YOUNG INVESTIGATOR AWARD

In vivo mapping of hippocampal venous vasculature and oxygen saturation using dual-echo SWI/QSM at 7 T: A potential marker for neurodegeneration

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Background

The current understanding of the venous system in the hippocampus is mostly based on histological and autopsy studies.[1] However, the main disadvantage is that it only reveals the anatomy of the vascular system at the post-mortem stage and lacks physiological aspects associated with neuronal metabolism. *In vivo* characterization of the venous system using susceptibility weighted imaging (SWI) at 7 T could provide valuable information on both venous anatomy and blood oxygen saturation, through high-resolution SWI venography[2] and quantitative susceptibility mapping (QSM).[3] In this study, we aim to elucidate the hierarchical network of the hippocampal venous system and then test the feasibility of using venous susceptibility to characterize venous oxygenation level changes related to neurodegeneration.

Methods

Seven healthy volunteers were recruited for this study. We used high in-plane resolution of flow-compensated dual-echo gradient echo sequence (TE1/TE2/TR=7.5/15/22 ms, voxel size: 0.25*0.25*1 mm). SWI and QSM were then reconstructed using the iterative SWI and mapping (iterative SWIM) algorithm,[3] as shown in Figure 1. Hippocampus masks were extracted from the T1-MPRAGE image, which was transformed to SWI space afterwards. To reduce the partial volume effect from the tissue-vessel boundary, we extract the venous susceptibility value from each voxel along the centerline of the vessels.

Results

High-resolution *in vivo* mapping of hippocampal venous vasculature exhibits a high analogy to Duvernoy's reference[4] for hippocampal vascularization. As shown in Figure 1, there is a shape of venous arch near the fimbria of the hippocampus, and small veins extending through the arch are possibly the intrahippocampal veins. The intrahippocampal veins will eventually reach the inferior ventricular vein (IVV) (anteriorly) and medial atrial vein (MAV) (posteriorly), before joining the basal vein of Rosenthal (BVR). For venous susceptibility quantification, Figure 1 shows the representative color-coded QSM for centerline extraction on BVR.

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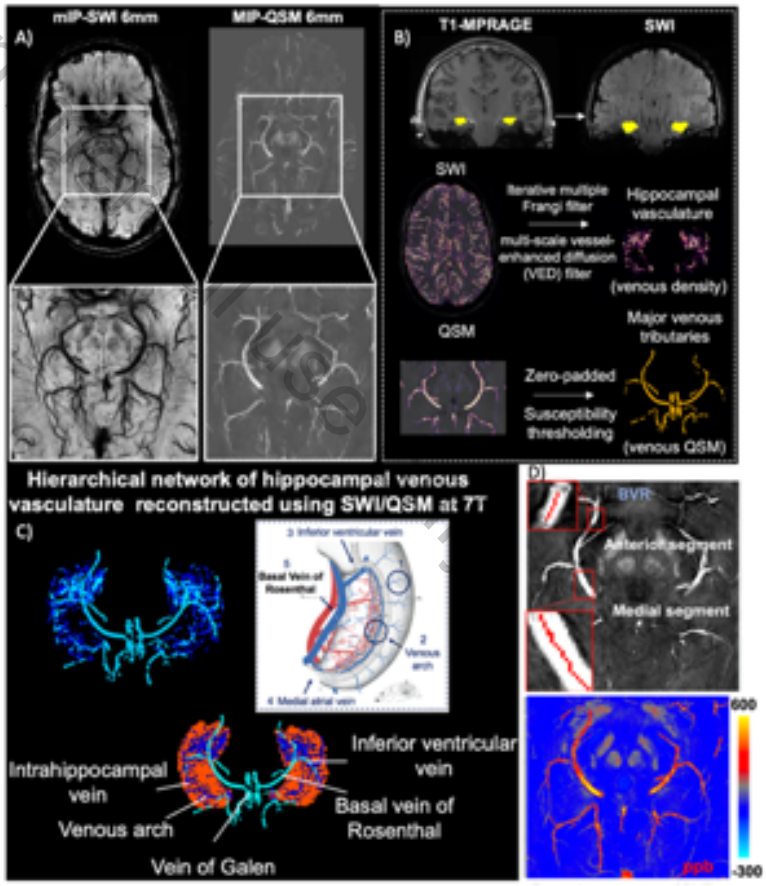

Fig 1. A) Representative SWI (TE = 15ms) and QSM (TE = 7.5ms) images reconstructed from double gradient echo sequence; B) Image processing overview using T1-MPRAGE and SWI to extract venous density from SWI and venous susceptibility from QSM; C) Reconstruction of hierarchical network of venous system in hippocampus. D) Color-coded QSM maps at mid-brain level and susceptibility value will be extracted along the centerline of the vessels.

Figure 1.

Conclusions

Our results showed improved visualization of the micro venous system in the hippocampus using high-resolution 7 T SWI data without the contrast agent.[5] In summary, the characterization of venous QSM in major tributaries related to the hippocampus offers a novel perspective on oxygen utilization in the hippocampus, which may be useful for studying age-related dementia. We delineated the hierarchical network of the hippocampus venous system using SWI/QSM at 7 T and extract the venous density and venous susceptibility value in hippocampus-related small veins and major venous tributaries, as an overall measure for venous oxygenation level related to the hippocampus, which may be used as an early marker for hippocampal atrophy in Alzheimer's disease.

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