



## Diagnostic Tests for Vestibular Problems

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The inner ear's vestibular organs and the associated nerves and brain centers form a complex system that serves many functions and can be affected by a number of outside systems. A thorough evaluation of the inner ear may therefore require several different kinds of tests. Doctors use information from a person's medical history and findings from a physical examination as a basis for ordering diagnostic tests to assess the vestibular system function and to rule out alternative causes of symptoms. Most people tolerate these tests well. However, sometimes the tests are fatiguing and can result in temporary unsteadiness.

### TESTING VESTIBULAR DYSFUNCTION

The vestibular and visual systems are connected to each other and to the muscles in the eyes and neck that help maintain good balance. Head movements or other stimulation of the inner ear sends signals through the nervous system to control eye muscle movements. This forms a reflex pathway called the *vestibulo-ocular reflex*, or VOR. This system is designed to generate eye movements that maintain clear vision when the head is in motion. Many vestibular tests use equipment to monitor the eyes for normal and abnormal movements when the vestibular system is stimulated.

### ELECTRO/VIDEO-NYSTAGMOGRAPHY (ENG OR VNG)

Electronystagmography (ENG) refers to a group of tests or *test battery*, and uses small electrodes placed over the skin around the eyes during testing. Videonystagmography (VNG) refers to the same test battery run using goggles with video cameras to monitor the eyes. Both the video cameras and the electrodes can measure eye movements to evaluate signs of vestibular dysfunction or neurological problems. Generally these tests are performed in a room that is dark or with low lighting. The examiner asks random questions that are meant to occupy the person being tested and keep them alert. ENG/VNG tests are the most common set of tests administered to people with dizziness, vertigo, and/ or imbalance.

Parts of the ENG/VNG test battery evaluate the movement of the eyes as they follow different visual targets. Other parts of the ENG/VNG observe eye movements as the head is placed in different positions. A third component of the ENG/VNG is called the *caloric test*, which uses changes in temperature within the ear canal to stimulate part of the vestibular system. Air or water may be used to modulate the ear canal temperature, which may be warmer or cooler than body temperature. This test should provoke jerking eye movements (*nystagmus*) for a short time.

### ROTATION TESTS

Rotation tests are another way of evaluating how well the eyes and inner ear work together. These tests also use

video goggles or electrodes to monitor eye movements. The head is rotated side to side at moderate or slow speeds, and associated eye movements are analyzed. Like the ENG/VNG, rotation tests are performed in a room that is dark with the examiner asking random questions during testing. Rotation tests provide information beyond the ENG/ VNG about how well the balance organs are functioning. Not all people in the diagnosis phase will require rotation tests.

There are different kinds of rotation tests: auto head rotation, computerized rotary chair, or a screening test. In auto head rotation, the person being tested is asked to look at a fixed target and move his/her head back and forth or up and down for short periods of time. During computerized rotary chair tests, the patient sits in a motorized chair that swivels side to side at a controlled rate. Screenings can be performed with the examiner watching the eyes while turning the subject side to side in a swivel chair.

## **VIDEO HEAD IMPULSE TESTING (VHIT)**

vHIT also evaluates how well the eyes and inner ears work together. A small set of glasses with a camera are used to monitor eye movements. The vHIT is similar to rotational testing, where the head is moved to evaluate the *vestibulo-ocular reflex*. However, the vHIT test uses very small and quick movements of the head to evaluate reflex function, as opposed to the slow or moderate speeds used in rotation testing. Not all people in the diagnosis phase will require vHIT tests.

## **VESTIBULAR EVOKED MYOGENIC POTENTIAL (VEMP)**

VEMP testing is used to evaluate whether certain vestibular organs and associated nerves are intact and functioning normally. Responses in this test are measured from different muscles in the neck and around the eyes. VEMP testing uses adhesive, skin surface electrodes (like ENG or some rotational tests) and earphones (like those used during a hearing test). Sound is played for a few seconds through the earphones, the vestibular organs are stimulated and activate muscle responses, and electrodes record the results.

## **COMPUTERIZED DYNAMIC POSTUROGRAPHY (CDP)**

CDP tests postural stability or the ability to maintain upright posture in different environmental conditions. Maintenance of postural stability depends on sensory information from: the body's muscles/joints, eyes, and inner ears. This testing investigates relationships among these three sensory systems and records the balance and posture adjustments made when different challenges are presented. This test may also be used in a rehabilitative setting after a diagnosis has been determined, and is not performed on all people in the diagnosis phase.

