Segmentation of Small Veins Using 3D isotropic SW images at 7T

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[Target Audience] Researchers interested in Normal and Aging Brain Morphometry using 7T SW Images

[Purpose] We took 0.5 mm³ isotropic SW images to visualize small veins. The isotropic voxels allow for semi-automatic segmentation methods to track the vessels across slices. In addition we looked at the feasibility of using a 3D mask from isotropic images to use with high in-plane resolution 2D SW images (0.2mmx0.2mmx1.5mm) to segment structures like the hippocampus.

[Methods] High resolution 3D and 2D SWI images were obtained at 7T using parallel transmit system with a 20 channel transmit array in conjunction with a 32 channel receive-only array. Scan time of 2D without acceleration was 18min 3D with acceleration of 2 was 17min, 2D: TR=1960, TE=14. The 3D parameters were TR=40, TE20, FlipAngle=24. Both acquired with Bandwith 40Hz/pixel and 150V. Segmentation of venous vasculature tree was done using semi-automated region growing implemented in MIPAV. Voxels within a vessel were identified and thresholding was done interactively, and restricted regionally, to track vessel across slices.

[Results and Discussions] The signal to noise ratio (SNR) in the SWI images 2D and 3D was 40 to 50 depending on regions of interest in the brain. The SNR was evaluated at deep brain structures like Hippocampus, Substantia Niagra, etc. The semi-automated region growing method was able to segment the venous vascular tree in 3D, showing tracking of the vessels across slices, as illustrated in Fig 1 Left-Bottom. The arborization localization in 3D axial, sag & cor slices are marked blue in the 3D image set. Although one can get very high in-plane resolution by increasing the slice thickness using in 2D acquisition it is not suitable for tracking vessels across slices. Neighborhood based algorithms like region growing will benefit from an isotropic 3D image since these algorithms perform computations on uniformly sized neighborhoods (e.g. 3x3x3) centered on each voxel. Having higher resolution in plane will bias these algorithms towards the high resolution resulting in unexpected segmentations.


Figure 1: (Left) A triplanar view of the relevant slices, with the vessel segmentation overlaid over isotropic 0.5mm³ 3D SWI. Bottom-right 2D SWI 0.2x0.2x1.5mm shows smaller veins around midbrain not seen at 3T.