Multi-site multi-vendor reproducibility of APTw-CEST MRI at 3T

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INTRODUCTION:

Amide proton transfer weighted chemical exchange saturation transfer imaging (APTw-CEST) has demonstrated promise in the detection of (pseudo)progression in brain tumors[1]. Reproducibility of APTw-CEST has been investigated in single-site, single-vendor studies[2,3], and recently, a first approach to reach consensus on data acquisition and data analysis for APTw-CEST was published[4]. For homogenized quantitative evaluation of APTw-CEST, a multi-site, multi-vendor study is needed. This work is a first step towards an upcoming multi-center trial for standardization of APTw-CEST for early detection of brain tumor progression across vendors.

METHODS:

A cylindrical thermos flask containing five falcon tubes, with 20, 50 and 100 mM of Nicotinamide (NAM), was filled with water at 37˚C and 3g of salt per liter. The phantom was scanned at 3T at four different sites: Amsterdam UMC (AUMC) (Vida, Siemens Healthineers, Erlangen, Germany) ; Erasmus MC Rotterdam (EMC) (Premier, General Electric, Chicago, USA) ; UMC Utrecht (UMCU), Leiden UMC (LUMC) (Ingenia Elition X, Philips Healthcare, Best, The Netherlands). First the consensus-based6 protocol using 7 frequency offsets was acquired. In EMC and UMCU, a dataset was acquired using the site-specific standard, which is a full-sweep acquisition or the 7 point product option of Philips Healthcare, respectively. For the consensus acquisitions MTRasym was calculated with the same post-processing pipeline for all three sites. The site-standard datasets were analyzed according to the site-standard using in-house analysis scripts or the Philips on-scanner processing. The mean (±SD) APT level (%) was determined using hand-drawn ROIs.

RESULTS:

In all cases APTw signal increased with rising NAM concentration as seen in Figure 1. Although the mean MTRasym for the consensus protocols differed between the data acquired in AUMC and the other two sites, the ratios between the signals from the different concentrations of NAM were very similar as shown in table 1. The MTRasym values for the site-specific UMCU and EMC protocols were marginally different to the MTRasym values of the consensus acquisitions, and ratios are very similar. The EMC images, acquired with the highest spatial resolution, showed lowest SNR.

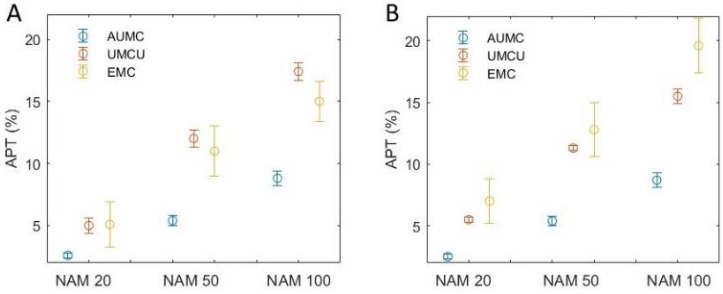

Figure 1. The mean APTw signal in percent for the consensus (A) and site standard (B) acquisitions at the three sites for increasing NAM concentrations in mM. Error bars show the standard deviation.

DISCUSSION:

MTRasym ratios between ROIs with different concentrations of NAM were similar across three different MRI systems at three different locations. While the consensus protocols were aligned across the three sites in terms of e.g., B1 and z-spectral points, other parameters (such as RF saturation duration) varied. Comparing the site-specific and consensus implementations of EMC and UMCU showed variations in MTRasym values as expected. Further work on harmonization includes improving standardization of the acquisition by investigating saturation pulse lengths and improving SNR of the EMC images. This work will include acquisitions in traveling volunteers as well as inclusion of another Philips site (Leiden UMC).

	AUMC	EMC	UMCU
50/20 NAM Ratio			
Consensus	2.1	2.2	2.4
Site-specific standard		*1.8*	*2.0*
100/50 NAM Ratio			
Consensus	1.6	1.4	1.4
Site-specific standard		1.5	1.4

Table 1. Ratios of APT values between the different concentrations of NAM at the different sites for the consensus protocol and the site-specific standard (grey italics)

CONCLUSION:

When using the APTw-CEST brain tumor consensus protocol on a traveling phantom with varying NAM concentrations consistent ratios in MTRasym values were found across multiple scanners from different vendors. This is a promising first step towards translating APTw-CEST into a clinically relevant, early biomarker of brain tumor progression.

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REFERENCES:

1. Wen Z, *et al*. NeuroImage 2010;51(2): 616-622
2. Wamelink I.J.H.G, *et al.* J. Magn Reson Imaging 2023;57:206-215
3. Wu Y *et al.* Scientific Reports 13(1)
4. Zhou J *et al.* Magn Reson Med 2022;88(2):546:574