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Joint implementation of a segmented 3D-GRASE pCASL sequence and online reconstruction

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Summary

Pseudo-continuous arterial spin labelling (pCASL) and segmented 3D imaging techniques have been recommended by the AID as a standard for ASL data acquisitions in clinical settings. The technique has been developed and implemented in several sites, optimizing different aspects of the sequence. In particular, the 3D-GRASE pCASL sequence initially implemented by Maria Fernandez-Seara (University of Navarra, Spain) has been transferred to and further developed at the National Hospital for Neurology and Neurosurgery (London) and the Cyclotron Research Centre (Liège, Belgium). The three sites are equipped with Siemens 3T scanners (3T Tim Trio in London and Navarra, 3T Allegra (research) and 3T Tim Trio (hospital) in Liège). Each site has slightly different settings and the implementations vary accordingly (software version, segmented or non-segmented imaging sequences, online or offline image reconstruction, other features).

The most recent implementation of the 3D-GRASE pCASL sequence from the University of Navarra, though supporting single-shot acquisitions only, allows the partitions within the imaging slab to be acquired using a centric reordering scheme, which is believed to provide superior signal-to-noise ratio and contrast-to-noise ratio compared to traditional sequential encoding schemes. Additionally, optimized background suppression (BS) scheme of the static tissue signal has been implemented within the sequence. BS has been shown to radically

improve the sensitivity of ASL by reducing physiological noise. The sequence developments carried out in Liège have focused on the imaging aspects with segmented 3D-GRASE and online reconstruction. Segmented 3D imaging has been implemented to improve the through-plane spatial resolution and to allow for whole brain coverage. Online reconstruction using ICE has been adapted to the ASL acquisition as it is essential to give clinicians a quick and convenient access to the data and facilitate workflow.

The mission therefore aimed at providing a joint implementation of the acquisition sequence and reconstruction software that benefits from our complementary expertises, meets the guidelines of the AID and can be used easily in a clinical environment. The mission allowed us to implement and test several segmentation schemes and compare 3D-GRASE and 3D-STACK OF SPIRALS readouts. Online reconstruction was also successfully tested and compared to offline reconstruction for the 3D-GRASE sequence. Offline reconstruction only was available for the 3D-STACK OF SPIRALS sequence and provided good quality images. The segmentation schemes and in-plane sampling patterns (spiral or Cartesian) were evaluated in terms of in-plane and through-plane spatial resolutions and distortions, SNR and SAR criteria to provide the best trade-off for CBF mapping with 3.44x3.44x3 mm^3 spatial resolution and a maximum of 4 minutes to acquire a perfusion map with whole brain coverage. The segmented 3D-STACK OF SPIRALS sequence, with its extremely efficient sampling of k-space, provides higher SNR and slightly better through-plane spatial resolution thanks to the shorter TE and echo train duration. The segmented 3D-GRASE sequence also provided very promising results with an easy workflow for clinical applications thanks to the online reconstruction. It will be further tested in the next few months and applied at the hospitals of the three sites involved as part of multi-centre translational research projects.