

## Quantitative assessment of the cortical vessel sign after mechanical stroke treatment

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### Purpose:

The cortical vessel sign (CVS) on susceptibility-weighted images (SWI) is a known phenomenon in case of ischemic stroke. The CVS is defined by an enhanced visibility of venous blood vessels which is based on an increased deoxyhaemoglobin to oxyhaemoglobin ratio [1]. SWI is a technique which is sensitive to the concentration of deoxyhemoglobin and therefore ideal for CVS analysis. The purpose of this study is the quantitative assessment of the cortical vessel sign after ischemic stroke treatment using SWI and automatic vessel segmentation.

### Materials and Methods:

SWI and diffusion weighted imaging (DWI) was performed in 13 patients in the subacute stage of embolic stroke. Inclusion criteria: 1) mechanical thrombectomy for major intracranial vessel occlusion within two days prior to imaging; 2) motion-free source images sufficient for reliable postprocessing results; 3) absence of major intracranial hemorrhage. Imaging was performed on a 3 Tesla Philips Achieva. The SWI images were intensity-corrected and the image intensity was rescaled in the arbitrary chosen range between 0 and 100. Automatic vessel segmentation [2] was performed with a multiscale method which uses the second order image information, represented by the Hessian matrix to compute the likeliness of a voxel to be a part of a tubular structure (vessel). Regions of interest (ROIs) were defined in consensus by two readers for areas of reduced apparent diffusion coefficient (ADC) including a 0.5 cm margin and within the contralateral hemisphere serving as internal standard.

### Results:

Automatic vessel segmentation was successfully performed on all SWI data sets. The venous volume portion within all ROIs was 0.5% where the affected regions showed an increased mean venous volume portion of 0.54% compared to 0.47% within the control ROIs. The difference between the affected and the control ROIs was not significant (T-Test;  $p=0.4$ ).

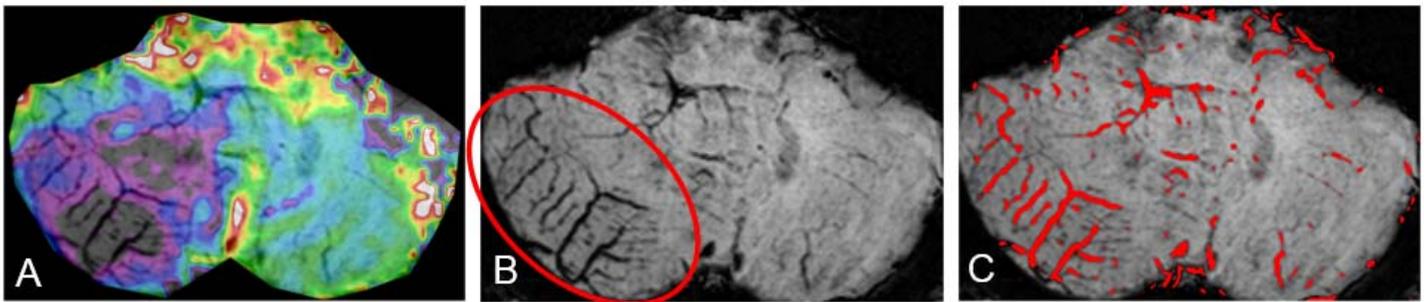


Figure 1: Stroke patient with an ischemic lesion in the territory of the right posterior inferior cerebellar artery; A shows the perfusion map overlaid to SWI, B the original SWI image, where the affected ROI is indicated with a red ellipse (the real ROI is 3-dimensional). C shows the automatically segmented veins overlaid to the SWI image – the volumetric fraction of veins within the affected area is 0.79% compared to 0.39% within the healthy, contralateral hemisphere.

### Discussion and Conclusion:

The quantitative assessment of the cortical vessel sign is in good agreement with previous studies where the CVS has been classified visually. An advantage of automatic vessel segmentation is that it eliminates inter- and intra-rater variability and that it is performed within seconds for a 3D SWI data set. While the CVS may occasionally be positive in the region of irreversible ischemic brain infarction, automatic quantitative CVS analysis showed no significant difference between paired vascular territories in the subacute stage after mechanical thrombectomy.

**References:** 1) Baik et al. Cerebrovascular Diseases, 2012      2) Frangi et al. LNCS, 1998