Accelerating CEST Sequence Development and Clinical Translation: Integrating Pulseq Preparation, Vendor Readout, and Neural Network Based Parameter Estimation

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KEYWORD: **Data analysis, AI, Standardization, Novel Acquisition**

INTRODUCTION:

Developing new CEST MRI sequences is challenging and time-consuming, often resulting in prototypes that only experts can run or evaluate. Common offline post-processing complicates this further. Larger clinical studies require easy-to-use, robust solutions. We propose a hybrid CEST MRI method with: (i) Pulseq-based pTx CEST preparation and B1 mapping. (ii) Vendor native readout sequence with basic reconstruction. (iii) Online neural network (NN) for parameter estimation and DICOM image generation.

METHODS:

MRI measurements were performed on two Siemens 7T systems with different software versions after written informed consent: Terra VE12U at Mayo Clinic, USA, and Terra-X VA60 in Erlangen, Germany. The proposed 7T CEST MRI approach uses Pulseq[1], a hardware-independent framework, to simplify CEST preparation and B1 mapping in a single customized sequence (Fig. 1a). This file is then executed by an interpreter sequence running as sequence building block of the customized vendor sequence[2,3], which provides the standard image readout including basic image reconstruction (Fig. 1b). CEST parameters are estimated using a neural network (NN) integrated into Siemens' ICE framework, named ICEDeepCEST[4] (Fig. 1c). The NN, trained on 8 subjects, uses CEST-weighted images and the B1 map to output CEST maps, which are stored as DICOM files, fully utilizing the DICOM dynamic range (Fig. 1d).

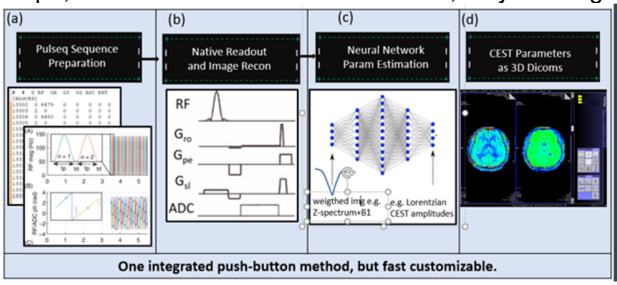

Fig. 1: Scheme of the integrated Pulseq-CEST hybrid sequence with NN reconstruction

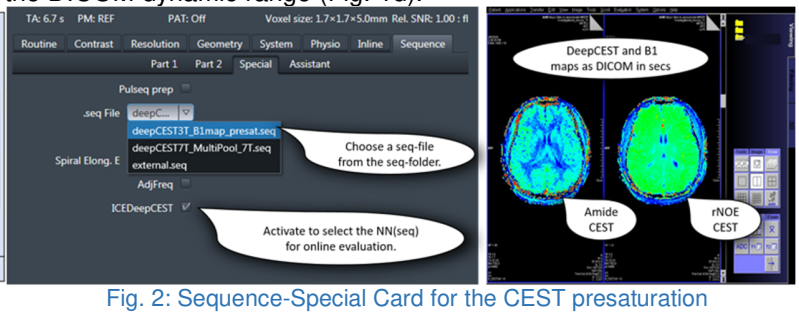

Fig. 2: Sequence-Special Card for the CEST presaturation

RESULTS:

Fig. 2 shows the simple interface of the hybrid sequence. NN-estimated parameters for 7T CEST are consistent across acquisitions and clinical sites (Fig. 3), within the method's previously estimated variance (Fig. 4).

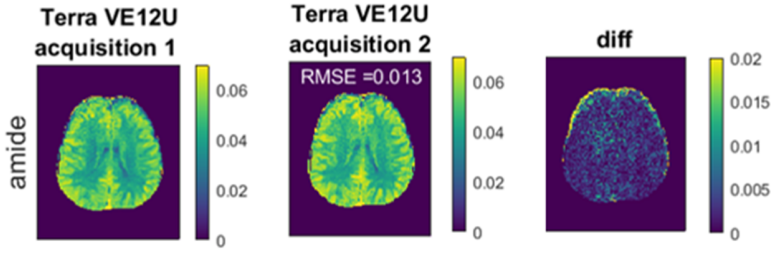

Fig. 3: comparison of the integrated NN-estimated parameters for 7T CEST for two intrasubject acquisitions.

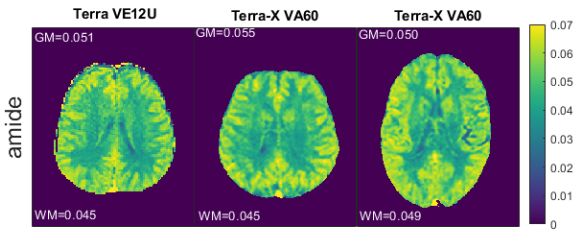

Fig. 4: Comparison of NN reconstruction for 3 subjects scanned at two different sites

DISCUSSION and CONCLUSION:

This work extends the Pulseq-CEST approach[3] for pTx functionality and NN recon. The integrated NN facilitates immediate DICOM generation, yielding CEST maps directly on the scanner with just a .seq file and .nnet file. Implemented for 7T CEST with pTx preparation and B1 mapping, it ensures robustness against B0 and B1 inhomogeneities. The approach provides consistent parameters for all subjects and sites that match the published ranges and accelerates the testing and evaluation of new CEST sequences. With this tool, preparation and NN can be exchanged at the scanner without re-compilation.

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