

Preoperative cerebral oxygen extraction fraction imaging generated from 7-tesla magnetic resonance quantitative susceptibility mapping predicts development of cerebral hyperperfusion following carotid endarterectomy

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Abstract

BACKGROUND AND PURPOSE: Preoperative hemodynamic impairment in the affected cerebral hemisphere is associated with the development of cerebral hyperperfusion following carotid endarterectomy (CEA). Cerebral oxygen extraction fraction (OEF) images generated from 7T magnetic resonance (MR) quantitative susceptibility mapping (QSM) correlate with OEF images on positron emission tomography. The present study aimed to determine whether preoperative OEF imaging generated from 7T MR QSM could identify patients at risk for cerebral hyperperfusion following CEA.

METHODS: Seventy-seven patients with unilateral internal carotid artery stenosis ($\geq 70\%$) underwent preoperative three-dimensional T2*-weighted imaging using a multiple dipole-inversion algorithm with a 7T MR imager. QSM images were then obtained, and OEF maps were generated. Quantitative brain perfusion single-photon emission computed tomography (SPECT) was also performed before and immediately after CEA. Regions of interest (ROIs) were automatically placed in the bilateral middle cerebral artery territories using a three-dimensional stereotaxic ROI template, and affected-to-contralateral ratios in the ROIs were calculated on QSM-OEF images.

RESULTS: Ten patients (13%) showed post-CEA hyperperfusion (cerebral blood flow increase $\geq 100\%$ compared with preoperative values in the ROIs on brain perfusion SPECT). Multivariate analysis showed that a high QSM-OEF ratio was significantly associated with the development of post-CEA hyperperfusion (95% confidence interval (CI), 33.5 to 249.7; $p=0.0019$). Sensitivity, specificity, and positive- and negative-predictive values of the QSM-OEF ratio for the prediction of the development of post-CEA hyperperfusion were 90%, 84%, 45%, and 98%, respectively.

CONCLUSION: Preoperative OEF imaging generated from 7T MR QSM identifies patients at risk for cerebral hyperperfusion following CEA.