Amide Proton Transfer Imaging of the Head and Neck at 3T: A Feasibility Study and preliminary results

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Purpose: APT-MRI has been proposed as a promising molecular MRI technique by investigating the chemical exchange between free water and mobile amide protons of protein/peptide backbones. It has been proposed and applied for a number of clinical cancer imaging applications such as in brain, prostate and breast [1-3]. Head and neck (HN) is traditionally a challenging region in which to perform APT-MRI because of large susceptibility, movement, and the wide range of different anatomical tissues within a small area. To this end, the major purpose of this study is to investigate the feasibility of performing APT-MRI in the HN at 3T, and to preliminarily test whether APT-MRI could generate APT-weighted contrast between the HN tumors and normal tissues.

Methods: APT-MRI was conducted on five healthy volunteers and five HN cancer patients using a Philips Achieva TX 3T scanner with high-order shimmed fat-suppressed FSE sequence to mitigate susceptibility. Imaging parameters: FOV= 230x230mm^2, voxel size = 2x2 mm^2, slice thickness=4mm, TE/TR= 8/2000ms, ETL= 14, SENSE=2, Partial Fourier=0.7, B_{1sat}=2μT, T_{sat}=200ms (the longest duration due to hardware restriction), offsets =±0.25, ±0.5, ±1, ±1.5, ±2, ±2.5, ±3, ±3.5, ±4, ±4.5, ±5.0, ±5.5, ±6.5, ±7.5ppm). Voxel-wise APT MTR_{asym} (3.5ppm) and ΔB_0 values were calculated by 12th-order polynomial fitting, interpolating and shifting of Z-spectrum. To ensure APT quantification reliability, voxels would be excluded from APT map if they showed either low goodness-of-fit (R^2<0.99), or had large ΔB_0 shift ($|\Delta B_0|$>2ppm), or were not fully saturated due to short T_{sat} and/or incomplete fat suppression.

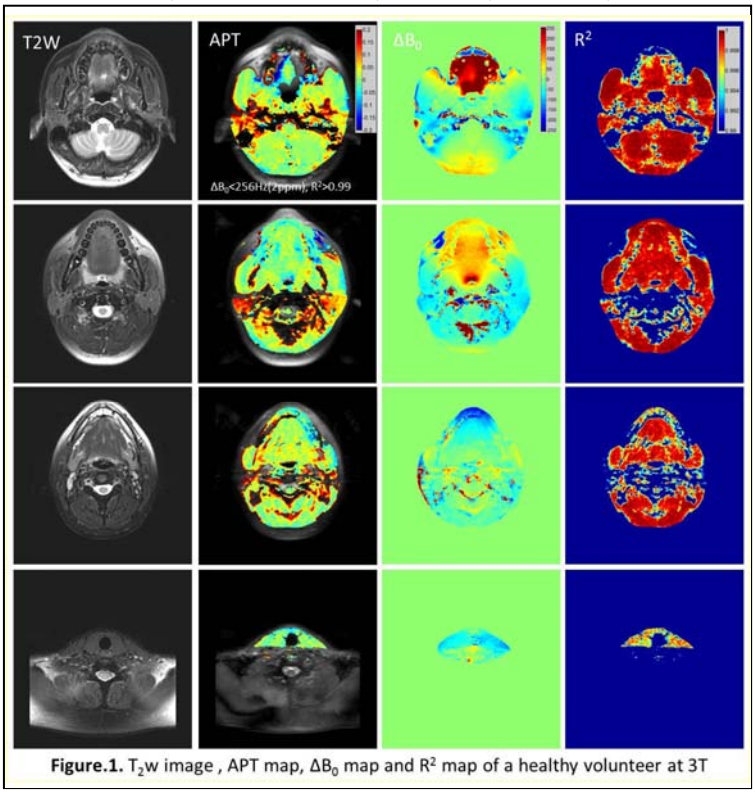

Figure.1. T_2w image , APT map, ΔB_0 map and R^2 map of a healthy volunteer at 3T

Results: Figure 1 shows the APT-MRI results on four representative slices (including major HN tissues such as the parotid and submandibular gland, muscle and tongue, palatine tonsil, and thyroid gland) of a healthy volunteer along with anatomical T2W images, ΔB_0 and R^2 maps. Despite the presence of severe field inhomogeneities ($|\Delta B_0|$>2ppm), very good R^2 (>0.99) could still be achieved to ensure APT mapping reliability. It is interesting to find that parotid glands exhibited very high APT contrast (>10%) while the submandibular gland showed moderate APT contrast, probably indicating the difference of secretion produced by these two salivary glands. Figure 2 illustrate the APT maps and Z-spectra of a primary tumor of parotid gland (1st row) and nasopharyngeal carcinoma (NPC, 2nd row) in two patients. The high parotid gland APT contrast provides good delineation from the relatively lower APT contrast of the parotid gland tumor. Note the contralateral high normal parotid gland APT contrast also. The NPC tumor exhibited a positive APT contrast and the heterogeneity of this APT contrast may be helpful for tumor characterization, yet to be studied in the future.

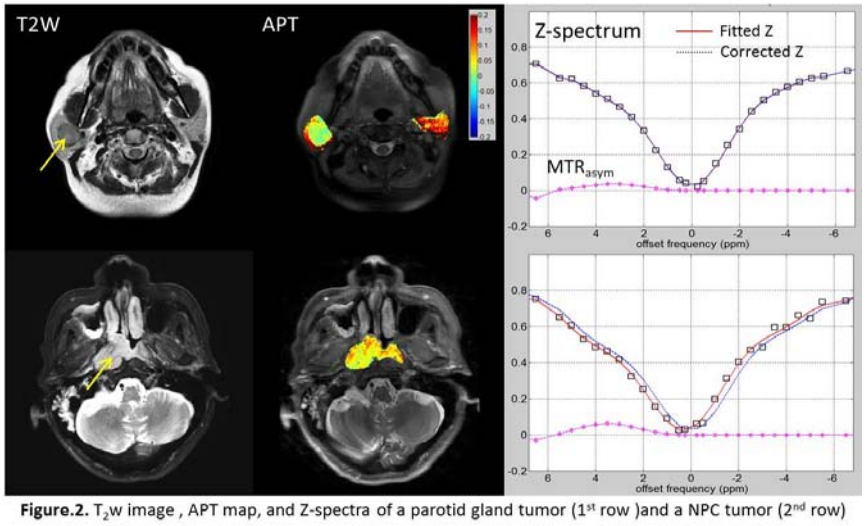

Figure.2. T_2w image , APT map, and Z-spectra of a parotid gland tumor (1st row)and a NPC tumor (2nd row)

Discussion: We for the first time tested the feasibility of APT-MRI for the HN imaging and illustrated preliminary results of APT contrast on HN tumor patients at the clinical field strength of 3T. The APT contrast source and the variation of APT contrast with regard to saturation RF field strength will be further investigated in future studies. Grant support: HK RGC grant SEG_CUHK02 and USA NIH grants R01EB009731, R01CA166171.

References: [1] Wen Z, Hu S, Huang F, Wang X, Guo L, Quan X, Wang S, Zhou J. Neuroimage 2010;51(2):616-622; [2] Jia G, Abaza R, Williams JD, et al. J Magn Reson Imaging 2011;33(3):647-654; [3] Dula AN, Arlinghaus LR, Dortch RD, et al. Magn Reson Med 2013;70(1):216-224.