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Age-related Changes of Brain Perfusion by Arterial Spin Labeled MRI

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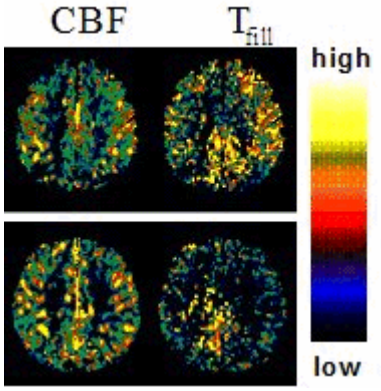
Background: It is generally accepted that normal aging is associated with decreased cerebral blood flow (CBF). However, whether reduced CBF is due to diminished demand (e.g. reduced neuronal activity) or due to reduced supply (e.g. reduced vascularity) has not been determined. To test if normal aging is associated with reduced capillary density we used arterial spin labeled (ASL) MRI, which employs endogenous arterial water as tracer for blood flow. Specifically, using dynamic measurements of perfusion, we studied the effect of age on transit times of labeled blood water. **Objective:** To characterize age-related changes of brain perfusion dynamics using ASL-MRI. **Methods:** Eleven normal subjects, between 29 and 88 years old were studied with pulsed ASL-MRI. To measure perfusion dynamics, 16 perfusion-weighted image frames (3×3 mm^2 inplane and 8mm slice thickness) were acquired by increasing the post-labeling delay from 200ms to 2000ms. Perfusion weighted images were registered to T1-weighted structural MRI data to measure perfusion separately in gray matter and white matter. The perfusion data were fit to a kinetic model to estimate CBF with considerations of capillary filling time, variable arterial transit times, and bolus durations. **Results:** The figure shows representative parametric maps of CBF and filling time (T_{fill}) from an 80-year-old (top) and a 33-year-old subject (bottom), indicating prolonged filling time and decreased CBF in the 80-year-old subject. Globally, filling time increased with age ($r = 0.71$, $p < 0.02$), as hypothesized. In contrast, the other vascular factors arterial transit time and bolus duration were not significantly associated with age. Furthermore, CBF decreased with age ($r = -0.25$, $p > 0.1$) independent of vascular factors, albeit the correlation did not reach significance.



Conclusions: A strong correlation between prolonged filling time and increasing age is consistent with pathological studies that brain microvasculature is altered with normal aging. Quantitative studies of CBF should therefore account for age-related alterations of brain microvasculature, because these vascular effects could mimic reduction of blood flow. Furthermore, prolonged filling time could also be an important physiological variable to study

changes of brain vascularity in Alzheimer's disease and the confounding effects of cerebrovalscular disease.