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CLINICAL IMAGE

# Amide Proton Transfer Imaging of Cavernous Malformation in the Cavernous Sinus

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**Keywords:** *amide proton transfer imaging, chemical exchange saturation transfer, cavernous malformation*

Amide proton transfer (APT) imaging is an emerging molecular MRI technique based on chemical exchange saturation transfer where the imaging contrast is generated by endogenous mobile proteins and peptides. Previous studies have shown that APT signal increases with increasing malignancy grade of gliomas, hypothetically reflecting abundant cytosolic protein due to high cellularity. Cavernous malformation is rare, highly vascular benign lesion that has very low cellularity. Here, we report a cavernous malformation that showed markedly high APT signal.

A 70-year-old woman presented with left facial discomfort and progressive loss of vision in the left eye for 6 months. Magnetic resonance imaging was performed using a 3T scanner (Ingenia 3.0T; Philips Healthcare, Best, The Netherlands) equipped with dual-source parallel radiofrequency transmission system and a 15-channel head coil for signal reception, which revealed a left cavernous sinus mass with hypointensity on $T_1$-weighted imaging, marked hyperintensity on $T_2$-weighted imaging, and strong homogenous enhancement after contrast injection (Fig. 1).

Amide proton transfer imaging based on two-dimensional single slice single-shot turbo spin-echo technique was performed: TR, 4550 ms; TE, 4.8 ms; flip angle 90°; turbo factor 128; number of signal averaging, 1; FOV, 230 × 230 mm$^2$; imaging matrix, 128 × 128 (reconstructed in 256 × 256); slice thickness, 5 mm. A quasi-continuous saturation pulse with an amplitude of 2 μT and a duration of 2 s (40 × 50 ms, sin *c*-Gaussian elements) was applied at 27 offset frequencies including 24 ranging from +6 to −6 ppm with a step of 0.5 ppm and 2 at ±9.6 ppm as well as one far off-resonance frequency (−1560 ppm) for signal normalization. During postprocessing, the $B_0$ field inhomogeneity was corrected on a voxel-by-voxel basis using a separately obtained map of $B_0$. The APT images were obtained by calculating the magnetization transfer ratio asymmetry ($MTR_{asym}$) between ±3.5 ppm using the $B_0$-corrected MT-spectrum:

$$MTR_{asym}\ (3.5\ ppm) = (S_{-3.5\ ppm} - S_{3.5\ ppm})\ /S_0 \times 100\ (\%),$$

where $S_{\pm 3.5\ ppm}$ and $S_0$ represent signal intensities at ±3.5 ppm and −1560 ppm, respectively. The intratumoral APT signal ($MTR_{asym}$ at 3.5 Vppm) was 6.9%, which is substantially higher than that in the contralateral normal-appearing tissue (0.8%) (Fig. 2) and also, par or even higher than the values previously reported for glioblastomas (typically, 4–5%). The mass was partially resected. Histopathological examination revealed a cavernous malformation.

We speculate that the high APT signal in the cavernous malformation is attributable to the blood filling multiple dilated vascular channels in the lesion, which contains various

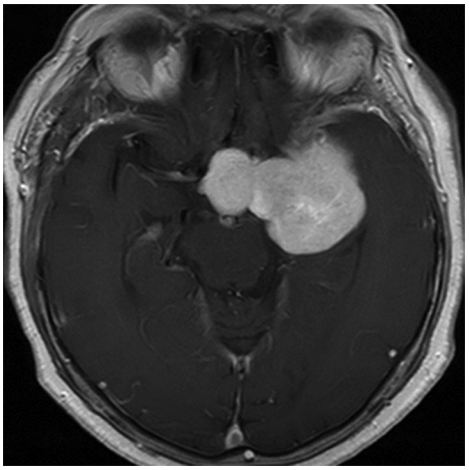

**Fig. 1** Axial $T_1$-weighted gadolinium-enhanced MR image reveals a dumbbell-like mass with strong and homogenous enhancement in the left cavernous sinus.

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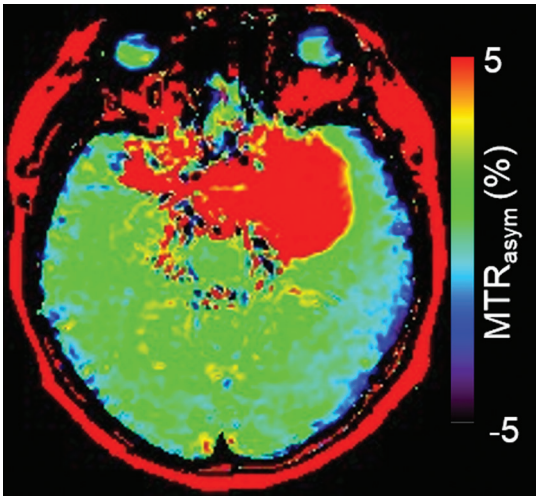


**Fig. 2** The amide proton transfer (APT) image shows markedly high APT signal (mean, 6.9%) in the lesion. The mean APT signal in the contralateral normal appearing white matter is 0.8%.

proteins and peptides like albumin.[1] Using a 3T clinical scanner, Zheng et al. reported that porcine whole blood samples showed large $MTR_{asym}$ up to almost 10%, peaking around 3 ppm.[2] Jeong et al. have shown that a high APT signal can be seen in acute hemorrhage.[3] The markedly high APT signal may help differentiate cavernous malformation from other tumors in this location, such as neurinoma and meningioma. Moreover, our case suggests that, in addition to cytosolic proteins and acute hemorrhage, blood in tumor vessels may be a major source of the APT signal in hypervascular tumors.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

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