Otolith Effect on Torsional Quick Phases of Vestibular Nystagmus in Humans

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The vestibulo-ocular reflex (VOR) ensures the stabilization of the foveal image during head movements. The VOR can be characterized by the gains in both the velocity (eye velocity divided by head velocity) and position (eye position divided by head position) domains. In the absence of quick phases, velocity and position gains are equivalent. Vestibular slow phases are usually interrupted by anticompensatory quick phases, which move the fovea away from the target in a direction opposite to the slow phase, thus reducing the position gain of the VOR. In the upright position, both semicircular canal and otolith organs contribute to the velocity gain of the torsional VOR. During this off-vertical axis rotation, the otoliths provide an additional positional signal as they sense the angle between the head and gravity vectors. This signal can be used to increase the position gain of the VOR by modifying the anticompensatory quick phases. A previous study has shown that, in humans, the otoliths decrease the frequency of quick phases during torsional oscillatory VOR stimulation. To investigate which parameters of the quick phases are influenced by the otoliths, we studied the torsional quick phases elicited during torsional whole-body position steps (amplitude 10°, peak acceleration of 90O/s^2) in the upright (with otolith input) and supine (without otolith input) body positions in healthy human subjects. Eye movements were recorded binocularly in three dimensions with dual search coils. The number of position steps that evoked quick phases was significantly greater in the supine (average: 14.2 ± 4.4 SD of 20 trials) than in the upright position (7.0 ± 5.3 of 20 trials). The latencies from the beginning of the turntable movement to the appearance of a quick phase were significantly shorter in the supine (181 ms ± 50.99) than in the upright position (250 ms ± 67.69). No significant differences were seen in the amplitude, duration, and peak velocity between the two body positions. However, a comparison of the main sequence of the torsional quick phases showed that the peak velocities relative to amplitudes were higher in the upright than in the supine position. These results indicate that the otoliths increase the positional stability of the eye-in-space during torsional head movements through two

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mechanisms: by inhibiting the generation of torsional quick phases and by modifying their dynamics.

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