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Purpose: Watershed areas (WSAs) of the brain are most susceptible to acute hypoperfusion due to their peripheral location between vascular territories. Additionally, chronic WSA-related vascular processes underlie cognitive decline especially in patients with cerebral hemodynamic compromise. Despite of high relevance for both clinical diagnostics and research, individual in vivo WSA definition is fairly limited to date. Thus, this study proposes a standardized segmentation approach to delineate individual WSAs by use of time-to-peak (TTP) maps and investigates spatial variability of individual WSAs.

Methods: We defined individual watershed masks based on relative TTP increases in 30 healthy elderly persons and 28 patients with unilateral, high-grade carotid stenosis, being at risk for watershed-related hemodynamic impairment. Determined WSA location was confirmed by an arterial transit time atlas and individual super-selective arterial spin labeling. We compared spatial variability of WSA probability maps between groups and assessed TTP differences between hemispheres in individual and group-average watershed locations.

Results: Patients showed significantly higher spatial variability of WSAs than healthy controls. Perfusion on the side of the stenosis was delayed within individual watershed masks as compared to a watershed template derived from controls, being independent from the grade of the stenosis and collateralization status of the circle of Willis.

Conclusion: Results demonstrate feasibility of individual WSA delineation by TTP maps in healthy elderly and carotid stenosis patients. Data indicate necessity of individual segmentation approaches especially in patients with hemodynamic compromise to detect critical regions of impaired hemodynamics.
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