Amide Proton Transfer Imaging in Hemorrhagic Brain Lesions at 3T

Sung Soo Ahn[1], Yoon Seong Choi[1], Ha-Kyu Jeong[2], Jinyuan Zhou[3], Yansong Zhao[4], and Seung-Koo Lee[1]

[1]Radiology, Yonsei University College of Medicine, Seoul, Korea, [2]Philips Korea, Seoul, Korea, [3]Radiology, Johns Hopkins University, Baltimore, Maryland, United States, [4]Philips Healthcare, Cleveland, Ohio, United States

Target Audience: Clinicians who are interested in amide proton transfer (APT) imaging in the brain.

Purpose: Amide proton transfer (APT) imaging, a specific form of chemical exchange saturation transfer, can detect low concentration mobile proteins and peptides containing amide protons without exogenous contrast agents.[1] APT imaging has been shown to demonstrate high magnetization transfer ratio asymmetry (MTRasym) in malignant tumors that commonly are accompanied by hemorrhage. However, there has been no study investigating the effects of hemorrhage on APT signal, therefore the aim of this study is to evaluate APT signal in hemorrhagic brain lesions using 3D gradient- and spin-echo (GraSE).

Methods: Five patients with hemorrhagic brain lesions including glioblastoma (n=1), metastasis (n=2), and cavernous malformation (n=2), confirmed by pathology, were evaluated. MRI studies were performed at a human 3 T (Achieva TX, Philips) using 32 channel receive head coil with body transmit coil. In addition to standard MR protocols, APT imaging was performed using 3D GraSE[2] with FOV=212x185.5 mm, voxel size=2.2x2.2 mm, slice thickness=4.4 mm, TR/TE=3000/17 ms, TSE factor=22 and EPI factor=7. Six saturation frequency offsets (±3.0, ±3.5, ±4.0) were adapted for sufficient SNR within clinical timeframe.[3] Water frequency shift due to field inhomogeneity was measured using water saturation shift referencing[4] method with alternating offset frequencies ranging from -1.5 ppm to 1.5 ppm at a step of 0.125 ppm. Saturation RF powers of 0.5 μT and 2 μT were used with two and four block saturation pulses for inhomogeneity measurement and APT imaging, respectively. After water frequency shift correction, MTRasym values were calculated. All processing was performed offline using Matlab (MathWorks, Natick, MA). Regions of interest were defined within the enhancing portion when present, hemorrhage, perilesional T2 hyperintensity, and contralateral normal appearing white matter based on conventional MRI in each patient.

Results and Discussion: MTRasym values were 4.3 ± 0.8 in the enhancing portion, 5.3 ± 0.8 in hemorrhage, 0.9 ± 0.5 in perilesional T2 hyperintensity, and 0.1 ± 0.5 in contralateral normal appearing white matter. MTR asym values in each patient are shown in Table. MTRasym within hemorrhage was higher than other portions of the lesions in all patients regardless of underlying pathology. A recent experimental study reported that high MTRasym in blood may be contributed to the presence of abundant amino acids, proteins and peptides, which is consistent with our results showing high MTRasym in hemorrhagic portion.[5]

Patient No	Pathology	Enhancing portion	Hemorrhage	T2 hyperintensity	Contralateral normal appearing WM
1	Glioblastoma	4.0 ± 1.4	5.0 ± 1.7	0.8 ± 0.8	-0.6 ± 1.0
2	Metastasis	4.6 ± 0.7	5.3 ± 0.6	1.8 ± 0.4	0.6 ± 0.3
3	Metastasis	3.5 ± 0.9	6.2 ± 0.6	0.9 ± 0.9	-0.3 ± 0.4
4	Cavernous malformation	NA	5.9 ± 0.6	0.3 ± 0.5	0.2 ± 0.5
5	Cavernous malformation	NA	4.2 ± 0.7	0.9 ± 0.7	0.4 ± 0.3

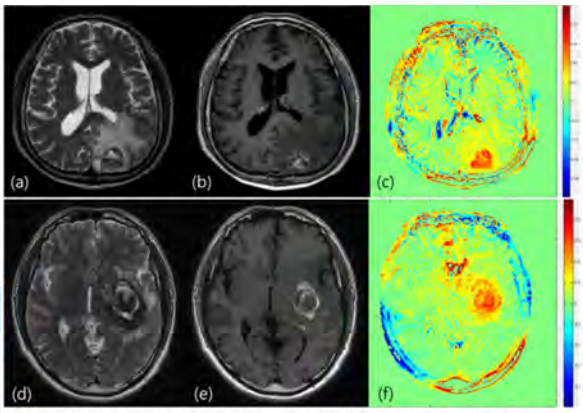

Figure. MR images of metastasis (upper row) and cavernous malformation (lower row). T2WI (a) shows cystic lesion with fluid-fluid level due to internal hemorrhage and contrast-enhanced T1WI shows irregular peripheral enhancement. Corresponding MTR asymmetry map (c) demonstrates high signal within the hemorrhage as well as in the enhancing portion. T2WI (d) and T1WI (e) show multiloculated cystic lesion with hemorrhage of mixed stages, suggestive of cavernous malformation. MTR asymmetry is also elevated (f).

Conclusion: Hemorrhage shows high MTR asymmetry regardless of underlying pathology, which we should be aware of for interpreting brain lesions with hemorrhage.

References

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