Comprehensive 7T CEST imaging displays promising features for tumor (sub)grading

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Introduction Tumor classification prior to biopsy or resection is of high importance to therapy and clinical outcome of high-grade tumor patients[1,2,3]. So far, only single pool or single exchange regime CEST experiments have been carried out in tumor patients. The comprehensive 7T CEST approach[4] suits as a combination of CEST experiments at different B1 regimes, and is aquired in 15 min, which allows application in larger patient cohorts. We plan to get differentiated insight into the CEST features of different brain tumors and metastases.

Methods Data was acquired from 12 patients (Glioblastoma wild type: 6, Glioblastoma IDH1 mutation: 1, low-grade tumors: 3, bronchial carcinoma metastasis: 2), after written informed consent and under approval of the local ethics committee, at a MAGNETOM Terra.X 7 Tesla scanner (Siemens Healthcare GmbH, Erlangen, Germany) with an 32ch Rx and 8ch Tx head coil. Homogeneous pre-saturation was realized using the MIMOSA[5] scheme for the different pre-saturations of 7T comprehensive CEST[4]. Image readout was a centric 3D snapshot GRE[6]. GRAPPA 2 was applied in the first phase encoding direction[7]. The evaluation of CEST data was done according to[4].

Results Two patients suffering from a Glioblastoma WHO grade IV with IDH1 mutation (Figure 1) and wild type (Figure 2) show different features in CEST imaging, e.g. increased Amine value (E) in active, Gd enhanced tumor tissue for IDH1 compared to wild type.

Figure 3 displays boxplots of patient mean values regarding supposedly active tumor tissue (active Gd enhancement) of all patients. Tumor types show different features in the CEST maps. For example, Metasases show the smallest value for A_{Amide} and the IDH1 patient shows highly elevated signal compared with the wild type tumors in MTR_{Amine}. In the perifocal edema ROIs (data not shown), rNOE and ssMT display different values for Glioblastoma wild type and IDH1 mutation.

Discussion In order to get a deeper insight into CEST imaging of different exchange regimes on tumors, we followed a more comprehensive CEST approach covering three important exchange regimes. So far, possible CEST markers for prediction of tumor mutation and subtype have been discussed, like APT/Amide[2,3] and rNOE[1,8]. Our approach serves as a combination of these markers and other effects like Amine[9] and Hydroxyl CEST[10]. The data of these six CEST maps combined provides a promising dataset for tumor feature detection and future Machine Learning approaches.

Conclusion We applied the 7T comprehensive CEST approach in tumor patients of different tumor subtypes and different WHO tumor grades. Already in this limited dataset, we see specific features for each of the patient groups. We plan further subject acquisition in order to solidify these preliminary results.

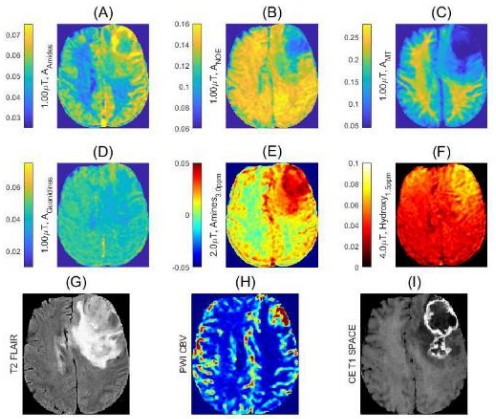

Figure 1: comprehensive CEST maps (A-F) and clinical imaging (G-I) of a male patient suffering from Glioblastoma WHO grade IV, IDH1 mutation

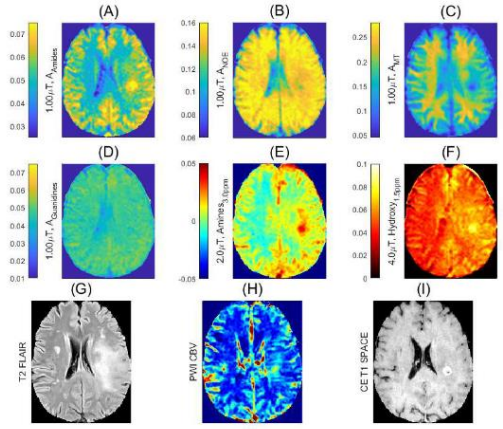

Figure 2: Figure 2: comprehensive CEST maps (A-F) and clinical imaging (G-I) of a female patient suffering from Glioblastoma WHO grade IV, wild type

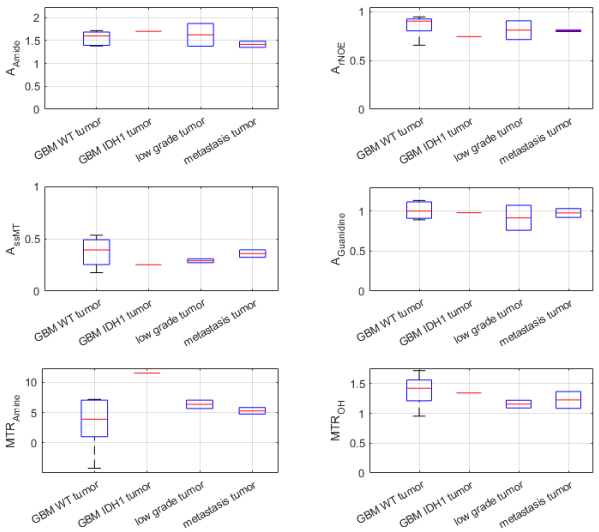

Figure 3: Boxplot of single slice ROI mean values of comprehensive CEST contrasts regarding supposedly active tumor tissue (active Gd enhancement). Values are normalized by contralateral reference tissue.

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