Abnormal computerized dynamic posturography findings in dizzy patients with normal ENG results

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Abstract
The complexities of the balance system create difficulties for professionals interested in testing equilibrium function objectively. Traditionally, electronystagmography (ENG) has been used for this purpose, but it provides information on only a limited portion of the equilibrium system. Computerized dynamic posturography (CDP) is less specific than ENG, but it provides more global insight into a patient’s ability to maintain equilibrium under more challenging environmental circumstances. CDP also appears to be valuable in obtaining objective confirmation of an abnormality in some dizzy patients whose ENG findings are normal. Our review of 33 patients with normal ENG results and abnormal CDP findings suggests that posturography is useful for confirming or quantifying a balance abnormality in some patients whose complaints cannot be confirmed by other tests frequently used by otologists.

Introduction
Electronystagmography (ENG) has long been the gold standard for the evaluation of patients with complaints of dizziness and/or vertigo. For many years, ENG was the only objective means of assessing disorders of the balance system, and it is still used widely in clinical practice. However, its sensitivity and specificity are limited because ENG caloric testing provides (1) information primarily about the lateral semicircular canals, (2) less information regarding possible central pathology, and (3) limited insight into overall balance function.

Within the past 2 decades, another method of vestibular testing has become better understood. Computerized dynamic posturography (CDP) provides information on not only the vestibular system but on the multiple sensory systems that contribute to balance maintenance, as well. CDP can elicit information that is not detected by ENG. In this article, we review the abnormal CDP findings in 33 patients with complaints of disequilibrium whose findings on ENG caloric testing were normal.

Patients, methods, and findings
We retrospectively reviewed the records of 650 patients of the senior author (R.T.S.) who had been evaluated by CDP (EquiTest; NeuroCom International; Clackamas, Ore.) between 1993 and 1999. Among this group, 33 patients—16 men and 17 women, aged 31 to 82 years (mean: 52)—had normal ENG/caloric test results and abnormal CDP results. All of these patients had presented with dizziness and/or vertigo, and all had at least one other complaint: 23 patients (69.7%) complained of concomitant hearing loss, 22 (66.7%) complained of tinnitus, 11 (33.3%) complained of ear pain, 6 (18.2%) complained of headache, and 5 (15.2%) complained of aural fullness.

Balance testing. All 33 patients had undergone a comprehensive neurotologic assessment, including CDP, ENG, a sensory organization test (SOT), and a motor control test (MCT). The SOT measures the extent of a patient’s sway while he or she is standing on a force platform during six conditions (see “Components of the SOT”). Each patient underwent the SOT three times.

CDP results were considered to be abnormal if the composite equilibrium score on the SOT fell below the fifth percentile for that of an age-matched population of normal subjects. The composite equilibrium score was calculated by averaging the scores obtained during the three tests under condition 1 and again under condition 2, adding these two averages to the total of the equilibrium scores obtained during each of the three trials under conditions 3, 4, 5, and 6, and dividing the sum by 14.
The MCT has a latency component (small, medium, and large translations, forward and backward) and an adaptation component (rotation of the toes, up and down). MCT findings were considered to be abnormal if any score obtained during latency or adaptive testing fell outside the normal range, provided that examination of the raw latency data showed accurate take-off point identification.

ENG testing included calibration, identification of spontaneous nystagmus and gaze nystagmus, positional tests, Dix-Hallpike maneuvers (unless contraindicated because of neck pathology), sinusoidal tracking, optokinetic testing and, in selected patients, alternate binaural bithermal caloric testing (right warm [RW]; right cool [RC]; left warm [LW]; left cool [LC]). ENG calorics were considered to be normal if the unilateral weakness score was less than 20%. This score was calculated thusly:

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\text{unilateral weakness} = \frac{(RW + RC) - (LW + LC) \times 100}{(RW + RC + LW + LC)}
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In patients in whom alternate binaural bithermal testing was equivocal or the results were unexpected, simultaneous binaural bithermal caloric testing was also performed. For the purposes of this study, ENG results were considered to be abnormal if a patient exhibited any anomaly.

Other testing. In addition to ENG and CDP, all patients underwent an interview and examination by the senior author and a comprehensive neurotologic evaluation. The decision to order specific laboratory tests was based on the patient’s history, physical examination results, and audiometric findings.