CDP tests involve standing still on a platform. The platform may be still or able to shift, or a visual target may be still or able to move during testing. Pressure gauges under the platform record shifts in body weight (body sway) as the person being tested maintains balance under different conditions. A safety harness is worn as a precaution, should the patient lose their balance.

## **AUDIOMETRY (HEARING TESTS)**

Audiometry measures hearing function. Hearing evaluations are an important part

of vestibular diagnostics, because the inner ear contains both hearing and balance organs. More than one hearing test may be required when a person has a vestibular disorder, especially when there is evidence of hearing loss, a sensation of fullness in the ears, or tinnitus (ringing or noise in the ears).

The audiometric test battery is carried out in a sound-treated room. Earphones are used to present words and tones at different pitches and levels. A response is requested when these sounds are heard. Testing with words may include repeating words in a quiet room or when noise is playing.

Another part of a standard hearing test is *tympanometry*, which can help detect problems between the ear drum and the inner ear. Tympanometry uses a small earpiece that creates pressure and plays sound in the ear canal to gather information. The same equipment can also be used for *acoustic-reflex testing*, which measures the reflex of muscles in the middle ear in response to pressure and loud sound.

### **OTOACOUSTIC EMISSIONS (OAE)**

OAE testing provides information about how the hair cells of the cochlea are working by measuring the responsiveness of hair cells to a series of clicks produced by a tiny speaker inserted into the ear canal. Most often this test is used to evaluate hearing for people who are unable to respond to a traditional hearing test (such as infants).

### **ELECTROCOCHLEOGRAPHY (ECoG)**

ECoG measures a response to sound from the nervous system. It utilizes an earphone and electrodes while the person being tested lays still in a comfortable

position. Not all people in the diagnosis phase will need ECoG tests.

An earphone plays sound in the ear and an electrode measures a response. Different electrodes can be used in this test. Some may be adhesive, skin-surface electrodes. Others may fit in the ear canal like an earphone, while a third type of electrode is designed to gently rest against or touch the eardrum. A fourth type of electrode is a needle that is placed through the eardrum to touch the inner ear. Most clinics use the first three types of electrodes to measure an electrical signal while sound is playing.

### **AUDITORY BRAINSTEM RESPONSE TEST (ABR; OR BER, BSER, OR BAER)**

The ABR measures how the nervous system responds to sound. The test setup and procedure is similar to the ECoG. Most often ABR is used to test hearing for people who are unable to respond for *audiometry* (such as infants). Occasionally this test is used when someone cannot have imaging performed (such as people with a metal plate in the body/brain).

Under certain circumstances, this test can indicate the presence of an acoustic neuroma (a rare, benign tumor of the vestibulo-cochlear nerve). It may also help identify conditions such as multiple sclerosis if they have affected the auditory pathway to the brain.

### **MAGNETIC RESONANCE IMAGING (MRI)**

MRI uses a magnetic field and radio waves to produce cross-sectional images of body tissues being scanned. An MRI of the brain can reveal the presence of tumors, stroke damage, and other soft-tissue abnormalities that might cause

dizziness or vertigo. MRIs of structures in and around the inner ear can be helpful in the diagnosis of some vestibular disorders.

## COMPUTERIZED AXIAL TOMOGRAPHY (CAT, OR CT)

A CT scan is an X-ray technique that is best for studying bony structures. The inner ear is inside of the skull's temporal bone on each side. These scans are often used to look for abnormalities around the inner ear, such as fractures or areas with thinning bone.

## OTHER TESTS

Depending on your circumstances, other tests may be necessary to discover the cause of a balance disorder. Blood work, allergy tests, vision tests, and other exams may help rule out causes of imbalance that are unrelated to the vestibular system.

## WHO PERFORMS VESTIBULAR TESTING?

Generally your primary care physician, ENT or neurologist will refer you to: an audiologist for hearing or balance related testing, a physical therapist for gait or balance related testing, or a radiologist for imaging testing. These specialists will send your test results back to your physician with an analysis, and your physician will explain them to you.

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