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Common Misconceptions about ENG

(Electronystagmography)

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Electronystagmography (ENG) has been the cornerstone of vestibular testing for more than fifty years. Yet there is some confusion about the extent and limitations of the information that can be obtained from an ENG examination. It is essential that the results be used in the context of the patient's history and medical examination. This article reviews some of the possible "misses" that can occur when a more comprehensive evaluation is not made available to those with a normal ENG exam.

ENG refers to a battery of tests that examine specific aspects of the vestibular system. This battery consists of oculomotor tests, positioning and positional tests, and the caloric test.

Oculomotor tests involve evaluating the efficiency of voluntary eye movements that are modulated by the cerebellum, a part of the brain responsible for balance and coordination. Oculomotor tests are used primarily to screen for central nervous system (CNS) disorders. This portion of the ENG, along with inspection for spontaneous and gaze nystagmus (abnormal rhythmic eye movement), is usually performed prior to any tests of labyrinthine (inner ear) function, because oculomotor abnormalities can affect the validity of subsequent vestibular tests.

Positioning and positional tests are performed to determine whether the vestibular system responds normally and symmetrically to changes in head position. Benign paroxysmal positional vertigo (BPPV), one of the most common vestibular pathologies, can often be diagnosed by the positioning test.

Caloric testing looks for the presence and symmetry of vestibular responsiveness (nystagmus) to stimulation by temperature change. This test evaluates the right-side and left-side vestibular apparatus (labyrinth and vestibular nerve) separately, one at a time. This is most commonly done by irrigating the ear canal with a stream of water that is seven degrees above or below body temperature. The resulting change in the temperature and density of the inner ear fluid (endolymph) causes the test ear to generate a sensation of motion. But because that motion is not detected by the non-test ear, a sudden asymmetry exists. This results in subjective vertigo and recordable nystagmus in most cases.

Clearly, ENG is a critical element of the examination of vestibular function, and many vestibular abnormalities can be diagnosed within the constraints of this standard test battery. However, in many

cases, ENG alone is unable to detect vestibular-function abnormalities. This means that when a diagnosis is made based only on the information obtained from the ENG battery, many treatable patients will be incorrectly told that they have normal vestibular function and that their dizziness is not the result of an inner ear problem. Recent studies (see sidebar on page 3) indicate that up to half of patients with normal ENG exams may have been incorrectly given a clean bill of vestibular health.

Failure to diagnose a vestibular pathology can lead to increased health care costs

Failure to diagnose a vestibular pathology can lead to increased health care costs as the patient, convinced that the inner ear has been ruled out, continues to seek diagnosis from other specialists. This is likely to lead to frustration and even depression, as untreated inner ear problems have been shown to have a significant impact on quality of life. Considering that only a small percentage of patients complaining of dizziness are referred for specialist evaluation, the importance of accurate and sensitive evaluation at the specialist level cannot be overstated.

Finding BPPV with repeat testing

There is very little literature addressing the issue of BPPV that is inactive at the time of exam (for two studies, see Desmond 2002 and Norre 1994).[1, 2] BPPV is by far the most common cause of episodic vertigo, and it can be successfully treated in one or two office visits approximately 90% of the time. Yet in our clinic, we find that in almost 40% of patients complaining of positional vertigo, BPPV is not detected through positional testing upon initial exam. In order to address this observation, in 2001 we asked a group of these patients to return for repeat positional testing a few days after the first test. We instructed them to avoid any provoking movements for several hours prior to the additional examination. On repeat testing, 40% (10 of 25) had a positive positioning test, allowing us to make a clear diagnosis of BPPV.[1] Since then, when a person complaining of positional vertigo has negative exam results, including a normal ENG, we start them on a home program of exercises known to speed up resolution of BPPV. We have found that more than 90% of patients then have resolution of their symptoms within two weeks, as opposed to the typical duration of several weeks for untreated BPPV.

Testing the VOR

The vestibular-ocular reflex (VOR) can be defined as reflexive eye movement in response to head movement. This very important reflex allows for a stable gaze (clear, focused vision) while the head is moving.

Within the ENG battery, caloric testing stimulates the labyrinth at a level comparable to head movements at very low speeds (about .003 to .005 Hz) but not head speeds encountered during typical movements in day-to-day activities, which are estimated to be .5 to 5 Hz. Measurements of these higher head-movement speeds can be made with rotational testing.

