Reduced FOV Amide Proton Transfer on Brain Tumor

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Purpose: Amide proton transfer (APT) imaging is a molecular imaging technique which detects endogenous mobile protein and peptides in tissue via saturation of the amide protons[1,2]. It has been successful applied to many pathological studies in clinical patient[3,4]. Recently, more and more APT applications require small region-of-interest (ROI) or high-resolution for precisely pathological identification and analysis. For example, there is only small ROI associated with neurodegeneration in Parkinson's disease[5] and image field-of-view (FOV) cannot be confined to prostate or gland due to plenty of surrounding tissue interference, i.e., aliasing, at pelvis. We recently developed a reduced FOV (rFOV) APT technique which could be helpful to analyze APT signal in such a small ROI without unwanted signal interference. Additionally, compared to conventional APT sequence, mostly single-shot EPI (SS-EPI), rFOV APT sequence may provide following benefits: 1. Increases imaging resolution and reduces image distortion as well as susceptibility artifact. 2. Time efficiency and image blurring can be improved due to decreasing the readout duration and/or the number of phase encoding steps. The purpose of this study is to evaluate the performance of rFOV APT on small brain tumor (size < 0.8 cm^3) and compare it with the routine full FOV SS-EPI method in a clinical setting.

Material & Methods: MRI acquisition was performed on 3T clinical scanner (Discovery 750, GE Healthcare, Milwaukee, USA) using an 8-channel brain coil as the signal detection and whole body coil for RF transmission. APT imaging for both of full FOV and rFOV was based on a single-shot, EPI readout (SS-EPI). To avoid image aliasing, a rFOV APT using 2D excitation pulses and a frequency selective refocus 180 pulse was employed[6]. The image acquisition parameters were as follows: saturation pulse= 400 ms x 3 fermi pulses, B_1=1.6 μT, TR/TE= 3500/40 ms, FOV= 24 cm and 8 cm for full and rFOV APT, respectively; matrix size=128x128, slice thickness=5mm, 31 saturation frequencies S_{sat}(w) (0, ±0.25, ±0.5, ±0.75, ±1, ±1.5, ±2, ±2.5, ±3, ±3.25, ±3.5, ±3.75, ±4, ±4.5, ±5, ±6 ppm), and S_0 (without saturation pulse), NEX=2. In the data analysis, the APT image was calculated as the formula of (S_{sat}(-3.5ppm)-S_{sat}(+3.5ppm))/S_0 with pixel-by-pixel B_0 correction.

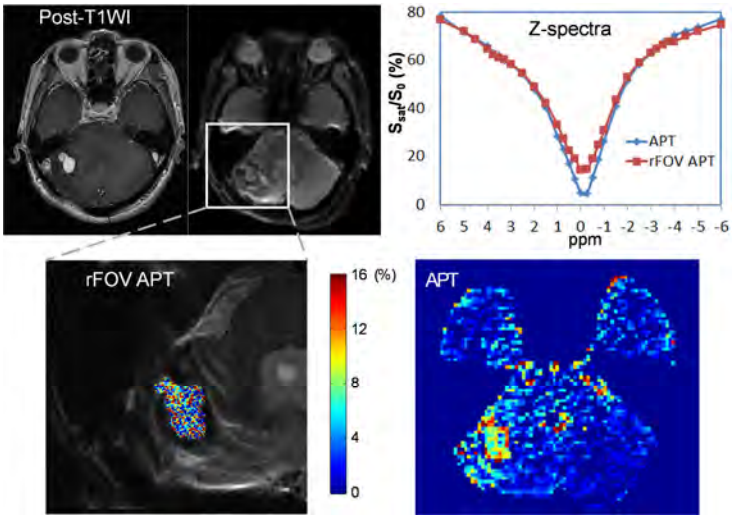

Fig. 1. MR images for a patient with hemangioblastoma in the right cerebellum.

Results & Discussions:
Gd-enhancing T1WI and APT images on full and reduced view in brain tumor patient with hemangioblastoma are shown in Fig. 1. Enhanced signal on post-contrast T1WI is observed, implying the tumor location is at right cerebellum. Hyperintense signal was noted on APT and rFOV APT imaging within Gd-enhancing tumor area, suggesting increased content of protein and peptides. Image resolution is obviously improved on rFOV APT image (i.e., more pixels in the tumor can be analyzed) which is especially important for evaluating small pathological region or subtle change of pathology. Z-spectrum of APT is similar to that of rFOV APT and quantitative value is found to be similar, 5.4% and 5.5% for APT and rFOV APT within tumor area, respectively.

Conclusion: This study demonstrates that a rFOV APT shows the improved image resolution and similar Z-spectrum over frequencies and quantitative results to conventional SS-EPI APT imaging. This finding suggests that rFOV APT may be a clinically feasible approach to evaluate APT on the small pathological region or organism.

Reference: 1. J. Zhou, et al., PNMRS, 48:109-136, 2006. 2. P. van Zijl et al., MRM, 65:927-948, 2011. 3. F. Kogan, et al., Curr Radiol Rep 1:102–114, 2013. 4. E. Vinogradov, et al., J Magn Reson, 229: 155-172, 2013. 5. C. Li, et al., Eur Radiol, 24:2631-2639, 2010. 6. E. Saritas, et al., MRM 60:468-473, 2008.