The Characteristics of Amide Proton Transfer MR Imaging of Human Brain Tumors
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TARGET AUDIENCE
Radiologists and oncologists who are interested in molecular imaging of brain tumors using a new MRI contrast mechanism.

PURPOSE
To evaluate the potential of newly developed, cellular protein-based Amide Proton Transfer (APT) MR imaging1,2 in diagnosis and differential diagnosis among meningiomas, metastasis and different grades of glioma.

METHODS
65 patients with brain tumors, including 22 meningiomas, 11 metastases and 32 gliomas (10 low-grade and 22 high-grade gliomas), were scanned on a Philips 3T MRI scanner using APT and several other conventional MRI sequences. The APT imaging protocol3 was: RF saturation power = 3 μT; saturation time = 500 ms; slice thickness = 6 mm; matrix = 128x64; FOV = 240x240 mm². For quantitative analysis, three ROIs were drawn according to Gd-enhanced T1w and T2w images, and areas of Gd enhancement were defined as the tumor core. The APT image was calculated and displayed in color by a PC, using a window of -5% to 5%. The average APT signal intensities and corresponding 95% confidence intervals were calculated for each ROI of each tissue group (meningiomas, metastases, low-grade gliomas and high-grade gliomas). Statistical differences were calculated using the one-way ANOVA test.

RESULTS
APT imaging of different brain tumors: Fig.1 shows the typical MRI results of 4 patient groups. Gd-T1w imaging reveals Gd-enhancing tumor cores (red arrow) of different groups of brain tumors (meningiomas, metastases and high-grade gliomas). On the APT images, these tumor cores were hyperintense (red arrow). No increased high signals were observed in both the APT and Gd-T1w images of low-grade glioma (Fig.1C). Fig.2 shows the results of two metastatic tumors with different APT intensities. Both tumors were heterogeneously hyperintense in the Gd-T1w images (red arrow) and T2w images, but with obviously different intensities in APT imaging, which is hyperintense in case 1 and hyperintense to isointense in case 2.

Data analysis: The average APT signal intensities of the viable tumor cores for all patient groups were significantly higher than those of peritumoral edema or CNAWM (P<0.001). The average APT signal intensities of the peritumoral edema were significantly higher than those of CNAWM (P<0.001). The APT intensities of tumor cores were significantly higher in meningiomas, metastases, and high-grade gliomas (P<0.001) than those in low-grade glioma (Fig.3A). No significantly different between high-grade gliomas and meningiomas (P=0.339) or between high-grade gliomas and metastases (P=0.859) were observed in tumor cores. However, the APT signal intensities of edema was significantly higher in high-grade gliomas than in meningiomas (P<0.001, probably reflecting tumor invasion), but not significance difference with metastasis (P=0.328).

DISCUSSION
APT imaging as an endogenous contrast mechanism for MRI is sensitive to endogenous cytosolic proteins in tissue through saturation of the amide protons in the peptide bonds1,2. APT-MR imaging can detect meningiomas, metastases, and high-grade gliomas. However, our initial study shows that it may be difficult to differentiate these three tumor types using APT imaging, probably due to the diverse manifestations and tissue types of metastases (Fig.2). The APT signal may be related to the cellularity, microvessels and other tissue factors, and a further MRI-pathology correlation study is required to understand our MRI findings.

CONCLUSION
Our study shows that APT-MR imaging is feasible in brain tumor detection and has the potential to identify tumor heterogeneity using the endogenous contrast mechanism.

REFERENCES