I can see clearly now the fluids are gone – 3T APTw CEST with fluid suppression in different brain tumors

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Introduction: Amide proton transfer weighted (APTw) CEST imaging has great potential to differentiate between low- and high-grade gliomas[1,2,3,4]. In order to ensure general comparability when analyzing APTw data, guidelines have been defined in a consensus paper[5]. However, APTw imaging suffers from hyperintensities in the fluid compartments such as cystic and necrotic tissue compartments[6,7], which have been largely neglected in evaluation so far. To investigate the benefits of fluid suppression, a large cohort of patients is being recruited to gain deeper insight into the characteristics of CEST in relation to different tumor subtypes including metastases, WHO grade 1-3 and WHO grade 4.

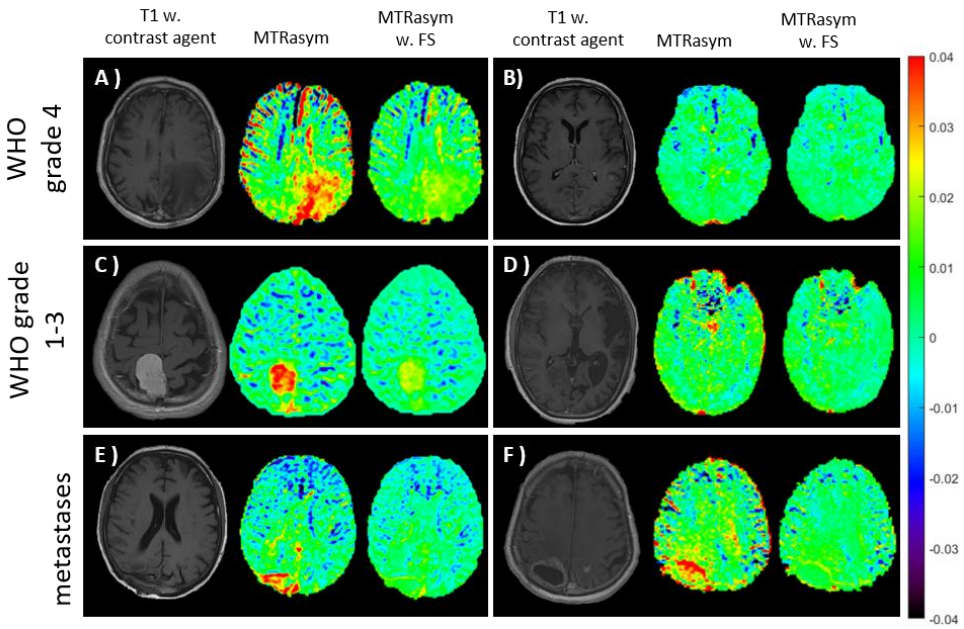

Fig.1: *Illustration of MTR_{asym} without and with fluid suppression of two glioblastoma (top row; WHO grade 4, IDH wildtype, MGMT neg.), one meningioma, one pilocytic astrocytoma (middle row; WHO grade 1-3), and two metastases patients (bottom row). Corresponding T1-imaging post contrast agent of the same slices.*

Methods: So far, data of 34 patients of different kind of brain tumors and metastases have been acquired (glioblastoma WHO grade 4: 6; lower grade tumors: 16; meningioma: 9; metastases: 3) on a 3T scanner (MAGNETOM VIDA, Siemens Healthineers) after written informed consent. For CEST data acquisition, a standardized APTw CEST protocol with B_{1rms} = 2µT and T_{sat}=2s as defined in the Pulseq-CEST library[8] and following the APTw-consensus[5] was used with a centric 3D snapshot GRE readout[9]. B0, B1 were mapped by WASABI[10]. Regions-of-interest (ROI) were defined on increased MTR_{asym} values in the tumor region. The calculation of the fluid-supressed (FS) MTR_{asym} was performed according to Schuere et al.[7]

Results: Figure 1 illustrates the fluid artefacts in MTR_{asym} and how these are suppressed by FS-MTR_{asym} in different type of brain tumor patients. The data reveals decreased APTw image contrast in the tumor region after correction, but also different structures that correlate less with liquid areas. This observation could be shown for all tumour types where MTR_{asym} highlighted areas. The glioblastoma (B) showed no increased APTw signal. Figure 2 corroborates these observations. When examining normal-appearing white matter (WM), MTR_{asym} values remain relatively stable after FS correction, while all tumors show decreased values.

Discussion: The initial results indicate that the APTw image contrast decreases significantly after performing fluid suppression in brain tumors, and fluid signal could lead to misleading interpretation of active tumors or altered metabolism. After fluid suppression, the hyper intense structures appear differently, indicating probably fluid independent changes in the CEST signal. The preliminary results also suggest that a differentiation between low-grade and high-grade gliomas may be associated with higher fluid content when using MTR_{asym} only. In order to further clarify this issue, we are aiming to analyse a large cohort of tumor patients and compare the data after FS to histopathological findings.

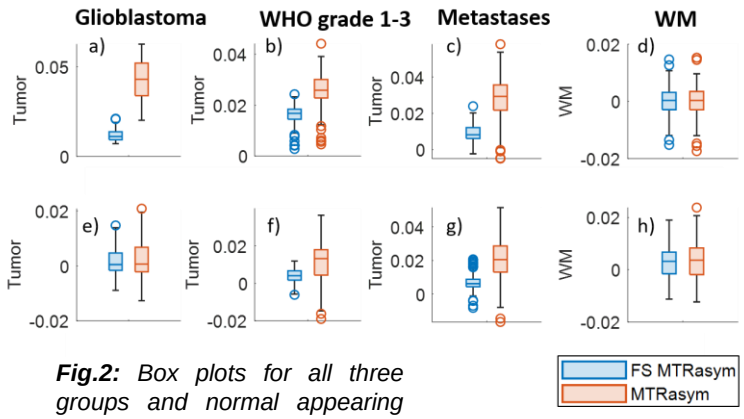

Fig.2: *Box plots for all three groups and normal appearing white matter before and after fluid suppression. Interestingly, the glioblastoma (B) didn't show any increase in MTR_{asym} nor FS.*

Conclusion: Fluid artefacts are present in brain tumor APTw imaging for different tumor entities. Fluid suppression is a necessary correction to avoid misinterpretation of APTw images. It reduces image contrast, which makes it unpopular, but remaining signals might be much more meaningful.

References

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