Role of Otolith Inputs in Cerebral Blood Flow & Blood Pressure Regulation

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Assumption of the upright posture places the brain above the heart, causing a reduction in cerebral perfusion pressure due to hydrostatic pressure changes related to gravity. Since vestibular organs, specifically the otoliths, provide immediate feedback on position relative to gravity, vestibular inputs may assist in adaptation to the upright posture. The goal of this study was to examine the effect of direct vestibular stimulation using off vertical axis rotation (OVAR) on cerebral blood flow (CBF). During one session subjects were placed in a chair that was tilted 20° off-vertical and accelerated at 25°/s² to a constant velocity. Rotation occurred at three frequencies (0.03125, 0.125 and 0.5 Hz) and subjects heads were placed either forward, or turned 40° left or 40° right during each frequency. The purpose of changing head position relative to the body was to determine if changing otolith orientation relative to gravity would also shift the cerebral blood flow response, even though effects of centripetal acceleration on the body weren’t changed. During testing, CBF (transcranial Doppler), blood pressure (Finapres), and end tidal CO₂ (Puritan Bennet) were measured continuously. All rotations were done in the dark. Subjects demonstrated sinusoidal patterns of both cerebral blood flow (±2.6% at 0.5; ±8.8% at 0.125; ±8.7% at 0.03125 Hz) and blood pressure (±7.9 mmHg at 0.5; ±5.9 mmHg at 0.125; ±5.1 mmHg at 0.03125 Hz) that were related to the frequency of rotation. Turning subjects heads resulted in a phase shift in the associated CBF signal (42±29° at 0.5 Hz; 6±31° at 0.125 Hz; 52±20° at 0.03125 Hz). In contrast, oscillations in blood pressure were unaffected by head position. These data indicate that changing otolith position 40 degrees by head rotation resulted in a similar phase shift in CBF. The attenuated shift at 0.125 Hz may have been associated with the nauseogenic nature of the middle frequency disrupting normal vestibular inputs into CBF control. Since trunk position remained unchanged, these data suggest that oscillations in CBF associated with OVAR are primarily due to otolith stimulation. Supported by NIH NIDCD and NASA.

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