Barbecue Whole-Body Position Modulates Cerebellar Downbeat Nystagmus

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Downbeat nystagmus is a frequent ocular motor sign in patients with lesions of the vestibulocerebellum.[1] Upward drift in cerebellar downbeat nystagmus is caused by two concurrent mechanisms[1,2]: (1) a gaze-evoked drift due to a leaky vertical neural integrator, and (2) an upward-directed velocity bias independent of vertical gaze eccentricity and already present with "gaze straight ahead." Recently, we have shown that the velocity bias, that is, the vertical drift in gaze straight ahead, consists of two components[3]: (1) a gravity-dependent component that sinusoidally modulates as a function of whole body position along the pitch plane, and (2) a gravity-independent component that is directed upward. The combination of these two components leads to an overall vertical drift that is minimal in supine and maximal in prone position. In the roll plane, however, no modulation of the vertical drift occurs; that is, the vertical velocity bias is approximately the same in upright and 90° ear-down body positions. Healthy subjects showed a similar sinusoidal modulation of the vertical drift velocity as a function of whole-body position, but in a scaled-down manner.

In upright and ear-down positions, the overall drift mainly consists of the gravity-independent component. In the supine position, the gravity-dependent component is directed downward and opposes the gravity-independent component, which is always directed upward. Thus, the overall vertical drift in both upright and ear-down positions is faster than in supine position. As a result, even though the gravity-dependent component modulates only along the pitch plane, changing whole-body position about the earth-horizontal yaw axis (barbecue rotation) should modulate downbeat nystagmus. Specifically, upward drift should be faster in the ear-down side positions than in the supine position.

FIGURE 1 confirms this hypothesis: vertical drift velocity during gaze straight ahead is plotted as a function of the angular whole-body position about the earth-horizontal yaw axis (barbecue position). In patients with cerebellar atrophy (left panel), the gravity-dependent component modulates sinusoidally and adds to a constant upward-directed, gravity-independent component. The overall drift is maximal in prone position and minimal in supine position, whereas in 90° side positions, the ve-

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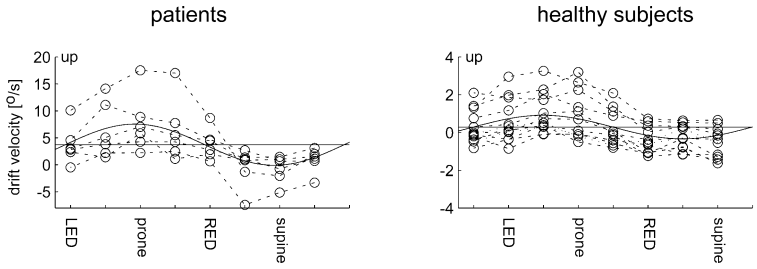

FIGURE 1. Vertical ocular drift velocity in gaze straight ahead as a function of whole-body angular position about the earth-horizontal yaw axis (barbecue position in 45° steps) and dual search coil recordings of right eyes. Median velocities of slow phases (*open circles* connected with dashed lines) are plotted for all subjects. First-harmonic sines (*solid lines*) were fitted through the pooled data. Offsets of sine fits are also indicated (*horizontal solid lines*). Note the different scaling of the ordinate in the two panels. *Left panel:* Patients with cerebellar downbeat nystagmus ($n = 6$). *Right panel:* Healthy subjects ($n = 12$).

locity of the overall drift is in between. In healthy subjects (right panel), there is no gravity-independent component, and thus the overall drift consists only of the gravity-dependent component. Therefore, the minimal overall drift is in the ear-down side positions.

At the bedside, it is not easy to observe downbeat nystagmus in prone position. In most cases, however, comparing the intensity of downbeat nystagmus between supine and ear-down side positions should be sufficient to demonstrate the influence of gravity on upward drift velocity. In patients with cerebellar atrophy, downbeat nystagmus increases when turning the head from supine position to the side.

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