Amide Proton Transfer Imaging for High-grade and Low-grade Brain Tumors

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INTRODUCTION:

Amide proton transfer (APT) MR imaging is a type of chemical exchange-dependent saturation transfer (CEST) imaging that indirectly detects low concentration, endogenous mobile proteins and peptides in the brain tissues using a change of the bulk water signal by magnetic saturation transfer of amide protons [1-3]. The purpose is to evaluate whether APT imaging can provide useful information in differentiating malignant and anaplastic brain tumors (World Health Organization [WHO] grade III & IV) from benign tumors (WHO grade I and II) and chemotherapy-induced pseudoprogression and irradiation necrosis, and discuss the role of APT imaging in evaluating pre- and post-therapeutic brain tumors.

MATERIALS and METHODS:

MR examinations were performed with a clinical imageroperating at 3-tesla (MAGNETOM Trio, A Tim system, Siemens) using a 32-channel head coil. APT imaging was added to a standard MR protocol for brain tumors including diffusion imaging, T2-weighted imaging FLAIR and gadolinium (Gd)- dynamic perfusion study. APT imaging was performed using a gradient-echo sequence for CEST (work-in-progress) with thirteen frequency offsets from + 4.5 to -4.5 ppm. The imaging parameters used were: echo time = 2.46 msec, a flip angle = 10 degree; RF irradiation power = 1.6μT; and saturation time = 100 msec. The calculated MTR asymmetry map at the offset of 3.5 ppm is called the APT image.

Thirteen patients with intraaxial brain tumors of varying grade confirmed by histopathology or diagnosed by combination of diffusion imaging and perfusion study were studied [4]. The enrolled neoplasms consisted of grade IV glioblastoma multiforme in six, grade III anaplastic astrocytoma in one, grade II diffuse astrocytoma in two, grade I dysplastic gangliocytoma in one and post-therapeutic necrosis (irradiation necrosis and temozolomide-induced pseudoprogression) in three.

RESULTS:

Increased APT signal was observed in grade IV glioblastoma and grade III anaplastic astrocytoma. Elevation of APT signal was visible in not only the Gd-enhancing solid core but also cystic portion. However, no increase in APT signal was recognized in patients with grade II diffuse astrocytoma, grade I gangliocytoma and chemoradiation- induced necrosis.

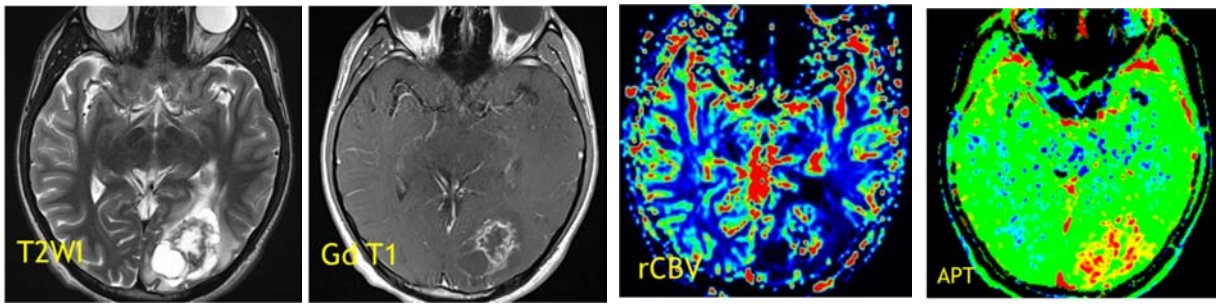

Fig. Glioblastoma (grade IV). T2-weighted image shows solid and cystic tumor in the occipital lobes. Gd T1-weighted image demonstrates heterougeneous enhacement in the core. Increased rCBV was identified in the tumor core. APT image displays high signals in not only the core but also cystic portions.

CONCLUSIONS:

APT imaging at 3-tesla has the possibility to diagnose WHO grade IV glioblastoma and grade III anaplastic astrocytoma without the need for an exogenous contrast agent. APT imaging can provide adjunct information utilized for differentiating high-grade malignant tumors from low-grade benign neoplasms, and for evaluating post-therapeutic viability and necrosis.

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