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SY09-3

Dynamic BOLD-DSC Perfusion MRI Enables Monitoring of Ischemic Progression and Differentiation of Stroke Outcomes

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Background: Despite advances in acute stroke management, ischemic stroke remains a leading cause of mortality and long-term disability worldwide. Current perfusion imaging primarily characterizes the magnitude of cerebral blood flow (CBF) and cerebral blood volume (CBV) but provides limited information about the temporal dynamics of microvascular perfusion. Emerging evidence suggests that these dynamic perfusion characteristics may better reflect microvascular dysfunction and improve identification of salvageable tissue.

Purpose: We hypothesized that temporal perfusion metrics derived from blood oxygenation level-dependent dynamic susceptibility contrast (BOLD-DSC) MRI would improve characterization of the ischemic penumbra and provide early prediction of tissue fate beyond conventional perfusion measurements.

Methods: Longitudinal BOLD-DSC MRI was performed in transient middle cerebral artery occlusion (tMCAO) rat models with 90- and 120-min occlusion durations. Imaging was acquired at baseline, throughout arterial occlusion, repeatedly during the first 4 h after reperfusion, and again at 24 h. In addition to conventional perfusion metrics, temporal parameters describing contrast arrival and washout kinetics were quantified to assess microvascular function. These dynamic biomarkers were evaluated for their ability to differentiate tissue subtypes, compare different ischemic severities, and predict tissue outcomes. Within the 120-min occlusion group, temporal perfusion dynamics were further investigated to distinguish animals with survival and non-survival outcomes.

Conclusions: Longitudinal BOLD-DSC MRI enables simultaneous assessment of conventional perfusion and temporal hemodynamic dynamics. Time-resolved perfusion biomarkers have the potential to reveal microvascular dysfunction that is not captured by conventional perfusion imaging, thereby improving ischemic penumbra characterization and early prediction of tissue fate after stroke.

Keywords: *Ischemic stroke, BOLD-DSC, Dynamic biomarker, Penumbra, Tissue outcome*