Two techniques of rotational testing are commercially available. *Rotational chair* (RC) is a passive test; the patient sits in a motor-controlled chair that moves at speeds typically from .01 to .64 Hz. *Active head rotation* (AHR) involves having the patient voluntarily move the head back and forth at a speed of 1 Hz and up to as fast as the patient can manage.

RC is considered the "gold standard" for evaluating the VOR, has good test-retest reliability, and has been the subject of much research. In the United States, AHR is used in more clinics than is RC (most likely because the equipment is less expensive), and it simulates the condition (rapid head movement) most likely to elicit a complaint from a patient with vestibular dysfunction. Some vestibular specialists consider AHR experimental and are critical of its test-retest reliability.[3] Regardless of test technique, however, rotational tests consistently demonstrate better sensitivity than ENG for detecting chronic vestibular pathology (see sidebar).

Rotational test results may be important in designing a customized vestibular rehabilitation program. For example, bilaterally absent caloric responses with ENG might be misinterpreted as an absence of vestibular function if higher-frequency rotational tests are not performed. (Goebel and Rowdon [1992] report that two-thirds of a group of 34 patients exhibiting bilaterally reduced caloric responses had normal gain of the VOR at .5 Hz.)[4] This type of information is critical, because therapy for patients with total loss of vestibular function differs from therapy for those with residual vestibular function.

The ENG in treatment planning

Vestibular rehabilitation (VR) has gained popularity in the past decade and has been shown to be an effective treatment for uncompensated vestibular dysfunction. The ENG battery, however, provides no information that can be used to determine candidacy for, or benefit from, VR.

As noted above, the oculomotor portion of the ENG is primarily a test of cerebellar function. Patients with dizziness of CNS origin might benefit from VR, but the prognosis is unpredictable. Patients with spontaneous nystagmus of labyrinthine origin are not necessarily candidates for VR, as exercise has not been shown to increase recovery from tonic vestibular asymmetry (although many of these patients will develop a reduction in VOR gain and may be candidates for VR, this is not detected on ENG testing). The most commonly detected abnormality on positioning tests (BPPV) is treated with canalith repositioning maneuvers, not with ongoing VR. A caloric asymmetry can exist in a well-compensated vestibular injury. A documented unilateral weakness does not necessarily indicate that a patient will benefit from VR, and a caloric weakness will not diminish as a result of VR.

Conclusion

The ENG battery is a necessary part of the workup for diagnosing vestibular disorders, but the information obtained must be put in the context of the patient's complaints. Unless the ENG yields an answer to the question "Why am I dizzy?" additional studies are indicated. To say that there is no vestibular problem based on normal ENG

findings would be equivalent to saying your keys are not in your house because you didn't find them on the kitchen counter. Normal ENG results do not necessarily mean an absence of vestibular abnormalities!

Sensitivity of ENG and rotational tests in detecting chronic vestibular pathology

Shepard and Telian (1996) report on a group of 2,266 patients undergoing vestibular evaluation at the University of Michigan. Sixteen percent of those patients had normal ENG examinations. But "among those with normal ENG results, RC indicated abnormalities suggesting peripheral system pathology in 80% of cases."[5] Jacobson (2002) performed comprehensive vestibular evaluation on a series of patients complaining of postural and/or gait instability. He found abnormalities on the caloric exam in only 25% of patients, while RC abnormalities were identified in 56%.[6]

More recently, Arriaga, Chen, and Cenci (2004) presented data (as yet unpublished) exploring the sensitivity and specificity of ENG versus RC testing on a series of 1,000 patients.[7] Their results are strikingly similar to Jacobson's, in that 29% had abnormal ENG and 56% had abnormal RC tests. They calculate that RC has a sensitivity of 71% for detecting vestibular pathology, as opposed to 31% for ENG testing. Because ENG has a substantially higher specificity than RC, they recommend using RC as a primary vestibular test and ENG as a confirmatory test.

Active head-rotation testing has been shown to be significantly more sensitive than ENG in detecting abnormalities in patients reporting balance disorders. Saddat et al. (1995) performed both caloric testing and AHR on 39 patients complaining of balance disorders. Of this group, 24 had abnormal caloric studies, but 37 had abnormal AHR tests. In the same study, the researchers found that four of ten patients with confirmed acoustic neuroma (a benign tumor of the auditory nerve) had normal caloric studies, but all ten had abnormal AHR tests.[8]

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