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(G*) Low-Frequency Oscillations in Cerebral Microvascular Perfusion, Oxygenation, and Metabolism in Mild-Cognitive Impairment Patients

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Introduction: A promising approach for detecting early-stage mild cognitive impairment (MCI) is identifying changes in cerebrovascular regulation prior to overt changes in cognition. Low-frequency oscillations (LFO) in cerebral perfusion and oxygenation, originating from neurogenic and myogenic regulation of hemodynamics, may be altered in patients with MCI. Previous work has shown increased LFO in oxygenation of Alzheimer's and MCI patients compared to healthy, older adults. For this study, we hypothesized that MCI patients would exhibit increased power of LFO in cerebral (1) perfusion, (2) oxygenation, and (3) metabolic rate of oxygen (CMRO2) consumption.

Methods: 12 MCI (74 ± 6 years) and 8 cognitively intact control (CTL) participants (69 ± 7) were recruited. An in-house built diffuse correlation spectroscopy (DCS) and time-resolved near-infrared spectroscopy (trNIRS) system was used to record microvascular perfusion and oxygenation, respectively. Data were acquired from the forehead for 480 seconds during seated rest. DCS and trNIRS measurements were analyzed with custom scripts (MATLAB) to calculate relative changes in cerebral blood flow (rCBF), tissue oxygen saturation (StO2), and relative CMRO2 (rCMRO2). A continuous wavelet transform was used to decompose time courses into time-varying frequency components. The power of neurogenic (0.02-0.06 Hz) and myogenic (0.06-0.16 Hz) oscillations were isolated. Mann-Witney tests were used to compare MCI and CTL. Effect sizes are reported as Cohen's d.

Results: MCI patients had lower neurogenic power in rCBF ($p = 0.03$, $d = 0.89$) but greater myogenic power in StO2 ($p = 0.03$, $d=1.00$). Although not significant, this pattern remained for myogenic power in microvascular perfusion ($p = 0.09$, $d = 0.52$) and neurogenic power in StO2 ($p = 0.08$, $d=0.86$). There were no differences in neurogenic or myogenic LFO power for rCMRO2 (both $p \geq 0.3$, $d = 0.16$).

Discussion: Participants with MCI have lower oscillatory power in cerebral microvascular perfusion but greater power in cerebral oxygenation. Interestingly, these opposing responses counteract, resulting in similar metabolic oscillations which demonstrates potential adaptations that occur to support neural metabolism in people with MCI. Immediate future work will be to analyze macrovascular perfusion and blood pressure oscillations to understand systemic differences.

Keyword-1

Optical Spectroscopy

Keyword-2

Mild Cognitive Impairment

Keyword-3

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