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 imaging[1,2] 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 protocol[3] was: RF saturation power = 3 μT; saturation time = 500 ms; slice thickness = 6 mm; matrix = 128×64; FOV = 240×240 mm^2. For quantitative analysis, three ROIs were drawn according to Gd-enhanced T_1w and T_2w 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 imaging 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.

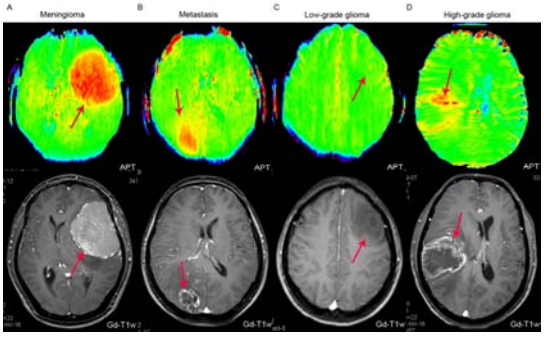

Fig. 1 APT and Gd-T_1w imaging features of different tumor types. The Gd-enhancing tumor cores showed high APT signals, except the low-grade glioma (showing no Gd enhancement and a low APT signal).

RESULTS

APT imaging of different brain tumors: Fig.1 shows the typical MRI results of 4 patient groups. Gd-T_1w 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-T_1w 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-T_1w images (red arrow) and T_2w images, but with obviously different intensities in APT imaging, which is hyperintense in case 1 and hyperintense to isointense in case 2.

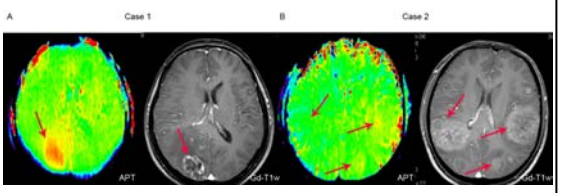

Fig. 2 Two brain metastases from lung adenocarcinoma showed very different APT features. The Gd-enhancing tumor core (red arrow) was hyperintense in case 1 (A) and hyperintense to isointense in case 2 (B) in APT imaging.

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 gliomas (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).

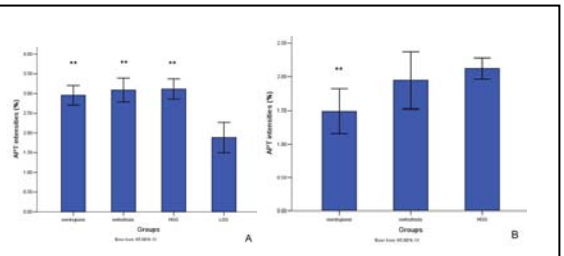

Fig. 3 (A) Mean APT intensities of tumor cores for four groups. APT intensities of tumor cores were significant higher in meningiomas, metastases and high-grade gliomas than in low-grade gliomas (all p<0.01). (B) Mean APT intensities of peritumoral edema. There was a significant difference between meningiomas and high-grade gliomas (p<0.01).

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 bonds[1,2]. 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

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