Radiologic testing. In addition, 24 patients underwent imaging studies, including gadolinium-enhanced magnetic resonance imaging (MRI) in 20 patients, computed tomography (CT) in 15, Doppler ultrasonography in 5, magnetic resonance angiography (MRA) in 3, and single-photon emission computed tomography (SPECT) in 21. All 24 patients exhibited at least one imaging abnormality.

MRI. Of the 20 patients who underwent MRI, results were abnormal in 16. Of this group, 4 had cortical atrophy, 3 had an acoustic neuroma, 1 had an anteroinferior cerebellar artery vascular loop, 1 had a Chiari malformation, and the remaining 7 had changes consistent with small-vessel ischemic disease.

CT. Abnormal results were seen in 10 of the 15 patients who underwent CT. Most of these anomalies manifested as mild opacification in a few mastoid cells or as evidence of mastoid sclerosis without signs of active disease. None of these abnormalities was considered to be causally related to dizziness.

Doppler ultrasound. Abnormalities were seen in 2 of the 5 Doppler studies—significant carotid stenosis in 1 patient and hemodynamically insignificant stenosis in another.

MRA. All 3 patients who underwent MRA exhibited an abnormality. One patient had an anteroinferior cerebellar artery vascular loop, 1 had carotid stenosis, and 1 had small-vessel changes.

SPECT. Of the 21 SPECT studies, 16 were abnormal; all showed areas of hypoperfusion. These 16 patients included the 16 who had an abnormal MRI, all 10 who had an abnormal CT, the 2 who had an abnormal Doppler scan, and 2 of the 3 patients who had an abnormal MRA.

Discussion

In a dizzy patient, an ENG finding of unidirectional nystagmus and abnormal calorics suggests a peripheral pathway disturbance in, for example, the VIIIth cranial nerve or an end organ. The most significant and diagnostically useful aspect of ENG is that it lateralizes vestibular pathology. The disadvantage of ENG is that it evaluates primarily the function of the lateral semicircular canals.

Dating back to 1853, many authors have attempted to quantify postural control (i.e., the ability to maintain one’s balance) in patients with vertigo. All concluded that postural control is affected by vestibular, visual, and...
proprioceptive inputs. Posturography was designed to determine whether a patient’s balance system is disturbed during standing, a position that requires coordination of the sensory inputs from the vestibular, visual, and proprioceptive systems. 16-19

CDP, which became commercially available in 1986, was designed to evaluate a patient’s postural control in two ways—via the SOT and the MCT. The clinical value of CDP in relation to ENG for the evaluation of patients with dizziness and/or vertigo has been the subject of close scrutiny. 11,20-23

Goebel and Paige used both ENG calorics and CDP to evaluate 159 dizzy patients with and without complaints of vertigo. 12 They reported that (1) caloric testing was more likely to be abnormal in patients with vertigo and (2) CDP could demonstrate a posturographic disturbance but could not distinguish among dizzy patients with and without vertigo. They also identified patients with abnormal postural control despite normal caloric testing. In another study, Lipp and Longridge compared the results of CDP and ENG in 375 patients. 19 They reported that CDP findings were abnormal in approximately 40% of patients who had normal ENG/caloric test results and no clearly defined central or peripheral cause of their dizziness and/or imbalance. Only 10% of dizzy patients with normal ENG results had an abnormal ENG caloric test. Finally, Goebel et al demonstrated that CDP can help distinguish between organic and nonorganic (e.g., malingering or hysteria) balance complaints. 24

One criticism of CDP concerns its inability to localize and identify pathology specific to central or peripheral causes. Nevertheless, CDP does measure postural control under various somatosensory and visual conditions, which ENG does not assess. Voorhees noted that CDP has only a limited capability to distinguish between central and peripheral abnormalities, but it does help determine the functional level of a patient’s balance. 6 Overall, most authors agree that CDP and ENG provide different but complementary information and that neither should be used as the sole modality in the evaluation of dizzy patients. 11-13

The findings of our study, despite the small sample size, emphasize the value of CDP in helping to confirm the presence of abnormalities in selected patients with imbalance whose ENG results are normal. CDP is also valuable for assessing patients in whom it is impossible to confirm or quantify a balance abnormality through conventional techniques such as ENG. This is especially true for patients whose ability to work may be affected by dizziness; these patients might be denied job modifications, disability compensation or, most important, appropriate medical evaluation and treatment if their balance dysfunction cannot be confirmed.

References


