POSTURAL EFFECTS ON THE EYE AND EAR

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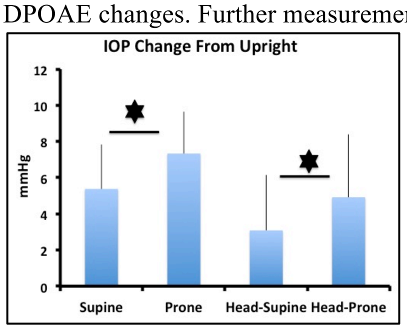
Background: Entrance into microgravity eliminates hydrostatic gradients compared to 1-G. In conjunction with developing a numerical model to predict ocular changes in microgravity, we are measuring changes in eye and ear parameters produced by changing hydrostatic gradients between the seated, supine and prone postures. In the eye, we hypothesize that intraocular pressure (IOP) and axial length will change based on the direction of the hydrostatic gradient. Also, since changes in distortion product otoacoustic emissions (DPOAE) are being studied as a method to assess both fluid shifts and changes in intracranial pressure, we are also studying the effects on various postures on DPOAEs. Since middle ear pressure changes can affect DPOAEs independent of alterations in intracranial pressure, we are also performing tympanometry.

Methods: Six subjects were placed in the following positions: seated upright, supine, prone, head-supine, and head-prone. IOP was determined using Perkins tonometry, tympanometry as used to measure middle ear parameters, and DPOAEs were assessed using level/phase mapping (DPOAE mapping) over a wide range of f2 frequencies and ratios. We also developed the capability to measure axial length in the supine and prone postures using was a Lenstar biometer. IOP and tympanometric peak pressure (TPP) were measured in all 5 positions. Due to technical constraints, axial length and DPOAEs were only measured in the first 3 positions in 2 subjects (5 measures per eye per position). Further measures are ongoing.

Results: IOP was position dependent. IOP increased in each position compared to seated upright ($p<0.05$). IOP in the prone position was significantly greater than in the supine position (15.6 ± 3.5 vs 13.6 ± 2.1 mmHg; $p = 0.02$, *left figure*), and the head-prone was greater than head-supine (13.2 ± 1.0 vs 11.3 ± 2.0 mmHg; $p = 0.04$). TPP was increased at all positions compared to upright, and that head-supine was greater than head-prone (22.7 ± 21.2 vs 6.3 ± 12.6 mmHg; $p = 0.003$). Preliminary axial length data showed a decrease in axial length in the supine and prone positions (*right figure*). Preliminary DPOAE mapping also showed a subtle change in emissions depending on posture (*bottom figure).* The maps provide a comprehensive picture of DPOAE changes with posture and offer a detailed way to assess cochlear changes from posture, which may reflect ICP changes.

Conclusions: Hydrostatic gradients affect the eye and need to be taken into account when modeling the effects of microgravity. Additionally, posture affects middle ear pressure, which needs to be considered when interpreting DPOAE changes. Further measurements are ongoing.



IOP changes from baseline (left), axial length changes from 2 subjects (right), DPOAE mapping (bottom)