5T scanner). An incidental meningioma was found in the left parasellar region. In T₁-weighted images, no apparent abnormality was seen in the middle cerebellar peduncle (not shown).

Fig. 6. Wallerian degeneration of the pontocerebellar tract after pontine hemorrhage in a 66-year-old man

a: A computed tomography scan obtained at the time of onset shows a large pontine hemorrhage. b, c: Axial T₂-weighted (TR/TE, 4000/117) images obtained 11 months after ictus show a faint oval lesion bilaterally in the middle cerebellar peduncles, indicative of wallerian degeneration (0.3T scanner). In T₁-weighted images, no apparent abnormality was seen in the middle cerebellar peduncle (not shown).
hemorrhage, a faint symmetrical hyperintense lesion may develop at the midportion of the bilateral middle cerebellar peduncles in $T_2$-weighted MR images. These lesions are regarded as wallerian degeneration of the pontocerebellar tracts (Figs. 5, 6). Even if the initial pontine lesion is unilateral, this degeneration always develops bilaterally and symmetrically because the pontocerebellar tracts cross the midline at the basis pontis. An associated pontine lesion is the key to a definitive diagnosis of this type of wallerian degeneration of the pontocerebellar tracts. The characteristic MR finding of this wallerian degeneration is a faint oval lesion located at the central portion of the middle cerebellar peduncle.

**Wallerian degeneration after central pontine myelinolysis**

By the same mechanism mentioned above, symmetrical middle cerebellar peduncular lesions occur in patients with central pontine myelinolysis in the chronic stage (Fig. 7). Differential diagnosis of extrapontine myelinolysis and wallerian degeneration after central pontine myelinolysis can be difficult, but the lesions of wallerian degeneration may be fainter than those of extrapontine myelinolysis.

**Leukodystrophy**

Several types of leukodystrophy exist, but all show a characteristic distribution of white matter degeneration. In most types of leukodystrophy, the middle cerebellar peduncle is not affected, but in a minority of patients the middle cerebellar peduncle may also be affected (Fig. 8). Other family members had similar symptoms; however, because gene analysis was not performed, our patient was not proven to have a specific type of leukodystrophy.

**Neurodegenerative diseases**

Symmetrical atrophy of the middle cerebellar peduncle can be seen in multiple system atrophy and spinocerebellar degeneration. In patients with these diseases, diffusely but minimally increased signal intensity may be seen in the middle cerebellar peduncle in $T_2$-weighted images. Olivopontocerebellar atrophy (OPCA), Shy-Drager syndrome
Fig. 8. Adult-onset autosomal-dominant leukodystrophy in a 69-year-old woman
a: An axial FLAIR (TR/T1/TE, 10002/2200/125) image shows an oval lesion bilaterally in the middle cerebellar peduncles (1.5T scanner). The pons is also affected. b, c: FLAIR images at the level of the upper brainstem (b) and corona radiata (c) show hyperintense lesions in the cerebral peduncle and superior cerebellar peduncle—and diffusely in atrophic cerebral white matter—indicative of leukodystrophy.

Fig. 9. Olivopontocerebellar atrophy (OPCA) in a 53-year-old woman
a: An axial T1-weighted (TR/TE, 2000/80) image (1.5T scanner) shows a subtle hyperintense lesion bilaterally in the middle cerebellar peduncles (arrows). Because the transverse pontine fibers are affected, the pons has the “cross sign” suggestive of OPCA. b, c: Axial T1-weighted (b 4000/80) and T2-weighted (c 500/9) images obtained seven years later show markedly atrophic pons, middle cerebellar peduncles, and cerebellum.

(SDS), and striatonigral degeneration (SND) are major clinical subtypes of multiple system atrophy. According to Okamoto et al.,1 the bilateral middle cerebellar peduncles are more frequently and severely affected in OPCA than in SDS or SND. In our experience, the lesions observed in the middle cerebellar peduncles were subtle during the early clinical stage of OPCA (Fig. 9).
Toluene abuse

A patient with a history of toluene abuse and with neurological signs and symptoms shows diffuse hyperintense white matter lesions, including lesions in the middle cerebellar peduncles, in T1-weighted and fluid-attenuated inversion recovery (FLAIR) MR images (Fig. 10). Toluene has an affinity to myelin lipids, resulting in widespread demyelination. An accurate case history is essential for a correct diagnosis of toluene abuse.

Other possible lesions

Other rare metabolic disorders and toxic diseases should be considered if bilateral middle cerebellar peduncular lesions are observed in MR images. Bilateral middle cerebellar peduncular lesions can be seen in patients with bilateral infarctions of the anterior inferior cerebellar artery territories. Hypertensive encephalopathy, metastatic brain tumors, meningeal carcinomatosis, lymphoma, gliomatosis, encephalitis, brain abscesses, and other multiple brain lesions can also be seen bilaterally in the middle cerebellar peduncles. However, the majority of these lesions are asymmetrical.

Conclusions

Several different diseases manifest symmetrical middle cerebellar peduncular lesions. Although differential diagnosis of these diseases is clinically easy, examination of the associated brainstem and supratentorial lesions in MR images is also important for correct diagnosis.

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References

