

Amide Proton Transfer MR Imaging in Peritoneal Metastasis Evaluation

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Target audience This abstract contains information of interest to radiologists, oncologists, and other professionals working with chemical exchange saturation transfer (CEST) or in the field of MRI.

Purpose Cytoreductive surgery has emerged as a neoadjuvant treatment to intraperitoneal and hyperthermic chemotherapy, which are potentially effective in controlling local disease. Therefore evaluation of peritoneal dissemination is essential for early diagnosis and treatment planning. MRI has been used in peritoneal metastasis imaging, with gadolinium-enhanced MRI sensitive in depicting peritoneal disseminations of small volume. CEST MRI is a novel molecular imaging technique that is able to assess the concentration of mobile proteins and peptides indirectly through bulk water signals. CEST MRI using amide protons as contrast agent, termed as amide proton transfer (APT) has been applied in tumor imaging, as the concentration of mobile amide protons increases in malignant tissues¹. APT MRI can provide complementary information to current MR sequences used in clinical practice in peritoneal metastasis imaging. The purpose of this study is to assess APT MRI at 3 Tesla in peritoneal metastasis evaluation.

Methods

Six patients (male: female=1:2, mean age of 56±6 years) with suspected peritoneal metastases were recruited for MRI scans. Peritoneal dissemination was confirmed by histology in three patients, the remaining three patients had radiological follow-ups for verification of the peritoneal metastasis. Axial CEST images were acquired by a 3T Achieva scanner (Philips Healthcare, Best, the Netherlands) using single-slice turbo spin echo (TSE) sequence (imaging parameters: TR/TE=3000/60ms, slice thickness=7mm, voxel size=2×2mm², total scan time=3min 39sec; RF saturation pulse: 300ms and 1.5μT). CEST data with 33 offsets were collected with presaturation pulses from -8 to 8ppm with 0.5ppm interval with respect to water resonance. Another 3 data sets without saturation were acquired and averaged. Before data analysis, B₀ field inhomogeneity correction was applied using CEST data according to method published previously². Regions of interest (ROIs) were contoured over tumor, and 2 pixel ×2 pixel ROI over fat and muscle. Mean of the magnetic transfer ratio asymmetry (MTR_{asym}) within the selected ROIs were integrated over the 3-4 ppm as the resonance of amide protons is at 3.5ppm with respect to water resonance.

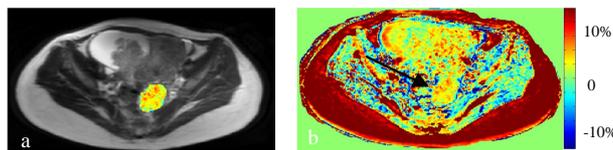


Fig. 1 APT color map of left peritoneal metastasis (arrow) superimposed on raw APT image (a) and whole APT color map (b).

Results

A total of 8 peritoneal metastases in 6 patients were analyzed. Fig. 1 shows a typical APT color map of one of the peritoneal metastasis in the left pelvis, and lesion has good separation from its surrounding tissue. The integrated mean MTR_{asym} for peritoneal metastases was 0.85%±0.94%, which was significantly different from that of fat (10.40%±1.43%, p<0.001) and that of muscle (-2.02%±1.48%, p<0.001), as illustrated in Fig. 2.

Discussion

After B₀ field inhomogeneity correction, no large spatial signal fluctuation was observed in the APT map covering the pelvic region (Fig. 1b). The symmetrical APT signals over muscle and fat suggested that inhomogeneity correction was efficient and the APT value for peritoneal metastasis was reliable. The significant differences in APT value between peritoneal metastasis, fat and muscle indicated that APT MRI was feasible in aiding the detection of peritoneal dissemination especially when the metastases are close or adherent to fat or soft tissue.

Conclusions

This pilot study demonstrates the feasibility of APT MRI in differentiating peritoneal metastases from fat and muscle. This is clinically relevant as peritoneal metastases can be deposited in the area with abundant fat or adherent to soft tissue; therefore separation of these different tissue compositions will aid detection and assessment of peritoneal metastases.

References

[1] Jia G, Abaza R, Williams JD, et al. Amide proton transfer MR imaging of prostate cancer: a preliminary study. *J Magn Reson Imaging*. Mar 2011;33(3):647-654. [2] Kim M, Gillen J, Landman BA, Zhou J, van Zijl PC. Water saturation shift referencing (WASSR) for chemical exchange saturation transfer (CEST) experiments. *Magn Reson Med*. Jun 2009;61(6):1441-1450.

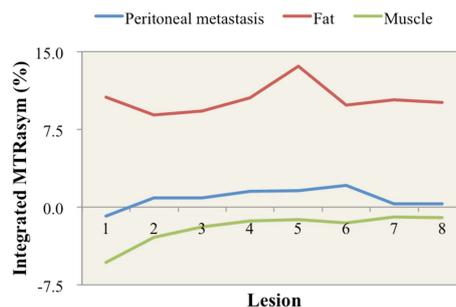


Fig. 2 Mean integrated MTR_{asym} of peritoneal metastasis, fat and muscle in percentage.