Amide proton transfer imaging

Amide proton transfer (APT) imaging is a Molecular magnetic resonance imaging technique to detect endogenous mobile proteins and peptides through chemical exchange saturation transfer.

Amide proton transfer (APT) imaging is one subset of CEST imaging that refers specifically to chemical exchange between protons of free tissue water (bulk water) and amide groups (−NH) of endogenous mobile proteins and peptides. It has been reported that such exchangeable protons are more abundant in tumor tissues than in healthy tissues [1].

Differentiation between hemangioblastoma and brain metastases remains a challenge in neuroradiology using conventional MRI. Amide proton transfer imaging can provide unique molecular information. A study by Kamimura et al. from Kagoshima aimed to evaluate the usefulness of APT imaging in differentiating hemangioblastomas from brain metastases and compare APT imaging with diffusion-weighted imaging and dynamic susceptibility contrast perfusion-weighted imaging.

This retrospective study included 11 patients with hemangioblastoma and 20 patients with brain metastases. Region-of-interest analyses were employed to obtain the mean, minimum, and maximum values of APT signal intensity, apparent diffusion coefficient (ADC), and relative cerebral blood volume (rCBV), and these indices were compared between hemangioblastomas and brain metastases using the unpaired t-test and Mann-Whitney U test. Their diagnostic performances were evaluated using receiver operating characteristic (ROC) analysis and area under the ROC curve (AUC). AUCs were compared using DeLong's method.

All MRI-derived indices were significantly higher in hemangioblastoma than in brain metastasis. ROC analysis revealed the best performance with APT-related indices (AUC = 1.000), although pairwise comparisons showed no significant difference between the mean ADC and mean rCBV.

APT imaging is a useful and robust imaging tool for differentiating hemangioblastoma from metastases [2]

APT imaging is an exciting prospect in differentiating LGGs from HGGs and with potential to predict the histopathological grade. However, more studies are required to optimize and improve its reliability [3].

When applied to rats implanted with 9L gliosarcoma tumors in brain, APT imaging was able to distinguish between pathology-confirmed regions of tumor vs. tissue edema, whereas standard T1W, T2W, and fluid-attenuated inversion recovery imaging or diffusion-weighted imaging could not. Other previous reports demonstrated that the APT signal increased by 3–4% in tumor compared with peritumoral brain tissue in an experimental rat glial tumor at 4.7 T [4].

APT imaging can predict the histopathological grades of adult diffuse gliomas [5].

Results suggest that the APT signal in glioma may be a useful functional biomarker of treatment

response or degree of tumor progression. Thus, APT imaging may serve as a sensitive biomarker of early treatment response and could potentially replace invasive biopsies to provide a definitive diagnosis. This would have a major impact on the clinical management of patients with glioma [6].

Gerigk et al. report a case of necrosis after radiotherapy of an AVM to illustrate the potential of 7 Tesla MRI including amide proton transfer (APT) for necrosis imaging [7]

To correlate and compare diagnostic performance with amide proton transfer (APT) imaging as a tumor proliferation index with that with magnetic resonance (MR) spectroscopy in subgroups of patients with pre- and posttreatment glioma. Materials and Methods This retrospective study was approved by the institutional review board. In 40 patients with pretreatment glioma and 25 patients with posttreatment glioma, correlation between APT asymmetry and the choline-to-creatine and choline-to-N-acetylaspartate ratios in corresponding voxels of interest was determined, and the 90% histogram cutoff of APT asymmetry values (APT90) for the entire solid portion of gliomas was calculated for diagnostic performance. Area under the receiver operating characteristic curve (AUC), leave-one-out cross validation, and intraclass correlation coefficients were analyzed. Results The APT asymmetry values showed a moderate correlation ($r = 0.49$, $P < .001$) with the choline-to-creatine ratios and a mild correlation with the choline-to-N-acetyl-aspartate ratios ($r = 0.32$, $P = .011$) in the corresponding lesions. The APT90 showed comparable diagnostic accuracy for grading of gliomas (AUC, 0.81-0.84 vs 0.86; $P = .582$-$.864$) and superior accuracy for differentiation of tumor progression from treatment-related change (AUC, 0.89-0.90 vs 0.60; $P = .031$-$.046$) compared with those with MR spectroscopy. The cross-validated area under the curve and accuracy of the APT90 in posttreatment gliomas were 0.89-0.90 and 72%, respectively. The interreader agreement for APT90 was excellent in both pretreatment and posttreatment gliomas (intraclass correlation coefficient, 0.95 and 0.96, respectively). Conclusion APT imaging used as a tumor proliferation index showed moderate correlation with MR spectroscopic values and is a superior imaging method to MR spectroscopy, particularly for assessment of post treatment gliomas [8].

References

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